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DEPARTMENT OF NATIONAL DEVELOPMENT

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THE IGNEOUS AND METAMORPHIC ROCKS OF THE SOUTHERN PART OF CAPE YORK PENINSULA, QUEENSLAND.

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SUMMARY

A belt of igneous and metamorphic rocks 300 miles long and up to 40 miles wide forms the backbone of Cape York Peninsula, which is otherwise composed of soft Mesozoic and younger sediments. In 1966 a combined party from the Bureau of Mineral Resources and the Geological Survey of Queensland mapped the southern half of this belt, including the Yambo inlier, which is separated from the south end of the main belt by Mesozoic sandstone, a few miles across.

The Dargalong Metamorphics exclusively form the metamorphic rocks of the Yambo inlier, and form scattered outcrops in the main belt. Within these metamorphics, the Arkara-type gneiss is made up predominantly of biotite-quartz-feldspar gneiss with bands of amphibolite and bands of quartzite. The Arkara-type gneiss grades into the Pombete-type schist, composed of muscovite-quartz schist and muscovite-biotite-quartz-feldspar schist. Both these units contain scattered outcrops of the Saraga-type schist, a very distinctive unit composed of muscovite-quartz schist alternating with quartzite; much of the muscovite forms pseudomorphs after sillimanite.

In the main belt the bulk of the metamorphic rocks have been grouped in the Holroyd Metamorphics. In these the Kalkah-type schist is muscovite-biotite-feldspar-quartz schist and muscovite-quartz schist, similar to the Pombete-type schist, and grades into the widespread Lukin-type schist, a low-grade fine-grained muscovite-quartz schist with abundant graphite in places. Thick bands of greenschist and quartzite are locally prominent in the Lukin-type schist. Closely associated with the Lukin-type schist are the Pretender-type schist and the Pollappa-type schist.

The metamorphic rocks mostly represent fine-grained clastic sediments with beds of arenite in places. Amphibolite and greenschist mainly represent eruptive or minor intrusive basic igneous rocks; some may be metamorphosed impure limestone or dolomite.

A large batholith makes up a great part of the outcrop in both the Yambo inlier and the main belt. Its main constituent is the Kintore Adamellite, a medium-grained, even-grained biotite-muscovite adamellite

including a scattered muscovite-granite phase. The Aralba Adamellite, a discrete phase of the Kintore Adamellite, is a biotite-muscovite rocks with a much higher proportion of muscovite than the Kintore Adamellite. Another discrete phase, the Lankelly Adamellite, is a porphyritic biotite adamellite. The Flyspeck Granodiorite is also emplaced in the batholith. It is dominantly composed of biotite granodiorite, with abundant hornblende- biotite tonalite.

Basic dykes intrude metamorphic rocks in the Yambo inlier, and acid dykes intrude adamellite in the main belt. Acid dykes are associated with the Upper Permian Nychum Volcanics in the Yambo Inlier, and similar intrusions pierce the adamellite in the main belt. A single plug of olivine nephelinite in the metamorphics is probably a Tertiary intrusion.

The Mesozoic sediments are composed of a basal freshwater sandstone and conglomerate, the Wrotham Park Sandstone, succeeded unconformably by marine(?) siltstone and mudstone of the Blackdown Formation. Cainozoic sediments include the poorly consolidated sandstone of the Lilyvale Beds, and unconsolidated residual, alluvial, and beach deposits.

In the metamorphic rocks a marked axial-plane foliation generally strikes northwards and dips steeply, except where deformed by the intrusion of the granitic rocks. The contacts of the granitic rocks also appear to dip steeply, and the trend of the batholith parallels the regional trend of foliation. Shearing in the granitic rocks trends roughly north, as does the Palmerville Fault, which probably bounds the eastern side of the belt.

The axial-plane foliation was presumably imposed at the time of the regional metamorphism. This was closely followed or even accompanied by an episode of thermal metamorphism in which spotted schist and andalusite-bearing schist were crystallized in the Holroyd Metamorphics, without significant deformation. The thermal episode in turn may be correlated with the emplacement of the batholith.

The batholith is probably no younger than Devonian. The Dargalong Metamorphics are almost certainly Precambrian.

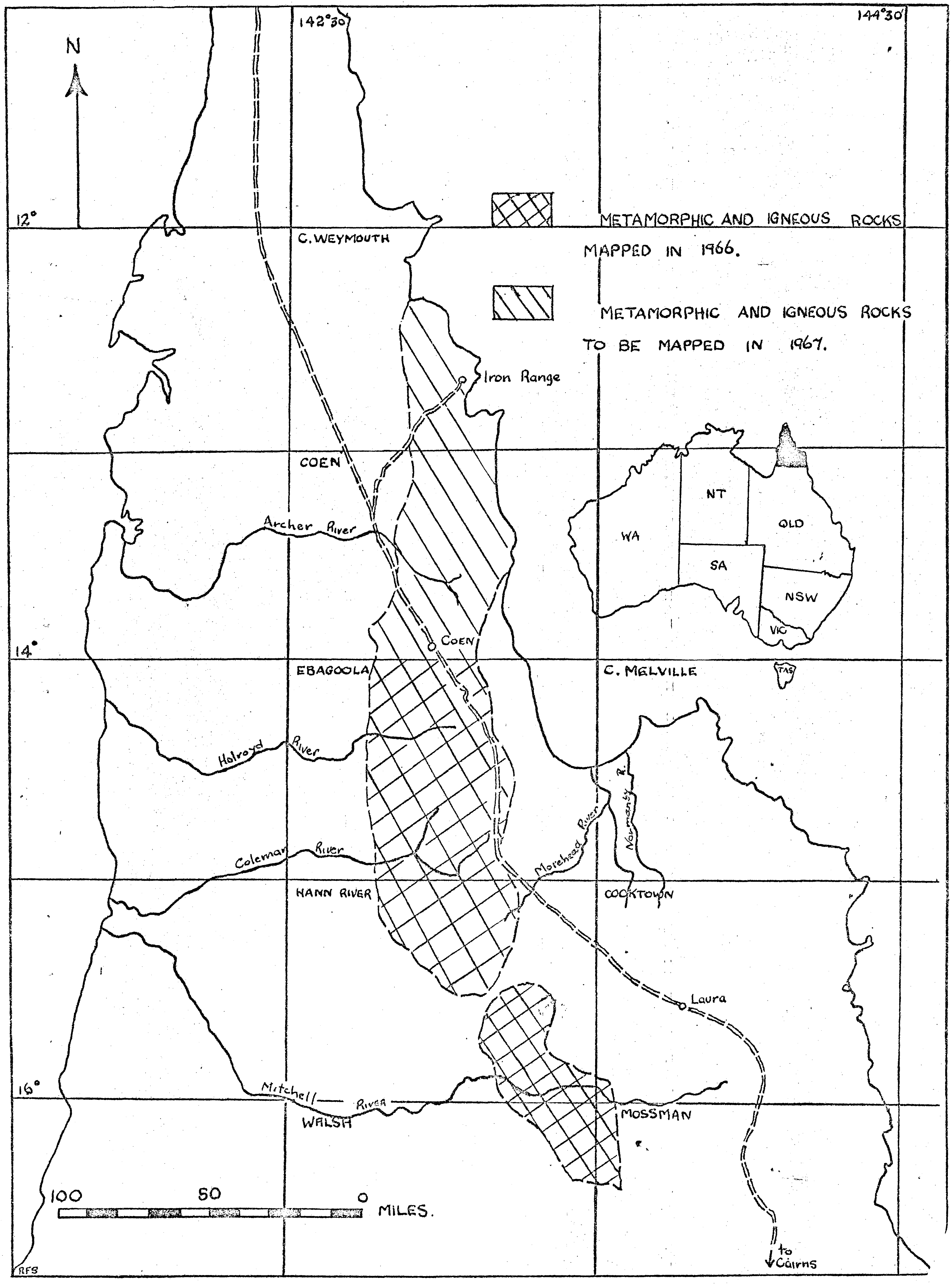

Fig. 1. LOCALITY MAP, METAMORPHIC AND IGNEOUS ROCKS OF CAPE YORK PENINSULA.

The Palmerville Fault has controlled later sedimentation in the Laura Basin along the eastern side of the belt. Sediments west of the belt have been deposited in the shallow, epeiric Carpentaria Basin.

Around the turn of the century gold was produced from alluvial workings and reefs in adamellite at the Alice River and in metamorphics at Potallah Creek and Ebagoola. Alluvial gold was obtained from the Palmer River, within the Yambo inlier. All mining has ceased. A small deposit of mica and minor concentrations of antimony, graphite, and heavy minerals in river sands have been reported. Petroleum is not likely to be present in large amounts in sediments bounding the belt. Surface water could be conserved and underground water exploited in places.

INTRODUCTION

This report describes the preliminary results of 1:250,000 scale mapping of the metamorphic and igneous rocks in the Walsh, Hann River, and Ebagoola Sheet areas in the southern part of Cape York Peninsula (Fig. 1). The mapping was carried out between May and October, 1966, by a combined party from the Bureau of Mineral Resources and the Geological Survey of Queensland, which comprised five geologists (D.S. Trail, I.R. Pontifex, W.D. Palfreyman, and W.F. Willmott - B.M.R., and W.G. Whitaker - G.S.Q.), supported by five field assistants, a camp manager, a mechanic, a cook, and a draftsman.

In 1967 the combined party will go on to map the igneous and metamorphic rocks through the Coen and Cape Weymouth 1:250,000 sheet areas, to their termination in the sea. After this, a report on the results of the two-year survey will be produced for publication.

The area mapped in 1966 forms roughly the southern half of a belt of igneous and metamorphic rocks up to 40 miles across, which runs northwards from the Mitchell River (latitude 16° 30'S) for 300 miles to enter the sea north of the Pascoe River (latitude 12° 30'S). This belt forms the backbone of the Cape York Peninsula, which is otherwise composed of relatively soft, Mesozoic and younger sediments.

The south end of the belt is a sub-circular area 30 miles across, isolated by younger sediments. It has been named the Yambo inlier, following White's (1961) usage in naming the Georgetown Inlier, and it appears to be a continuation of the outcrop of the Dargalong Metamorphics exposed near Chillagoe.

The main access road is the Peninsula Development Road which connects Coen in the north with Cairns and Cooktown. It is a broad, partly formed and graded dirt road which crosses the north-east corner of the Hann River Sheet area and runs north through the Ebagoola Sheet area (Fig. 1). A few dirt tracks branch east and west from this road and run beyond the limits of the area, and a rough track follows a telegraph line south from the Peninsula Development Road to the Palmer and Mitchell Rivers. The Mitchell River is most conveniently approached by a well formed dirt road through Chillagoe, from Mareeba.

Most of the country is covered by low and sparse eucalypt forest, which is dense enough to hinder overland travel by Land Rover. Incised creeks with soft sandy beds are also formidable obstacles to motor vehicles.

A DC3 aircraft calls twice weekly at the large grass airstrip 15 miles north of Coen. Many stations have small grass airstrips and light aircraft provide a weekly mail service to some of these. The population of the area is thinly spread and is almost entirely engaged in raising beef cattle.

Early in the dry season waterholes are abundant, but they dry up rapidly within the outcrop of the igneous and metamorphic rocks, and permanent surface water is then effectively confined to the surrounding soft sediments.

Exposure of the metamorphic and igneous rocks is generally poor. Geological information was obtained by making numerous traverses by Land Rover to identify and delineate units discerned on air photographs. Geology was plotted on photo-scale maps (some at 1:50,000, some at 1:80,000) made by the Royal Australian Survey Corps from air photographs taken by Adastra Airways Pty Ltd. As the photographs used were taken up to 11 years before the survey, many roads are not now in the position shown by the photographs, and in places the vegetation pattern has altered in detail.

PREVIOUS INVESTIGATIONS

The first recorded geological observations in the area were made by N. Taylor, a member of Hann's 1872 expedition to northern Queensland (Hann, 1873a, b, also Jack, 1922). Gneiss, mica schist and granite, capped in places by sandstone were seen as far north as the Stewart basin. This expedition was the first to record gold in the Palmer River, a few miles downstream from Palmerville. Mulligan in 1875 made similar observations (Jack, 1922). No payable gold was found by either of these expedtions other than that in the Palmer River.

In 1879-80 R.L. Jack made two expeditions crossing the area from north to south (Jack 1881). He made a large number of observations of granite, mica schist, and gneiss capped in part by flat-lying sandstone. This area on the 1953 Geological Map of Queensland is largely based on his observations. Jack visited the Palmer River area in 1887 recording gneisses, schist and granite in the Palmer River and desert sandstone to the north (Jack 1888).

Gold was discovered in 1900 at Ebagoola (Hamilton Goldfield) by Dickie, and mining began to the south at Yarraden the following year (Dickie, 1900; Ball, 1901). Production was never large and virtually ceased after the First World War. Ball (op. cit.) mapped the geology at Ebagoola, and indicated the presence of two distinct granite phases.

Dickie made several prospecting trips, reporting gold from the upper Coleman River (Dickie, 1900), between the King and Kennedy River north-west of Palmerville (Dickie, 1901), and on the Alice River (Dickie, 1903, 1905). Cameron (1906) visited and described the main workings at the Alice River (Philp), Hamilton and Coen Goldfields. He also described the Perseverence Reef at Potallah Creek. A geological sketch map of the Cape York gold and mineral fields was published in 1911 (Greenfield, 1911).

In 1922 Jack's book "Northeast Australia" was published, giving notes on the geology as well as the history of mining in Cape York.

H.I. Jensen (1923) reviewed and presented an interpretation of the geology of the Cairns hinterland in which the rocks west of Palmerville were given Ordovician and Silurian ages. He later (1940a, b) suggested a Precambrian age for the gneisses (Frome Series) west of the then unnamed Palmerville Fault, including granite of Silurian(?) age. The alluvial mining prospects of the Palmer River area were also discussed in the report. In 1964 Jensen published a final interpretation of the geology and physiography of Cape York in which the history of mining is summarized.

Ball (1943) described a muscovite prospect about 26 miles south-south-west of Musgrave Homestead.

Summaries of the geology of Cape York appear in Bryan and Jones (1946), Maxwell (1948), David (1950), and Hill and Denmead (1960). The three 1:250,000 sheet areas to the east of the area described here, were mapped in 1960-1963 (Amos and De Keyser, 1964; Lucas and de Keyser 1965a, b), by combined parties from the Bureau of Mineral Resources and the Geological Survey of Queensland.

In 1962 an exploratory well, Cabot-Bluebury No. 1 was drilled for oil near Marina Plains Homestead, near the mouth of the Annie River. It penetrated Mesozoic and Cainozoic sediments. Petroleum search in the Laura Basin is summarized in Lucas and de Keyser (1965 b).

De Keyser (1963) described the Palmerville Fault and its possible extension to the north along the western shore of Princess Charlotte Bay. The Mesozoic section in the Walsh 1:250,000 sheet area was described by Woods (1961) and the same author (1962) reported on Cretaceous macrofossils collected from the Hann and Morehead Rivers.

Richards, White, Webb, and Branch (1966) obtained a radiometric age of about 360 m.y. for a specimen of granodiorite collected near Musgrave Homestead by K.G. Lucas.

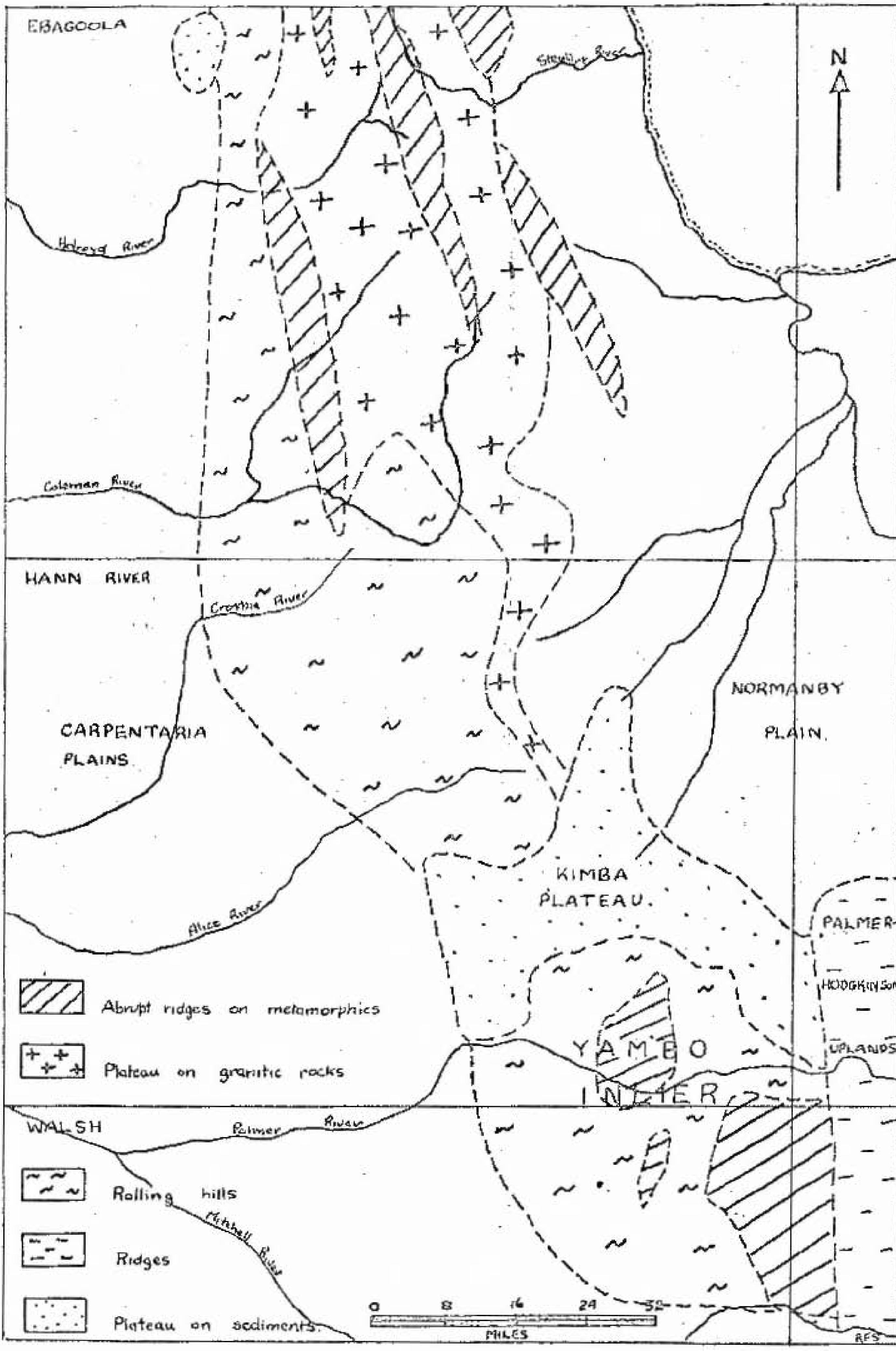

Fig. 2. LAND FORMS, SOUTHERN PART OF CAPE YORK PENINSULA.

PHYSIOGRAPHY

The area mapped in 1966 consists of the Great Dividing Range, a north-trending highland of igneous and metamorphic rocks bordered on the east by the Normanby Plain (Lucas and de Keyser, 1965a, b), developed on the sediments of the Laura Basin, and on the west by the Carpentaria Plains (Twidale, 1966) developed on the sediments of the Carpentaria Basin. Two plateaux of flat-lying Mesozoic sediments occur within the Dividing Range; the larger is the Kimba Plateau.

The Normanby Plain rises gently westwards from the sea to a height of a few hundred feet, where it butts against the escarpment forming the eastern side of the highland. The plain is formed on Lilyvale Beds, residual sand and alluvium. Many low rises in the plain are probably underlain at little depth by Mesozoic sediment or soft schists.

The rivers around the south-western part of Princess Charlotte Bay are braided for the greater part of their length in the plain. They meander only within a few miles of the coast. Twidale (1966) describes similar braided rivers in north-west Queensland and concludes that braiding is the result of a complex of variable factors, such as slope, volume of sediment, load, etc. He considers that the unusual profusion of braided rivers may be a result of the intermittent transport in these rivers: shallow shoals can be stabilized by plants, alluviation is excessive compared to permanent streams, and brief heavy discharges may tend to develop trough cross-sections in channels.

The change from braiding to meandering near the coast marks a break in the slope of the plain, and is notably co-incident with the inland extent of the beach ridges or strandlines mapped by de Keyser and Lucas (1964).

The coastline is remarkably smooth, with inlets only at the mouths of the North Kennedy River and of the Stewart River. These inlets appear to be small drowned valleys. At the time of the drowning, probably only these two rivers were sufficiently mature to have valleys graded to the earlier, low sea-level.

The beach ridges mapped around the mouth of the North Kennedy River indicate an emergence of about 10 feet. Dead trees around tidal inlets at the North Kennedy River suggest recent slight submergence following a sudden and perhaps short-lived period of high sea-level, probably at the time of the climatic optimum about 4,000 years ago.

The Carpentaria Plains in many places merge gradually with the western edge of the highland; between the Coleman River and the Alice River the change in slope between the plains formed by sediments, and the highland formed by soft schists, is slight. The margin of the plain is located at about 400 feet above sea-level between these rivers and in the valleys of the Mitchell and the Palmer Rivers, but elsewhere it rises up to 200 feet higher. Residual hills of sandstone, generally less than 100 feet high, in the plain indicate that considerable erosion has occurred over it.

Drainage in the Carpentaria Plains is dendritic in the smaller streams. The larger streams are braided and broad, but follow much more clearly defined courses than the streams of the Normanby Plain; they commonly run between banks up to 20 feet high, cut in Cainozoic sediments.

The Great Dividing Range is formed predominantly by the igneous and metamorphic rocks, but the Kimba Plateau, which rises to 1000 feet, is formed by the sandstone which separates the Yambo inlier from the main belt of igneous and metamorphic rocks. The plateau is dissected along its eastern and southern sides.

South of the Kimba Plateau the igneous and metamorphic rocks of the Yambo inlier form country which ranges from gently undulating hills on the granitic rocks, to rugged and craggy ridges on the Saraga-type schist. The Yambo inlier is bounded on its eastern side by a low scarp, running along the Palmerville Fault, but its western and southern limits are indistinct and it merges with the Carpentaria Plains. A few hills within the inlier rise up to 800 feet above the valley of the Palmer River and rise above the highest level of the Kimba Plateau, through the plateau generally is much higher than the surface of the inlier.

North of the Kimba Plateau, the main outcrop of the granitic rocks forms a very large plateau which rises from a height of less than 400 feet above sea-level at the headwaters of the Morehead and Alice Rivers to a height of about 750 feet near the Stewart River. The eastern edge of the plateau is an abrupt scarp, rising steeply form the Normanby Plain. The undulating surface of the plateau falls westwards as well as southwards and at a height of about 500 feet on the west only a low slope separates it from the Carpentaria Plains, except where high quartzite ridges are present.

Several elongated sharp ridges of metamorphic rock, mostly quartzite, rise several hundred feet above the undulating plateau, and fringe it in places on its east and west sides. A few high granite hills lie outside the eastern boundary of the plateau, and are probably remnants.

A small plateau north of the Holroyd River, is composed of silicified Mesozoic siltstone and mudstone, rising about 100 feet above the neighbouring part of the Carpentaria Plains.

The plateau on the granitic rocks, and possibly the Kimba Plateau, are gently inclined eastwards and southwards. The age of the plateau on the granitic rocks is unknown. It appears to merge, west of the Morehead River, with the pre-Mesozoic land surface cut in the metamorphic rocks. It may represent the surface of a hinterland peneplained before the Mesozoic sediments were deposited in the Carpentaria Basin. Its southern margin is considerably lower than the Kimba Plateau, cut on Mesozoic sandstone. Its eastern scarp is located close to the greatest depth of sediment in the Laura Basin and the scarp probably marks a fault active in Mesozoic times. The quartzite ridges may be very resistant remnants of mountains built long before the planation. The plateau was probably tilted during Mesozoic activity on the Palmerville and associated faults (de Keyser, 1963).

On the granitic rocks drainage is dendritic or rectangular, reflecting the joint pattern in many places; drainage is generally dendritic on the metamorphic rocks. Many west-flowing streams rise near the eastern edge of the granite plateau, but the headwaters of some of these have been captured by the steeper east-flowing streams; for example the Stewart River has captured the headwaters of the Holroyd River. The large west-flowing rivers, Holroyd, Coleman, Palmer and Mitchell, cut across the dominant geological trends in the igneous and metamorphic rocks and appear to follow an antecedent or superimposed drainage pattern, possibly inherited from Mesozoic sediments. The upper part of the Coleman River flows south along these trends, and appears to have captured the headwaters of the superimposed streams to the north.

DESCRIPTION OF ROCK UNITS

In this report a rock-unit classification is used which, for the metamorphic rocks, may have little relation to time, and the maps show rock-units rather than time-units. Until a program of radiometric age dermination can be undertaken, the ages of the bulk of the metamorphic and igneous rocks will remain doubtful.

Hence among the metamorphic rocks, similar rock types have been given the same name, even where the outcrops are widely separated and have different geological associations. It is, for instance, unlikely that the Saraga-type schist and the Arkara-type gneiss which crop out in the northern part of the Ebagoola 1:250,000 Sheet area, represent sediments deposited at the same time as the Arkara-type gneiss and Saraga-type schist in the southern part of the Yambo inlier, over 100 miles away. Nevertheless the rock types exposed in these widely separated localities are closely similar in texture and mineral composition, and they have therefore been given the same name with "type" appended to the geographical name, to emphasise that the name applies to a rock-type and not to a stratigraphic unit, and with a small initial letter for the lithological term, as the name is informal.

Table 1 summarises the characteristics and relationships of the main rock units.

Table 1 SUMMARY OF ROCK UNITS, SOUTHERN PART OF CAPE YORK PENINSULA

AGE		NAME	THICKNESS (feet)	DESCRIPTION	RELATIONSHIPS
CAINOZOIC	Recent	Beach sediments	20 max.	Quartz sand, shell sand, pumice, rare heavy minerals	Disconformable on alluvium
	Recent & Pleistocene	Alluvium	50 max.?	Silt of quartz, mica, humus	Along existing streams
		Gravel	50 max.?	Quartz	Residual on granite, or alluvial
		Clay	?	Some kaolin	Residual on claystone, or alluvial
		Sand	50 max.?	Quartz	Residual on granite or sandstone
	Tertiary	Lilyvale Beds	140 max.?	Poorly consolidated feldspathic sandstone and conglomerate	Unconformable on Cretaceous
		Olivine nephelinite		Fine-grained, porphyritic, olivine-nepheline-clinopyroxene rock	Plug in metamorphics
MESOZOIC	Cretaceous	Undifferentiated	?300	Pebbly sandstone and conglomerate, siltstone	Unconformable on basement
		Blackdown Formation	+100	Siltstone and mudstone, rare glauconite	Disconformable on Wrotham Pk. Sst
		Wrotham Park Sandstone	200 max.?	Pebbly sandstone and conglomerate	Unconformable on basement and Nychum Volcs
PALAEOZOIC	Upper Permian	Little River Coal Measures	?	Coal measures (Lucas & de Keyser 1965a)	Small block in Palmerville Fault
		Nychum Volcanics	500	Rhyolite and dacite flows and pyroclastics (Amos & de Keyser, 1964)	Pierce metamorphics

Table 1 (Cont.)

AGE		NAME	THICKNESS (feet)	DESCRIPTION	RELATIONSHIPS
PALAEOZOIC	Silurian -Devonian	Chillagoe Formation	10,000	Limestone, chert, greywacke, siltstone, conglomerate, basalt (Amos & de Keyser, 1964)	Faulted against metamorphics
	Pre-Permian	Flyspeck Granodiorite		Biotite granodiorite and hornblende-biotite tonalite	Part of batholith in metamorphics
		Kintore Adamellite		Biotite-muscovite adamellite, even-grained	Bulk of batholith in metamorphics
		Lankelly Adamellite		Biotite adamellite, porphyritic, sheared	Phase of Kintore Adamellite
		Aralba Adamellite		Biotite-muscovite adamellite, porphyritic; feldspar and muscovite phenocrysts	Phase of Kintore Adamellite
PRECAMBRIAN		Dolerite		Hornblende-pyroxene-feldspar rock; medium-grained	Intrudes schists
	HOLROYD METAMORPHICS	Pretender-type schist	?	Plagioclase-biotite-muscovite-quartz schist, coarse-grained, fine-grained, or gneissic	Grades into Lukin-type schist and Pollappa-type schist
		Pollappa-type schist	?	Sericite-quartz schist with andalusite and sillimanite, interbedded quartzite	Grades into Lukin-type schist and Pretender-type schist
		Lukin-type schist	?	Mica-quartz schist, fine-grained and medium-grained, graphite in places; phyllite, slate, indurated mudstone and siltstone. Beds of quartzite, greenschist	Grades into Kalkah-type schist
		Kalkah-type schist	?	Muscovite-quartz schist muscovite-biotite-feldspar-quartz schist, medium-grained	Grades into Lukin-type schist

Table 1 (Cont.)

AGE		NAME	THICKNESS (feet)	DESCRIPTION	RELATIONSHIPS
PRECAMBRIAN	DARGALONG METAMORPHICS	Pombete-type schist	?	Biotite-muscovite-quartz schist biotite-quartz-feldspar schist	Grades into Arkara-type gneiss
		Saraga-type schist	?	Muscovite-quartz schist, sillimanite in places; quartzite	Grades into Arakara-type gneiss and Pombete-type schist
		Arkara-type gneiss	?	Biotite-quartz-feldspar gneiss, garnet in places, quartzite, amphibolite	

Metamorphic Rocks

The metamorphic rocks in the eastern part of the Yambo inlier were described as Dargalong Metamorphics by Amos and de Keyser (1964), because of their strong similarity to the gneiss and coarse-grained schist of the Dargalong Metamorphics exposed on the nearby Atherton 1:250,000 Sheet area (Best, 1962).

North of the Kimba Plateau, in the southern part of the main metamorphic belt, gneiss and coarse-grained schist of the Dargalong Metamorphics are subordinate to a widespread group predominantly composed of fine-grained schist with phyllite, greenschist, and quartzite, which is named the Holroyd Metamorphics.

DARGALONG METAMORPHICS

The Dargalong Metamorphics comprise all the rocks metamorphosed under the conditions of the almandine-amphibolite facies, with the exception of the Kalkah-type schist which is classed with the Holroyd Metamorphics because it grades into the low-grade Lukin-type schist.

The Dargalong Metamorphics are best exposed in the Yambo inlier, and crop out intermittently along the eastern margin of the main belt of igneous and metamorphic rocks.

De Keyser and Wolff (1965) record that a granite from the Dargalong Metamorphics near Chillagoe has a radiometric age of 1044 million years, and conclude that the Dargalong Metamorphics are no younger than Middle Proterozoic.

The most distinctive rock unit within the Dargalong Metamorphics is the Saraga-type schist, composed of medium-grained muscovite-quartz schist with sillimanite in places, which generally forms abrupt ridges, easily discernible on air photographs. The remainder of the outcrop of the Dargalong Metamorphics in the Yambo inlier is composed of coarse-grained biotite-quartz-feldspar gneiss in the east, and of coarse-grained muscovite-quartz-feldspar schist in the west. An arbitrary boundary has been drawn between these types, located in a broad zone of gradation between them. They have been named respectively the Arkara-type gneiss and the Pombete-type schist.

Arkara-type gneiss

The main outcrop of the Arkara-type gneiss forms the central and eastern parts of the Yambo inlier. It extends in to the previously mapped Mossman and Cooktown 1:250,000 Sheet areas, where the unit was mapped as Dargalong Metamorphics by Amos and de Keyser (1964) and Lucas and de Keyser (1965a), and was tentatively assigned by them to the Archaean. The outcrop of the gneiss is bisected by a north-trending body of adamellite several miles wide.

The Arkara-type gneiss also forms three bodies within the main metamorphic belt, north of the Yambo inlier. One runs northwestwards from Watch Branch Creek to the Coleman River and is about 4 miles wide. The second outcrop of gneiss forms the core of the elongated body of metamorphic rocks trending north-north-west from old Bamboo Homestead, and lying within a very large body of adamellite. The third crops out near the northern margin of the area mapped in 1966 and has a complex relationship with the adamellite.

In the Yambo inlier the Arkara-type gneiss is well exposed in rivers and large creeks. Elsewhere it weathers to form undulating country covered by residual sand, except where resistant bands of quartzite or amphibolite form hills and ridges rising up to 200 feet.

The dominant rock type in the Arakara-type gneiss is biotite-quartz-feldspar gneiss; within this and forming an integral part of the unit are many bands of quartzite and of amphibolite, ranging in thickness from a few inches to several hundred feet. Composite gneiss, migmatite, veined gneiss, pegmatite, and mylonitized gneiss are irregularly distributed throughout the unit, and are particularly common in the northern and central parts of the Yambo inlier, and near the Palmerville Fault.

The unweathered biotite-quartz-feldspar gneiss is grey or greenish grey. The gneiss is commonly banded; light-coloured granular bands of quartz and feldspar up to 5 mm thick alternate with dark bands of biotite up to 2 mm thick. Abundant biotite gives the gneiss a dark colour; where muscovite is abundant the gneiss is light-coloured. The gneiss is medium-grained to coarse-grained; it has a schistose appearance in places, but generally it is an even-grained, granoblastic, and rather massive rock. With decreasing mica content and increasing grain-size, schistosity and the foliation formed by the banding become less obvious, and the schistose rocks grade into gneiss and in places massive biotite-bearing granulite.

Porphyroblasts of feldspar are locally common in the gneiss. They range up to 40 mm across and generally lie in a medium-grained matrix of quartz and felspar with curved trains of biotite and subordinate muscovite. In some exposures the porphyroblasts are augen; some augen are elongated parallel to the general foliation and others are slightly bent.

The gneiss is composed essentially of feldspar, quartz, and biotite. Garnet is abundant in places. and is a common accessory. Minor minerals are muscovite, apatite, chlorite, and epidote; the last two may be secondary. Myrmekite is about as common as the minor minerals. Accessory minerals are monazite, zircon, sillimanite, clinozoisite, calcite, opaque minerals, and sphene.

The most abundant feldspar is plagioclase, which is generally andesine and less commonly oligoclase. It forms anhedral to subhedral grains. The plagioclase in porphyroblasts is commonly zoned, Alkali feldspar appears to be confined to the reconstituted gneiss, which is described below. Where the rocks are sheared and near zones of migmatite, the plagioclase has been extensively altered to sericite; in one thin section (66480042) plagioclase has been altered to prehnite.

Quartz forms between 35 and 55 percent of the rock as interlocking, granular, strained grains which have a uniform size and which commonly have a preferred elongation broadly parallel to the foliation. Much of the quartz appears to be recrystallized.

Biotite forms large flakes with a roughly parallel orientation. Some flakes partly wrap around large grains of other minerals, but generally the biotite is concentrated in discontinuous undulatory bands which give the rock its foliation. The biotite is strongly pleochroic, from pale brown to dark brown. Some contains inclusions of zircon, apatite, or monazite(?).

The occurrence and abundance of garnet in the gneiss is highly variable, but it seems to be more common in schistose rocks. In places, garnet porphyroblasts range up to 25 mm in diameter and form up to 20 percent of the gneiss; in other exposures small garnet crystals are disseminated in the gneiss. At Mount Fox, near Palmerville, both types occur; poorly foliated, medium-grained garnet-biotite-feldspar-quartz gneiss grades imperceptibly into a much coarser and well banded quartz-biotite-feldspar gneiss with accessory garnet.

Muscovite is an almost ubiquitous minor mineral, and in some varieties of the gneiss forms up to 30 percent of the rock, particularly where the gneiss is sheared and is schistose or strongly foliated.

Chlorite is mainly derived from biotite and less commonly from garnet.

Apatite forms small grains (up to 2 mm) scattered through the matrix of many gneisses, or forms inclusions in micas, feldspar, and quartz; rarely it occurs in small aggregates. Apatite forms about 3 percent of one garnet-biotite-feldspar gneiss (66480039).

Micropegmatite, consisting of graphic and bleb-like intergrowths of quartz in felspar, and myrmekite are fairly common interstitially. They are most abundant in zones of migmatite, but they are also present in little deformed, banded and recrystallized gneiss.

Amphibolite bands and quartzite bands, up to several hundred feet wide and half-a-mile long, occur throughout the Arakara-type gneiss in the Yambo inlier and are particularly common south of the Palmer River. Both types are resistant and may be picked out as hills or low ridges on air photographs; the quartzites are commonly mantled by light-coloured sand and scree; the amphibolites are overlain by dark red-brown soil. Almost

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everywhere the strike of the bands parallels the regional foliation in the surrounding biotite-quartz-felspar gneiss.

Remarkably, both the quartzite and amphibolite bands have a similar size, distribution, and abundance within the predominant biotite-quartz-felsapr gneiss. The contacts of the two types of band are rarely exposed, even in areas which consist almost entirely of quartzite inter-banded with amphibolite.

Both types of band have a haphazard distribution in the outcrop of the Arkara gneiss. In places amphibolite bands about 3 feet wide and 30 feet long lie close together and resemble a dyke swarm. In other places bands of this size and much larger bands are isolated in the gneiss.

The amphibolite is a very tough rock and ranges in texture from fine-grained and massive to medium-grained and lineated, schistose, or grano-blastic. It consists predominantly of hornblende with feldspar, quartz, and garnet. Apatite is a common accessory in some amphibolites and makes up about 3 percent of one (66480036). In several thin sections (e.g. 66480067) sphene surrounds cores of ilmenite(?). A description of the amphibolites in the Arkara gneiss is given more fully under Amphibolites and Dolerites.

The quartzite bands fall into two distinct types: one consists essentially of a brownish-grey, even-grained mosaic of quartz, the other is composed of coarsely crystalline, clear or translucent quartz.

The even-grained, brownish-grey quartzite bands are by far the more abundant. They consist almost entirely of a granoblastic to allotriomorphic aggregate of quartz containing minor or accessory sericite, biotite, feldspar, and opaque minerals. Most of the bands are massive; many are cleaved and jointed; some are exposed only as blocky rubble, and they show little evidence of original clastic features. Bedding planes can be recognized in places. Where the matrix has weathered out these quartzite bands have a fine sandy surface.

The bands have probably been derived from the metamorphism of almost pure quartz-arenite beds sporadically distributed laterally and vertically in a predominantly argillaceous sequence, represented by the biotite-quartz-feldspar gneiss. The small quantities of mica in some quartzite bands represent small amounts of clay in the original arenite.

The coarsely crystalline, clear or translucent quartzite has a distinctive vitreous lustre, but it does not resemble the white "buck" quartz, which forms reefs within the Arkara-type gneiss. The coarse quartzite consists of an allotriomorphic aggregate of severely strained quartz grains; the margins of the grains are intricately sutured, and most of them have a rough common parallelism. The bands contain minor muscovite and chlorite, scattered flakes of micaceous hematite, and accessory apatite. Similar flakes of micaceous hematite occur in quartzite bands in the Ebagoola 1:250,000 Sheet area.

The coarse quartzite is less abundant than the other type, but it forms more prominent bands; the bands resemble dykes but almost everywhere conform to the foliation of the adjacent gneiss. Its contacts with the gneiss are sharp. It is commonly strongly jointed and strike joints invariably dip very steeply.

This quartzite probably has the same origin as the even-grained type, but has undergone severe recrystallisation and during metamorphism has been reconstituted to a greater extent than the even-grained type. Nothing indicates that the coarsely crystalline type has an igneous source.

A few quartzite bands, similar in size and in relatiosnhips to the others, are mineralogically distinct. One (66480124) is a band intercalated with amphibolite; it is a banded quartzite in which scattered subhedral grains of plagioclase and potash feldspar form up to 15 percent of the rock, and biotite is accessory. It may be a regionally metamorphosed, acid volcanic rock.

Another (66480116) is a garnet quartzite, of which 75 percent is strained, recrystallized, elongate and roughly parallel quartz grains, 20 percent is rounded to sub-angular garnet in irregular bands up to 3 mm thick, and 5 percent is small anhedral grains of apatite, associated with the garnet.

In the northern part of the Yambo inlier, migmatite, veined gneiss, and pegmatite are particularly common in the Arkara-type gneiss, where it borders the Kintore Adamellite.

The migmatite is a mixed rock, essentially a banded gneiss which appears to have been intimately invaded by granitic material, and which could be named migmatite, composite gneiss, or injection gneiss. The veined gneiss contains discontinous, branching veins rich in quartz and feldspar, sub-parallel in some rocks and irregular in others. The pegmatite is generally composed of feldspar, quartz, muscovite, and garnet. It forms irregular patches and contorted bands and veins and appears to have recrystallised from the surrounding host rock.

These rocks are widespread in a west-north-west-trending zone, about 2 miles across, at the contact of the gneiss with the Kintore Adamellite near the main branch of the Kennedy River. The zone consists mainly of bands of massive or foliated muscovite-biotite adamellite which grade into granitic gneiss with the abundant development of migmatite, veined gneiss, and pegmatite. In the western extension of the zone granitic gneiss grades into fine-grained sillimanite-biotite-bearing schist, which contains irregular patches of white quartz and of muscovite-quartz-felspar pegmatite.

In the major tributary of the Kennedy River, at grid reference 154009, massive, leucocratic muscovite-biotite adamellite, with rare feldspar phenocrysts grades into banded granitic gneiss which is folded and contorted. The gneiss contains lenses of quartz and feldspar; one is composed (66480040) of quartz (30 percent), microcline (45 percent), and oligoclase (25 percent), and has a granitic composition. The gneiss contains dykes, up to 6 feet wide, of muscovite-quartz-feldspar pegmatite with accessory garnet; they have large blocky feldspar crystals with graphic intergrowths of quartz. The dykes are commonly discordant, but in places they grade imperceptibly into banded gneiss.

In the headwaters of Yambo Creek porphyritic muscovite-biotite adamellite grades into leucocratic gneiss, which is an augen gneiss in places. These rocks contain abundant white quartz veins and dykes and garnet-bearing granite-pegmatite, which has mixed with the gneiss to produce migmatite. The creek runs for 2 miles in granitic gneiss and migmatite, which are well banded and have veins of quartz and feldspar sub-parallel to the banding. These veins are ptygmatic in places. A sample of the gneiss (6680041) consists of quartz (40 percent), microcline (30 percent), oligoclase (15 percent), and biotite (10 percent). It is cut by veins made up of perthite, plagioclase, poikilitic quartz, and myrmekite. Some garnet-bearing biotite-quartz-feldspar gneiss, in Gorge Creek, carries minor sillimanite.

On the western side of the Kintore Adamellite, in the northern part of the Yambo inlier, coarse-grained gneiss has undergone potash metasomatism. It is composed of 45 percent potash feldspar, 20 percent quartz, 20 percent plagioclase, and 5 to 10 percent biotite. The potash feldspar is mainly microcline perthite, which is associated with recrystallized quartz, plagioclase and myrmekite.

The emplacement of the Kintore Adamellite has produced the migmatite, veined gneiss, and pegmatite, the potash feldspar and myrmekite, the hydrothermal alteration of feldspars, and the development of sillimanite from mica in the Arkara-type gneiss at the northern end of the Yambo inlier. Some of the changes appear to result from the injection of magma; some, in isolated lenses, from the transformation of gneiss perhaps when partially mobilised and deformed during the shearing which affected the adamellite. The adamellite body has no sharp boundaries, characteristic of intrusion, and it is composed essentially of the same minerals as the gneiss. It may be the end product of metasomation and granitisation in the Arkara-type gneiss.

Along the contact between the Arkara-type gneiss and the eastern side of the Kintore Adamellite, in the central and southern parts of the Yambo inlier, migmatite is absent. The contact is a poorly defined, sheared transition, in which biotite-quartz-felspar gneiss grades through gneissic adamellite into massive muscovite-biotite adamellite. Both gneiss and adamellite are sheared near the contact, and are commonly dificult to distinguish. Rare isolated pods and veins of calcite occur in the gneiss, and late-stage calcite veins are evident in thin sections. Sillimanite replaces mica in some gneisses near this contact (e.g. 66480043), and veined gneiss occurs in places. In one place tonalite, in which biotite is altered to clinozoisite and epidote, forms bands several feet wide in the gneiss.

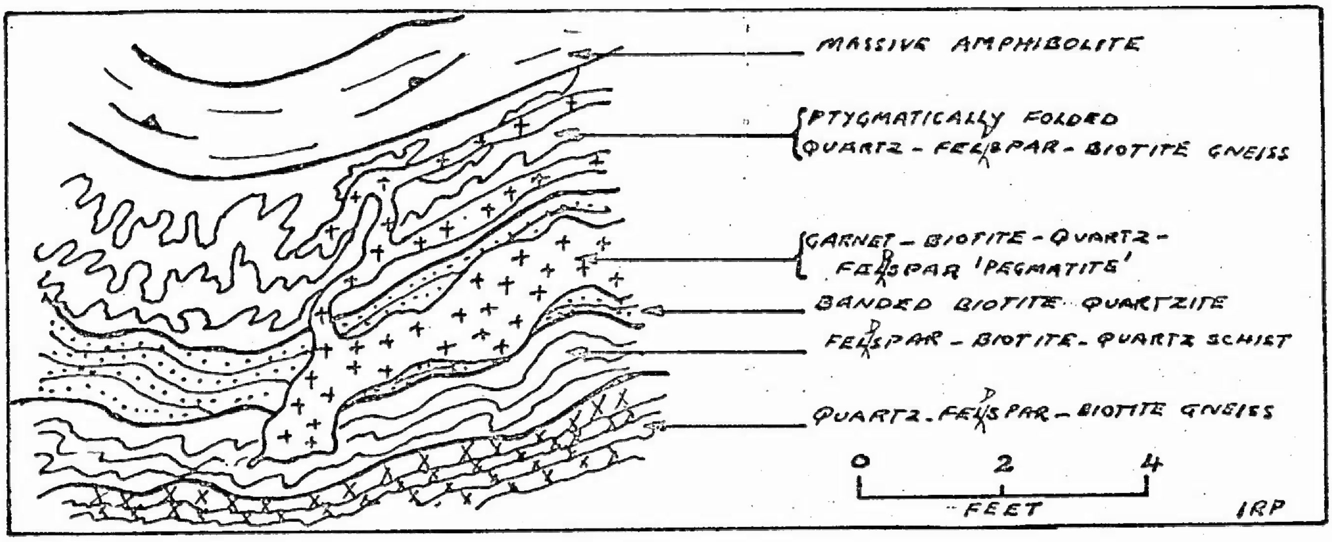

FIGURE 3. COMPLEX RELATIONSHIPS BETWEEN COMPONENTS OF ARKARA-TYPE GNEISS IN TWELVE-MILE CREEK.

The contact between the western side of the adamellite and the Arkara-type gneiss is poorly exposed. Shearing is not prominent and there is little evidence of migmatite development. However pegmatities of igneous type are common. Near Fox Creek a stockwork of veins of quartz and feldspar cuts a quartz-biotite-feldspar schist, which grades into biotite-quartz-feldspar gneiss. Veins of muscovite-quartz-feldspar pegmatite with minor garnet are also common here. At the contact, where exposed, the adamellite is commonly represented by pegmatite and the gneiss by schistose rock. Biotite in the gneiss adjacent to the contact is extensively altered to chlorite, and minor sillimanite occurs in places. These minerals may be products of recrystallisation during the emplacement of the adamellite.

Isolated zones of migmatitic rocks were found sporadically distributed in the Arakra-type gneiss, away from the contacts. Some are associated with small amphibolite bands; figure 3 illustrates the relationships of these rocks, exposed in Twelve-Mile Creek about 5 miles due south of the Palmer River. Some of the injected quartz-feldspar rock in this area has the composition of a tonalite (66480114).

The migmatites within the gneiss are attributed to localised zones of intense deformation which have resulted in the folding, mobilisation and reconstitution of the rock, more-or-less in situ. This may have been supplemented by metasomatism derived from underlying extensions of the adamellite to the west. Adjacent to the Palmerville Fault, the Arkara-type gneiss is sheared and mylonitised in many places.

Near Palmerville Homestead the gneisses are fine-grained and schistose; minor contorted folds of variable plunge and chevron-type shear-folds occur, and banded mylonitic augen gneiss is common. Irregular quartz-feldspar lenses with accessory garnet are also present. In one sample (66480038) quartz forms mostly small recrystallised grains and abundant sub-parallel granular veins penetrating trains of plagioclase granules. Plagioclase also forms porphyroblasts which are extensively sericitised and are penetrated by abundant stringers of quartz. Veins and granules of quartz and trains of mica, which bend around larger grains, give the rock a mylonitic texture. These textures and structures are products of cataclastic deformation and were formed when the gneiss was sheared and recrystallised, during movement along the adjacent Palmerville Fault.

In the south-western, western and north-western parts of the Arkara-type gneiss in the Yambo inlier, particularly where it is in contact with the Pombete-type schist, the gneiss is schistose and commonly grades into coarse-grained biotite-quartz-feldspar schist. The gneiss has a well developed foliation and is characterised by numerous lenticular feldspar porphyroblasts. The foliation planes are slightly crenulated and are defined by micas which wrap around the porphyroblasts; this produces an irregular lineation. Some of the aligned feldspar phenocrysts are ovoid cylinders and hence produce strong rodding.

This gneiss grades into finer and more even-grained phases in which a more prominent and regular foliation is developed. As the grain-size decreases the feldspar porphyroblasts and intergranular quartz and feldspar coalesce to form narrow bands (1-2 mm) parallel to the foliation. These features across the contact between Arkara-type gneiss and Pombete-type schist suggest that it is a transitional contact, produced by a decrease in metamorphic grade.

The rocks mapped as Arakara-type gneiss north of the Yambo inlier, in the main belt of metamorphic and igneous rocks, are made up of biotite-quartz-feldspar gneiss with hornblende in places, and muscovite-quartz-feldspar gneiss, commonly with biotite; the bands of quartzite and amphibolite are notably less abundant there than in the Yambo inlier.

Biotite-quartz-feldspar gneiss forms the core of the body of metamorphic rocks within adamellite, between Six-mile Creek and Ebagoola Homestead. It also occurs among the mixed rocks in the north-eastern part of the Ebagoola 1:250,000 Sheet area.

The feldspar is andesine, probably intertwinned with potash feld-spar. Biotite forms between 20 and 30 percent of the gneiss, and many samples contain minor amounts of muscovite. The common accessory minerals are garnet, monazite, and apatite. Feldspar has altered to clinozoisite and biotite to to chlorite in some samples, but the minerals in the gneiss are less altered than those in nearby exposures of Kintore Adamellite.

In the Lukin River at the foot of Mount Ryan, the biotite-bearing gneiss contains bands of hornblende-garnet-biotite-quartz-plagioclase gneiss and garnet-hornblende-labradorite-quartz gneiss; hornblende forms 20 percent of the latter.

Muscovite-bearing gneiss is confined to the outcrop between Watch Branch Creek and the Coleman River. Both schistose and massive types occur; the latter is richer in muscovite. The gneiss is essentially a biotite-muscovite-quartz-feldspar rock. The muscovite content (including sericite) ranges from 20 to 30 percent. The feldspar consits of andesine and microcline(?). Biotite forms about 10 percent of the gneiss. The muscovite occurs as thin prismatic crystals which were mistaken for sillimanite in the field, and which closely resemble the muscovite pseudomorphs of sillimanite typical of the Saraga-type schist.

In the main belt the texture of the gneiss ranges from massive and granoblastic to schistose. It is generally even-grained, but in places it contains feldspar porphyroblasts which are equant or elongated parallel to the foliation. In some banded gneisses the grain-size is irregular.

In the schistose banded gneiss, bands rich in mica commonly wrap around feldspar porphyroblasts. In the more massive banded gneiss, bands rich in biotite alternate with bands rich in quartz and feldspar. In coarse-grained and medium-grained gneiss the bands are parallel and have constant width. The bands rich in quartz and feldspar are generally coarser and some contain porphyroblasts.

The contacts of the Arkara-type gneiss with the neighbouring Saraga-type schist and Kalkah-type schist were not found, but they are either sharp contacts or they are transition zones less than 500 yards wide. The contact of the gneiss with the Kintore Adamellite is discussed in the description of the adamellite.

In the main belt the biotite-bearing gneiss is closely similar to the biotite-bearing gneiss exposed in the Yambo inlier, in both structure and mineralogy. The muscovite-bearing gneiss is not duplicated in the Yambo inlier, but differs only in its higher muscovite content from the gneiss exposed west of the Kintore Adamellite in the inlier. Possibly the muscovite-bearing gneiss of the main belt represents a sediment with more alumina than the original rocks in the Yambo inlier. Alternatively the northern gneiss may have obtained potash from the nearby adamellite.

The Arkara-type gneiss has been metamorphosed under the conditions of the almandine-amphibolite facies, as defined by Turner and Verhoogen (1960). The presence of hornblende and sillimanite in a few gneisses suggest that they may be allocated to a sub-facies high in that facies. The local development of muscovite and the common lack of potash feldspar suggest that the original sediments generally had less potash than normal pelitic sediments.

Retrogressive metamorphism in the Arkara Gneiss, such as the alteration of biotite and garnet to chlorite and the alteration of feldspar, is most common near its contacts with bodies of adamellite and almost certainly is a product of the emplacement of the adamellite.

Foliation in the gneiss almost invariably dips at an angle greater than 75°. In a very few places it dips gently or moderately steeply. Trends of foliation can be traced for distances up to 5 miles in the Yambo inlier; they undulate about a northerly trend in the southern part of the inlier, and about a north-easterly trend in the northern part. The foliation parallels the trends of the quartzite bands throughout the gneiss outcrop, and probably follows the bedding planes of the original sediments.

Minor folding, which is commonly intense, is present in parts of the gneiss outcrop complicated by migmatites and other rock types described above. It is accompanied by structures indicating plastic flow, mobilisation, and local intrusion of the gneiss. They are particularly common in the northern part of the inlier, near the Kennedy River, along the lower reaches of which a structural hinge-line appears to separate north-trending gneiss in the east from east-trending gneiss in the west.

Saraga-type schist

The Saraga-type schist is typically developed in the Parish of Saraga, (Dept. of Public Lands, Queensland, 1961) which lies between the Palmer and King Rivers in the Hann River 1:250,000 Sheet area.

The unit is predominantly composed of muscovite-quartz schist and quartzite and forms scattered large bodies, and broad bands up to 5000 feet across, within both the Pombete-type schist and the Arkara-type gneiss. In the Yambo inlier the Saraga-type schist forms a large body eight miles across, at the headwaters of Terrible, Annie, and Oswald Creeks, and another, five miles across, east of the headwaters of Fox Creek. Smaller bands of the Saraga-type schist up to five miles long and half a mile wide also occur in the Yambo inlier. In the Ebagoola 1:250,000 Sheet area the Saraga schist crops out in three belts: one north-east of Musgrave Homestead, one north of Ebagoola town-site, and one north of the Coen/Port Stewart Road.

The quartzite bands, and to a lesser extent the muscovite-quartz schist, form steep hills rising up to 1000 feet, which easily distinguish the unit from the other metamorphic rocks. In spite of the relief, exposure is poor and the schist is intensively weathered.

Typically the Saraga-type schist consists of bands of quartzite from ten to several hundred feet thick, alternating with bands of muscovite-quartz schist of similar thickness. The contacts between the bands are gradational and quartzite bands also grade laterally into schist. Rare bands of amphibolite occur within the outcrop at the headwaters of Fox Creek.

The schist is usually purple to red, fine-grained to medium-grained, and has a moderately well developed schistosity, which in places is finely contorted. Grains of quartz are markedly elongate. Small to medium-sized shreds of muscovite occur between the quartz grains, and in most specimens aggregates of very fine flakes of muscovite also form fine needles which appear to be pseudomorphs after sillimanite. The aggregates range up to about 2 mm by 8 mm, but some are porphyroblasts up to 40 mm in length. The aggregates have a marked preferred orientation and define both schistosity and foliation.

The schists are heavily stained by hematite, particularly along the planes of schistosity. The hematite may be a product of enrichment at the weathered surface or a product of the breakdown of biotite or garnet, but in places the hematite is abundant as small needles parallel to the schistosity and may be a primary constituent of the schist.

The quartzite is grey to white and medium-grained to coarse-grained. It has a sugary texture, but in places individual quartz grains have a preferred elongation, and define a schistosity which is parallel to that in the neighbouring muscovite-quartz schists. Muscovite, some of it forming sillimanite pseudomorphs, occurs in minor amounts in most quartzites, garnet is an abundant constituent in some bands, and hematite staining is usually present.

Thin section examination shows that the schist and quartzite are composed essentially of muscovite and quartz. The quartz usually forms medium-sized irregular anhedral grains with serrated interlocking margins; rarely it forms porphryoblasts. Almost all the quartz is strained. Many quartz grains enclose small flakes of muscovite.

In places the quartz has recrystallized as small unstrained grains, usually associated with patches of muscovite. The quartz grains in the quartzite are nearly equidimensional giving the rock a granoblastic or weakly schistose texture. However, the schist contains quartz grains which are elongated and oriented to produce a schistosity. In many specimens of schist the quartz grains are broken by fractures which generally parallel the schistosity.

Three types of muscovite are present in the schist and quartzite. One type forms medium-sized flakes about 1 mm long, distributed randomly amongst the quartz grains; this is predominant in the quartzite. The second type of muscovite, predominant in the schist, forms small aggregates of intergrown minute flakes between quartz grains. These aggregates are elongate parallel to the schistosity. This type of muscovite appears to have been derived by alteration of sillimanite, as in some specimens small remnant crystals of sillimanite occur within these areas.

Presumably these rocks were originally muscovite - sillimanite-quartz schists. In the north of the Ebagoola Sheet area, near the contacts of the unit with the Kintore and Lankelly Adamellites, a third type of muscovite forms large fresh, randomly oriented flakes which may have grown from the areas of very small muscovite crystals.

The presence of sillimanite, garnet and biotite in the two main rock types produce the following variations: sillimanite-quartz-garnet schist, garnet-sillimanite-quartz schist, garnet quartzite, biotite quartzite, and biotite-muscovite-quartz schist.

In these variations the unaltered sillimanite occurs as numerous small parallel needles 0.1 mm across in aggregates between quartz grains. The aggregates are sub-parallel and define a schistosity. A few porphryoblasts of sillimanite up to 3 mm across are also present. Almost all the sillimanite is altered, and rocks containing remnant crystals of sillimanite are rarer in the Ebagoola Sheet area than in the Yambo inlier.

Garnet is a relatively common, but sporadically distributed mineral in the schist. It is confined to bands which may correspond to original beds. Garnetiferous quartzites are common; in one, the garnet forms 60 percent of the rock. The garnet is colourless to pale pink and forms euhedral to subhedral porphryoblasts which are much fractured and altered. In many places the garnets are represented by hollow boxworks of limonite; in others they are altered to chlorite.

Biotite is rarely present in the Saraga-type schist; it occurs as medium-sized flakes associated with the coarser flakes of muscovite. However, in the north of the Ebagoola Sheet area, biotite is common as large fresh flakes cutting across the schistosity. This may be an effect associated with the intrusion of the nearby Kintore and Lankelly Adamellites. Small flakes of hematite are abundant in some quartzites from the northern outcrops of the Saraga-type schist. They are parallel to the schistosity and appear to be primary.

Common accessory minerals in the unit include monazite, zircon, graphite, hematite and in places, tourmaline.

Towards the margins of some of the outcrops of the Saraga-type schist, chlorite-muscovite-quartz schist, andesine-chlorite-garnet-muscovite-quartz schist and muscovite-biotite-andesine-quartz schist occur. These rocks may represent a gradation from the muscovite-quartz schists into surrounding muscovite-biotite-bearing schists and gneisses.

The several outcrops of the Saraga-type schist do not represent a single stratigraphic unit. They probably include several discrete sedimentary units of similar composition, laid down in different locations and at different times during the deposition of the sediments which formed the Dargalong Metamorphics. The Saraga-type schist grades into the neighbouring mica-quartz-feldspar schist or gneiss with increasing amounts of biotite, chlorite, andesine and garnet, and with decreasing amounts of quartz. Quartzites, which are abundant in the Saraga-type schist, are generally lacking in the surrounding rocks.

North of the old town of Ebagoola, and particularly near the Stewart River, the Saraga-type schist is intimately intruded by the Kintore Adamellite and the Lankelly Adamellite. The intrusive relationship is complicated; closely intermixed metamorphics and adamellite extend over considerably distances.

Near Mount Walsh in the Ebagoola Sheet area a patch of calc-silicate rock, exposed within the Saraga-type schist, is composed of up to 80 percent tremolite, with lesser amounts of talc and muscovite; it may been derived from metamorphism of impure limestone or dolomite.

In the Yambo inlier at the headwaters of Annie and Oswald Creeks, the schist outcrop appears to have a faulted margin, which has been intruded by dolerite. In the same outcrop the schist is intruded by a small plug of Aralba Adamellite, which has silicified the schists nearby. At the junction of Fox Creek and the Palmer River a small outcrop of the Saraga-type schist appears to have been hydrothermally altered and contains a mineral which may be a zeolite, and which forms 60 percent of the rock.

Throughout the whole region, the Saraga-type schist, as well as the surrounding metamorphics, is penetrated by white milky quartz reefs and veins which are usually barren of any other mineral except muscovite.

The original sediments which gave rise to the Saraga-type schist were probably quartz sandstones; some were pure, but many had a clayey matrix now represented by silimanite and muscovite. The thickness of the unit in any one outcrop is difficult to estimate because of the presence of isoclinal folding. In the Yambo Inlier it would probably not excede 5000 feet. Further to the north, near the Stewart River, it could be much thicker.

The Saraga-type schist generally has been isoclinally folded about axes trending north-north-west. The schistosity, which was probably developed during this folding, is a fairly uniform axial-plane schistosity, parallel to the bedding revealed by bands of quartzites along the limbs of the folds. The general coincidence of bedding with schistosity suggests that the area has been subjected to only one major period of deformation.

However, in the northern part of the Yambo Inlier, the fold axes and the bedding swing around to strike north-east. The folds here are more open, and the rocks may have been locally warped and broadly folded about a north-east-trending axis. Minor faults in the schist, trending north-west, may be related to activity along the Palmerville Fault.

The presence of sillimanite and garnet in a number of specimens suggests that the rocks originally were regionally metamorphosed under the conditions of the almandine-amphibolite facies (Turner and Verhoogen, 1960). However, there is widespread evidence of retrogressive metamorphism; sillimanite has been altered to muscovite and garnet and biotite to chlorite. The retrogressive metamorphism may have been brought about by the widespread intrusion of the Kintore Adamellite. A similar retrogressive metamorphism has been reported in the Precambrian metamorphics of the Georgetown Inlier (White, 1965), where it is attributed to the intrusion of the Precambrian Forsayth Granite.

<u>Pombete-type schist</u>

The Pombete-type schist crops out in the north-western part of the Yambo inlier; it ranges in composition from muscovite-quartz schist to muscovite-biotite-quartz-feldspar schist.

The schist is in contact with the Arkara-type gneiss, the Saraga-type schist, and the adamellite. It forms rolling hills and is generally well exposed only in deeply incised creeks.

The Pombete-type schist is predominantly composed of muscovite-quartz schist and biotite-feldspar-quartz schist. In the muscovite-quartz schist biotite is present in places as a minor mineral, and accessory sillimanite occurs. Quartz forms between 50 and 65 percent of the schist, generally as equant xenoblastic grains; in some rocks it forms strained, elongated porphyroblasts, which parallel the foliation. Many porphyroblasts are ringed by small secondary crystals of quartz.

Muscovite forms between 20 and 40 percent of most specimens, as xenoblastic flakes concentrated in irregular bands and lenses parallel to the plane of foliation. In some specimens muscovite and sericite form haphazard aggregates, pseudomorphous after silimanite. Small quantities of plagioclase (oligoclase-andesine) and microcline form up to 5 percent of most specimens as xenoblastic laths or equant grains, and as xenoblastic porphyroblasts in a few specimens. Plagioclase is more abundant than microcline, and is altered in places to clay minerals or sericite.

Biotite forms up to 5 percent of the muscovite-quartz schist as xenoblastic flakes in the muscovite-rich bands. Sillimanite is the most abundant accessory mineral, and forms about 1 percent of several specimens as haphazardly oriented or sub-parallel needles, partly altered to muscovite. Monazite forms rounded xenoblastic grains in some specimens.

In the biotite-feldspar-quartz schist quartz is again the most abundant mineral, as irregular xenoblastic grains. The rare quartz porphyroblasts have generally been recrystallized to mosaics of equant grains. Feldspar is abundant and forms up to 30 percent of the schist. It occurs as both lath-shaped porphyroblasts up to 8 mm long, and as equant grains from 0.2 to 0.5 mm across. Oligoclase or andesine is more abundant than microcline. The plagioclase is partly altered to clay minerals and sericite. Biotite forms up to 30 percent of these schists, as xenoblastic flakes concentrated in irregular bands; it is commonly partly altered to chlorite, and contains many inclusions of zircon. In places small quantities of muscovite are associated with biotite, and sillimanite is an accessory mineral in these muscovite-bearing rocks. Garnet occurs in biotite-rich schist, as fractured and partly replaced xenoblastic grains. Monazite is accessory in all specimens of the biotite-feldspar-quartz schist.

Both the muscovite-quartz schist and the biotite-feldspar-quartz schist are generally medium-grained; some are fine-grained. The schist with muscovite is finer and has a clearer foliation than the schist with biotite; the latter is commonly porphyroblastic. In some exposures of the Pombete-type schist the foliation is irregularly crumpled; in a few it is regularly folded.

Rare, concordant bands of quartzite range in thickness from a few inches to 50 feet in the schist. Quartz forms between 80 and 100 percent of the quartzite generally with subordinate biotite, muscovite and feldspar; garnet, tourmaline, monazite, and hematite are accessory. The quartz grains are irregular in size and shape. They have undulose extinction, and, where elongated, are aligned to produce a foliation. The quartzite bands are sharply distinct from schist above and below them, but several long bands appear to grade laterally into schist. Bands of intermediate texture and composition, effectively quartz-rich schists, are interbanded with the more common schist types in places.

The Pombete-type schist comprises metamorphosed sediments ranging from impure aluminous siltstone or shale to pure quartz sandstone. The presence of relict sillimanite indicates that the schist was metamorphosed under conditions of the upper almandine-amphibolite faceis (Turner and Verhoogen, 1960) and was retrogressively metamorphosed under conditions of the lower almandine-amphibolite facies. In the immediate vicinity of contacts with adamellite, the schist has been hornfelsed, and xenoliths of schist occur in the adamellite in places.

The biotite-feldspar-quartz schist of the Pombete-type is closely similar in many places to the biotite-quartz-feldspar gneiss of the Arkara-type gneiss, and intermediate types exposed near the contact between the units suggest that a gradiation exists between them. The biotite-feldspar-quartz schist grades into the muscovite-quartz schist, within the Pombete-type schist.

The muscovite-rich schist of the Pombete-type schist is distinguished from similar rocks in the Saraga-type schist by the lack of interbanded quartzite and by the presence of feldspar and minor biotite in some exposures. Muscovite-quartz schist is abundant in the Pombete-type schist, and a gradation probably exists between the units.

Undifferentiated rocks

Several bodies of gneiss and schist, up to 10 miles in length, crop out on the east side of the Kintore Adamellite in the southern part of the main belt of igneous and metamorphic rocks. Most of these bodies are overlain on their eastern sides by Mesozoic or Cainozoic sediments. The bodies are formed by one or more of the following rock types: biotite-quartz-feldspar gneiss, with muscovite in places; muscovite-biotite-quartz-feldspar schist; muscovite-quartz schist with sillimanite in places.

The gneiss is a massive, medium-grained to coarse-grained, granoblastic rock with only a slight foliation. It is well banded in places and the bands are commonly contorted. Muscovite occurs in the gneiss where it is in contact with adamellite.

The muscovite-biotite-quartz-feldspar schist grades from a coarse-grained schistose rock, otherwise similar to the gneiss described above, to a fine-grained schist. There is a considerable range in the abundance of muscovite in the schist; at its contact with the adamellite, muscovite is more abundant than biotite. The muscovite-quartz schist is fine-grained or medium-grained with a moderately or well developed schistosity. Sillimanite is partially or more commonly completely replaced by muscovite in this schist.

Minor hornblende-plagioclase amphibolite is associated with the gneiss. A diopside-tremolite rock crops out in the Morehead River just west of the crossing of the telegraph line. Diopside forms 25 percent of the rock, as xenoblastic equant grains intergrown with xenoblastic laths of tremolite. This rock is probably a metamorphosed impure limestone or dolomite.

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The schists and gneiss in these bodies have undergone considerable thermal metamorphism and some metasomatism during the emplacement of the emplacement of the adamllite. Veins, dykes, and irregular patches of aplite and granite-pegmatite intrude the margins of the bodies, with associated hornfelsing and migmatization. Muscovite has been introduced and in places potash feldspar as well, forming porphyroblasts up to 10 mm across.

These undifferentiated schists and gneiss have not been assigned to any unit of the Dargalong Metamorphic because they are poorly exposed, they have a small extent, and they are affected by thermal metamorphism and metasomatism. The rocks which comprise them closely resemble types found in variously the Arkara-type gneiss, the Pombete-type schist, and the Saraga-type schist.

HOLROYD METAMORPHICS

The Holroyd Metamorphics are low-grade to medium-grade, regionally metamorphosed rocks, mainly mica-quartz schist, phyllite, and sillimanite-andalusite-bearing mica-quartz schist. Together with minor quartzite, actinolite-bearing schist, and spotted and knotted schists, they form the western margin of the main belt of igneous and metamorphic rocks located in the Hann River and Ebagoola 1:250,000 Sheet areas.

These rocks constitute a group, of which the mica schists and phyllites form the major part; most of the other rock types listed have varying degrees of continuity, and form distinctive units within this group.

None of the units has been previously named and the following names are applied to rock-units; the name Holroyd Metamorphics is used as a group-name for the constituent units: Kalkah-type schist, Lukin-type schist, Pollappa-type schist, and Pretender-type schist.

The outcrop of the Holroyd Metamorphics forms a north-trending belt about 100 miles long. It is about 30 miles wide in the southern part and less than 10 miles wide in the northern part of the Ebagoola Sheet area.

The western and south-western margin of the belt are overlain by Mesozoic sediments. Most of the eastern margin is bounded by the Kintore Adamellite but in the southern part the Holroyd Metamorphics contain an isolated area of Arkara-type gneiss.

The Lukin-type schist extends throughout almost the whole outcrop of the Holroyd Metamorphics. The Pollappa-type schist is more or less confined to the central and eastern parts of the northern half of the outcrop. The Pretender-type schist occurs in the northern part of the Ebagoola Sheet where it occupies almost the entire width of the outcrop. This unit also forms part of the eastern side of the outcrop between the Lukin and the Holroyd Rivers. The Kalkah-type schist is restricted to the south-eastern part of the outcrop.

These units within the Holroyd Metamorphics form fairly distinctive land forms. The Lukin-type schist, the Pretender-type schist, and the Kalkah-type schist generally form flat to undulating country and, to a lesser extent, erosional slopes at the base of ridges of the more resistant Pollappa-type schist and of mesas and cuestas of Mesozoic sandstone. Exposure is poor and scattered; the rocks are extensively weathered and they are best seen in steep-sided valleys where they are dissected by creeks with banks up to 20 feet high.

Much of the outcrop of the Holroyd Metamorphics is covered by sand and, in places, clay. The Pollappa-type schist is mainly restricted to the high lands in the area and is easily identified on air photographs. The sillimanite-bearing schists of this unit are in most places interbedded with abundant quartzite bands, which form ridges between 100 and 300 feet high and up to 15 miles long. The highest of these is about 1300 feet above sea-level, the highest point in the belt of Holroyd Metamorphics.

Wide, sand-covered valleys between the ridges are occupied mica-quartz schists, belonging to the Lukin-type and Pretender-type schist, and by minor bodies of adamellite.

Kalkah-type schist

The Kalkah-type schist is confined to the main belt of igneous and metamorphic rocks. It is composed predominantly of muscovite-quartz schist and muscovite-biotite-feldspar-quartz schist. Its largest outcrop lies between the Lukin-type schist and the main body of the Kintore Adamellite, and it is intruded by stocks and offshoots of the adamellite. Bodies of schist, from a few feet to 2 miles across, occur within the adamellite on either side of the Coleman River.

The boundary of the Kalkah-type schist with the fine-grained Lukin-type schist is a transition zone between one-half and two miles wide. The greenschist bodies common in the Lukin-type schist do not extend into the Kalkah-type schist, and their easternmost limit marks this boundary. Except where quartzite or quartz-rich schist occurs, the Kalkah-type schist forms low hills and is poorly exposed.

Schistosity is well developed, except in some fine-grained biotite-quartz-feldspar schist and some coarse-grained muscovite-quartz schist, where the muscovite lacks a strong preferred orientation. Crenulation and a poorly developed lineation are common.

Muscovite-quartz schist is the predominant rock type and crops out north of the Coleman River. South of the river biotite-plagioclase-quartz schist predominates. In the muscovite-quartz schist, the ratio of muscovite to quartz ranges from 1:3 to 4:1, but quartz is generally more abundant than muscovite. Graphite and iron oxide minerals are common accessories.

The muscovite forms idioblastic flakes which are concentrated in irregular bands. The strong preferred orientation of the flakes parallels the banding except is some coarse-grained muscovite-quartz schist.

In the muscovite-biotite-plagioclase-quartz schist, the feldspar is oligoclase; it forms laths and equant grains, incipiently altered to sericite. Biotite and muscovite form xenoblastic to idioblastic flakes with a good preferred orientation.

Various other rock types within the Kalkah-type schist are schists with staurolite, andalusite, or garnet, and schists with abundant graphite or iron oxide minerals. A hornblende-bearing rock, a tremolite rock, and a clinozoisite rock also occur.

The graphitic schist is fine-grained graphite-muscovite-quartz schist of which between 1 percent and 5 percent is graphite. It is commonly interbanded with fine-grained to medium-grained hematite-muscovite-quartz schist, in which the hematite coats the quartz grains and the muscovite flakes.

A fine-grained andalusite-hematite-biotite-muscovite-quartz schist, with andalusite porphyroblasts between one-quarter and one-half inch long, crops out just north of the junction of the roads from Potallah Creek and from the Alice River to Dixie Homestead. It lies near a stock of adamellite, but the schist is not obviously affected by thermal metamorphism, and the andalusite may be a product of regional metamorphism.

Garnet-staurolite-muscovite-quartz schist forms a small exposure on the south-eastern slopes of Manganese Hill, south-east of Glengarland Homestead. The garnet forms rounded to idioblastic porphyroblasts up to 10 mm across; the staurolite forms xenoblastic laths up to 8 mm long; muscovite and quartz form the bulk of the rock. Another specimen from this locality is a staurolite-quartz rock. As staurolite is unstable at low pressure, according to Deer, Howie, and Zussman (1965), these rocks are products of regional metamorphism.

The muscovite-quartz schist lies high in the greenschist facies or low in the almandine-amphibolite facies of regional metamorphism. Staurolite and garnet in the schist at Manganese Hill place these rocks in the lowest (staurolite-almandine) sub-facies of the almandine-amphibolite facies, according to Turner and Verhoogen (1960). Oligoclase in the biotite-bearing schist suggests it is also low in the almandine amphibolite facies.

Thermal metamorphism during the emplacement of the Kintore Adamellite has probably produced the growth of randomly oriented muscovite and,

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in places, biotite in the muscovite-quartz schist. Near the adamellite muscovite is converted to andalusite and sillimanite, and biotite and tourmaline are introduced; the biotite has a random orientation. These minerals characterise the hornblende-hornfels facies of metamorphism. More intense metamorphism has produced a fine even-grained hornfels enriched in potash, as described in the section on the Kintore Adamellite. This hornfels is extensive in the schist east of the bi-lobed stock of adamellite north of the Alice River Goldfield.

Also near this stock an exposure of hornblende-bearing rock in composed of bands rich in hornblende and plagioclase alternating with bands rich in quartz and containing small quantities of clinozoisite, hornblende, and plagioclase. Quartz forms up to 60 percent of the rock and its composition suggests a sedimentary origin rather then an igneous one. However, the presence of hornblende low in the almandine - amphibolite facies is to some extent anomalous, and it may have an igneous origin.

Near the junction of the roads to Dixie Homestead from the Alice River and from Potallah Creek, a small exposure is composed of a rock which is 99 percent xenoblastic, granoblastic clinozoisite, and about 1 percent sphene.

Within the Kintore Adamellite, adjacent to the Kalkah-type schist, an isolated exposure is composed coarsely crystalline white tremolite (about 95 percent)and minor talc. This rock was probably produced by thermal metamorphism of a calcareous sediment.

Lukin-type schist

The Lukin-type schist is the most extensive of the Holroyd Metamorphics and forms a continuous outcrop from just north of the Alice River to within 6 miles of the north of the Ebagoola Sheet area.

The Lukin-type schist is typically a fine-grained to medium-grained muscovite-quartz schist which grades imperceptibly into phyllite of similar mineral composition. These rocks form the greater part of the

Lukin-type schist but they show irregular regional variations, and, in places, grade into rocks which have a distinctly different composition or geological association. The other rocks include: quartzite and greenschist bands - some of which form marker bands on the map; spotted and knotted schists; bands of andalusite-bearing schist; schists of higher metamorphic grade than typical Lukin schist; schists containing, and affected by, minor acid-igneous and quartz intrusives; and indurated mudstones and siltstones. With the exception of quartzite and greenschist marker bands, none of these varieties were delineated as discrete bodies, mainly because of their irregular distribution and abundance, and because of the vague, gradational nature of their boundaries.

The typical Lukin schist is composed mainly of muscovite and quartz; the muscovite is generally of very fine grain-size and may be more properly called sericite. Generally the schist is associated with phyllites of the same mineral composition and to a lesser extent with coarser-grained muscovite schists. The schists and phyllites contain fissile psammitic bands from ¼ inch up to several feet thick, which are metamorphosed clayey sandstones. The psammitic bands do not have any systematic distribution. The schists and related rocks are generally extensively weathered so that their exposure is poor and their original composition is difficult to determine. They may be grey, purplish-red, yellowish-buff or reddish-brown. Commonly they are stained by iron hydroxides which may produce banded and irregular patterns of various yellows and reds. In many places the rocks contain graphite, and are grey-black.

In most places foliation is well developed; it is generally oriented parallel to the trend of the main belt (north-north-west) and normally it has a sub-vertical to vertical dip.

The schist consists essentially of quartz and sericite in almost equal proportions, or muscovite, biotite, and quartz in various proportions. They may contain accessory to minor amounts of graphite, chlorite, feldspar, garnet and opaque minerals as well as accessory tourmaline and zircon.

The quartz occurs as small anhedral grains, generally slightly elongate with the long axis parallel to the schistosity. In places these are concentrated in lenses and bands up to several centimetres thick,

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alternating with bands of sericite or muscovite. The sericite flakes have a common orientation, and may partly wrap around the quartz grains. They also commonly form narrow bands and discontinuous lenses.

Graphite forms up to 20 percent of the schists and phyllites in some places. It occurs in flakes which are oriented roughly parallel to the schistosity; they are scattered throughout some rocks but tend to be localised in bands and lenses in others. Some of the graphite forms very small, dust-like, disseminated particles.

Chlorite and feldspar were rarely identified. They form up to 3 percent of some sections, but they may have been extensively altered and commonly iron-stained in these weathered rocks. Garnet and opaque minerals (iron oxides), are typically scattered as small grains mainly along the foliation planes. Tourmaline and zircon occur as detrital grains.

No systematic variation of the mineral content, degree of metamorphism, or texture was observed within the typical schists. However, some variations are described.

Schists and phyllites which contain essential amounts of graphite are most widespread in the southern part of the belt, between Potallah Creek, O'Lane Creek, and Ethel Creek. The rocks are characteristically dark grey and some weather to a puggy, greasy, black dust. This ill-defined area of graphitic rocks does not extend northwards in the Lukin schists but similar rocks do occur near the Coleman River between the westernmost quartzite marker band and the Mesozoic boundary.

North of the Coleman River graphite is wide-spread but scattered. It is consistently abundant in the schists between Eighteen-mile Creek and the King River, and also along the western side of the King River in an area up to 6 miles wide.

About 8 miles north-north-east of the junctions of the King and Coleman River, dark grey, graphtic schistose phyllites are exposed in numerous small creeks. They have a prominent sub-vertical foliation, which has a silky sheen. In places the foliation is intersected by a second plane of parting which produces a steeply plunging lineation on it.

A specimen (66480291) from this area consists mainly of quartz (50 percent), in slightly elongated grains parallel to the schistosity, and muscovite (30 percent) in roughly parallel flakes which in some places are, more or less, concentrated into bands. Graphite (up to 10 percent) is scattered through the rock in small flakes and aggregates of dust-like particles. Sericite and associated clayey material occur in scattered patches. The rock is iron-stained with some suggestions of limonite pseudomorphs after pyrite. Thin stringers of quartz occur along some foliation planes.

The graphitic schists and phyllites in this general area commonly contain narrow bands (up to 1 ft. wide) of amphibolite, quartzite and quartz-muscovite schist. Narrow bands and pods, up to 15 ft. wide, of coarsely crystalline quartz, muscovite and feldspar, with muscovite books up to 1½" across, are not uncommon.

Another regional variation of the typical schists forms a north-trending belt up to 2 miles wide near Drovers Creek, south of the Coleman River. The rocks in this belt are notably massive, very fine-grained biotite-muscovite quartz schists which are somewhat hornfelsed. They are poorly cleaved but in places they contain narrow bands or beds of slightly different grain-size which are parallel to the foliation. These bands are intercalated with bands up to several feet thick of well foliated micaceous schist, blue-grey shale, quartzite and minor greenschist.

The Lukin-type schist north of the Lukin River is a consistently monotonous sequence of fine-grained muscovite-quartz schists which typically contain minor biotite and accessory graphite. They grade into yellow-brown and grey phyllites. Sample 66480395, taken about 4 miles north-east of Pollappa out-station, is typical of these schists. It consists of muscovite (55 percent), quartz (25 percent), biotite (15 percent) and accessory garnet, tourmaline and iron-oxides. It has an average grain-size of 0.2 mm, and a strong schistose texture. The garnets measure up to 0.5 mm.

Hematite is common throughout the southern part of the Lukin-type schist. In some iron-stained specimens (66480441) from near Potallah Creek Mine hematite forms up to 5 percent. It occurs in scattered stringers and rectangular forms; the latter may be pseudomorphs after sulphides. Small

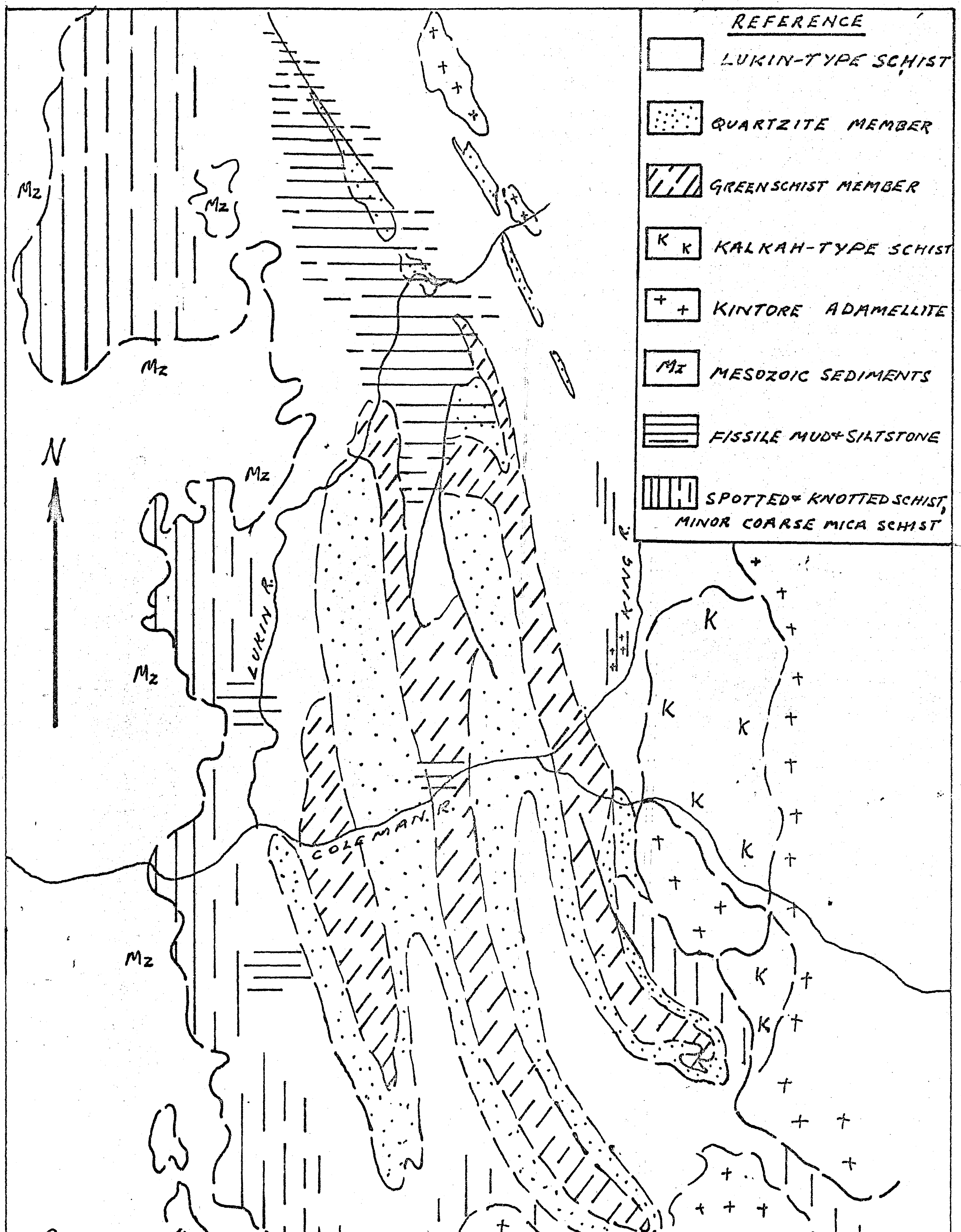


FIGURE. 5. VARIATIONS IN THE LUKIN-TYPE SCHIST IN THE VICINITY OF THE COLEMAN + LUKIN RIVERS.

quartz lenses in graphite-sericite-quartz schist, 4 miles west of the mine, carry large grains of iron oxide.

Rocks of distinctly different composition to the typical schists form an integral part of the Lukin-type schist. These variants occur mostly in the vicinity of the Coloman and Lukin River (Fig. 5). The rock types differentiated in Figure 5 are generalised with the exception of the quartzite and greenschist members, and their boundaries within the unit are gradational.

The most distinctive quartzite in the Lukin-type schist crops out between 10 miles north and 12 miles south of the Coleman River. It is in bands up to 1 mile wide which are prominent on air-photos and may be traced continuously along strike, for up to 18 miles. The quartzite bands form prominent low hills, in places up to about 250 feet high, covered by blocky rubble. The margins of the bands are not as easily seen on the ground as on the air-photos since they commonly include narrow bands of phyllite, mica-schist and greenschist, and the neighbouring schists contain narrow bands of quartzite.

Bedding was observed in some places and rarely a crude cross-bedding can be recognised; however, the quartzite is generally recrystallised to the extent that primary sedimentary features are obliterated. In places, small variations in grain size over several feet outline bands which may be the original bedding. Variations in the weathered surface of the quartzite indicates that its degree of crystallisation is variable. Some exposures weather to clean, sub-vitreous massive blocks, others tend to develop a sandy iron-stained surface from which the removal of fine matrix has left individual non-fused grains. Narrow white quartz veins, less than 1 inch thick, are common and some probably fill tension fractures caused by folding; others occur along cleavage joints, or are normal to this direction.

The most common quartzite is white to grey, fine-grained to medium-grained, and essentially massive, but with a well developed jointing in many places, which may be so close as to resemble a cleavage parallel to the strike of the exposure. The rock commonly consists almost entirely of an interlocking aggregate of strained quartz grains which have serrate margins and are slightly elongated roughly parallel to joint planes or crude schistosity, (L221, 66480175).

Some contain up to 10 percent clayey or silty matrix. Minor sericite is common and gives the rock a schistosity. The quartzite is commonly iron-stained and contains minor hematite, rare scattered feldspar crystals, and chlorite. Graphite occurs in some quartzite associated with phyllitic rocks. Accessory tourmaline and zircon of detrital origin were found in specimen 66480296.

Smaller quartzite bands are scattered through other parts of the Lukin-type schist. In the south it contains abundant bands near Crosbie Creek, which appear to be marginal to the thick quartzite band shown on the map. South of Crosbie Creek, schists and psammitic rocks contain quartzite bands ranging from several inches to several feet wide. These are white, light-brown, or dark-grey, and medium-grained to fine-grained; slight differences in grain size indicate original bedding. They are commonly cleaved. Some fine-grained quartzite on the south side of Crosbie Creek contains cylindrical structures several millimeters long which resemble worm burrows.

Near O'Lane Creek, pink medium-grained and even-textured quartzite which contains up to 10 percent sericite, 66480416 has been sheared. The shearing has produced micro-recumbent folds, elongation, and preferred orientation of some of the larger grains 66480148, 66480149).

Along the western part of Crosbie Creek quartzite bands up to 10 feet thick are medium-grained, massive and have abundant silt-size matrix and minor feldspar content; they are intercalated with blue-grey sericite-quartz schist. The bands are concordant with the foliation of the enclosing schist and have sharp contacts with it. Graphitic schistose phyllites west of Eight-mile Creek (a tributary of the King River) are interbanded with isolated quartzite bands up to 200 feet wide, 100 feet high and up to 2 miles long. The strike is parallel to the metamorphic foliation of the enclosing rocks. In some places, the phyllites, which may be psammitic, grade into quartzite.

About 2 miles north of Eight-mile Creek graphitic phyllites grade into a tough knotted muscovite schist which forms the slopes of a quartzite ridge. The quartzite has abundant closely spaced cleavage or joint planes along which sericite has developed. Cleaved and indurated, sandy sericitic siltstone is interbedded with the quartzite.

North of the Lukin River quartzite bands are generally far less common, they rarely exceed several feet in width and they are discontinuous. An exception to this is west of the main belt of Pollappa-type schist, south of the Holroyd River, where the schists are intercalated with bands of quartzite up to 30 feet thick.

Greenschist bands in the Lukin-type schist are not widespread. The largest are shown on the map, where they range up to 20 miles long and 2 miles wide. They are distinctive dark bands on the air photos.

The distribution of the greenschist member is controlled by the same structures that control the distribution of the quartzite member. The greenschist, however, does not have the same continuity of outcrop as the quartzite. In places it forms patches of large scattered boulders on low rises; elsewhere, it presence is recognised by a characteristic reddish soil containing residual fragments of greenschist.

The composition and texture at one outcrop is fairly consistent; between different outcrops, however, there is considerable variation. Typically the rocks are fine-grained to coarse-grained, dark green, and consist of a fairly uniform interlocking aggregate of fibres and prisms of amphibole or chlorite.

Table 2 shows the mineral composition of 10 rocks collected from different bands of greenschist.

An amphibole of the actinolite - tremolite series is generally the most abundant mineral. It typically occurs as subhedral randomly extended lath-like prisms which may form aggregates; they may be colorless, various pale shades of green, or pale brown. Large flakes contain inclusions of other minerals, commonly plagioclase. The amphibole is generally partly replaced preferentially along cleavage planes, by chlorite. Some chlorite forms very fine, commonly interstitial xenoblastic laths and needles as an alteration product after amphibole. In other places it is intimately associated with amphibole as a fine mesh of randomly oriented flakes which have no relict amphibole characters and are assumed to be primary chlorite.

Table 2 Mineral composition of rocks in the greenschist bands of the Lukin-type schist.

ROCK NUMBER (66480...)	359	171	172	368	247	293	294	373	360	170
Epidote										20
Hornblende										40
Biotite							5			
Apatite						acc				
Altered minerals		20		10	10					
Opaques	acc			acc				acc		
Sphene						5	acc	40	10	5
Plagioclase		5					25			acc
Quartz						20	15		50	25
Chlorite	75			75	40					
Actinolite						75	55		40	
Tremolite	25		100							
Tremolite - Actinolite		75		15	50			60		

acc = present in accessory amounts.

The plagioclase is invariably andesine. It occurs in irregularly shaped laths interlocking at random with the amphibole. It has inclusions of amphibole and in 66480294, it appears to be replacing it. The feldspars are commonly extensively altered to cloudy aggregates of saussurite which is associated with minor chlorite. Quartz is interstitial between amphibole and plagioclase. Sphene occurs as small grains and clumps of very fine grains which may be associated with aggregates of a very fine opaque mineral, possibly ilmenite. Hornblende and epidote have a restricted occurrence as fine-grained granular masses elongated parallel to the schistosity.

Although many of the greenschists consist largely of a random fibrous aggregate of minerals, others are schistose, foliated and granoblastic. Some contain bands of different grain size which are parallel to the foliation. In some rocks, notably in 66480373, the texture is essentially that of doleritic rock, modified by the crystallization of actinolite. This suggests that the rock was derived by relatively low-grade metamorphism from a dolerite. Further evidence of igneous origin was found near the headwaters of Dinah Creek where approximately 50 feet of an altered basaltic rock was found (66480368). The basalt is dark grey-green, massive, has imperfect cleavage or jointing and contains amygdules in bands and irregular areas. The amygdules are elongated and roughly parallel. The groundmass (average grain-size 0.1 mm) consists of hornblende (40 percent) albite (40 percent), quartz (10 percent) and accessory clinozoisite, sphene and cloudy alteration products. The amygdules contain albite (60 percent), quartz (30 percent), hornblende (6 percent), and calcite (5 percent). The groundmass has an essentially basaltic texture although evidence of recrystallisation suggests that the rock is a hornfels, derived by the metamorphism of an intermediate to basic volcanic rock, possibly an andesite. The evidence is insufficient to show that the entire member has this genesis. It may have been formed at least in part, by the retrogressive metamorphism of an amphibolite which may have had either an igneous or a sedimentary origin.

Smaller greenschist or amphibolite bands are rare in other parts of the Lukin-type schist. Several isolated lenses and bands of greenschist were found near Potallah Creek. They are essentially green-grey, fine-grained, massive feldspar-sericite - actinolite schists and are not associated with quartzites as is the greenschist member to the north. These minor bands appear to be isolated extensions of the larger member, and they probably have the same origin. In the Lukin-type schist north of the Lukin River several small amphibolite bands are sporadically interbanded with schist and phyllite. Some of them appear to be the metamorphosed equivalents of small basic igneous intrusives.

Spotted and knotted schists are fairly widespread and continuous along the western margin of the Lukin-type schist. They extend northwards from the southern part of the Lukin-type schist until they become generally inconspicuous several miles north of the Holroyd River. Their eastern margin is poorly defined, but may be represented by a zone roughly parallel to the Mesozoic boundary and up to 6 miles east of it. Along this zone the spotted rocks grade into the more or less typical schist. Spotted and knotted schists are also common adjacent to the large bodies of Kintore

Adamellite in the Potallah Creek area.

Along the western margin, the rocks are mainly very fine-grained quartz-sericite and quartz-muscovite schists, their composition and texture is generally homogeneous but psammitic bands with gradational boundaries are not uncommon. The rocks are usually light grey, and in some places ferruginous; they are generally not graphitic.

The spotted and knotted schists have a marked foliation which may be moderately crenulated and lineated. Most of the schists contain disseminated spots which consist of discrete mineral crystals almost invariably less than 1 mm in diameter. They have a random but fairly uniform distribution through the rocks and may form betwwen 2 percent and 15 percent of them. Porphyroblastic segregations of sericite, muscovite and quartz also occur in places. The crystals and small porphyroblasts were formed after the main schistosity of the enclosing schist was established. Spots of biotite and garnet are the most common; typically they are altered to hydrous iron oxides which partly fill the cavities of the pre-existing mineral. A few small crystals of andalusite were recognised in some spotted biotite-quartz-muscovite schists. Long prim-shaped pseudomorphs of sericite after andalusite were found in a leached sericite schist which contained abundant euhedral crystals of muscovite up to 1 mm across. North of the Lukin River, sporadic bands less than ½ mile across commonly contain small disseminated spots of biotite, garnet or sericite.

About 6 miles south of Pollappa outstation, a fine-grained biotite-quartz-muscovite schist (66480306) contains small disseminated garnet crystals 0.5 mm across, with andalusite crystals 3 mm across. The micas wrap around the garnet, and a second generation of quartz, slightly coarser than the quartz in the matrix, has crystallised in "strain shadow" areas adjacent to some porphyroblasts. Andalusite is largely replaced by sericite. North of the Holroyd River, within 5 miles of the Mesozoic contact, only localised areas of fine-grained, spotted schist occur within the fine-grained sericite schist. The spotted schist contains scattered subhedral andalusite porphyroblasts which measure up to 5 mm across and form up to 10 percent of the rock; in some places the andalusite is completely pseudomorphed by aggregates of sericite. Biotite is a constituent of the spotted schist north of the Holroyd River and far more common than in the more widespread spotted schist south of the river. The presence of biotite indicates a more widespread effect and slightly higher grade of thermal metamorphism contrasting with the apparent zonation and more restricted effects of thermal metamorphism in the southern area.

In the Potallah Creek area, near the Kintore Adamellite bodies, the schists are essentially the same as all those along the western margin to the north. Neither contact aureole nor mineral zoning was delineated on the scale at which the mapping was carried out. Near Ethel Creek a dark grey graphitic sericite schist (66480433) has abundant rod-shaped aggregates of graphite, iron-oxide and sericite; most are oriented parallel to the place of schistosity; the rest cut the schistosity at various angles. They have evidently formed after the schistosity was established.

At the head of Ethel Creek a sandy dark-grey massive graphitic rock (66480425) contains about 60 percent sericite, which has no preferred orientation but is concentrated in scattered spots up to half an inch long. Quartz (20 percent) is also scattered and commonly forms spots. In upper Potallah Creek, near the Kintore Adamellite, blue-grey to black, fine-grained spotted graphite-sericite schist contains rods, 2 mm x 5 mm of graphite, sericite, iron oxide and clay in a well foliated matrix of graphite, mica and clay. It is intruded by minor white quartz bodies. One 3-foot band weathers to a powder and is partly covered by white efflorescence of aluminium sulphate. An adjacent psammitic sericite-quartz rock has no spots and no parting planes but has a moderate schistosity.

Bands of andalusite-bearing schist also have a sporadic distribution, through the Lukin-type schist. They differ from the spotted and knotted schists in that they are distinct and well defined bands, mainly within schist which lacks andalusite. Generally they have a maximum width of about 110 feet and a maximum observable strike length of about 1 mile. They do not show up on the air-photographs. In the vicinity of Eight-mile Creek graphitic schistose phyllites contain a band about 60 feet wide of a knotted and spotted grey muscovite schist. The knots or porphyroblasts, which are most clearly exposed on the weathered surface of the rock, measure up to 2 inch across, have a rectangular shape, and although they have a random orientation they are mainly distributed along the foliation planes. Their textural relationships indicate that they formed after the development of the main schistosity. Some are zoned crystals of andalusite and chiastolite but most are dark grey, dense and rather nodular porphyroblasts made up of pseudomorphs of cryptocrystalline sericite or muscovite after andalusite (N107, 66480295). The schistose matrix containing the porphyroblasts in 66480295 consists mainly of quartz (50 percent) muscovite (25 percent) and graphite (5 percent). The quartz and muscovite occur respectively in elongate grains and flakes oriented parallel to the schistosity and wrapped around the porphyroblasts. Quartz and muscovite also form minor porphyroblast aggregates. Graphite is generally disseminated as dust-like particles; fine (0.05 mm) grains of tourmaline make up to 5 percent of the rock. Near the andalusite schist massive, coarse quartz-muscovite schist, slightly pegmatitic in character, is associated with coarse quartz-chlorite-muscovite schist, in lenses up to 30 feet wide.

Muscovite-quartz schist containing up to 20 percent andalusite (66480193) was also found in the narrow belt of Pretender-type schist within the Kintore Adamellite, about 2 miles south-west of the junction of Bamboo Creek and the Lukin River. The andalusite and associated biotite form porphyroblasts up to 7 mm across in a schist of average grain size of 0.5 mm. It is similar to the andalusite-bearing schist found throughout the Lukin-type schist.

Mica schists of higher metamorphic grade than typical Lukin-type schist form small isolated areas and sporadic bands throughout the Lukin-type schist; they are most abundant in poorly defined zones along the margins of the unit. South of the Coleman River, near the headwaters of Lindalong Creek and adjacent to the Kintore Adamellite and Kalkah-type schist, the eastern margin of the Lukin-type schist consists mainly of coarse-grained quartz-muscovite schist, with garnet in places. Muscovite is the main component and the rocks have a prominent foliation which is commonly crenulated, to give a strongly developed lineation. The schist is spotted; relatively fine-grained schist contains spots of biotite; the coarser-grained rock carries small, disseminated grains of garnet which have been extensively altered to hydrous iron-oxides. These rocks are considered to be of higher metamorphic grade than the typical Lukin-type schist because of their coarse grain-size and of their garnet content.

The spotted schist towards the head of Potallah Creek contains several isolated exposures of muscovite-biotite-feldspar-quartz schist. Sample A 149 is medium-grained, moderately well foliated, and has poorly developed spots of muscovite on some foliation planes. The presence of oligoclase (30 percent) and biotite (15 percent)indicates that it is of higher metamorphic grade than the associated sericite-quartz schists. In the head-waters of Ethel Creek, (T154) crenulated medium-grained to coarse-grained schists contain mostly muscovite in contrast to sericite in rocks to the west.

The rock at the head of Lindalong, Potallah and Ethel Creeks form the western margin of a transitional zone from Lukin-type schist to medium-grained Kalkah-type schist to the east.

Dykes and veins of quartz and quartz-feldspar-muscovite rock are common in some parts of the Lukin-type schist. They are most abundant in the southern part of the unit, in the general vicinity of the numerous igneous intrusives; they are almost certainly related to the intrusives.

Near the Potallah Creek mine, veins and stringers of white quartz up to 5 mm wide carry limonite pseudomorphs after pyrite. They are probably related to a nearby milky-white massive quartz band up to 50 feet wide and 200 feet long. A sluiced area on the north side of Potallah Creek exposes irregular pods and veins of quartz and kaolinite up to 4 inches wide. These are semi-concordant with the schistosity of a weathered, rather friable country rock which appears to have been granitised. Narrow seams of grey pug are also present.

Near Ethel Creek, sericite - quartz schist and quartzite contain irregular stockworks of kaolinite and chalcedony; intense fracturing has destoyed lithological banding in some exposures. In the upper part of Potallah Creek near the Kintore Adamellite, a well foliated sericite-quartz schist and bands of psammitic rock are cut by abundant dykes and irregular bodies of muscovite granite-pegmatite. Some are greater than 30 feet wide and carry muscovite crystals up to 3 inches across; white quartz veins up to 5 inches wide cut the pegmatite. This intrusive material is derived from the nearby adamellite.

Although the effects of the adamellite on the Lukin-type schist are largely restricted to the development of spotted schists and the introduction of quartz veins, evidence of possible granitisation was found in Nine-mile Creek, where the schist near the granite has been hornfelsed and recrystallised to fine-grained and medium-grained muscovite-biotite-quartz-feldspar schist. Spots and narrow bands of granitic rock, which are parallel to the schistosity, have formed by metamorphic differentiation; their contacts are gradational. Bands and pods of biotite-muscovite adamellite cut across the schistosity and have sharp contacts. Minor recumbent folds are distorted and cut by minor faults. Sample 66480436 from here is a banded muscovite-biotite-quartz rock containing medium-sized to small anhedral feldspar crystals. The rock appears to be a recrystallised schist with the feldspar introduced, probably by processes of metasomatism. Garnet-muscovite granite-pegmatite with graphic texture forms exposures up to 50 feet across in the banded, hornfelsed schists in this area.

About 4 miles north-east of the confluence of the King and Coleman Rivers, the exposure of the Lukin-type schist is poor but white quartz reefs are abundant. The quartz reefs commonly contain drusy cavities, and muscovite-quartz-feldspar pegmatite which in places looks like a very coarse porphyritic granite. Grey schist and phyllite to the north contain less abundant quartz reefs and pegmatitic muscovite-quartz rocks.

With the exception of minor iron oxides the intrusives appear to be barren of any opaque or heavy minerals. Near the sheared areas associated with the large fault west of the ridges of Pollappa Schist narrow bands, veins and stringers of quartz and of granitic rock are common along the foliation, rarely cutting it, particularly in the crenulated and slightly contorted rocks. Quartz reefs up to 15 feet wide and 200 feet long are common; they trend parallel to the prevailing metamorphic foliation. Rare poorly developed box-works with limonitic filling in some reefs are possibly evidence of pre-existing iron sulphide minerals. Several crystals of arsenopyrite and stibnite and minor graphite were found in reefs between Strathaven Homestead and the Edward River.

Indurated mustone and siltstone occupy a poorly defined belt up to 4 miles wide which extends about 8 miles south of, and about 10 miles north-north-west of the Lukin Gorge. Small isolated outcrops also occur near the Coleman River. These rocks have transitional boundaries with the surrounding schist and phyllite. The boundaries are poorly exposed and therefore can not be delineated.

The rocks consist mainly of fissile mudstone, siltstone, shale, and some quartzite. The quartzite near the Lukin Gorge, because of its apparent association with shale, is also included in this group of rocks.

Primary sedimentary features can be recognised and slaty cleavage both transgresses and is parallel to the bedding. The cleavage planes commonly have a rather silky sheen and show lineation caused by the intersection of bedding and cleavage planes.

These rocks generally crop out as low hills which are covered with blocky and tabular scree. Generally they are extensively stained with iron-oxides; they are red with irregular bands and patterns of various colour tones. Almost identical rocks from the Warramunga Group near Tennant Creek, and area of comparable weathering conditions, are mainly grey and dark green chloritic shale, siltstone and subgreywacke below the zone of oxidation.

Not all of the rocks are iron-stained. Sample 66480392 from a sequence of mudstone, siltstone and sandstone about 6 miles north-north west of the Lukin Gorge has irregular laminae of dark grey mudstone interbanded with light grey silty-mudstone. The irregularity of the banding suggests slumping or distortion by compaction. The rock is made up of quartz (50 percent), sericite (30 percent), partly altered plagioclase (10 percent), chlorite (10 percent), and accessory zircon and iron-oxides.

Another rock from the same gereral area (66480394) has essentially the same composition, but it has a distinct foliation and contains about 3 percent disseminated garnet grains (less than 1 mm across), which have been extensively replaced by hydrous iron oxides, and the chlorite is replaced by biotite. Isolated relict pods, with the original bedding and no garnet, have been preserved and cut across the foliation.

The ridges near The Gorge on the Lukin River consist mainly of sandy quartzite and indurated sericitic siltstone. The quartzite and siltstone grade into subgreywacke which has a fine, sericitic, silty matrix, containing rare rock fragments. Fine bedding is discernable in the relatively even-textured sandy quartzites and crude cross-bedding is present in places. The cleavage which is generally near vertical, commonly cuts acroos the bedding.

On the western side of the main quartzite ridge extending north-north-west from The Gorge, phyllitic shale grades westwards into the fine schist; some contain small spots of garnet and sericite.

Pollappa-type schist

The Pollappa-type schist has a discontinuous outcrop in the central and eastern part of the Holroyd Metamorphics, between the Lukin River and the northern margin of the Ebagoola 1:250,000 Sheet area. South of the Holroyd River the maximum width of its outcrop is 10 miles and maximum length 18 miles. North of this river it forms a belt about 1 mile wide, and 12 miles long. The Pollappa-type schist consists mainly of andalusite-bearing and sillimanite-bearing sericite-quartz schists which are intimately interbanded with quartzite.

The mineralogy and appearance of the Pollappa-type schist are in most respects analagous to the Saraga-type schist of the Dargalong Metamorphics. However, since it forms an integral part of the western belt of low-grade metamorphics, which is lithologically and geographically quite distinct from the rocks associated with the Saraga-type schist, the Pollappa-type schist is differentiated as a separate unit.

The quartzite in the Pollappa-type schist forms bands up to 200 feet thick which in places have a continuous strike length of up to 15 miles. They are separated by belts of schist which are less well defined but may measure up to half a mile thick, and have a comparable but less continuous strike length.

Consistent with the regional metamorphic foliation throughout the Holroyd Metamorphics, the quartzite horizons are oriented in a north-westerly direction and invariably have dips, either to the west or to the east, greater than 70°. They are rarely faulted and minor folding in them is localised. They commonly form sheer cliffs up to 300 feet high.

The quartzite is white to grey, medium-grained to coarse-grained and has a granulose texture. It is massive, and sedimentary features are rarely seen. It consists almost entirely of quartz but may contain minor sericite and accessory iron oxides in the matrix, and an irregular veneer of muscovite on some joint planes. Individual grains, which are slightly elongated and commonly aligned, are generally discernible, but in some places the grains have fused into a homogeneous siliceous aggregate and cannot be recognised in hand specimen.

The schist associated with the quartzite bands is medium-grained to coarse-grained. It is generally red to maroon due to very finely disseminated hematite and iron-staining; where it contains graphite it is dark grey; rarely it is grey-green. The colour of the rocks changes, in places, over distances of several feet, because the distribution and abundance of graphite and, to a much smaller degree, hematite, are variable.

Schistosity in the relatively fine-grained rocks is moderately well developed and generally has a north-westerly trend and a steep dip. In the coarser-grained rocks the schistosity is poorly developed. They typically form coarse, boulder-covered and rubble-covered, outcrops which scarcely show the structural trends of the underlying rocks. The schist is slightly more resistant to weathering than the neighbouring Lukin-type schist but its prominent relief is probably due to its intimate association with quartzite.

Although the schist commonly contains both sillimanite and andalusite, the sillimanite-bearing schist is probably more widespread. The andalusite-bearing schist is generally restricted to discontinuous bands, up to 100 feet thick, within sillimanite-bearing schist.

A petrological examination of 11 schist samples from widely separated localities in the Pollappa-type schist indicates that they have basically a consistent and simple assemblage of minerals. These are listed in the table below.

Table 3 Minerals of the Pollappa-type schist (11 sections)

Mineral	Abundance (percent)	Number of Sections containing Mineral
Quartz	35 - 60	11
Muscovite & sericite	10 - 50	11
Sillimanite	0 - 20	7
Andalusite	0 - 20	9
Biotite	0 - 30	2
Iron Oxides	5 - 10	11
Graphite	0 - 10	6
Rutile	less than 5	3
Zircon	" " 5	5
Tourmaline	" " 5	2
Monazite	" " 5	4
Sphene	" " 5	4
Garnet	" " 5	1

Quartz grains are ubiquitous in the rock matrix but typically they are concentrated in granulose aggregates in lenticular bands. The bands are intercalated with, and have gradational boundaries with, mica-rich bands. The quartz grains are generally slightly elongated and roughly aligned parallel to the foliation; some quartz aggregates give the rock augen structure, on a small scale.

The sericite has two modes of occurrence:

In the first the sericite is an essential part of the rock matrix. It occurs in aggregates associated with quartz and minor sillimanite, which form irregularly elongated zones and bands up to 5 mm thick intercalated with quartz-rich bands. The aggregates are aligned parallel to the rock foliation. Variable amounts of sericite also occur in the quartz aggregates in the matrix. This sericite is commonly oriented roughly parallel to the foliation.

In the second the sericite partly, and rarely completely, replaces sillimanite and andalusite porphyroblasts, in all the sections examined. A corona of sericite characteristically encloses the andalusite and sillimanite but generally retains the shape of the original crystal. In some places (6648298) the sericite is arranged in rows of flakes which have grown perpendicular to the andalusite crystal-faces. Andalusite is also replaced by sericite along its 2 sets of cleavage fractures. The orientation of the sericite is controlled by the orientation of the pre-existing mineral and not by the rock foliation.

In specimen 66480312 euhedral crystals of muscovite (up to 2 mm across) are randomly scattered through a relatively fine-grained muscovite-quartz-graphite matrix. They form porphyroblasts which give the rock an augen structure. Some of the coarse muscovite appears to have been rolled possibly during cataclasic deformation.

Sillimanite (or the altered equivalent) occurs in aggregates of prisms and fibres, or as a felted mass of fine needles (e.g. 66480313) throughout the rock matrix. Individual prisms are up to 3 mm long. In some places the prisms have a common orientation which produces a lineated rock with a good foliation. Generally, however, the prisms only have a very rough common alignment, and the rock is poorly foliated.

Andalusite, in fairly well defined prisms, generally has a more-or-less random scatter through a quartz-sericite matrix, which may or may not contain sillimanite. Most andalusite is partly altered to sericite. In 6648030 andalusite porphyroblasts contain abundant needles of sillimanite which may have been derived from the andalusite by alteration.

The most striking andalusite-bearing schist occurs about 1 mile north-east of Pollappa. It forms a band about 100 feet wide in sericite-sillimanite schist and associated quartzite. Specimen 66480310 has a medium-grained to coarse-grained granulose matrix of quartz (forming 45 percent of the rock, biotite (25 percent) and muscovite (5 percent). It is massive and has essentially no metamorphic foliation. The biotite, which was found in only one other specimen, forms flakes up to 3 mm across, scattered randomly through the quartz matrix. Andalusite (forming 20 percent of the rock) occurs in large, unaltered euhedral prisms up to 4 inches long and $\frac{3}{4}$ inch wide. The prisms are randomly distributed throughout the rock; the micas in the matrix adjacent to each prism are aligned parallel to the andalusite crystal-faces. The andalusite is poikiloblastic and carries inclusions, commonly in zones, of quartz, zircon, rutile and iron oxides.

Another feature of this rock is the abundance and variety of heavy minerals. Zircon and monazite are common inclusions in biotite and have pleochroic haloes. Accessory grains, measuring up to 0.5 mm, are composed of brookite or anatase, polymorphs of rutile. They are associated with biotite. Sphene occurs in isolated patches, and graphite and hematite in scattered flakes.

A similar assemblage of accessory minerals was found in an andalusite-sericite-graphite-sillimanite-quartz schist about 15 miles north-north-west of Pollappa. About 10 miles west of the junction of Bamboo Creek and the Lukin River sillimanite-sericite-quartz schist alternates with bands of andalusite-quartz-sericite schist (66480298). The andalusite, which is extensively replaced by sericite, forms prisms up to 2 inches long and $\frac{1}{4}$ inch wide within a graphitic and hematitic, fine-grained matrix. The andalusite crystals have a random orientation. They appear to have been silicified on the exposed surface and therefore stand out prominently from the softer matrix.

Pretender-type schist

The Pretender-type schist is mainly confined to the eastern part of the Holroyd Metamorphic belt between the Lukin and Holroyd Rivers, and to the northern 12 miles of the belt on the Ebagoola Sheet area. An isolated band of Pretender-type schist was also found along the western side of quartzite ridges about 10 miles north-west of Pollappa.

The Pretender-type schist consists essentially of medium-grained to coarse-grained biotite-muscovite-quartz schist, which in places contains minor plagioclase. It is generally grey or speckled dark grey-green, rather massive and poorly schistose. Outcrop of the schist in most areas is very poor being extensively covered by white sand. The trends within it are conformable to those throughout the belt. The gross characteristics of the Pretender-type schist are not significantly different from those of the Lukin-type schist and it is impossible to distinguish between them on the air photographs. However, it is possible to delineate the Pretender-type schist as a separate unit on the ground. The mapped position of the boundary between the Pretender-type and Lukin-type schists is approximate only because of the gradational nature and the similar air-photo pattern of the two units.

The boundaries between the Pretender-type schist and the Pollappa-type schist are well defined on the air photographs and on the ground.

Rocks within the Pretender-type schist are distinguished from rocks of similar mineralogy within the Lukin-type schist by their coarser grain-size, higher biotite content (generally greater than 10 percent), and by the widespread development of an incipient gneissic texture. An additional distinguishing feature is the presence of feldspar in the Pretender-type schist. Apparently the Pretender-type schist underwent a higher degree of metamorphism than most of the Lukin-type schist.

An examination of seven thin-sections from widely separated areas in the Pretender-type schist indicates a consistent assemblage of minerals throughout the unit. Table 4 summarizes the approximate composition of the thin-sections:

<u>Table 4</u> <u>Minerals of the Pretender-type schist</u>

Mineral	Abundance (percent)	Number of Sections containing Mineral
Quartz	50 - 80	7
Muscovite	5 - 40	7
Biotite	0 - 20	6
Plagioclase	0 - 10	6
Graphite	0 - 10	3
Sillimanite	0 - 8	4
Apatite	0 - 3	2
Tourmaline	less than 5	3
Monazite	" " 5	3
Zircon	" " 5	4
Iron Oxides	" " 5	5

Although the mineralogy of the Pretender-type schist is moderately consistent, the gross characteristics of the rocks in different areas of outcrop are variable.

The schist is most distinctive in the northern part of the Holroyd Metamorphic belt. It consists of plagioclase-biotite-muscovite-quartz schist with a grain-size range of 0.5 mm to 3 mm. The plagioclase is andesite or oligoclase. The rock is almost massive although the common orientation of most components produces a crude schistosity. Light-grey elongate aggregates of sericite within a black to dark-grey biotite-sericite-quartz matrix produces a spotted or speckled porphyroblastic texture. In 66480319 muscovite forms coarse flakes up to 1.5 mm long which are recrystallised around their margins. The muscovite in this rock, and similar coarse muscovite in 66480323, is replaced within the centre of some flakes by diffuse patches of felted sillimanite. The sillimanite was presumably derived from the alteration of the muscovite, possibly by thermal metamorphism. Although clouded with alteration products several grains which are possibly feldspar, in 66480319, are also partly replaced by sillimanite in their cores. Sample 66480139 appears to be a rock intermediate in composition between fine-grained sericite-quartz schist typical of the Lukin-type schist, and the sillimanite-muscovite-quartz schist typical of the Pollappa-type schist.

A local variant of the Pretender-type schist (66480329) forms a band about 20 feet thick across Pretender Creek. It is a spotted and knotted biotite-chlorite-sericite-quartz rock which contains elongated xenoblasts and discontinuous knotted bands of very small quartz and sericite crystals. Although the rock has an overall gneissic texture, the fine-grained matrix is rather schistose and it wraps around the xenoblasts and bands. The aggregates appear to be pseudomorphs, possibly after cordierite. The chlorite has been derived from the alteration of biotite.

Along the margin of the Pretender-type schist adjacent to the Kintore Adamellite, both in the north and in the outcrops in the headwaters of Big-rock Creek, the schist shows the initial stages of the development of a gneissic texture. In specimen 66480325, discontinuous, streak-like bands composed largely of elongate porphyroblastic aggregates of muscovite appear to have segregated from and more or less alternate with the fine-grained muscovite-biotite-quartz matrix. The coarse flakes of muscovite have extremely irregular, ragged margins which appear to be disintegrating to fine-grained aggregates of sericite. Sillimanite has formed at the expense of muscovite in the centre of some of the flakes.

In 66480322 xenoblastic grains of saussuritised oligoclase up to 5 mm across are scattered through a fine-grained muscovite-biotite-quartz schistose matrix. The rock is within several yeards of the adamellite contact and, as is usual along this contact, the schist is associated with differentiates (or contaminated extensions) of the adamellite. The differentiates include a medium-grained muscovite granite, fine-grained to medium-grained garnet-bearing aplite and irregular patches and veins of pegmatitic muscovite, feldspar, and quartz. They all grade into a coarse biotite-muscovite adamellite. Poorly developed foliation planes in the aplitic rock are conformable to the regional metamorphic foliation in the schist.

In some places the differentiates are absent and medium-grained biotite-muscovite adamellite appears to grade imperceptibly into medium-grained sericite-feldspar-biotite schist. The presence of well developed metamorphic foliation in both rock types along the contact, makes it difficult to define the contact clearly.

In places along the contact, the schist contains minor amounts of micropegmatite composed of vermicular and graphic intergrowths of quartz and feldspar (i.e. 6648032, 66480323). Tourmaline in prisms up to 2 mm long, also occurs in accessory abundance in part of the contact schist.

The texture and mineralogy of the Pretender-type schist in the northern part of the belt, indicates that it has been formed under the conditions of a higher grade of metamorphism than the widespread regional metamorphism throughout the Holroyd Metamorphics. This was probably a thermal metamorphism due to the effects of the intrusion of the Kintore Adamellite and related igneous rocks, which, apart from being in contact with the schist where mapped on the surface, probably underlie the schist at a moderately shallow depth. In the headwaters of Big-Rock Creek the Kintore Adamellite forms the valleys and lower erosion slopes between hills and ridges of Pollappa-type schist and Pretender-type schist for up to one mile west of the main contact between the schists and adamellite.

The Pretender-type schist between the Lukin and Holroyd Rivers has essentially the same mineral content as in the northern part of the belt, but it is generally slightly finer grained and less commonly shows evidence of gneissic texture, even within several feet of its contact with the Kintore Adamellite. The muscovite-biotite-quartz schist of the Pretender-type schist is commonly confined to narrow belts near the Kintore Adamellite and mainly enclosed by Pollappa-type schist. Specimen 66480302, is fairly typical of the Pretender-type schist in this area. It consists of quartz (60 percent), biotite (20 percent), muscovite (15 percent), and plagioclase (5 percent), with accessory zircon, apatite, and tourmaline; the average grain-size is 0.5 mm and most of the components are elongated and have a common preferred orientation which produces a moderately good foliation. Some muscovite flakes are unusually coarse and have grown oblique to the direction of preferred orientation. Zircon in the biotite has pleochroic haloes.

In some places along the contact with the adamellite the schist is associated with medium-grained to fine-grained, muscovite granite and garnet-bearing aplitic rocks. Patches and irregular veins of very coarse quartz-feldspar-muscovite pegmatite are common. In most places the contact is not clearly defined; commonly the lack of any structure in the granite, conformable with the metamorphic foliation, suggests that it was introduced after the development of the foliation. In other places, however, ghost banding and crude foliation in the granite are parallel to the foliation in the metamorphic rocks.

These relationships are similar to those found along the same contact in the northern part of the belt. The main belt of Pretender-type schist between the Holroyd and Lukin Rivers contains two separate acid igneous bodies presumably derived from the Kintore Adamellite. The northern body (about 1 mile south of Dingo Creek) is strongly sheared and the rocks around its margin have the appearance of a very coarse biotite-quartz-feldspar granite-gneiss. It contains abundant bands, up to 3 inches wide, of coarsely crystalline quartz and feldspar aggregates. Both bodies within the Pretender-type schist belt occur roughly along the strike of metamorphic foliation and they are elongated in that direction.

South of the Holroyd River the Pretender-type schist appears to have been derived by the moderate thermal metamorphism of regionally metamorphosed rocks.

The restriction of the Pretender-type schist to a roughly defined belt, sheared in part, and the occurrence of small, isolated acid igneous intrusives along the strike of the belt, suggest that it has developed above a ridge of acid plutonic rocks which are responsible for the relatively high metamorphic grade of the schist.

Structure of the Holroyd Metamorphics

The most prominent structure in all units within the Holroyd Metamorphics is metamorphic foliation, both on the air photographs and in outcrop. Throughout most of the belt the metamorphic foliation is oriented north-west to north-north-west and trends of this direction can be continuously traced, commonly through different units, for distances up to 20 miles. The dip of the foliation is mostly greater than 75°, and vertical dips are common. The consistent regional trend of foliation is disturbed only in the south-east of the Holroyd Metamorphic belt where the trends are variable but commonly strike east; this is caused by the introduction of numerous igneous bodies in this area. The parallelism of quartzite bands and of the regional foliation, particularly in the Pollappa-type schist, indicates that the foliation follows the original bedding in most places.

In slightly coarser grained phyllite and schist the foliation is accentuated by thin segregation bands, alternately rich in quartz or mica. This may be evidence of greater activity of permeating fluids in these rocks during metamorphism. Rather massive, coarse-grained schist, notably in the south-east part of the Lukin Schist, has a marked but disturbed foliation. The foliation planes are commonly wavy; in some places they are folded; in some there is a plication of the schistosity or a strain-slip cleavage along the axial-plane direction of the micro-folds. These features most likely belong to post-crystalline movement on surfaces of later origin than those of the slaty cleavage.

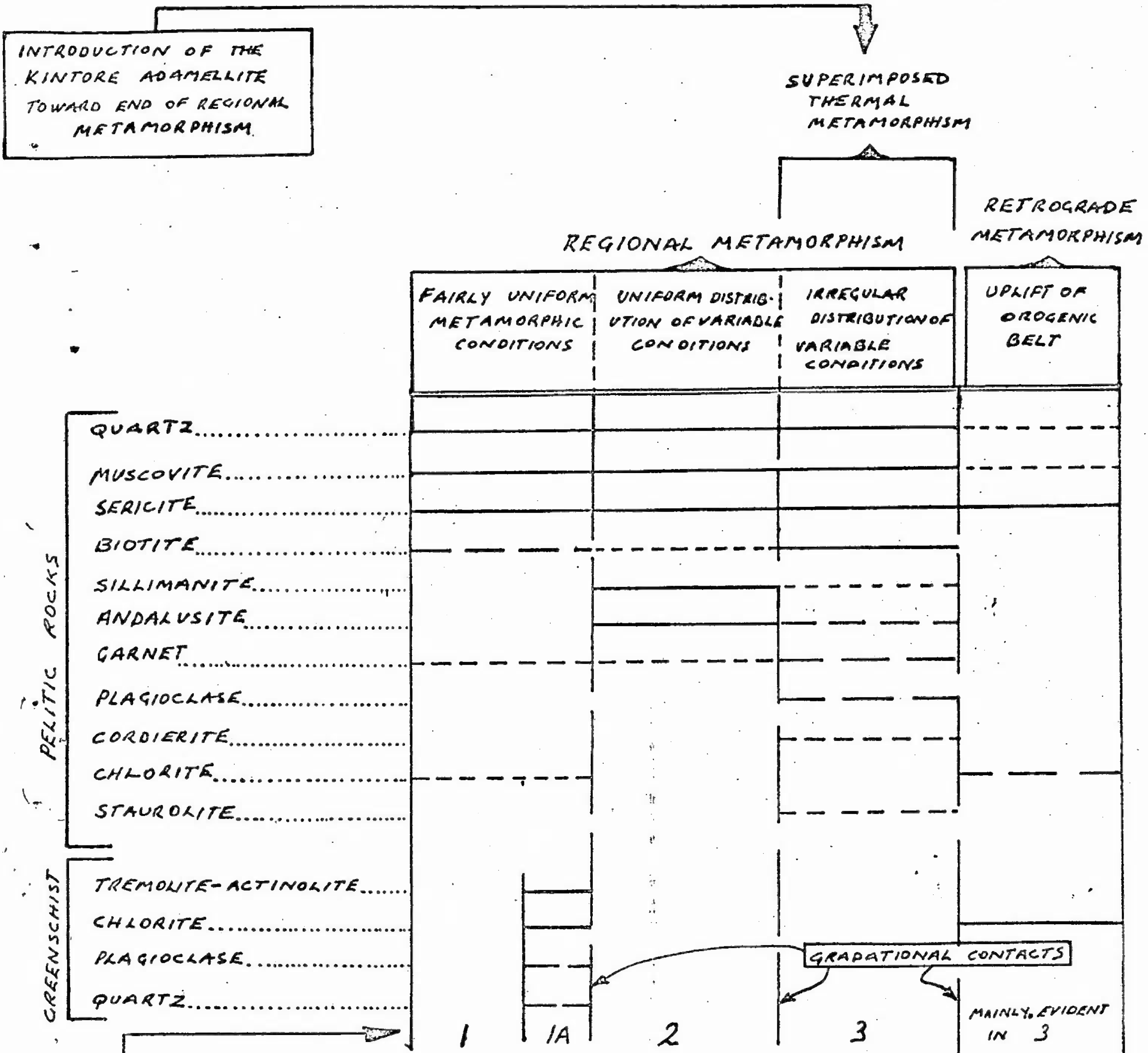
They are not attributed to a separate phase of structural deformation of the belt, but rather to a more intense effect of the main episode of regional metamorphism, largely pressure, and have possibly been caused by the restricted effects of localised folding.

Lineations are common on foliation planes of some phyllites, fine-grained schists and slates. Two sets of foliation planes intersect at a low angle to produce a steeply plunging lineation most commonly in a north or south direction; this type of lineation is particularly common in the rocks between the Lukin and Coleman Rivers. The intersection of bedding and cleavage in rocks south of The Gorge on the Lukin River produces a lineation on the cleavage plane. The foliation planes in many of the phyllites have a finely crenulated surface which results in the surface being lineated. In places in the Pollappa-type schist the common orientation of closely packed aggregates of sillimanite produces a marked lineation. A common orientation of clumps of sericite and andalusite porphyroblasts produces a rodded structure in some schists.

The major variation of the north-north-west trend of foliation occurs in a restricted area of folding near the Coleman River, where quartzite, greenschist and enclosing schist are repeated by four gently north-plunging, overturned isoclinal folds. The structures can be traced for about 12 miles and in the north the noses of the least two anticlines are truncated by, and appear to have been crumpled up against a strike fault about 8 miles long. The axial planes of the folds dip steeply to the east and strike roughly southwards changing to south-eastwards in their southern extensions. Most of the schists have a prominent, steeply dipping axial-plane cleavage. The folds are best seen on the air photographs, since the nature of the outcrop of the rocks in this area does not provide structual features which may be measured, with the exception of metamorphic foliation in mica-schists, and, rarely, bedding in the quartzite.

Isoclinal folds also occur in the Pollappa-type schist between the Holroyd and Lukin Rivers, but their continuity is difficult to establish on the air photographs, and even more difficult on the ground.

Several major faults were recognised in the metamorphic belt, all within the Lukin-type schist. They have no geomorphological expression but they do show as linear features on the air photographs. The fault between the Holroyd and Lukin Rivers, in the western part of the Lukin-type schist is extensively concealed by sand but it can be recognised in some exposures where the rocks are brecciated and mylonitised.



1. FINE-GRAINED MICA SCHISTS AND PHYLLITES OF THE LUKIN-TYPE SCHIST.

1A. GREENSCHIST MEMBER OF THE LUKIN-TYPE SCHIST.

2. ANDALUSITE AND SILLIMANITE BEARING MUSCOVITE-QUARTZ SCHISTS OF THE POLLAPPA-TYPE SCHIST.

3. MEDIUM TO COARSE, COMMONLY SPOTTED AND KNOTTED MICA-SCHISTS AND ANDALUSITE SCHISTS IN THE LUKIN-TYPE SCHIST; COARSE MICA-SCHISTS OF THE PRETENDER-TYPE AND KALKAH-TYPE SCHIST.

——————— ESSENTIAL ABUNDANCE

— — — MINOR ABUNDANCE

- - - - - ACCESSORY ABUNDANCE

TABLE 5. A DIAGRAMMATIC REPRESENTATION OF THE GENESIS AND VARIATION OF MINERALS IN THE HOLROYD METAMORPHICS.

I.R.P.

Several small faults occur in the Pollappa-type schist. The apparent displacement on them is small and they appear to be associated with minor folding. In several places the sillimanite schist is altered to anomalously large amounts of kaolinitic puggy material. Strongly elongated and mylonitised quartz grains in a puggy matrix similar to fault gouge suggests the presence of a fault zone about 4 miles south-south-east of Polappa out-station. Because of differences in competency of the interbanded sillimanite-sericite schist and quartzite in the Pollappa-type schist local faults and crush zones are probably very common but are not well exposed.

Evolution of the Holroyd Metamorphic belt.

The geological events involved in the formation of the Holroyd Metamorphic belt, together with the mineralogical variations which developed during its metamorphism are diagrammatically represented in table 5. This table is based on the field relationships and petrology of the rocks forming the belt. The sequence of geological events which occurred during the evolution of the belt are summarised as follows:

1. Deposition (probably in Precambrian time) of a sequence of predominantly argillaceous sediments which contained some arenaceous beds.

2. Regional metamorphism of these sediments probably in the upper zones of an orogenic belt which was active during the Precambrian.

3. The introduction of the Kintore Adamellite probably towards the end of the episode of regional metamorphism. This caused contact metamorphism and an upgrading of some of the regionally metamorphosed rocks. This event may have occurred in Precambrian or early Palaeozoic time, and was probably continuous with event No. 2.

Discussion

The Holroyd Metamorphics were derived from a sequence of mudstone and siltstone, in various proportions, and numerous bands or lenses of quartz sandstone. In places quartzite grades into enclosing schist and psammitic rocks indicating transitional facies changes in the original sediments; in other places the contacts indicate breaks in the deposition of the original sediments.

The greenschists in the belt, notably in the Lukin-type schist, indicate that layers of intermediate to basic volcanic rocks occurred sporadically through the sedimentary pile. Minor basic igneous rocks may have been intruded during metamorphism.

The sediments appear to have been deposited in a north-trending trough, probably in Precambrian times. The thickness of sediments cannot be measured but a likely order of magnitude is between 30,000 feet and 60,000 feet. The sediments were then folded and subjected to regional metamorphism, probably within the upper parts of an orogenic belt. During this episode the fundamental mineralogy and fabric of most of the rocks were developed.

The fine-grained mica schist and related rocks which comprise most of the main belt were derived from sediments with an overall homogeneous composition. The spotted and coarse-grained schists of the Lukin-type, Kalkah-type and Pretender-type schist were derived from similar sediments, but underwent further metamorphism.

Although the rocks of the Pollappa-type schist were also primarily formed by the same agencies of regional metamorphism that operated elsewhere in the belt, the development of their characteristic mineral assemblage must have involved additional factors. What these were is not clear, but two suggestions are:

(i) Competent quartzite bands which are relatively abundant in the Pollappa-type schist may have been responsible for an irregular distribution of metamorphic conditions within the interbedded schists. Hence sillimanite and andalusite may have developed in restricted areas of relatively higher temperature and pressure.

(ii) Underlying igneous rocks may have influenced the composition of the rocks-types. The Kintore Adamellite is close to parts of the unit and some rock samples contain a highly distinctive heavy mineral assemblage which may be of igneous origin. However the remoteness of large belts of the Pollappa-type schist from outcrops of igneous rock, and the regional development of andalusite and sillimanite, indicate that regional metamorphism is more prominent than thermal metamorphism in the development of the rock as a whole.

Although perhaps of no great significance in the formation of the Pollappa-type schist, the thermal metamorphic effects of the Kintore Adamellite were probably responsible for the formation of many of the rocks characteristic of the Kalkah and Pretender schist-types. Thermal metamorphism probably formed the andalusite, biotite and garnet porphyroblasts which post-date the main metamorphic foliation in the knotted schist of the Kalkah-type schist. The Pretender-type schist was probably formed by the thermal metamorphism of Lukin-type and Pollappa-type schist during the final stages of regional metamorphism.

Spotted and knotted schists which form a fairly continuous zone along the western margin of the Lukin-type schist and also occur near Potallah Creek and the eastern of the belt may be attributed mainly, but certainly not exclusively, to the effects of contact metamorphism. Small porphyroblasts of biotite, garnet, muscovite and, rarely, andalusite, were developed after the establishment of the primary fabric produced by regional metamorphism. In some places however, the porphyroblasts do show incipient stages of preferred orientation, parallel to the primary fabric, which indicate that regional and contact metamorphism were probably partly contemporaneous.

No igneous rocks are exposed in the western part of the belt, with the exception of a small porphyry plug about 4 miles north-west of The Gorge on the Lukin River. However, the zone of spotted and knotted schists along the Mesozoic boundary grades imperceptibly into normal Lukin-type schist to the east. This suggests that igneous rocks (presumably acid rocks) are fairly extensive under the Mesozoic cover, and occur probably not far to the west of the Mesozoic boundary. The igneous rocks presumably form the western margin of the metamorphic belt and may represent the western margin of the orogenic belt in which the metamorphics have evolved

Isolated bands of andalusite-bearing and strongly spotted schists in the eastern part of the Lukin-type schist (e.g. the occurrence near Eight-Mile Creek) do not appear to owe their existance to the nearby Kintore Adamellite. In fact graphitic phyllite and fine-grained mica schist in places along the contact, e.g. near Entire Creek, show no evidence of thermal metamorphism except perhaps a poor development of spots. Other andalusite-bearing and spotted schists in the central part of the Lukin-type schist are not adjacent to igneous bodies. Hence factors are involved in the formation of the isolated andalusite-bearing and spotted bands in the Lukin Schist which are divorced from any genetic relationship to igneous rocks.

Some of the minerals which resulted from the episode of regional metamorphism and the subsequent local reconstitution, were later altered by retrograde metamorphism. The andalusite and sillimanite in the Pollappa-type schist in particular are extensively pseudomorphed by sericite. This retrograde metamorphism conceivably occurred during the uplift of the belt from the depths at which the earlier phases of metamorphism took place. It is not known if this took place in Precambrian or early Palaeozoic times.

The distribution and abundance of the rock types through the Holroyd Metamorphic belt indicate that the range of temperatures and pressures which were active during its evolution is too wide to be definitive of a single metamorphic facies as defined by Turner and Verhoogen (1960). Although the origins of the various types are not in accord with the genetic implications of this facies classification, the fine-grained mica-quartz schist, phyllite and slate of the Lukin-type schist, which have the greatest extent in the belt, were formed under conditions of the greenschist facies of regional metamorphism. The spotted schist in the Lukin-type schist has a mineral assemblage typical of that developed by pelitic rocks under the conditions partly defining the hornblende-hornfels facies of contact metamorphism and partly the lower almandine-amphibolite facies of regional metamorphism. The andalusite-sillimanite-bearing rocks of the Pollappa-type schist are difficult to classify according to the system of Turner and Verhoogen because of the anomalous association of these two minerals. They may, however, be partly classified in the upper almandine-amphibolite facies of regional metamorphism and partly in the pyroxene-hornfels facies of contact metamorphism. The mineral assemblages of the Pretender-type schist are best compared to those derived from pelitic rocks under conditions of the upper part of the almandine-amphibolite facies of regional metamorphism though this schist probably represents rocks of the other types upgraded by thermal metamorphism. The Kalkah-type schist may be classified as belonging to the lower part of the almandine-amphibolite facies.

The constituent units of the Holroyd Metamorphics are obviously intimately related both genetically as well as spatially. It is also evident that they evolved under a more integrated set of variable conditions than the distinctive, rather independent sets of conditions which define the separate facies of Turner and Verhoogen, to which they may be assigned. Since the belt evolved primarily during the one episode of metamorphism, in which variations of conditions were most likely interrelated, it seems best to consider the resultant variation of rock types in terms of the metamorphic facies series as defined by Miyashiro (1961), rather than in terms of individual metamorphic facies. Miyashiro's classification of metamorphic facies series is a classification of metamorphic terrains from the viewpoint of certain related and progressively variable external conditions, which cause observable mineralogical differences.

Of five "standard types of facies series" proposed by Miyashiro, the andalusite-sillimanite type includes all of the metamorphic rocks in the Holroyd Metamorphic belt with the exception of minor staurolite schists in the Kalkah-type schist. This facies type is characterised by the stability of andalusite in the lower grade and of sillimanite in the higher grade. It embraces the greenschist and the amphibolite facies of Turner and Verhoogen. Some of the mineral assemblages of the Holroyd Metamorphics, notably of the Pollappa-type schist, although at first sight abnormal and metastable, are according to Miyashiro, the normal and typical mineral assemblages for the andalusite-sillimanite type of facies series.

The andalusite-sillimanite facies series defines a type of regional metamorphism and rocks of this type are quoted by Miyashiro to be common in the Ryoke metamorphic belt of Japan, and more significantly to have formed in some metamorphic belts in New South Wales during early Palaeozoic time. In addition to mica schist, these belts typically contain synkinematic intrusions which are associated with rocks containing andalusite and cordierite generally classified as contact metamorphic rocks. These intrusions may be abundant in higher grade parts of the metamorphic terrain. Acid igneous rocks, however, may also occur abundantly outside the regional metamorphic terrain, and smaller amounts of basic igneous rocks may be present.

Many of the features characterising the andalusite-sillimanite facies series are typical of the Holroyd Metamorphic belt, particularly when considered in terms of the whole orogenic belt. Thus the range of the mineralogy of the rocks forming the Holroyd Metamorphics and the probable mechanisms involved in their evolution fall within the definition and conditions of andalusite-sillimanite facies series of Miyashiro. Thus it is easier to appreciate the fact that the belt evolved under the influence of several interrelated, probably progressive and perhaps telescoped sets of conditions which essentially involved only one episode of regional metamorphism in its broadest sense.

This hypothesis is preferred to an alternative which may suggest that the various rocks comprising the unit evolved by a series of separate events which represent different periods of metamorphism.

Igneous rocks

AMPHIBOLITE AND DOLERITE

Numerous bands and irregular bodies of dark basic rocks occur throughout the metamorphic terrain. They are generally seen only as small residual boulders on slight rises capped by reddish brown soil. These areas are characterized by the growth of a species of iron bark. In places the larger bodies crop out as prominent ridges composed of boulders up to eight feet in diameter. The basic rocks have been divided into two types amphibolite and dolerite.

Amphibolite

The amphibolite is a basic rock belonging to the almandine-amphibolite facies of regional metamorphism. It is a black to greenish-black, fine-grained rock in which hornblende crystals are oriented to produce a lineation.

A few specimens are only weakly lineated. The amphibolite forms bands ranging in width from a few feet to a quarter of a mile. Many bands are at least three miles in length; the narrower bands, which are poorly exposed, are probably not very extensive. The bands are essentially conformable with the foliation in the metamorphics, and the lineation in the amphibolite is parallel to the foliation.

In the Yambo inlier, the amphibolite is apparently confined to the Arkara-type gneiss, where it is quite abundant. Farther north, in the main belt it also occurs in the Arkara-type gneiss between Yarraden Homestead and Spion Kop. Isolated bands occur in the undifferentiated gneisses north of Kimba, and in the belt of Saraga-type schist, north-east of Musgrave Homestead, which extends to the northern limit of the Ebagoola sheet area.

The amphibolite is composed essentially of hornblende, plagioclase, and quartz. Garnet is present in some specimens. Accessory minerals include magnetite, apatite, sphene, zircon, monazite, muscovite, biotite and potash feldspar. The hornblende generally makes up between 50 and 70 percent of the rock, as long, roughly oriented subhedral crystals. It is commonly weakly pleochroic in abnormally pale colours with y very pale brown, b medium brown and a colourless to pale yellow. However, darker browns and greens occur in some specimens. The optic sign is negative with a large axial angle. The angle Z/C is 20^{o} - 22^{o}.

Plagioclase lies generally in the range An40 - An54 (andesine) although some is more calcic. It generally forms small anhedral grains, well twinned, and interstitial to hornblende. In some samples the grains are subhedral laths and in a few these laths parallel the preferred orientation of the hornblende. Most rocks are composed of between 15 and 30 percent plagioclase.

Quartz is present in almost all the amphibolite, and ranges from 5 to 15 percent of the rock; in places it contains up to 45 percent quartz. Typically the quartz forms small rounded anhedral grains, interstitial to hornblende. The grains are slightly strained. Some quartz forms small blobs segregated in partly recrystallized grains of hornblende, garnet and plagioclase. In some specimens garnet occurs as large, very pale pink porphyroblasts and may form up to 15 percent of the rock.

Opaque minerals are the most common accessory minerals. They are generally associated with the hornblende and have a sieve texture; sphene occurs as small scattered grains, and as small inclusions in other minerals. Apatite is abundant in some specimens as rounded grains enclosed in other minerals.

The amphibolite is generally lineated but in places alternating layers of plagioclase and hornblende produce a pronounced foliation. Some amphibolite is granoblastic. Most of the amphibolite forms conformable bands within the Arkara-type gneiss and the lineation is parallel to the foliation in the gneiss. The contact between the amphibolite and the gneiss is commonly intricate. One contact is illustrated in figure 4. At the contact it appears that during metamorphism the more competent amphibolite was fractured, and the plastic gneisses flowed in to fill the fractures. Thus the rock which gave rise to the amphibolite is thought to have formed bands or beds within the sediments now represented by the gneiss. The bands may represent impure limestone or dolomite, or basic igneous rocks such as lava, pyroclastics or dykes. Their composition is typical of amphibolites considered to have been derived from basic igneous rocks. (e.g. Williams, Turner and Gilbert, 1954). The isolated nature of the bands of amphibolite also suggests that they represent minor instrusives. Further chemical work could show more certainly the origin of these rocks (cf. Leake, 1963).

Small patches of amphibolite within the Kintore Adamellite are probably large xenoliths. Similar small patches of Saraga-type schist also occur within the adamellite.

Some specimens show evidence of alteration and recrystallization. Secondary minerals such as chlorite, prehnite, sericite and calcite are present, as well as small grains of recrystallized quartz. They appear to have eaten into crystals of garnet, plagioclase and hornblende. The alteration may be due to retrogressive metamorphism connected with the intrusion of the Kintore Adamellite.

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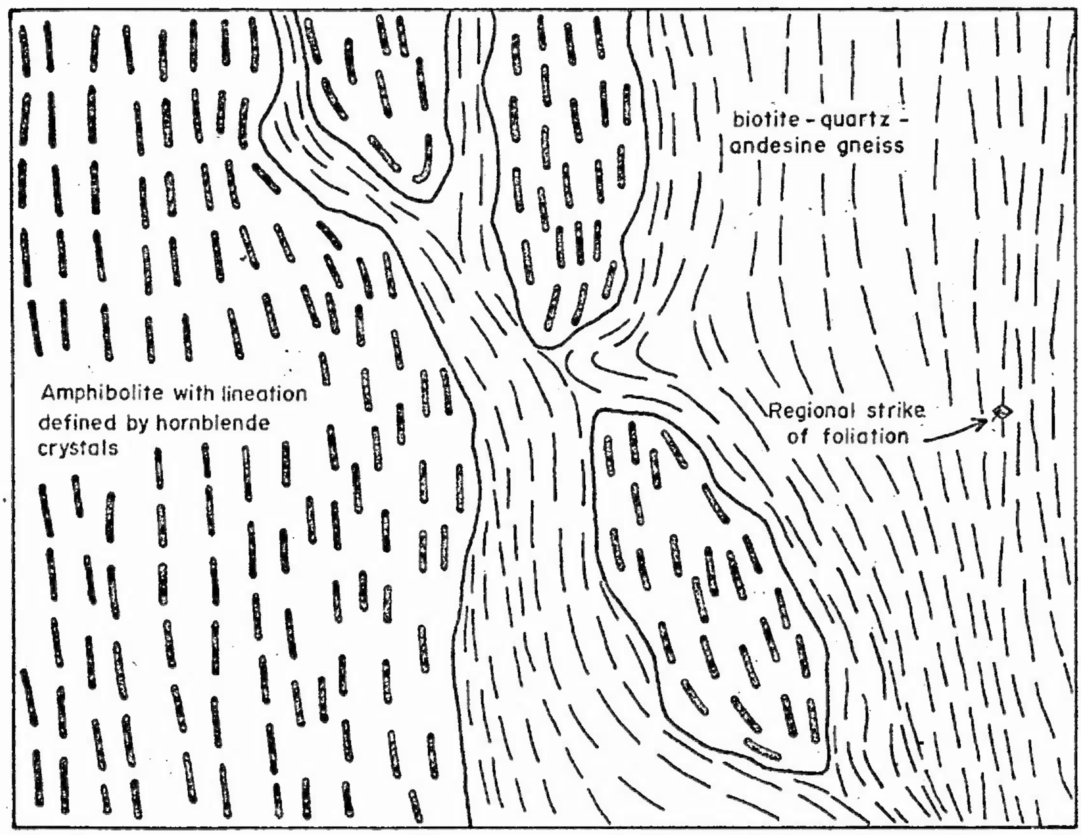
FIG. 4.



A CONTACT BETWEEN
GNEISS AND AMPHIBOLITE
PALMER RIVER

SCALE
0 5 FEET

Some amphibolite, e.g. 664780047 and 66480067, contains considerable amounts of clinopyroxene, which is much altered to hornblende. As these rocks also are lineated, the pyroxene is possibly a relic of the basic igneous rock which was metamorphosed to give amphibolite. The grain-size of the pyroxene suggests that the igneous rock was a dolerite.

Other amphibolite, e.g. 66480209, rich in quartz and containing less hornblende than normal, has probably been derived from sedimentary rocks rather than from basic igneous rocks. It is probably part of the sedimentary sequence represented by the Arkara-type gneiss.

Near Mount Walsh in the Ebagoola Sheet area, a patch of calc-silicate rock is exposed within an outcrop of the Saraga-type schist. It is made up of 70 to 80 percent fibrous flaky tremolite with lesser amounts of talc and muscovite. As this rock in one outcrop appears to grade into an altered amphibolite, it may represent an amphibolite which has been subjected to thermal or retrogressive metamorphism, probably related to the intrusion of the nearby Kintore Adamellite. However, the calc-silicate rock could also have been derived from metamorphism of an impure limestone or dolomite.

Dolerite

The dolerite is a brownish black, medium-grained massive rock with granular or ophitic texture. Irregular grains of plagioclase occur between black lustrous subhedral grains of pyroxene and hornblende. Some specimens are fine-grained.

The dolerite forms irregular bodies which are scattered throughout the metamorphic terrain. Some are several miles across, but smaller, dyke-like bodies also occur. They are most abundant in the western half of the Yambo inlier, and near the Coleman River south-south-east of Glengarland Homestead. Isolated dykes of dolerite occur in the Arkara-type gneiss of the Yambo inlier, in the metamorphics north of Kimba Homestead, and in the Saraga-type schist near the northern limit of the Ebagoola scheet area. In the west a few small dykes cut the Holroyd Metamorphics.

The dolerite is composed of plagioclase, hornblende and pyroxene. Some secondary minerals such as actinolite, chlorite and calcite are also present. Quartz is noticeably absent. Accessory minerals include opaques, apatite, sphene, zircon and biotite.

Plagioclase commonly makes up between 40 and 55 percent of the rock as well formed and usually well twinned laths which have a random orientation. In some specimens the laths are partly altered to clay minerals and are corroded in contact with grains of hornblende. The plagiocalse is labradorite, ranging in composition from An_{52} to An_{68}.

Clinopyroxene makes up between 10 and 35 percent of the rock. It occurs as subhedral to euhedral grains, interstitial to laths of plagioclase, and is colourless to very pale green or brown. The pyroxene appears to be diopside in some specimens, but augite is equally common.

The amount of hornblende present ranges from 10 to 35 percent. In general rocks with considerable amounts of hornblende have little pyroxene. The hornblende occurs as subhedral grains interstitial to plagioclase laths. It is commonly light pink-brown, and is only weakly pleochroic; some is medium brown. In some specimens it appear to be a primary mineral, in others the hornblende is probably an alteration product of pyroxene. Altered grains of pyroxene are surrounded by grains of hornblende which also appear to have eaten into grains of plagioclase. This alteration is possibly a late, deuteric change.

Opaque minerals are the most common accessories. Only minor amounts of sphene, apatite and biotite are visible. Secondary minerals such as actinolite, chlorite, and calcite are present in many specimens. They are probably derived from the ferromagnesian minerals. Some of the plagioclase is sericitized.

The characteristic texture of this group of rocks is doleritic, with grains of ferromagnesian minerals interstitial to laths of plagioclase. The texture is preserved even where pyroxene is almost completely replaced by hornblende. In a few samples, the texture is granular.

The large body of dolerite which partly surrounds the outcrop of the Saraga-type schist in the north-west of the Yambo inlier, in places has a very even granular texture. In one specimen (66480148) which is effectively a hornblende gabbro, the hornblende appears to be primary, as it forms subhedral to euhedral grains which show little evidence of being derived from the pyroxene. However, in nearby rocks in the same body the hornblende is probably derived from the alteration of pyroxene.

Near the Coleman River, basic rock occurs in a small patch of metamorphics within the Kintore Adamellite. It consists of 80 percent labradorite, 10 percent clinopyroxene, and 10 percent olivine. The olivine occurs as anhedral to subhedral rounded grains and has been partly-replaced by chlorite. As this rock has a doleritic texture, it is considered to be a variation of the dolerite.

Another specimen (66480361), which probably represents a small dyke, consists of 40 percent bytownite (An80), 40 percent enstatite, and 20 percent hornblende. The enstatite forms large continuous grains, ophitically enclosing grains and large patches of plagioclase. It is colourless with high relief, parallel extinction, low birefringence, and is optically positive with a moderate to large axial angle. The texture is doleritic or ophitic, and although the rock is an enstatite norite, it is considered to be a variation of the dolerite.

The dolerite was probably intruded into the metamorphics after the regional metamorphism but before the amplacement of the adamellite. Dolerites within the adamellite, are probably large inclusions caught up from the metamorphics. The retrograde metamorphism, indicated in the dolerites by the crystallization of actinolite and chlorite, was probably caused by the intrusion of the adamellite.

Similar dolerites have been described by White (1965) from the Georgetown Inlier where Precambrian gneiss has been intruded by the Cobbold Dolerite before the intrusion of the Precambrian Forsayth Granite. While the two dolerites may be similar in age, they cannot be compared directly. The Cobbold Dolerite has suffered extensively from retrograde metamorphism, the original minerals being replaced by actinolite, epidote and chlorite.

The Cobbold Dolerite also contains fine-grained varieties which are lacking in the dolerites of the Cape York Peninsula.

The dolerites show certain similarities to the amphibolites. They have roughly the same bulk composition, the accessory minerals are similar, and the very pale brown hornblende of the amphibolites is similar to the hornblende developing from the pyroxene of the dolerites. A similar type of basic igneous activity may have given rise to the two types of rocks. The amphibolites were probably intruded as dykes before and during metamorphism, and were metamorphosed along with the sediments. The dolerites were intruded after the metamorphism. The alteration of the pyroxene to hornblende in the dolerites, which has been attributed to deuteric changes, could equally be a result of regional metamorphism of the dolerites if they were intruded towards the end of the metamorphic episode. The concentration of the amphibolites in the eastern part of the Yambo inlier, and the concentration of dolerites farther to the west, suggests that in the inlier at least, the focus of basic intrusion moved westward with time.

KINTORE ADAMELLITE

A great part of the belt of igneous and metamorphic rocks exposed in the Cape York Peninsula is occupied by a north-trending batholith of granitic rocks which is continuously exposed over a length of 85 miles and which extends for well over 100 miles, from the south end of the Yambo inlier to a point beyong the northern limit of mapping in 1966. The batholith ranges up to 18 miles in exposed width, and its outcrop is over 1000 square miles in area. It is mainly composed of adamellite, with some granodiorite and tonalite, and a little granite. The batholith is entirely emplaced in metamorphic rocks, ranging in grade from low in the greenschist facies to high in the almandine-amphibolite facies. It is overlain by sediments ranging in age from Jurassic to Quaternary, and at its south end it is breached by intrusive rocks related to the Upper Permian Nychum Volcanics.

The bulk of the batholith is composed of even-grained biotite-muscovite adamellite, which has been named the Kintore Adamellite. The north-western part of the Yambo inlier contains a distinctive porphyritic biotite-muscovite adamellite, which has been named the Aralba Adamellite, and the

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north-east corner of the Ebagoola 1:250,000 sheet area contains a porphyritic biotite adamellite, which has been named the Lankelly Adamellite. Both these easily distinguished types are probably phases of the Kintore Adamellite. Biotite granodiorite and hornblende-biotite tonalite together form several large bodies within the batholith, which are markedly different from all the adamellite. The rock forming these bodies has been named the Flyspeck Granodiorite, since granodiorite predominates in them.

The outcrop of the Kintore Adamellite extends over the complete length of the batholith and covers over 700 square miles. If forms a gently undulating, little-dissected surface covered by sand or by small outcrops of Annie Beds, and is commonly poorly exposed, even in creeks. It is well exposed in the escarpment which forms the eastern boundary of the large plateau developed on the batholith in the Ebagoola 1:250,000 Sheet area, and in plateau remnants east of the scarp.

The Kintore Adamellite has been dated radiometrically at 360 million years, by Richards et al (1966)from a sample collected near Bamboo Homestead.

The adamellite is typically a light grey, fine-grained to medium-grained rock composed of muscovite, biotite, quartz, and feldspar, with accessory garnet in places. Its texture ranges from allotriomorphic to hypidiomorphic and granular; it is generally an even-grained rock, with feldspar phenocrysts in places.

Mineralogy

The average modal composition of the adamellite is 35 percent quartz, 28 percent microcline, 24 percent calcic oligoclase, 8 percent muscovite and 6 percent biotite. Potash feldspar forms 54 percent of the total feldspar content of the rock, and it is an adamellite according to Joplin (1964). In a few samples the ratio of potash feldspar to total feldspar is typical of granite and in a few others it is typical of granodiorite.

Quartz ranges in abundance from 20 percent to 50 percent of the rock. Generally it forms irregular, xenoblastic grains with undulose extinction and slightly sutured margins. In places quartz phenocrysts up to 5 mm across occur.

The microcline content of the adamellite ranges from 20 to 40 percent. The microcline forms anhedral and commonly irregular grains up to 10 mm across; isolated phenocrysts up to 25 mm across occur in places; it also forms part of the interstitial material. Twinning is generally absent or poorly developed; in a few samples cross-hatched twinning is well developed. Large crystals are commonly perthitic, and may contain irregular blebs of plagioclase.

The plagioclase content of the rock ranges from 15 percent to 35 percent, and the composition from An_{23} to An_{33}, averaging An_{28}, calcic oligoclase. Plagioclase forms subhedral laths between 1 mm and 4 mm long, which are well twinned and are zoned in some samples. The average variation in composition is probably less than An_5. The plagioclase is commonly slightly altered to sericite or clay.

Muscovite and biotite generally form between 2 percent and 25 percent of the adamellite; the muscovite content is almost everywhere slightly greater than or equal to the biotite content. The micas form subhedral laths with random orientation. In places biotite is partially altered to chlorite.

Garnet occurs only in a muscovite-rich granite phase of the adamellite. The garnet forms grains between 0.1 mm and 1 mm across, which range from rounded and anhedral to euhedral in form. They are commonly fractured, and the garnet may be partly altered to a greenish, opaque mineral, possibly chlorite.

Zircon and apatite are common accessory minerals in the adamellite; sphene and tourmaline are rare.

Structure

Bands and irregular patches up to a few feet wide, containing masses of feldspar intergrown with quartz and with muscovite in places, occur throughout the adamellite. In places near the margin of the adamellite a poor foliation is produced by sub-parallel alignment of mica flakes.

Biotite-rich layers alternate with layers rich in quartz and feldspar in the adamellite near its contact with gneiss, near the Morehead River. In some exposures the bands are straight and parallel; in others they are contorted. The garnet-bearing, muscovite-rich granite phase of the adamellite is commonly interbanded with normal biotite-muscovite adamellite.

Shear zones up to several miles long are prominent in the adamellite in the northern part of the Ebagoola 1:250,000 Sheet area and in the northern and central parts of the Yambo inlier. Near one isolated shear zone, 100 feet wide, which cuts both the Kintore Adamellite and the Flyspeck Granodiorite, the rocks have a well developed foliation produced by the parallel alignment of the micas and elongated grains of feldspar and quartz. Away from the shear zone the shearing has produced irregular, closely spaced fractures along which slight movement and possibly recrystallization have occurred. Near the shear zones in the Yambo inlier, the quartz is commonly recrystallized.

Where the adamellite is intimately mixed with gneiss, near the northern edge of the Ebagoola 1:250,000 Sheet area, widespread shearing has produced elongation and strain in quartz grains, preferential alignment in mica flakes, bending and fracturing in plagioclase laths, and rounding in microcline grains. The shear direction is parallel to the foliation of the metamorphic rocks. The adamellite is also sheared in places near its contact with metamorphic rocks north of Pollappa.

Minor variations

Adamellite with small phenocrysts forms small discrete bodies in places within the Kintore Adamellite. Its fine-grained to medium-grained groundmass is identical in composition with the normal adamellite, but contains subhedral to euhedral feldspar phenocrysts from 10 to 30 mm and rarely up to 50 mm across. This phase appears to be scattered at random through the adamellite; it grades into surrounding even-grained rocks. Where it occurs adjacent to the margin of the adamellite, the feldspar phenocrysts in places have a well developed preferred orientation.

Leucocratic adamellite, with a total mica content of less than 5 percent, forms a few small discrete bodies in the Yambo inlier tend in the main belt. It is a fine-grained to medium-grained rock with a few feldspar phenocrysts, up to 5 mm across; it has a random distribution and grades into normal adamellite.

Fine-grained adamellite has the composition of the normal type, but forms distinct bodies which grade into the surrounding medium-grained rocks. Again its distribution appears to be haphazard.

Muscovite granite forms many small bodies within the Kintore Adamellite, which cannot be differentiated at 1:250,000 scale. Some of the bodies contain abundant phenocrysts; others are fine-grained and even-grained; well defined veins and dykes in the adamellite in many places are formed by pegmatitic or aplitic phases of this rock type.

Porphyritic muscovite granite is common throughout the outcrop of the Kintore Adamellite, but appears to be concentrated near its margins, particularly near the escarpment north and west of Musgrave Homestead and along the road between Pollappa and Coen. It consists of microcline phenocrysts commonly about 50 mm across and ranging up to 300 mm, in a coarse-grained groundmass of muscovite, quartz, and feldspar. It forms irregular patches from a few inches to several hundred yards across; these have sharp margins but do not otherwise appear to be intrusive.

Fine-grained, even-grained garnet-muscovite granite forms patches which are generally intimately associated with the porphyritic muscovite granite. North of the Coleman River crossing of the Musgrave-Glengarland road, the fine-grained type predominates and contains scattered patches of the porphyritic type; elsewhere it is subordinate to the porphyritic type.

Veins and dykes of pegmatitic and aplitic garnet-muscovite granite are common near the margins of the adamellite, and cut both the adamellite and the adjacent metamorphic rocks. They are well defined, regular and usually straight; they range in width from a few inches to several feet, and in length from a few feet to several hundred. In some dykes pegmatitic rock is interbanded with aplitic rock.

In both aplite and pegmatite, the dominant feldspar is microcline, forming about 30 percent of the rocks. The plagioclase is generally albite, with subordinate oligoclase, and the rock is thus a granite according to Joplin (1964).

The aplite contains more garnet and less muscovite than the pegmatite. Both are generally even-grained rocks, but in places the pegmatite contains phenocrysts of feldspar or, more rarely, quartz.

The muscovite granite is markedly different in composition from the adamellite. It is possibly a late differentiate of the adamellite which has crystallized as dykes or irregular patches near the margins of the batholith, or in the adjacent metamorphic rocks.

Barren reefs of massive white quartz commonly crop out in the metamorphic rocks near their contact with the adamellite. The reefs range from 1 to 50 feet in width and from several yards to half a mile in length; one reef extends for 5 miles. A few reefs are composed of coarse granular quartz and intergrown feldspar, and a very few contain euhedral needles or stubby prisms of black tourmaline.

Contact effects

The effects of the emplacement of the Kintore Adamellite on the rocks with which it is in contact range from slight recrystallization and minor metasomatism, through hornfelsing, to mobilization with partial assimilation and the formation of migmatites.

The emplacement of the adamellite has produced either no effect or only slight recrystallization and metasomatism, in the adjacent metamorphic rocks near Glengarland Homestead, along the Coleman River and its tributaries the King River and the Lukin River, near the Alice River, and in the north-eastern part of the Ebagoola Sheet area. The metasomatism is represented by second-generation muscovite and biotite and by disseminated tourmaline in the Kalkah-type schist.

Metamorphics have been hornfelsed and altered by potash metasomatism near the junction of the roads from Alice River and from Potallah Creek to Dixie Homestead, in the vicinity of the headwaters of the Holroyd River, and near the Laura-Coen road a few miles north of the Morehead River. The metamorphics are large xenoliths or irregular masses and bands within adamellite or more commonly within the garnet-muscovite granite phase. They are massive fine-grained, even-grained mica-quartz-feldspar rocks, composed of biotite (5 percent), muscovite (10 to 20 percent), calcic oligoclase (15 percent), microcline (25 to 35 percent) and quartz (45 percent). Bands rich in biotite commonly alternate with bands rich in quartz and feldspar. Quartz-felspar veins, which emanate from the granite or adamellite, range from straight to ptygmatic.

The high microcline content of these rocks and the presence of scattered porphyroblasts of mascovite suggest that they have been affected by potash metasomatism.

Near the Morehead River blocks of biotite-quartz-feldspar gneiss, about 20 feet square, occur within the adamellite and within the muscovite granite phase. Smaller wispy xenoliths of gneiss are common in the granitic rocks near the blocks. At the margins of the blocks the gneiss has been partially mobilized and muscovite has recrystallized in it. Within the blocks the gneiss is only hornfelsed.

Schists are hornfelsed near the adamellite along Eight-mile Creek, in the northern part of the Hann River Sheet area. Fine-grained biotite-muscovite-quartz schist, which forms the country rock, grades into rock which has lost its schistosity and is medium-grained and granoblastic. Spots of muscovite and spots of microcline appear in the rocks, as contact metamorphism increases, and these coalesce laterally to form bands rich in mica and bands rich in feldspar. Some of the banded rocks are invaded by granitic material composed of quartz and microcline, and are converted to migmatite.

Between the Morehead River and the Mesozoic sediments forming the south-eastern boundary of the main belt of igneous and metamorphic rocks, gneiss has been extensively intruded by porphyritic biotite-muscovite adamellite, by muscovite granite, and by abundant veins and dykes of muscovite granite-pegmatite and granite-aplite, with the widespread production of mig-

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matites and hornfelsed gneiss.

In the central northern part of the Ebagoola Sheet area, northwest-trending ridges composed of muscovite-quartz schist interbanded with quartzite are separated by broad valleys floored by coarse-grained biotite-muscovite adamellite, which contains irregular patches of porphyritic muscovite granite and bands of muscovite-biotite-quartz-feldspar gneiss. In some places the gneiss has been granitized by the introduction of muscovite and microcline; in others it has been hornfelsed and discreetly intruded by granitic rocks.

A broad belt of biotite-muscovite adamellite, west of this part of the Ebagoola Sheet area, includes pods of muscovite-quartz schist which are bounded by banded migmatite composed of layers of biotite-rich rock alternating with layers of rock rich in quartz and feldspar; the banding parallels the direction of the foliation in nearby metamorphic rocks.

Granitisation and the development of migmatites are generally associated with the emplacement of the muscovite-granite phase of the Kintore Adamellite; they are also most common near the margins of the adamellite. Since the muscovite-granite phase, as a late differentiate, would presumably be concentrated near the roof of the batholith, and would have been accompanied there by metasomatising fluids rich in alkalis, the migmatites and granitized rocks may be primarily developed in or near the batholith's irregular roof. Where only hornfelsing or recrystallization has occurred in metamorphics along the margins of the adamellite, these rocks are presumably located on the walls of the batholith, at levels which were, at the time of emplacement, considerably lower than the irregular roof.

The development of migmatites and the granitization evident in the northern part of the Yambo inlier, and described in the section of the Arkara Gneiss, probably occur in a similar situation. These phenomena are significantly abundant near the ill-defined boundary between the Kintore Adamellite and the muscovite-rich Aralba Adamellite, which may be a high-level differentiate.

The overall trend of the batholith is concordant with the regional trend of the metamorphic rocks, but in places, particularly where the metamorphic rocks are strongly altered by the granitic rocks, the margins of the batholith cut across the local foliation. Where the metamorphic rocks are little altered they are commonly concordant with the margin of the batholith, even where the margin is discordant to the regional foliation, and the local concordance appears to have been imposed on the metamorphic rocks by forcible intrusion of the granitic material.

Outlying stocks of Kintore Adamellite

Several isolated stocks of adamellite pierce schists west of the margin of the batholith. They are sub-circular or irregular in shape and they range in area from 2 to more than 50 square miles. They generally intrude the Holroyd Metamorphics.

The adamellite forming the stocks is a medium-grained, even-grained rock composed of quartz (35 percent), microcline (30 percent), oligoclase (30 percent), biotite (5 percent), and muscovite (less than 1 percent, absent in some). Apart from the scarcity of muscovite, the modal composition of this rock is close to that of the Kintore Adamellite and the stocks are shows as Kintore Adamellite on the map. Irregular patches of porphyritic muscovite granite, and dykes and veins of muscovute granite-pegmatite and granite-aplite are commonly concentrated near the margins of the stocks.

Contact metamorphism round these stocks is slight; recrystallisation in the schists occurs only very close to the contact. The fine-grained Lukin-type schist is spotted around some stocks but this also occurs in places remote from the granitic rocks, and is a widespread metamorphic effect.

Many of the stocks are surrounded by discontinuous. massive white quartz reefs which form a zone up to half a mile wide in the country rock. The margins of the stocks, the strike of the quartz reefs, and the schistosity of the country rock are all concordant. The country rocks appear to have been deformed and forced into concordance with the margins of the stocks at the time of their intrusion.

The highest grade of metamorphism found in the Lukin-type schist is represented by biotite-microcline-quartz-muscovite gneiss, (N95, 66480292), which forms a margin around at least part of a small intrusive body of fine-grained biotite-muscovite adamellite on the Lukin River about 5 miles north-east of The Gorge.

The gneiss has a banded augen texture. Strongly elongated, porphyroblastic augen of quartz and felspar have segregated into bands up to 4 mm wide. Muscovite flakes in bands parallel to the schistosity, separate the quartz-feldspar bands and in places, wrap around quartz-felspar porphyroblasts and small aggregates of porphyroblasts. The rock has a granitic composition; it contains minor interstitial myrmekite and micro-pegmatite and accessory apatite, monazite and zircon. About 5 miles to the north-north-west in the headwaters of Fish Creek (a tributary of the Lukin River), a similar, but larger (5 miles by 2 miles), body of coarse-grained biotite-muscovite adamellite intrudes the Lukin-type schist and the Pollappa-type schist. The core of this body has a uniform, coarse igneous texture. Away from the core, towards the southern and northern margins, the rock becomes progressively more strongly banded and foliated and has the appearance of a biotite-muscovite-quartz-feldspar gneiss. However the mineralogical composition (66480297) and the banded granulitic texture of the gneiss indicates that it is a sheared, gneissic equivalent of the igneous core. The schist enclosing the igneous body and its gneissic margins shows no effects of contact metamorphism, with the possible exception of several narrow hornfelsed bands adjacent to the western contact.

It appears that both the igneous bodies were introduced along a belt within the Lukin-type schist which probably represents a ridge in an underlying acid igneous mass, almost certainly connected to the Kintore Adamellite. The gneissic rocks appear to have formed by the regional metamorphism, associated with shearing, of the margins of the intrusives. Their relationships suggest that the adamellite was introduced during the last stages of the episodes of regional metamorphism.

ARALBA ADAMELLITE

The Aralba Adamellite is probably a discrete phase of the Kintore Adamellite. It crops out as an irregularly shaped body covering about 150 square miles, in the north-western part of the Yambo inlier. It is a grey medium-grained to coarse-grained, porphyritic biotite-muscovite adamellite, distinguished from the Kintore Adamellite by a greater abundance of muscovite, by abundant feldspar phenocrysts, and by characteristic large crystals of muscovite.

Smaller bodies of Aralba Adamellite occur in the central part of the inlier; a body mapped as Aralba Adamellite south of the Palmer River, near the western boundary of the inlier, contains no biotite.

The mineral composition of the Aralba Adamellite is essentially the same as that of the Kintore Adamellite, except for the greater abundance of muscovite in the former. The muscovite forms about 10 percent of the rock, as subdiomorphic plates up to 15 mm across, which include small flakes of biotite. Quartz forms between 35 and 40 percent of the adamellite and is almost invariably strained. The composition of the plagioclase ranges from An_{24} to An_{28}; it is all calcic oligoclase. Zoning is common in the plagioclase, but the variation in composition from one zone to another is less than 5 percent An. Alkali feldspar forms between 15 and 40 percent of the rock, and is invariably microcline, which is generally perthitic. It is poikilitic, with inclusions of quartz, plagioclase, and rarely muscovite and biotite. The grains are almost all twinned and, as they form the phenocrysts, they range in size up to 15 mm; in places idiomorphic phenocrysts 70 mm across occur. Myrmekite is commonly developed in plagioclase grains adjacent to the microcline grains.

Zircon is the most common accessory mineral; apatite is also common. Pink garnet is sporadically present as an accessory mineral.

The Aralba Adamellite contains scattered patches of even-grained biotite-muscovite adamellite, identical with the Kintore Adamellite. Garnet-bearing muscovite granite-pegmatite and granite-aplite also form dykes throughout the Aralba Adamellite and are common in metamorphic rocks near its margins. A leucocratic adamellite with a very irregular outcrop, intrudes gneiss and migmatite in the headwaters of the Kennedy River. In spite of its leucocratic character, in texture it resembles the Kintore Adamellite rather than the Aralba Adamellite, and it is probably a separate late-stage, high-level phase of the Kintore Adamellite related to nearby quartz veins.

The contact of the Aralba Adamellite with the Kintore Adamellite, in the northern part of the Yambo inlier, is poorly exposed and is indistinct. The Aralba Adamellite appears to be little changed towards the contact, but muscovite granite-pegmatite is abundant near the contact, and obscures the relationship between the two adamellite bodies. Where patches of Kintore Adamellite occur within the Aralba Adamellite, the number of feldspar phenocrysts and the grain-size of the groundmass, particularly the size of the muscovite crystals, generally decreases gradationally towards the Kintore Adamellite over several feet. In one exposure, xenoliths of Kintore Adamellite up to 10 feet across have sharp boundaries with the Aralba Adamellite.

The contact of the Aralba Adamellite with metamorphic rocks is commonly a zone about one-quarter of a mile wide, in which bands of adamellite several feet wide become increasingly common in the metamorphic rocks. In places where the adamellite is in contact with gneiss, the gneiss grades into the adamellite through a zone in which it loses its foliation and becomes granular and enriched in quartz and feldspar.

In a few places the adamellite is faulted against the metamorphic rocks, and shearing is evident in the metamorphics.

LANKELLY ADAMELLITE

The Lankelly Adamellite is a grey porphyritic biotite adamellite, which crops out as a broad north-trending belt north and east of the Stewart River, in the north-east corner of the Ebagoola Sheet area.

Like the other granitic rocks, the Lankelly Adamellite forms low rounded hills, but in the southern part of its outcrop rafts of metamorphic rocks form steep ridges.

It is composed of quartz (30 percent), andesine (30 percent), microcline (25 percent), biotite (15 percent), and small amounts of muscovite in places. The outcrop of the adamellite contains dykes of felsite and of diorite. Elongate euhedral phenocrysts of microcline and microcline perthite, generally about 40 mm long, are evenly distributed throughout the rock. In many places the elongate crystals have a preferred orientation which may be a flow direction; in other places they have no preferred orientation. The phenocrysts are well twinned and contain irregular inclusions of quartz, plagioclase, muscovite, and small grains of microcline. Small anhedral grains of microcline also occur in the matrix of the adamellite.

The andesine forms subhedral laths up to 4 mm long in the matrix of the rock. They are well twinned and are commonly zoned. In composition they range from An_{32} to An_{39}. Some crystals are partly altered to muscovite. The quartz forms irregular grains up to 4 mm across, in the matrix of the adamellite. The grains are strained and have serrate or sub-serrate, interlocking margins. The biotite is scattered through the rock as anhedral flakes which are pleochroic from pale yellow to dark red brown. Small quantities of muscovite are associated with the biotite in places. Apatite in the only accessory mineral of importance; it forms grains up to 1.5 mm across.

The mineral composition of the rock is that of an adamellite according to Joplin (1964) but if the microcline phenocrysts were not present, the rock would be a granodiorite.

The Lankelly Adamellite is extensively sheared along directions between 150° and 170°. Some distinct shear zones have been delineated, and at least one extends for several miles; many exposures remote from these zones are also sheared. In the sheared rock the microcline phenocrysts are broken, and dark grey mylonitic material, containing feldspar crystals, forms thin bands. The biotite has been extensively altered to chlorite, plagioclase has been replaced by sericite, and in places the quartz has been recrystallized to a mosaic of smaller grains.

Xenoliths of fine-grained granitic rock, up to 1 foot across, are locally abundant in the Lankelly Adamellite and have also been sheared.

The adamellite is cut by veins and dykes of muscovite granite-pegmatite in places, but they are far less common in this unit than in the Kintore Adamellite. On the Laura/Coen Telegraph Line, near Station Creek, thick bands of quartz-biotite-andesine-hornblende rock occur within the adamellite. The bands are 60 feet or more in width; they are composed of fine-grained to medium-grained rock which is generally massive; one exposure is weakly foliated. The bands grade laterally into the adamellite. The quartz content of the bands is only between 5 and 10 percent, and hornblende and biotite together make up as much as 50 percent of the bands. The bands may be basic segregations of the adamellite, since they grade into it and have an igneous texture.

South of the Stewart River, the Lankelly Adamellite merges gradually into the Kintore Adamellite with an increase in the amount of muscovite accompanied by a decrease in the number and size of the microcline phenocrysts. The gradational nature of this contact suggests that the Lankelly Adamellite is a phase of the Kintore Adamellite.

In some exposures in the Stewart River, particularly in the gorge, xenoliths in the adamellite are composed of a fine-grained granitic rock which is closely similar to biotite granodiorite in the Flyspeck Granodiorite and the Lankelly Adamellite may be younger than the Flyspeck Granodiorite.

The contact of the Lankelly Adamellite with the metamorphic rocks is complex. Typically, bands and small irregular patches of the adamellite penetrate Saraga-type schist, and in places the adamellite has a gneissic texture, which may be a result of shearing.

In the Stewart River east of the Coen/Laura road, much of the schist has been recrystallized, with the production of second generations of muscovite and biotite, and it has been partly absorbed into an even-grained, leucocratic phase of the adamellite. Contorted and partly absorbed bands of schist alternate with bands of adamellite of variable composition.

FLYSPECK GRANODIORITE

The Flyspeck Granodiorite forms three large bodies exposed in the main belt of igneous and metamorphic rocks in the Hann River and Ebagoola Sheet areas. One lies north-west of the Alice River Goldfield, one is centred on the road from Dixie Homestead to the main Coen/Laura road, and the largest body extends for 35 miles north of Glengarland Homestead to Mount Lee Bryce.

The total outcrop of the Flyspeck Granodiorite is over 300 square miles in area. It is generally better exposed than the Kintore Adamellite, typically as groups of boulders surrounded by sandy soil, and it is well exposed in creek beds. The soil overlying the Flyspeck Granodiorite has a darker tone than the soil on the Kintore Adamellite, and can be picked out on air photographs.

The granodiorite is a mid-grey, medium-grained rock which ranges in composition from a biotite granodiorite to a hornblende-biotite tonalite. The granodiorite predominates and has an average modal composition of 35 percent quartz, 35 percent andesine, 15 percent microcline and 15 percent biotite. The average modal composition of the tonalite is 45 percent andesine, 25 percent quartz, 15 percent biotite, 10 percent hornblende and 5 percent microcline. The definitions of granodiorite and tonalite are taken from Joplin (1964). A few specimens are adamellite by definition.

In the granodiorite, potash feldspar forms between 20 and 40 percent of the total feldspar content; in most specimens it forms about 30 percent of the total. In the tonalite the potash feldspar forms, on average, only 5 percent of the total feldspar. The potash feldspar is exclusively microcline. It forms anhedral grains in the groundmass of all specimens; where it is relatively abundant it forms subhedral phenocrysts up to 10 mm across, which include quartz, plagioclase and biotite. Cross-hatched twinning is poorly developed in the microcline; it is perthitic in places.

The quartz forms equant or irregular grains which have slightly sutured margins and undulose extinction; strain is particularly evident in quartz phenocrysts. Some quartz is also recrystallized.

The andesine froms well-twinned laths which are zoned in places. They have been partially altered to sericite and clay.

The biotite forms reddish-brown, subhedral laths. The hornblende ranges from pale brown to green and forms subhedral laths with irregular basal sections. Small hornblende crystals are common in the tonalite.

Biotite-rich types have a clotted texture, in which mafic and accessory minerals form irregular aggregates.

Allanite is a characteristic accessory mineral in both the granodiorite and the tonalite. Zircon forms inclusions in the biotite, and apatite and sphene are accessory minerals. In places plagioclase is altered to clinozoisite.

In a few exposures, bands of biotite-rich rock alternate with bands of rock rich in quartz and feldspar; the bands are ill-defined and merge into normal, massive granodiorite. Biotite-rich rock also forms a few irregular bodies between 6 inches and several feet across. They have sharp margins and show no sign of reaction with the enclosing rock. They are probably xenoliths or autoliths.

Dykes of muscovite granite-pegmatite and granite-aplite cut the Flyspeck Granodiorite near its contact with the Kintore Adamellite.

Where it is sheared, north-west of the site of Ebagoola township, the Flyspeck Granodiorite is a weakly foliated rock with aligned crystals of biotite, quartz, and feldspar. The body of Flyspeck Granodiorite north-west of the Alice River also has a foliation, which is vertical and parallel to the foliation of the surrounding metamorphics.

The contact of the Flyspeck Granodiorite was seen at only one locality, in the Coleman River. The contact, with metamorphic rocks, is sharp and the metamorphics are not visibly affected outside a zone about 6 feet wide. The granodiorite at the contact is no different from the typical rock.

Hornblende-biotite tonalite forms the bulk of the Flyspeck Granodiorite in the body which crops out north-west of the Alice River goldfield. Elsewhere it is subordinate to biotite granodiorite, although it is generally more common in the southern exposures.

In places a transition is exposed between the biotite granodiorite and the hornblende-biotite tonalite; it ranges in width from 10 feet to 1 mile. Towards the tonalite, microcline and quartz decrease in quantity plagioclase increases, and hornblende appears. The total feldspar content remains much the same throughout the transition and hornblende increases as quartz decreases in quantity. A few hornblende-bearing rocks are strictly granodiorites, and a few hornblende-free tonalites occur. The two types have evidently been derived from a common source.

The contact between Kintore Adamellite and Flyspeck Granodiorite is sharp. No marked change occurs in the composition of either type towards the contact, apart from the usual concentration of muscovite granite towards the margin of the Kintore Adamellite. Dykes and veins of muscovite granite-pegmatite and granite-aplite, typical components of the Kintore Adamellite, cut the Flyspeck Granodiorite near the contact. Yet the body of Flyspeck Granodiorite north-west of the Alice River goldfield intrudes migmatite produced by the mixing of Kintore Adamellite and metamorphics. No chilled margin or sign of assimilation was found between the two units.

The Kintore Adamellite and the Flyspeck Granodiorite were probably emplaced in the batholith at about the same time, and they may be genetically related.

Morgan (1964) suggested that the Almaden Granodiorite, which resembles the Flyspeck Granodiorite, is a hybrid rock. The position of the main outcrop of Flyspeck Granodiorite along the western margin of the Kintore Adamellite, suggests that it could have been formed by assimilation of the metamorphic rocks by the adamellite. However, this is unlikely because the granodiorite is uniform in composition and texture, it contains very few xenoliths, it has reasonably sharp contact with Kintore Adamellite, and the mica schist which it intrudes is not a basic rock.

The Flyspeck Granodiorite may well be a fraction of the parent magma of the Kintore Adamellite, produced at a low level by gravity settling, and subsequently intruded into a relatively high level in the batholith, at about the time of the emplacement of the Kintore Adamellite.

DYKE ROCKS

Northwest-trending dykes are abundant in the western half of the Yambo inlier; dykes are associated with the Palmerville Fault, and dykes cut the granitic and metamorphic rocks of the main belt.

In the western part of the Yambo inlier the dykes are revealed on air photos as short dark lines striking north-west. They cut the Arkara-type gneiss and the Pombete-type schist, but do not cut the Aralba Adamellite; they are probably older than the intrusion of the adamellite. The dyke rocks are fine-grained, and intermediate to basic in composition. One specimens (66480145) is a dacite, composed of 20% quartz, 30% plagioclase, 25% hornblende and 25% secondary minerals. The grain size ranges from 0.2 to 0.3 mm. The presence of actinolite, chlorite and calcite indicates that the rock has been altered. The cause of the alteration is not known.

Small irregular dykes associated with the Palmerville Fault occur up to several miles west of the Palmerville Fault, in the Arkara-type gneiss in the Yambo inlier. They are well exposed in the Palmer River as short, thick irregular bodies. The dykes are very fine-grained and intermediate in composition. They have been intruded since the main episode of shearing associated with the Palmerville Fault as they cut mylonitized gneiss. One dacite rock contains up to 20% quartz, 40% plagioclase, 25% hornblende and 10% magnetite. Two long, narrow north-north-west-trending dykes in the same region are also dacite.

A number of dykes intrude the metamorphics, the Kintore Adamellite and the Flyspeck Granodiorite in the main belt of igneous and metamorphic rocks. Most of them are rhyolitic; they have no preferred trend. They are rarely greater than 30 feet in width, but are commonly a number of miles in length.

Most of the dyke-rocks are light pink and very fine-grained. They consist of a very fine mosaic of anhedral grains of quartz and untwinned feldspar. In some dykes, small euhedral phenocrysts of quartz, plagioclase, or untwinned feldspar, up to 5 mm in length, produce a porphyritic texture. Some specimens are light green owing to the presence of chlorite in the groundmass. Only in the coarser or more prophyritic rocks, can the composition be determined accurately. Most are rhyolite or rhyodacite.

Some much larger bodies consist of similar acidic rocks. A body a few miles west of Kimba Homestead is two miles in length and half a mile across. Near its centre it is a porphyritic rhyodacite (66480163) with phenocrysts of quartz, plagioclase and microcline perthite. Towards its margins it is very fine-grained and the phenocrysts are absent. At Flying Fox Hill very fine-grained rhyolite or rhyodacite (66480259) forms several low ridges trending north-east. Feldspar is the dominant mineral; quartz and sericite are subordinate. Approximately one mile to the south is an isolated hill of porphyritic rhyodacite. Phenocrysts of quartz, andesine, and orthoclase(?) are set in a very fine-grained groundmass of intergrown quartz and feldspar. Sericite is again present in minor amounts.

Spion Kop is an isolated hill composed of altered porphyritic rhyodacite (66480281). Phenocrysts of chalcedony, plagioclase, and microcline are set in a groundmass of quartz, feldspar and carbonate. Small patches of pyrite and arsenopyrite are disseminated through the rock. This body, and smaller mineralized acid dykes a few miles to the north, have been worked for gold.

Six miles north of Yarraden a large dyke a quarter of a mile in width and two miles in length forms low hills a few hundred feet high and intrudes the contact of the Saraga-type schist with the Kintore Adamellite. The rock is light brown, fine-grained and even-grained, and is probably a dacite. (66480287).

Four miles north of The Gorge on the Lukin River a small rounded body (6648039) a mile across intrudes phyllites of the Lukin-type schist. The rock is very pale-green, fine-grained, and contains fragments up to 3 inches in length of the phyllites which it intrudes. Phenocrysts of quartz and feldspar are also present. Euhedral flakes of muscovite 5 mm across and phenocrysts of feldspar replaced by fine acicular tourmaline are unusual features of this rock.

A few small dykes of andesitic composition occur in the Ebagoola Sheet area. These rocks are medium-grey and fine-grained. They are probably related to the rhyodacite dykes.

The age and origin of the acid dykes are unknown. As well as the metamorphics, they cut both the Kintore Adamellite and the Flyspeck Granodiorite. Their rather general distribution around the outcrop of the Flyspeck Granodiorite suggests they may be late-stage intrusive associated with this igneous body.

NYCHUM VOLCANICS

The Nychum Volcanics form small hills in the valley of the Mitchell River on the border of the Walsh and the Mossman 1:250,000 Sheet areas. Amos and de Keyser (1964) describe them as rhyolite and dacite flow-rocks, ignimbrite, crystal tuff, and volcanic breccia, with subordinate basalt and andesite, and conglomerate, sandstone, silstone, and coaly shale near the base of the succession. Plant fossils in the sediments are Upper Permian or Lower Triassic. The greatest thickness observed by Amos and de Keyser is 500 feet. They have also recognized volcanic necks.

The north-western part of the large outcrop of volcanics 5 miles south-east of Mount Mulgrave Homestead, on the Mitchell River, is a vent filled by agglomerate and bordered by steeply dipping, banded crystal tuff. Small hills north and south of the Mitchell River are formed at least partly by flow rocks, some of thich are a distinctive green colour. They are composed of small rounded crystals of quartz and orthoclase, with some albite in one, in a spherulitic groundmass. Agates are abundant in places in rubble on a hill south of the river. Hypersthene basalt crops out on a hill north of the river; it is predominantly composed of labradorite with 10 to 15 percent hypersthene. One exposure is vesicular; the vesicles contain calcite and chalcedony.

A basic minor intrusive rock is exposed at the west end of a hill south of the river. In contains traces of sulphide minerals and is composed of labradorite (60 percent), altered pyroxene (15 percent), needles of opaque mineral (5 percent) and a chloritic(?) mineral (20 percent). It carries faint copper staining.

In the bed of the Mitchell River, 7 miles west of Mount Mulgrave Homestead, steeply dipping porphyritic rhyolite, similar to the flow-rocks described above, occupies a fissure vent or thick dyke about 100 yards across. Towards the eastern end of the exposure rounded pebble-size fragments of muscovite granite are abundant in the rhyolitic rock, and it grades into sheared muscovite granite within about 100 feet. Similar rhyolitic rock forms dykes up to 50 feet thick in muscovite granite or muscovite-quartz-feldspar gneiss within one mile east and north of this exposure. They country rock is bleached and kaolinised within 20 feet of the dyke margins.

ALKALINE PLUG

A plug of olivine nephelinite, about one and a half miles in diameter, is exposed near Balclutha Creek, about 17 miles east-north-east of Yarraden Homestead. The plug forms a hill about 50 feet high, and the rock is exposed as scree in boulders up to 4 feet across. The flanks of the hill are covered by a dense growth of thorn scrub and vines; a distinctive band of reddish-brown soil surround the base of the hill, which rises from white sand probably overlying metamorphics.

The olivine nephelinite forming the hill is massive and fine-grained, with a basaltic appearance. It (66480456) is composed of subidiomorphic scattered olivine phenocrysts (12 percent) between 0.1 and 5 mm across, in a very fine-grained groundmass of light green clinopyroxene laths (50 percent) up to 0.1 mm long, anhedral nepheline grains (10 percent) and small grains of iron ore (28 percent). Nepheline, with a moderate proportion of kaliophilite, was identified in a whole rock diffractogram; in the thin section its only distinctive character is low birefringence.

No structure was seen in the plug and its contacts were not observed. The shape of the outcrop and its setting suggest that it is a plug intruding metamorphic rocks. No similar rocks have been recorded frrom this part of Cape York; nepheline basanite has been described by Morgan (1964) from the neighbourhood of Cooktown in the Piebald Basalt, which is probably Tertiary.

Sedimentary Rocks

The highland formed by the igneous and metamorphic rocks separates the Mesozoic sediments of the Carpentaria Basin in the west from the Mesozoic sediments of the Laura Basin in the east. The sandstone between the Yambo inlier and the main belt of igneous and metamorphic rocks links the two basins. Along the Palmerville Fault, on the east side of the Yambo inlier, metamorphic rocks are faulted against the Silurian-Devonian greywacke, limestone, and basalt of the Chillagoe Formation and the Upper Permian sediments of the Little River Coal Measures. Amos and de Keyser (1964) note that conglomerate in the Chillagoe Formation contains pebbles derived from the Dargalong Metamorphics.

CRETACEOUS

The only sediments examined in any detail in 1966 were the Cretaceous sediments overlying the igneous and metamorphic rocks. These sediments are sub-divided in the eastern parts of the Hann River and Walsh 1:250,000 Sheet areas in the 1:500,000 scale geological map of the Hodginson and Laura Basins compiled by de Kayser and Lucas (1964). In this report this sub-division has been adopted only around the western and southern sides of the Yambo inlier, where the difference between the Wrotham Park Sandstone and the Blackdown Formation is evident in outcrop and on air photographs. Around the northern side of the Yambo inlier and around the main belt the Cretaceous sediments have been mapped as undifferentiated rocks, as the distribution of different rock types within them is not sufficiently well known to enable the rock types to be mapped.

Wrotham Park Sandstone

The Wrotham Park Sandstone was named by Laing and Power (1959). It continues north-westwards from the Mossman 1:250,000 Sheet area, where it was mapped by Amos and de Keyser (1964), to crop out intermittently along the southern and western margins of the Yambo inlier. The base of the sandstone is generally a bed of conglomerate several feet thick, containing angular boulders of the underlying igneous and metamorphic rocks. The conglomerate grades upwards into a pebbly feldspathic sandstone with thin beds and lenses of pebble conglomerate. Current-bedding is common in the pebbly sandstone.

The sandstone dips very gently westwards; in most exposures bedding is horizontal. The thickness of the sandstone is not known accurately; it is probably less than 200 feet. In places the sandstone is missing and the overlying Blackdown Formation rests directly on metamorphic or igneous rocks.

Amos and de Keyser state that fossils are rare in the sandstone, and that Woods (1961) suggests a Neocomian age for it.

Blackdown Formation

The Blackdown Formation extends on to the Walsh 1:250,000 Sheet area from the Mossman 1:250,000 Sheet area, where it is described by Amos and de Keyser (1964) as 100 feet of shale, siltstone, sandy shale, and marl, thickening westwards. This formation extends northwards along the western side of the Yambo inlier and the main belt of igneous and metamorphic rocks. It is predominantly composed of kaolinitic siltstone and silicified mudstone. It rests unconformably on the Wrotham Park Sandstone.

At the south end of the Yambo inlier the Blackdown Formation is well exposed in the Mitchell River and in Sandy Creek. Here 10 feet of sandy basal conglomerate, with boulders of gneiss and acid igneous rocks, lie on bleached and kaolinized muscovite-quartz-feldspar gneiss intruded by sheared acid dykes. The conglomerate is succeeded by black silty shale with gneiss boulders, sulphurous black shale, siltstone, and silty sandstone. In one exposure, a calcareous siltstone with abundant organic material and a few percent of glauconite lies only 5 feet above the unconformity. Higher in the section, in Sandy Creek, dark grey mudstone and siltstone, over 20 feet thick, contain calcareous lenses up to 3 feet across, with common poorly preserved pelecypods. Septarian nodules a few feet across are common in the bed of Rocky Creek nearby.

Hills of pebbly sandstone up to 50 feet high, occur within the outcrop of the Blackdown Formation a few miles south and west of the Yambo inlier, and appear to represent sandstone lenses within the Blackdown Formation. Alternatively they may be composed of Wrotham Park Sandstone exposed in the cores of gentle anticlines.

The outcrop of the Blackdown Formation running northwestward from the Mitchell River along the western margin of the Yambo Inlier, is made up predominantly of siltstone and mudstone. Almost all exposures examined are leached or silicified. They are mottled in a variety of colours, from yellow through red to purple, and are ferruginous in many places. The sediments are generally massive and well sorted, though the siltstone contains quartz sand grains and muscovite flakes in places.

Amos and de Keyser (op. cit.) note that Woods (1961) consideres the age of the formation to be Aptian, on the basis of the pelecypods and ammonites he collected. Crespin (<u>in</u> Amos and de Keyser) is inclined to consider that microfossils from the formation are Albian forms.

Undifferentiated sediments

The undifferentiated Lower Cretaceous sediments crop out along the western and south-eastern margins of the main belt of igneous and metamorphic rocks and along the northern margin of the Yambo inlier. The sediments commonly form small scarps rising between 10 and 80 feet above the underlying metamorphic and igneous rocks.

South of the Alice River the sediments are predominantly a sequence of current-bedded pebbly sandstone with thick beds of conglomerate, which ranges up to a few hundred feet in thickness. The base of the sequence is generally a thick bed of conglomerate. North of the Alice River siltstone is abundant and in places predominates in these sediments.

Both sandstone and conglomerate are generally stained red or brown by iron oxides; in a few places they are light grey or white. The sandstone is predominantly medium-grained but is poorly sorted, with quartz grains ranging from silt-size up to granule, and quartz pebbles are scattered through most sandstones. The sandstone is commonly friable and has a soft clay cement; in some exposures the cement is limonite. Quartz grains form the bulk of the sandstone; kaolinized feldspar grains are abundant in many exposures; muscovite forms a small proportion of most rocks.

Cross-bedding, observed in a few exposures, is inclined in various directions and, in common with depositional dips in various directions, appears to reflect the considerable relief in the surface on which the sediments were deposited.

Conglomerate beds, other than the basal bed, generally contain pebbles of quartz or quartzite; one conglomerate at the head of the Kennedy River contains pebbles of jasper and indurated siltstone with quartz veins, which were probably derived from the sediments of the Hodgkinson Basin, several miles to the east and across the Palmerville Fault.

In graded beds 1 inch to 2 inches thick, in a sandstone exposure north of the upper part of the King River, the bottom quarter inch of each bed is coarse-grained, and the succeeding part is medium-grained and fine-grained. Around the northern side of the Yambo inlier at the head of the Kennedy River, and on the south-east flank of the Morehead River, the relief in the metamorphic rocks underlying the sandstone ranges up to 300 feet. Between the Alice River and the Coleman River the Cretaceous sediments lie on a peneplain cut on the metamorphic rocks. The old land surface and the overlying basal conglomerate are generally impregrated with iron oxides. In many exposures the matrix of the conglomerate has been almost completely replaced by limonitic material, which also fills joints in underlying quartzite. On this peneplain the thickness of the sandstone is generally less than 100 feet, and in places only a few feet of sandstone separate the old erosion surface from kaolinitic siltstone.

North of the Coleman River the relief in the surface of the metamorphic rocks increases, and small isolated basins of the undifferentiated sediments occupy depressions in the surface. At the western edge of the outcrop of the metamorphic rocks the sandstone-filled depressions are covered by a blanket deposit of siltstone.

The base of these isolated sandstone deposits is generally a conglomerate, up to 30 feet thick, containing angular boulders of quartzite up to 2 feet across. The conglomerate is an accumulation of scree, derived from the slopes surrounding the basins. This is overlain by up to 200 feet of fine-grained and medium-grained sandstone, in which sorting improves upwards. The sandstone is commonly cross-bedded; the foreset beds generally dip between west and south. In one locality ripple-marks with a wave length of 2 inches and an amplitude of $\frac{1}{2}$ to $\frac{1}{4}$ inch indicate current running to the north-east. In some small basins one margin appears to be faulted, but these margins may represent cliffs or abutments obliterated by the accumulation of sediment.

North of the Alice River, kaolinitic siltstone, a white, massive leached rock which contains in places veins of bluish-white kaolinite a few millimetres thick, is commonly interbedded with thin silty sandstone beds. The siltstone in this area is in places separated from the underlying metamorphics only by a thin basal sandstone and conglomerate member, about 20 feet thick.

North of the Coleman River, massive white or iron-stained siltstone and mudstone form a blanket overlying metamorphic rocks and small basins filled with sandstone and conglomerate. No angular discordance was seen between the bedding in the sandstone and the massive mudstone, but the outcrop pattern on the map, and the sharp change in lithology suggest that the fine-grained sediments lie unconformably on the coarse-grained sediments. Calcareous olive-green mudstone is exposed in the road crossing of Middle Branch Creek, north-east of Strathburn Homestead. Silicified siltstone and mudstone form prominent small plateaux west of the Coen/Pollappa road, and these sediments are at least 200 feet thick. Beyond the plateaux a ferruginized siltstone with weathered indeterminate microfossils underlies another siltstone, at least 5 feet thick, of which 20 percent is glauconite.

Hematite and limonite are abundant in many of the ferruginous, fine-grained sediments and commonly form up to 20 percent of the rocks.

An isolated exposure in the Ebagoola Sheet area where Gorge Creek enters Princess Charlotte Bay, is composed of cross-bedded quartz sandstone and conglomerate with pebbles of quartzite, ferruginous schist, and laterite. Lucas (1963) believes that similar sandstone forming the nearby Cliff Islands may be Cretaceous or Tertiary.

CAINOZOIC

Lilyvale Beds

The name Lilyvale Beds is applied here to the poorly consolidated and poorly sorted feldspathic sandstone and conglomerate which forms a blanket deposit on the low country east of the granite escarpment between the Stewart River and Musgrave, on the Ebagoola 1:250,000 Sheet area. They also occur in pockets on granite and metamorphic rocks west of the escarpment. Small outcrops are scattered over granite in the northern part of the Yambo inlier. The name is taken from Lilyvale Homestead, 25 miles north-north-east of Musgrave Homestead, in the Ebagoola 1:250,000 Sheet area.

The sandstone is a medium-grained rock composed of sub-angular fragments of quartz and weathered feldspar and flakes of muscovite, set in a matrix of silty kaolinite. It grades into poorly defined bands of conglomerate composed of pebbles of quartz and quartzite in a sandstone matrix. The sandstone is soft, friable and massive. It ranges up to 20 feet in thickness in single exposures, and is undoubtedly much thicker in the coastal plain of the Ebagoola Sheet area. In the Cabot-Blueberry Marina No. 1 well, Lucas and de Keyser (1965b) note 140 feet of clayey sand and grit, which appear to be the Lilyvale Beds.

In the northern part of the Yambo inlier, the formation both floors valleys and caps small hills on the granite. In the quartzite ridges east of the granite escarpment and a few hundred yards west of the edge of the escarpment, small valleys with moderately steep slopes are floored by these beds, and the intermittently flowing streams have cut deeply into them.

The sandstone in particular closely resembles decomposed granite. It has possibly formed in a climate markedly different from the present and may have been deposited by relatively rare sheet-floods in an arid climate, in which the granite weathered by exfoliation.

Poorly consolidated, poorly sorted, loosely cemented coarse micaceous sandstone and conglomerate with sub-rounded boulders is widespread on the Holroyd Metamorphics. These sediments have a maximum observed thickness of 15 feet, and they have been identified as Lilyvale Beds. They are commonly ferruginous on their exposed surface, which is also characteristically pockmarked. A lateritic profile occurs in a few exposures, for example in the upper 6 to 8 feet of a small cliff section about 2 miles south of the Lukin Gorge.

Rocks similar to the Lilyvale Beds form a discontinuous, dissected low scarp up to 15 feet high roughly parallel to the King River and up to half a mile west of it. They are probably part of a fossil river terrace of the King River. In this area similar sediments form scattered discontinuous outcrops, some up to 1 mile across, roughly confined to the upper reaches of some stream systems; they also occur on the tops of low hills where they appear to be largely unrelated to the present drainage.

Similar sediments were found in Pollappa Creek and Dry Creek about half a mile south of the Pollappa/Ebagoola road. They form 15-foot high cliffs in the creek banks. Most of the boulders in the conglomerate are quartzite or related rock types, presumably derived from the quartzite ridges of Pollappa-type schist, in the headwaters of these creeks. The uppermost 4 or 5 feet of the exposure is ferruginous.

Lesser thicknesses of similar rocks overlie the Pretender-type schist about 4 miles north-north-east of the confluence of Fish Creek and the Lukin River. A further 2 miles to the east, a creek bank, 25 to 30 feet high, is composed of similar sediments, which overlie Kintore Adamellite.

Laterite

Laterite is used here following Connah and Hubble (in Hill and Denmead, 1960) to mean "a massive vesicular or concretionary ironstone formation nearly always associated with uplifted peneplains ...."

Nodules and pisolites of laterite forms small patches up to 8 feet thick on the Lilyvale Beds and within other superficial deposits. Lateritization is most common in basal Mesozoic conglomerates and in the metamorphic rocks forming the pre-Mesozoic land surface. In many places, particularly north of the Alice River, the basal conglomerate of the Mesozoic sediments has matrix composed almost entirely of limonitic material in which the quartz pebbles are unchanged. Joints and fissures in the flat surface of the metamorphic rocks underlying the conglemerate are partly filled with limonitic material, and the metamorphic rocks are impregnated with iron oxides.

A high quartzite ridge, about 8 miles south-south-west of Pollappa, is capped by a lateritic accumulation of hematitic and limonitic material about 400 yards square and up to 30 feet thick.

It is a rubbly, loosely cemented irregularly nodular laterite, composed largely of sub-angular ferruginous rock fragments from ½ inch to 10 inches across, within a coarse sandy ferruginous matrix. Some bands consist almost entirely of massive hematite, iron-hydroxides, and siliceous material. No definite bedding is obvious but the rock fragments are rather tabular. They lie along wavy but more-or-less horizontal planes. Bands of iron oxides in the more massive parts of the outcrop are also more-or-less horizontal. The exposure is probably a remnant of well lateritized Cretaceous sediments.

The ridges of Pollappa-type schist in this area are notably flat-topped at a fairly consistent elevation, indicative of a dissected peneplain, but no other lateritic cappings have been located.

About 12 miles north-north-west of Pollappa outstation, however, isolated ridges of Pollappa-type schist are unconformably overlain by three mesas of flat Mesozoic sediments. The Mesozoic sediments are reddish laminated sandstone and siltstone of which the upper 10 to 12 feet is moderately lateritized and silicified. This appears to represent the initial stages of development of the lateritic capping south of Pollappa outstation.

The Mesozoic sediments probably floored a post-Cretaceous peneplain which covered most of the area. Subsequent uplift has caused dissection of this peneplain which, over the Pollappa-type schist, has left only a few small mesas of the Mesozoic sediments. These have been ferruginised and silicified. In restricted parts of the ferruginous cappings the pre-existing sediment has apparently been almost completely replaced by iron oxides and minor silica.

A lateritic accumulation about 4 feet thick also caps in places the low scarp south-west of Dixie Homestead. It generally lies on mica schist and is overlain by sand or soil. Similar accumulations overlie some amphibolites or dolerites.

In places in the metamorphic belt a rubbly accumulation of an iron-oxide, iron-hydroxide mixture forms an irregular, coarse, nodular concretionary aggregate which commonly contains abundant sub-angular ferruginised rock fragments. Minor manganese and sericite are generally associated with this rock. This accumulation has the appearance of a poorly developed laterite. It has a maximum observed thickness of about 10 feet, and a sporadic distribution; it generally occurs as irregular patches of boulder rubble, up to several hundred feet across. It commonly overlies the Lilyvale Beds and similar sediments, for example along the western side of the King River.

Between the Lukin River and about 15 miles north-north-east of Pollappa the laterite is scattered over flat country in irregular patches. Accumulations up to 10 feet thick of coarse irregularly nodular and concretionary laterite form low cliffs along the first 10 miles of the track from Pollappa to Coen. In places they overlie unconsolidated alluvial sediments. Also along this track areas extensively covered by white sand, presumably over the Kintore Adamellite, contain small isolated outcrops of ferruginous unconsolidated sediments and rubbly laterite.

Nodular and slightly pisolitic laterite also forms banks up to 15 feet high along Pollappa Creek, about 4 miles south of Pollappa. No weathering profile was found underlying this nodular laterite and in some places it appears to rest directly on schist. It may have been formed by the lateritization of conglomerate, resting on the schist, but in some places it seems to have accumulated by deposition of transported ferruginous material which has perhaps been cemented by subsequent lateritization.

Following the suggestions of Vine, Casey, and Johnson (1964) the small patches of nodular and pisolitic laterite common among Cainozoic sediments are probably composed of material derived from lateritized Mesozoic rocks. Pisolitic laterite is abundant in alluvium between Eight-Mile Creek and the Coleman River, where the land surface approximates fairly closely to a pre-Mesozoic peneplain. The presence of laterite pebbles in the cross-bedded sandstone and conglomerate at the mouth of Gorge Creek, on the Ebagoola 1:250,000 Sheet area, also suggests that laterite may have been formed before the deposition of at least the latest Cretaceous rocks.

Silcrete

Silcrete is effectively absent from the igneous and metamorphic rocks mapped in 1966, and it is strikingly rare in the sediments. It appears to be confined to the tops of mesas and small plateaux on fine-grained Mesozoic sediments which crop out west of the Pollappa Coen road, in the north-west corner of the Ebagoola 1:250,000 Sheet area. On these features quartz siltstone and mudstone are thoroughly impregnated with silica, forming very resistant rocks. On slopes around the larger plateaux pebbles of silicified sediments abound.

Sand

Very large patches of white sand lie on most sizable bodies of acid igneous rock and sandstone. The sands are residual and do not extend far beyond the outcrop of the parent rock. In many places they overlie small patches of Lilyvale Beds, which have also been derived from the underlying bedrock. Feldspar is absent from the residual sands, in contrast to the Lilyvale Beds which were probably derived from a similar source. Presumably at present the high summer rainfall removes kaolin from the weathered granite, and the tree cover may prevent the intense insolation of a more arid climate. Sand overlying schist in the eastern part of the Ebagoola sheet area contains some spherical, pitted grains which have been rounded by wind action.

Clay

Only the largest patches of clay are shown on the map, and probably overlie clayey Cretaceous sediments mapped by Lucas (de Keyser and Lucas, 1964). Kaolin patches overlying Lilyvale Beds on level ground east of the escarpment on the Ebagoola Sheet area are closely jointed in a polygonal or square pattern. They are probably concentrations of kaolin deposited in the wet season by streams on slowing down in flooded ground.

Gravel

Residual gravel of white quartz pebbles is common on low hills in the Kintore Adamellite towards the south end of the Yambo inlier. It forms small patches less than 10 feet thick. Quartz gravels are intermittently exposed in the banks of the Mitchell and Palmer Rivers, up to 50 feet above their beds.

Other alluvium

Most alluvium shown on the map is black soil, a dark silt-size deposit containing abundant humus with quartz and mica. It forms a small plain a few miles across on the north side of the Mitchell River at the south end of the Yambo inlier, and it covers many other small flood plains, generally less than a mile across, on the gently sloping reaches of large and small rivers throughout the area mapped. The alluvium forms the abundant swampy patches, near the heads of many streams, which appear as dark clearings on air photographs.

Beach sediments

The beach of Princess Charlotte Bay, for 10 miles south of the mouth of Gorge Creek, is a ridge of sand a few hundred yards across and about 20 feet high, resting on silty marine clay which extends out to sea beyond low-water mark.

The beach ridge is composed of lenses and beds, up to a few feet thick, of very coarse shell sand, silty coarse quartz sand, and beach rock. At least one layer of pumice is also present in or commonly on top of the beach. The beach ridge lies on a floor of blue clay with abundant shell fragments, which contains beds, a few inches thick, of shell sand and of quartz sand, both with a muddy matrix.

On the surface of the beach, in gentle depressions one foot deep between cusps of shell sand about 10 feet apart, a few inches of brown quartz sand with scattered grains of black heavy mineral had accumulated in August, 1966.

On the landward side of the beach ridge the blue clay contains abundant carbonised rootlets and is covered by a layer, generally less than one inch thich, of red silty sand and light grey clay with salt crystals.

Near the Annie River and near Port Stewart, where mangrove swamps form the margin of the sea and the beach ridge is not present, eucalypts or similar trees are dying at the heads of tidal inlets, indicating that the coast is subsiding.

On the beach at the south side of the mouth of Gorge Creek, several small shell middens are located between 3 feet and 10 feet above high-water mark. Three middens examined are each composed predominantly of a different type of shell. The largest is composed of oyster shells, another is predominantly composed of a "cockle" type of pelecypod, another is almost entirely made up of a "whelk" type of gastropod. Pebbles and cobbles from a nearby exposure of conglomerate are scattered among the shells in these middens. One of the middens appears to lie on a small berm of pumice.

Fragments of carbonized ant nests and hornet nests are also common in the shell middens. They are presumably the remains of wood burned in fires. A partly worked artefact of fine-grained igneous rock, foreign to the conglomerate exposed nearby, was recovered from one midden.

In a section in the beach ridge 7 miles south of Gorge Creek, a layer of pumice up to 1 foot thick lies on a lens of shells, which is composed of a variety of species; some are spider shells with unbroken spines so the lens is probably not a midden. Overlying the pumice, however, succeeding a thick layer of silty quartz sand, is a layer of pelecypods almost exclusively of one type, which contains abundant fragments of carbonized ant nests and hornet nests, and which is clearly a shell midden.

Although the pumice commonly lies on top of the beach, particularly at low points in the ridge, at no place could more than one layer of pumice be found where a section was examined. Although pumice is common on beaches on the east coast of Queensland from here for over 1000 miles south to Caloundra (Mr. L.G. Cutler, pers. comm.), the source of the pumice is unknown.

The alternating layers of shell sand and quartz sand forming the beach may reflect the annual alternations of wet season and dry season. During the wet season the rivers provide quartz sand, from the hinterland, which is concentrated by wave action on the beach. During the dry season, the strong south-east wind drives shell debris from offshore reefs on to the beach. However, it seems unlikely that layers over a foot thick represent the accumulation of a few months. The presence of the shell middens suggests that the beach has been stable at least since stone tools were superseded locally, and the layering in the beach ridge probably represents long-term fluctuations of climate or sea-level.

STRUCTURE

Almost all the major structures in the Cape York Peninsula strike north and dip steeply. The foliation and banding in all the metamorphic rocks, the contacts of the batholith, the shear zones in the granitic rocks, and the Palmervile Fault all parallel the northerly trend of the Peninsula. In the few places where the metamorphic rocks do not trend northerly, the anomalies appear to result from the forcible emplacement of the granitic rocks.

Clearly visible folds are comparatively rare in the metamorphic rocks, particularly on a small scale. The almost ubiquitous, north-trending foliation appears to be developed parallel to the axial planes of tight, north-trending folds, a few of which can be picked out on a fairly large scale on air photographs by greenschist and quartzite members in the Lukin-type schist and by the traces of thinner, poorly exposed bands in the same schist. The folds are nearly isoclinal and have amplitudes and wave-lengths measuring thousands of feet.

In the large outcrop of Saraga-type schist in the northern part of the Yambo inlier, broad folds with limbs dipping at less than 40° have axes striking north-east. The schist outcrop itself appears to form the core of a gentle synform, the axis of which strikes north-east. This structure is complemented by two upwarps in the cores of which the Aralba Adamellite and the Kintore Adamellite respectively have been emplaced. Broad folds with gently dipping limbs occur also in the Lukin-type schist south-east of the Potallah-Creek gold mine, and they appear to have been formed during the intrusion of stocks of adamellite in the schist.

A sharp diversion of the trend of foliation in the Arakara-type gneiss in the northern part of the Yambo inlier, may be a result of the emplacement of the Kintore Adamellite.

Tight minor folds with steeple plunging axes occur in the Arakara-type gneiss adjacent to the Palmerville Fault, but are much more clearly displayed in the neighbouring Chillagoe Formation. W.B. Dallwitz suggested that these might indicate transcurrent movement on the fault.

North-trending shear zones are prominent in the Kintore Adamellite in the Yambo inlier and in the main belt, and they are abundant in the Lankelly Adamellite. The shearing evident in the massive granitic rocks may also have deformed and displaced the schists and gneisses with little obvious effects, since it is everywhere broadly parallel to the trend of foliation. In some granitic rocks and some gneisses mylonitic rocks have formed as a result of intense shearing, and in places banding or foliation has developed along shear planes in adamellite.

Relatively few major faults were found in the area mapped. Again the dominant direction of brittle-style deformation, as exemplified by the shear zones and the Palmerville Fault, parallels the foliation in the schists, and it is probable that many strike faults in the schists have not been detected.

Large faults, cutting across the dominant northerly trend, partly bound the large outcrop of Saraga-type schist in the north of the Yambo inlier. No estimate of the displacement on these faults can be made, but they appear to be normal faults, probably initiated during the formation of the synform which contains this outcrop of schist.

De Keyser (1963) has suggested that the coastline of Princess Charlotte Bay may be determined by the northerly continuation of the Palmerville Fault. The escarpment which forms the eastern boundary to the plateau formed on the Kintore Adamellite, in the main belt, is strikingly straight, and along its foot springs are common; two at least are hot springs. Since the escarpment lies wholly within adamellite in a few places, and in others separates igneous from metamorphic rocks, it may be the surface trace of a major fault, which in this region separates the basement rocks from the Mesozoic and younger sediments of the Laura Basin.

De Keyser (1963) has outlined the history of the Palmerville Fault from its inception in Silurian times to the present day. The development of first the Hodgkinson Basin and then the Laura Basin appear to have been at least partly effected by subsidence along this fault, and the uplift of the igneous and metamorphic rocks west of the fault may have determined the eastern margin of the large Mesozoic Carpentaria Basin.

GEOLOGICAL HISTORY

During Precambrian or Lower Palaeozoic times a great thickness of clayey sediments, quartz sandstone, and some lavas and pyroclastic rocks accumulated in a geosynclinal trough over 100 miles long running parallel to the trend of Cape York Peninsula. Carbon-rich material accumulated in some of the sediments; the sedimentary pile was intruded by basic dykes and sills.

These rocks were metamorphosed under conditions of pressure and temperature which ranged from those characteristic of the upper part of the almandine-amphibolite facies, in the eastern part of the Yambo inlier, to those characteristic of the lower part of the greenschist facies, in the south-western part of the main belt. Tight folding on axes parallel to the length of the trough, and the development of a single axial plane foliation then occurred.

After the metamorphism but before the emplacement of the granitic rocks dolerite dykes were intruded into the metamorphics in the Yambo inlier. The granitic rocks were probably all intruded within a relatively short time, but considerably later than the completion of the metamorphism. Radiometric age determinations made by A. Webb (pers. comm.) on samples of the granitic rocks indicate ages between 360 and 370 m.y. - in the middle part of the Devonian period.

The emplacement of these rocks resulted in broad folds forming in metamorphics adjacent to them; shearing in the granitic rocks of the Yambo inlier and the main belt possibly took place at a late stage in their intrusion.

Movement on the Palmerville Fault, the eastern boundary of the Yambo inlier, began in Silurian times, according to de Keyser (1963) and until Carboniferous times the igneous and metamorphic rocks probably formed a low-lying hinterland to the marine Hodgkinson Basin east of the fault.

Igneous activity was renewed in Upper Permian times with the eruption of the Nychum Volcanics at the south end of the Yambo inlier. The dykes and other small bodies of fine-grained acid rock in the main belt probably were intruded at about this time.

The presence of Permian freshwater sediments in the Nychum Volcanics and along the Palmerville Fault (Amos and de Keyser, 1964; Lucas and de Keyser, 1965) suggests that Permian sedimentation in this region was confined to small freshwater basins. During the Jurassic sandstone being deposited in the Laura Basin, east of the Palmerville Fault, encroached slightly on the basement rocks, and in Lower Cretaceous times large areas of the basement outcrop, including perhaps the whole Yambo inlier, were covered by pebbly sandstone and conglomerate deposited by torrents. A reduction of relief in the hinterland and a rise in sea-level produced the relatively fine-grained Blackdown Formation in the Carpentaria Basin and the silty upper part of the Battle Camp Formation and the Wolena Claystone recorded by Lucas and de Keyser (1965a) in the Laura Basin.

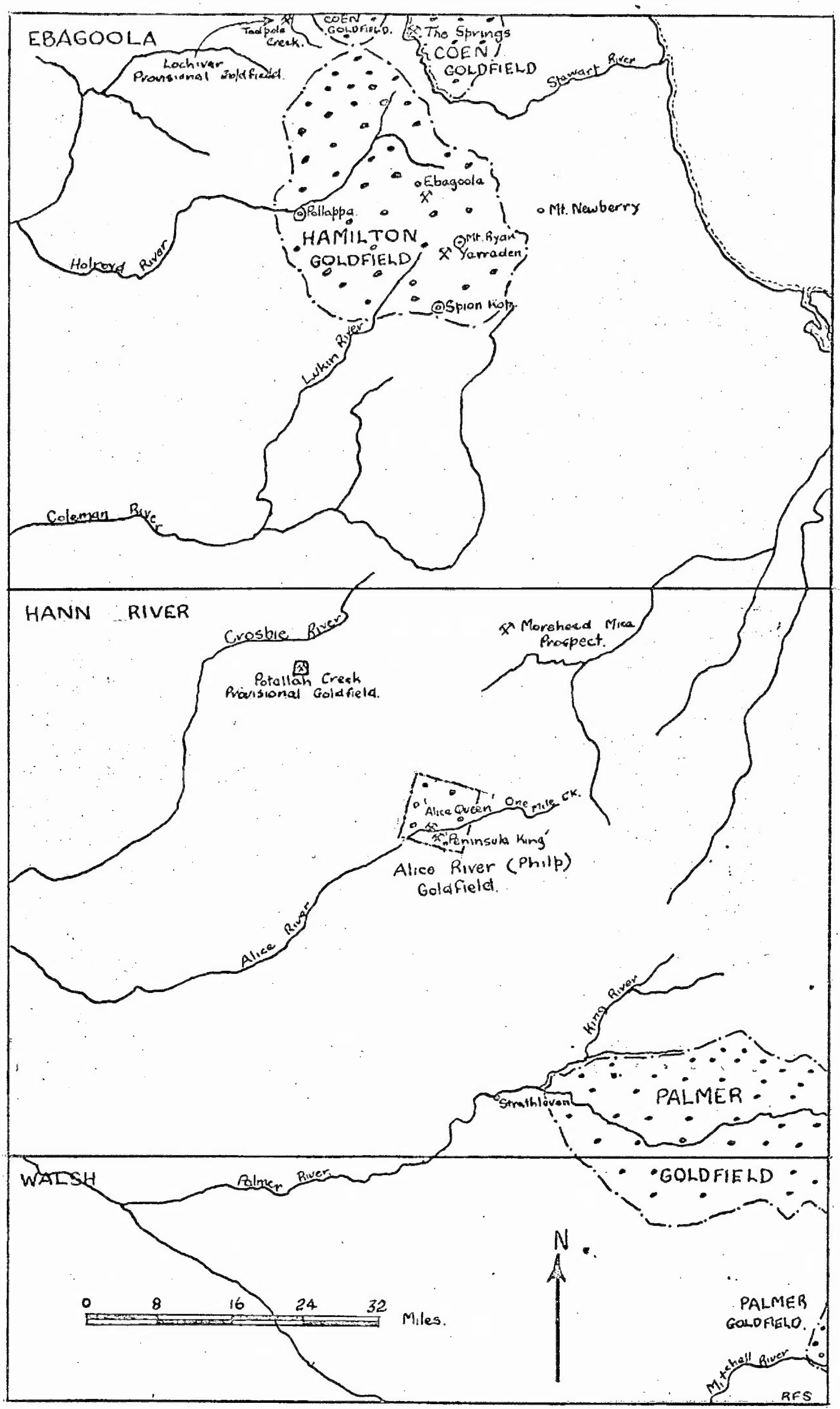

Fig. 6. GOLDFIELDS IN SOUTHERN PART OF CAPE YORK PENINSULA.

In late Cretaceous or Tertiary times, the sea receded and the basement rocks were again uplifted. An antecedent stream cut the valley of the Palmer River through the domed-up Yambo inlier. The escarpment along the east side of the main belt was probably initiated at this time, by movement along a fault parallel to the Palmervile Fault. The Lilyvale Beds were possibly also deposited following this uplift by sheet floods.

The uplift has recently been renewed, or has continued spasmodically since its inception, and the coast is continuing to subside. However, the beach ridges found inland at the head of Princess Charlotte Bay, point to a period of high sea-level, probably a eustatic rise a few thousand years ago, at the time of the climatic optimum.

The isolated plug of olivine nephelinite, in the north-eastern part of the Ebagoola Sheet area, is probably a remote offshoot of Tertiary volcanic activity in the Cooktown Sheet area.

ECONOMIC GEOLOGY

Gold is the only mineral which has been mined economically in the area; no mining is being carried on at present. The distribution of the goldfields is shown in Figure 6. Uneconomic deposits of gold and muscovite, and minor concentrations of antimony, tin, graphite and heavy minerals have been reported. Economic concentrations of petroleum are unlikely in the area. Water could be conserved and produced from small underground reservoirs.

Metals

GOLD

Palmer Gold and Mineral Field

Alluvial gold was first reported from the Palmer River below Palmerville in 1872 (Hann 1873a, b; Jack 1922). Mining began in earnest about two years later. Reef mining was confined to Palaeozoic sediments east of the Palmerville Fault, and the alluvial gold is derived from auriferous reefs found in the drainage basin of the Palmer River at least 12 miles upstream from

Palmerville, (Amos & de Keyser, 1964). The total recorded production for the field was 1,333,893 fine ounces, but the true figure was undoubtedly higher than this. Alluvial mining reached a peak in 1875, decreasing rapidly after this.

Dredging was carried out between 1926 and 1936 at the Strathleven, Glenroy and Bonanza areas west of Palmerville (Jensen, 1940b; Amos and de Keyser, 1964) but ceased when the recovery grade became too low at 4 pennyweights per cubic yard. Total production from dredging was approximately 3400 oz. of gold.

Hamilton Goldfield

Gold was first discovered at Ebagoola, 37 miles north-west of Musgrave Homestead early in 1900 by prospector John Dickie (Dickie 1900, Ball 1901). A minor rush followed. Gold was found further south near the Lukin River (Yarraden) in the following year. The field was not a large producer; the peak of production was reached in its first year with about 15,000 oz. (bullion) being won 11,000 oz. of which was alluvial. Mining virtually ceased during the First World War and has been only sporadic since. Total production for the field (1900 to 1951) has been 73,676 oz. bullion, made up of 44,099 oz. reef gold from 33,656 tons ore; 21,940 oz. alluvial gold, and 7,637 oz. gold from the treatment of 18,952 tons tailings.

The Ebagoola and Yarraden areas are approximately 10 miles apart along a line trending north-north-west. The Yarraden area stretches south from the Lukin River to Spion Kop, 14 miles south-south-east of Ebagoola. Mining at Ebagoola was centred about the old town. Gold principally occurs in the numerous quartz reefs in the area.

Ball (1901) reported that the reefs in the Ebagoola area strike more or less north-south along the zone of contact between the "Older" granite (Kintore Adamellite), which he considered to be metamorphosed, and schists and gneisses to the east. The quartz deposits occur either as leaders, independent veins, or compound reefs. The leaders are up to 6 inches wide and occur largely in shrinkage cracks in granite. They are of limited length or depth and seldom rich in gold. Most of the alluvial gold

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was considered to have been derived from these veins. Independent or true fissure reefs developed as the result of shearing along the junction of metamorphic and granitic rocks, e.g. the Caledonia and All Nations reefs. The compound fissure or compound bedded and fissure type of vein is associated with acid dykes or quartzite beds in places, e.g. the May Queen.

The water table is generally quite shallow, at 70 feet in the dry season, so a certain amount of trouble with water was met with in mining. As a result sulphides (pyrite with minor arsenopyrite, galena or stibnite) are found almost at the surface. Mining as a whole was generally not profitable at grades below 1½ oz. gold per ton.

The most productive workings in the Ebagoola area were the Caledonia, Hamilton King, May Queen, Hit or Miss, Violet, Hidden Treasure, All Nations and Golden Treasure (Table 6).

Table 6 GOLD PRODUCTION AT EBAGOOLA

Reef	Tons ore	Oz.Bullion
Caledonia	3,384	3,292
Hamilton King	2,195	3,662
May Queen	2,022	2,594
Hit or Miss	1,072	2,157
Hidden Treasure	1,514	1,534
All Nations	494	1,222
Golden Treasure	984	1,145
Violet	770	1,596

In the Yarraden area the two most important reefs were the Golden King and the Savannah. Their exact locations are not known. According to Cameron (1906) the Golden King reef strikes about north with a vertical dip and varies from 6 inches to 15 inches wide. It was being worked over a length in excess of 1,000 feet to a maximum depth of 212 feet. Mining was more or less continuous between 1901 and 1915 with further activity in 1917 and 1921. The recorded production is 7711 oz. bullion from 7568 tons ore. The Savannah reef lies about a quarter of a mile east of the Golden

King line and underlies steeply to the west. It is in excess of 100 feet long with a steep southerly plunge. Mining was carried on to a minimum depth of 124 feet. Between 1901 and 1907 and in 1912 a total of 2,717 tons of ore were mined producing 5032 oz bullion. Unsuccessful attempts were made to reopen the mine in 1939-40.

Other reefs of importance in this area were the Lukin King (total production 1901 to 1926 of 2,049 oz. bullion from 1605 tons ore), the Gold Mount (960 oz. bullion from 769 tons ore from 1901 to 1921) and the Hiaki, or Haikai, (1261 oz. bullion from 1596 tons ore from 1909 to 1918).

Alluvial gold mining was mainly restricted to the Ebagoola area (Ball 1901) with most of the production before 1910. The gold was fairly coarse and was derived mainly from reefs and leaders by weathering in situ (i.e. largely eluvial deposits).

Alice River (Philp) Goldfield

This small goldfield is situated on the upper reaches of the Alice River in Jerry Dodds, Dickies and One Mile Creeks, about 50 miles south-south-west of Musgrave Homestead. It was discovered by the prospector Dickie in 1903 (Dickie 1903, 1905).

There are two main reefs - the Alice Queen and the Peninsula King - situated about one mile apart in a north-north-west direction. The two reefs seem to be on the same line. The country rock is adamellite.

The Alice Queen reef is a vertical quartz reef 4 feet to 6 feet wide striking north and extending over about 300 feet with two shafts 30 feet apart at the northern end. The northern shaft underlies steeply to the west. Cameron (1906) reported that the workings in the southern shaft (now caved at 10 feet) were down to 112 feet on a 6-foot reef. The reef pinched out to 1 foot, about 20 feet south of the shaft. Some specimens of quartz from an old mullock dump carry fine-grained pyrite together with some stibnite. Felsite dykes, about 10 feet wide occur west of the workings; they strike at 160° and are invaded by narrow quartz stringers. The Alice Queen line was worked between 1904 and 1909 and again between

1912 and 1915. Production from the reef was 1190 oz. bullion from 1545 tons of ore.

On the Peninsula King line several shallow shafts were sunk on both sides of Dickies Creek. Cameron (1906) reported that the reef was 2 to 3 feet wide. Workings extended over 600 feet of the reef. 1002 oz. bullion from 622 tons of ore were produced between 1904 and 1909. Some prospecting has been done along this line in recent years. The field has a recorded production of 3000 oz. bullion from 2800 tons ore between 1904 and 1907, together with about 450 oz. of alluvial gold.

Coen Goldfield

Only a small part of the Coen Goldfield occurs on the Ebagoola 1:250,000 Sheet area. Mining was carried out at the Springs locality 8 miles south-south-east of Coen from the early 1890's to about 1901. The main reefs were the Westralia, where 448 tons of ore were crushed for 629 oz. bullion in 1901, the Goolha - Goolha (or Goohla Goohla); the Rothwell and the Suden where 204 tons of ore produced 431 oz. bullion between 1898 and 1901 according to Ball (1901). This part of the Coen field was abandoned during the rush to the Hamilton field in 1900 - 01.

The mapping in 1966 indicates that small workings occur up to 12 miles south-east of Coen, roughly in a straight line parallel to the main Coen/Laura road, and that these are located on, or are adjacent to, a prominent linear feature. This feature appears to be a regional shear or possibly a very narrow sheared belt consisting of closely spaced fissures. It can be traced continuously from south of Hanna Creek on the Ebagoola 1:250,000 Sheet area in a north-west direction onto the Coen 1:250,000 Sheet area, as far north as The Bend on the Coen River. The Great Northern gold mine near Coen township and minor diggings on the south side of The Bend on the Coen River are also located on this line of shear.

The shear occurs entirely within Lankelly Adamellite. Quartz reefs of variable length are located along it and near its southern end they measure up to 3 miles long and 300 feet wide.

The adamellite adjacent to this zone is strongly sheared and has a mylonitised, granulose texture; for example where the Coen road crosses

Station Creek (66480344), at a locality about 4 miles further north on the east side of the road (66480346), and near The Great Northern gold mine at Coen.

No diggings were found at Station Creek crossing but accessory pyrite and arsenopyrite were found in nearby sheared rocks. Small pits occur about half a mile west of the locality of rock 66480346, - on the west side of the road. These occur in small quartz reefs within 40 feet of an isolated outcrop of massive, very coarse, greenschist. Similar sheared rocks were found at several creek crossings between Station Creek and Coen.

At the Great Northern Gold Mine at Coen the lode appears to be a fairly distinctive quartz breccia mainly composed of angular fragments of sillicified granitic rock in a cement of white quartz.

This regional shear or shear zone, determines the distribution of all of these workings. The gold lodes have a hydrothermal origin. It may be assumed that the Lankelly Adamellite was reconstituted along the shear during the tectonic deformation, siliceous fluids evolved, and these acted as collectors of the gold and migrated to spaces along the shear where they crystallized, and the gold was concentrated. Areas where brecciation was most intensive facilitated the formation of richer lodes (e.g. the Great Northern at Coen).

This control of the distribution of the lodes along a lineament was probably recognised by the early prospectors, and therefore there are probably no surface indications of mineralisation between the known diggings. There is a possibility that subsurface mineralization is present between the known diggings but the relative small size of the already worked lodes does not appear to warrant the expense of further exploration.

Other Gold Occurrences

The Potallah Creek provisional goldfield is situated about 40 miles south-west of Musgrave Homestead in fine-grained sericite schist, a short distance west of a granitic stock. The only reef apparently worked in the field is the Perseverance. According to Cameron (1906) the reef strikes north and was 2 feet 6 inches wide at the 40-foot level. The only production recorded for 1903 - 04, is 587 oz. bullion from 584 tons ore. A shaft was opened at Potallah Creek in 1946, and the reef at the 100 feet level was reported to be 6 feet wide and carrying 10 dwt gold per ton. Jensen (1964) records that "the gold is contained in a shear zone striking north to south with rich reefs and leaders, in schist country".

A production of 70.7 oz. gold from 49 tons of ore is recorded from the Lochinvar provisional goldfield, on Tadpole Creek about 11 miles south-west of Coen in 1904.

Jensen (1964) mentions leader country at "Cohenville", 20 miles north of the Alice River Goldfield, gold-bearing greisen dykes in mica schist at the Crosby River goldfield 6 to 8 miles north of Potallah Creek; and the Olain or Olam goldfield south of the Coleman River (O'lane Creek is about 10 miles north-west of Potallah Creek). A production of 5¼ oz. gold is recorded for an Olain Creek locality in 1914.

Most small rich shows are probably effectively exhausted.

ANTIMONY

An antimony (? stibnite) deposit was reportedly discovered by Dickie in 1907, 20 miles east of the Alice River Goldfield. This has been referred to as the Coughlan Antomony deposit. Cherry (1907) describes the deposit as located at the head of the middle branch of the Alice River. Three outcrops have 12 antimony occurrences within 1½ miles of the Coughlan deposit. The Coughlan deposit produced ore of very fine quality giving an assay of 58 percent antimony. Stibnite is a minor mineral in gold shows in the Hamilton and Alice River goldfields.

TIN(?)

A little tin(?) together with ilmenite is reported locally from a quartz lode in dolerite near the headwaters of the King River, 26 miles north-west of Palmerville.

IRON

Minor concentrations of hematite together with hydrated iron oxides occur in some narrow schist bands within the Saraga-type schist in the Yambo inlier.

Scattered patches of poorly developed pisolitic laterite are not uncommon overlying the metamorphics and granite in the area. The Lilyvale Beds are generally enriched in iron and in a few places show the incipient stages of development of a lateritic profile. Some of the Mesozoic sandstone cappings are also ferruginous. All types of iron deposit contain rare small areas of fairly high iron enrichment but they are too small to be considered as possible sources of iron ore.

Some quartzite bands, notably in the Arkara-type gneiss contain abundant disseminated hematite flakes. They may be the "graphite flakes" reported by Ball (1901) to occur in quantity in quartzite near the Hamilton Goldfield.

Non - Metals

MICA

A prospect for the mining of muscovite was developed between 1941 and 1943 approximately 26½ miles south-south-west of Musgrave Homestead (Ball, 1943). The mica books averaged 30 square inches in places. They occured in quartz, pegmatite and greisen bodies having a conformable relation to mica schist and quartz-feldspar gneiss. Some early exploratory work was done in 1934.

The workings mainly consisted of shallow shafts, small open cuts and costeans. In 1942 some hundredweights were sent to Melbourne from 3½ tons of split mica. Either the mica was not of sufficient quality or could not be economically mined for the workings were closed down by 1944.

GRAPHITE

Fine-grained graphite-bearing schists occur throughout the Lukin-type and Pollappa-type schists. They are most abundant in the Lukin-type schist, south and south-east of Potallah Creek. Some narrow bands contain several percent graphite.

Graphite forms up to 20 percent of some schists about 6 miles south-east of the Potallah Creek gold mine, but it appears to be the earthy variety and forms only very small and disseminated flakes. Ball (1901) reported graphite flakes "in quantity" in quartzites on the Hamilton Goldfield.

HEAVY MINERALS

Concentrations of garnet, monazite and ilmenite have been reported from sands in the Palmer River but they are not likely to be of economic significance. Small patches of black heavy minerals, which are probably mainly ilmenite, occur on the beach adjacent to the cliffs of Mesozoic sandstone at Gorge Creek. They are clearly derived from the sandstone.

SILICA SAND

Some exploration work was done in 1964 to test the sands in Princess Charlotte Bay. Three shallow offshore holes were drilled near the mouth of the North Kennedy River. Results were not satisfactory and exploration was ceased due to drilling difficulties (Beggs, 1965).

LIME SAND

The beach sand of Princess Charlotte Bay in many places contains a very high proportion of shell debris.

AGATE

Agate was reported in basalt for 8 miles upstream along the Mitchell River from near Mount Mulgrave Station by Hann's expedition (in Jack, 1922). Agate is common in rubble on a hill composed of Nychum Volcanics a few miles south of Mount Mulgrave Homestead.

PETROLEUM

Petroleum exploration has been confined to the Laura Basin in the north-east part of the area. This work has been summarized in Lucas and de Keyser (1965b) and references given in their bibliography. Mines Administration (1965) have given a summary of data obtained by them on the Laura Basin, including the data from the Cabot-Blueberry Marina No. 1 well which was located near Marina Plains Homestead at the mouth of the Annie River.

Future prospects in the Laura Basin and in the Carpentaria Basin in the area mapped are not considered hopeful. Thin marine Cretaceous sequences occur near the surface in both basins, and are overlain unconformably by irregular terrestrial Cainozoic deposits.

In the Laura Basin small stratigraphic and structural traps might occur in the deepest part of the basin adjacent to the Palmerville Fault, but the source-rock content of that part of the basin is unknown.

Fine-grained sediment, and potential source-rocks, may increase in abundance offshore in the Laura Basin. The presence of glauconitic siltstone and some mudstone in the Carpentaria Basin, a few miles west of the metamorphic rocks near the northern limit of the Ebagoola Sheet area, suggests that source rocks may be present farther west towards the Gulf of Carpentaria where the section is presumably thicker.

WATER

In the winter of 1966, following an exceptionally dry summer, water flowed only in the Mitchell River, the Hann River, the Stewart River and its tributary Station Creek, and in part of the upper reaches of the

Alice River. Water persisted until August, 1966, in many waterholes in large rivers throughout the area mapped, but in September many of these dried up and surface water became very scarce.

Throughout the winter water continued to seep from several small springs in the escarpment bounding the eastern side of the Kintore Adamellite north of New Bamboo Homestead, and from springs around the sandstone plateau on which Kimba Homestead is located. A hot spring, with a surface temperature of about 150°F, located about 20 miles north of New Bamboo Homestead, flowed copiously throughout the winter.

Underground water is not extensively used in the area mapped. Many homesteads draw domestic water from wells, up to 30 feet deep, sunk in superficial deposits, and the few bores sunk near the outcrop of the igneous and metamorphic rocks are generally shallow and are sunk in superficial deposits.

Surface water, though still limited in quantity, is conspicuously more abundant and more persistent within the Mesozoic sediments bounding the outcrop of the igneous and metamorphic rocks. Waterholes within the sediments carried water through September, and the perennial water in the Hann River and in the headwaters of the Alice River has its source in the sandstone which separates the Yambo inlier from the main belt of igneous and metamorphic rocks.

This sandstone is almost certainly the best source of underground water in the area mapped. The continuity of supply to the Hann River and to springs along the north-western limit of the sandstone suggests that the sandstone contains abundant water not far below the surface of the Kimba plateau which it forms.

Nothing is known of the occurrence of underground water in the igneous and metamorphic rocks. Prominent zones of shearing in the adamellites may yield water. Secondary porosity may be well developed in cleaved or sheared metamorphic rocks.

Water could be supplied throughout the dry season within the igneous and metamorphic rocks from reservoirs dammed at suitable sites on the Coleman, Holroyd and Lukin Rivers in the main belt and on the Palmer River in the Yambo inlier.

Patches of permeable superficial deposits with sufficient depth and extent to constitute sizable reservoirs could also be selected as sources of underground water within the igneous and metamorphic rocks. A supply of this nature was being sought in June 1966 in a well sunk in sand lying on decomposed pegmatitic adamellite, near the Coen/Laura road, 13 miles south of Musgrave Homestead. The water-table at this locality was reported by the well sinker to be 32 feet below the surface. The average depth of the water table, reported by the well sinker, in the sand and decomposed granite country is 120 feet; it is likely however to be less than this in many places particularly near main drainages and depressions.

LATERITE

Though some laterite deposits are probably rich in iron, they are thin or small.

Pisolitic laterite is used wherever it is easily available, for surfacing the Peninsula Development Road. It appears to be most abundant on the low ground south of the Morehead River, where it forms pockets overlying Mesozoic sediments.

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NOTE ON PHOTOGRAPHS

In the captions to the photographs in the following pages, the units of metamorphic rocks illustrated are incorrectly named Arkara Gneiss, Saraga Schist, etc.

These names should read Arakra-type gneiss, Saraga-type schist, and so on, as given in the text for each unit of metamorphic rock.

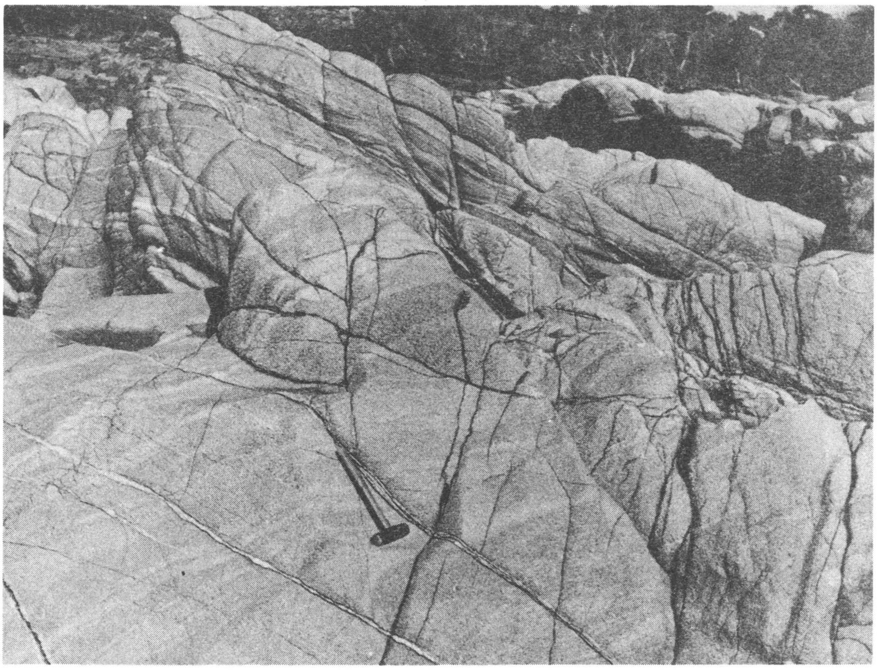

Fig. 7. Banding in Arkara Gneiss

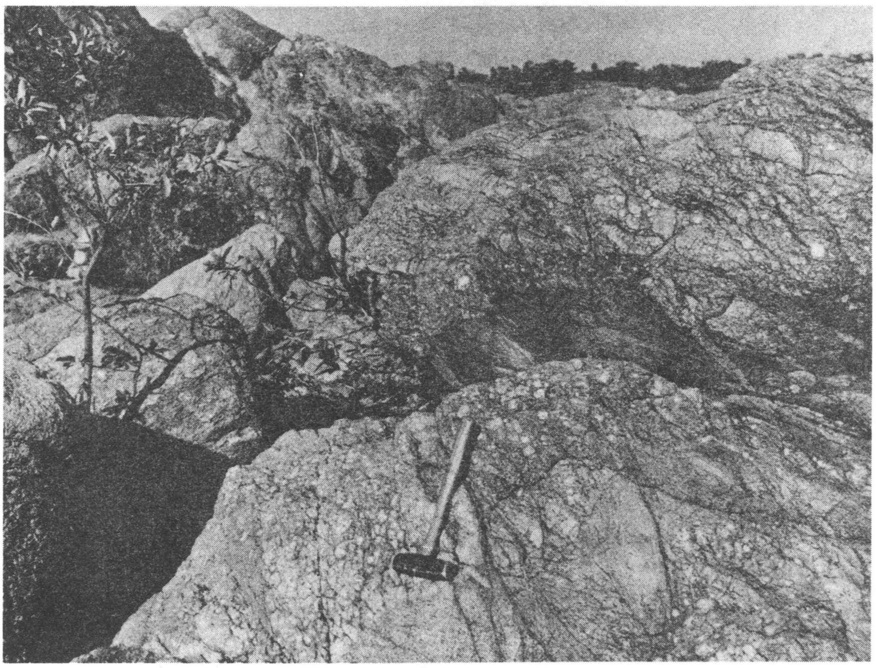

Fig. 8. Porphyroblasts in Arkara Gneiss

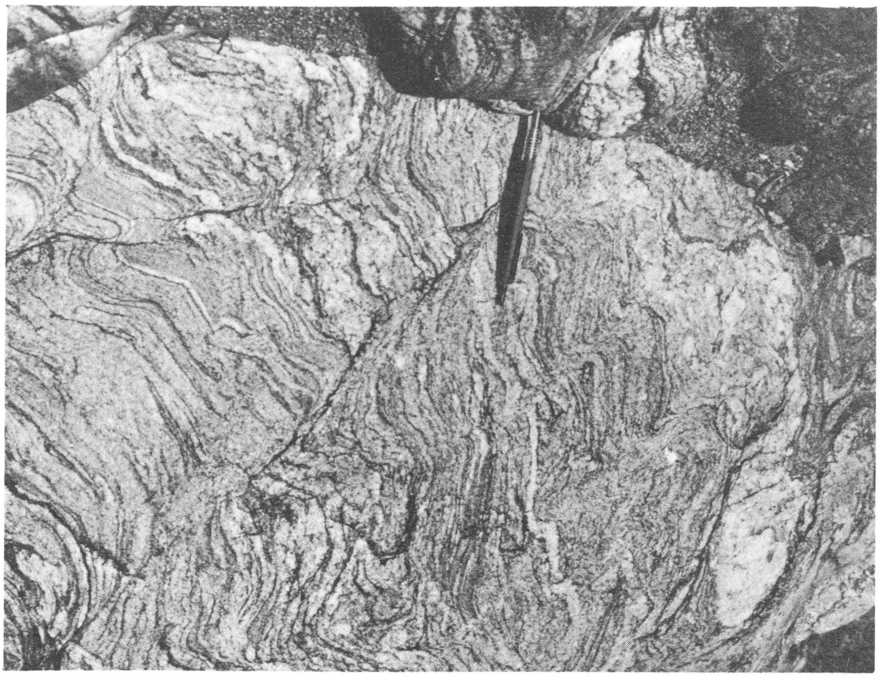

Fig. 9. Folding in Arkara Gneiss

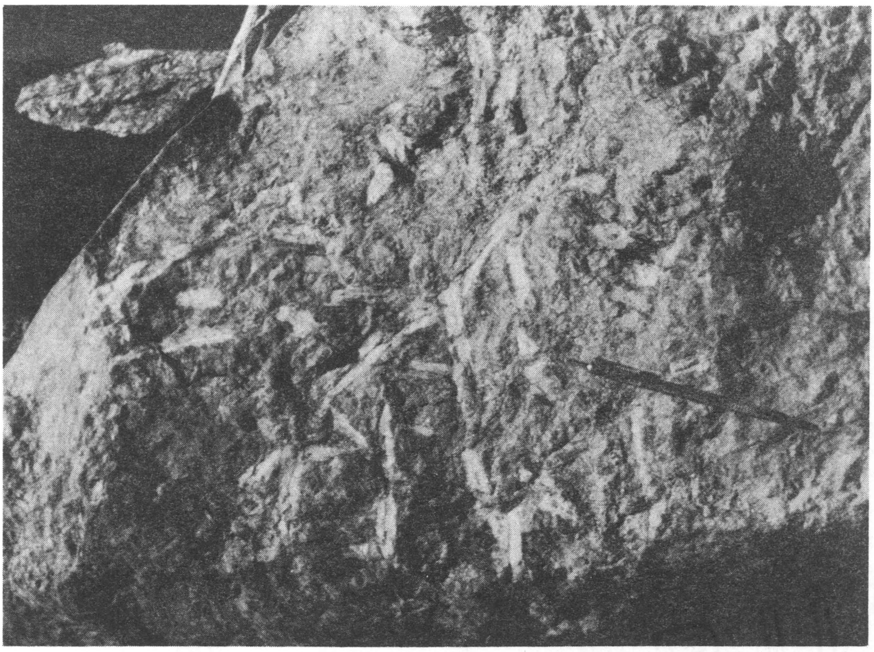

Fig. 10. Sillimanite porphyroblasts in Saraga Schist

Fig. 11. Cleaved siltstone in Lukin Schist.

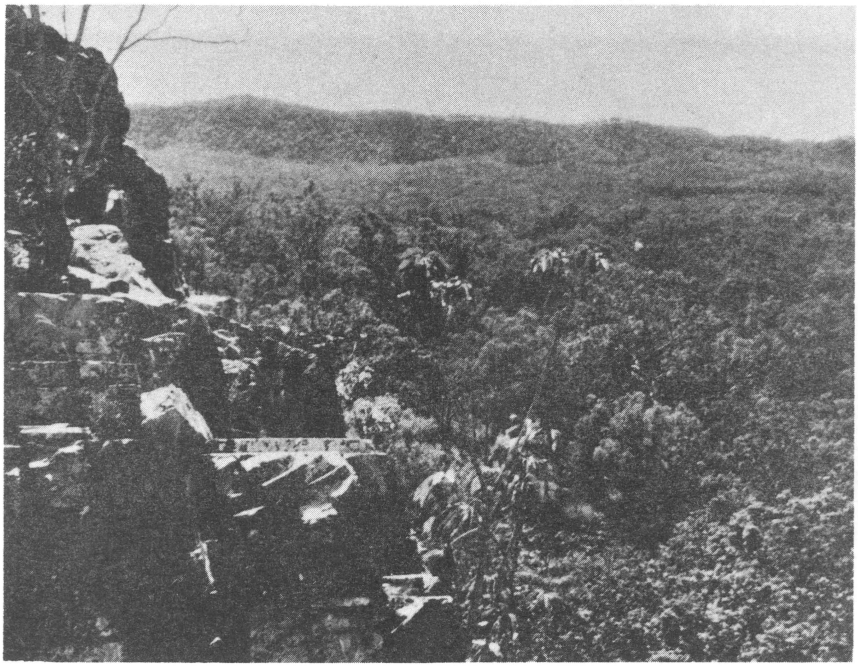

Fig. 12. Quartzite ridge in Pallappa Schist.

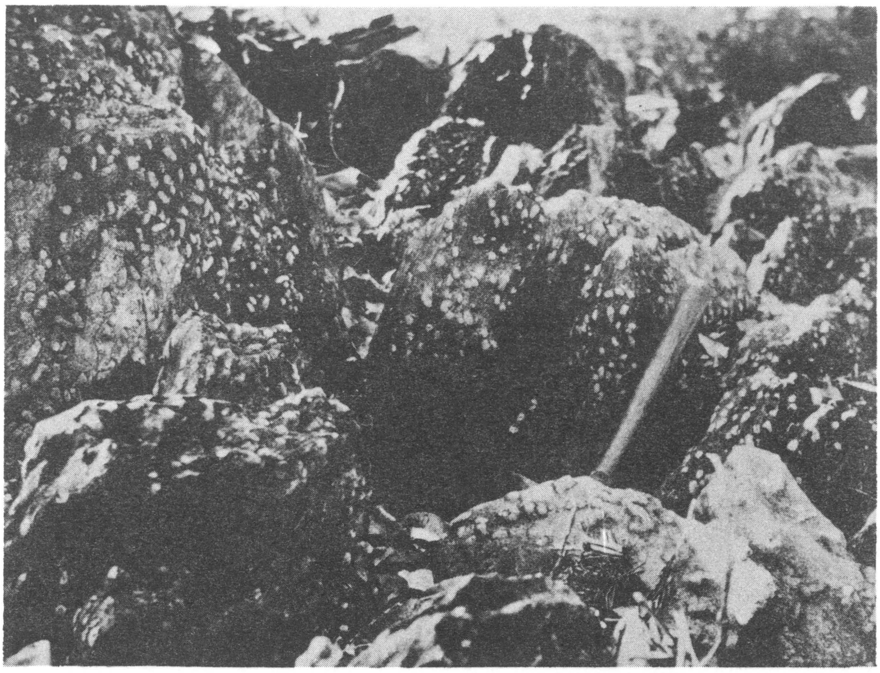

Fig. 13. Andalusite porphyroblasts in Lukin Schist.

Fig. 14. Porphyritic Flyspeck Granodiorite.

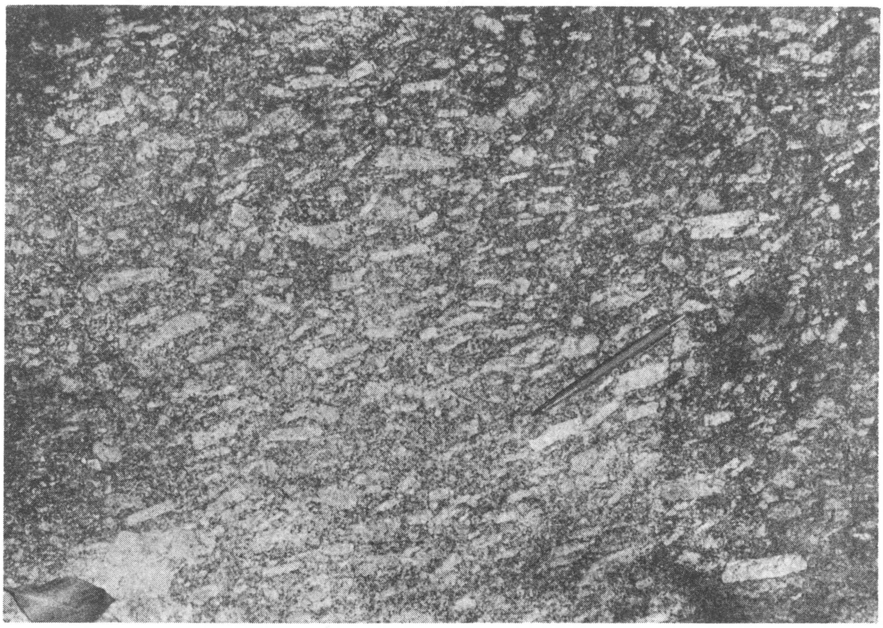

Fig. 15. Aligned phenocrysts near margins of Lankelly Adamellite.

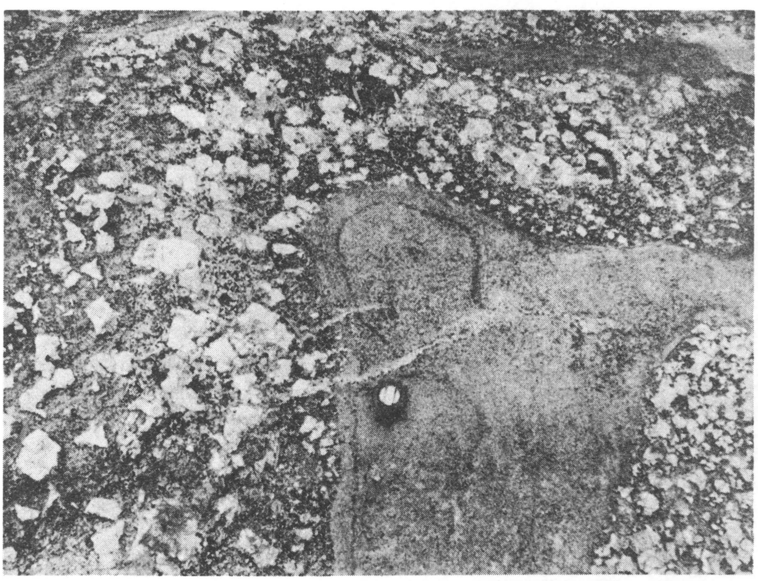

Fig. 16. Porphyritic muscovite granite phase of Kintore Adamellite surrounding medium-grained adamellite.

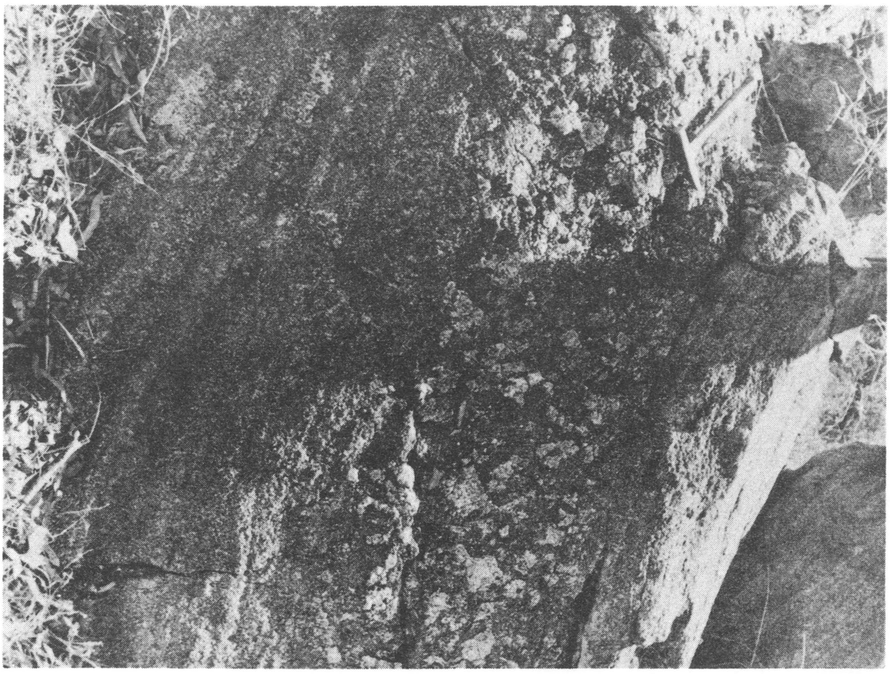

Fig. 17. Banding in Kintore Adamellite.

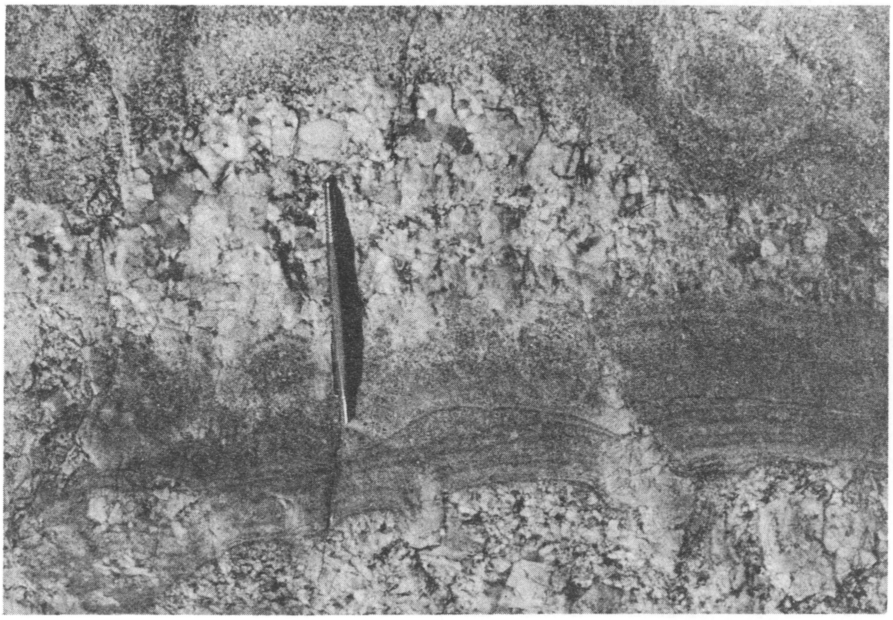

Fig. 18. Bands of apite and pegmatite at margin of Kintore Adamellite.

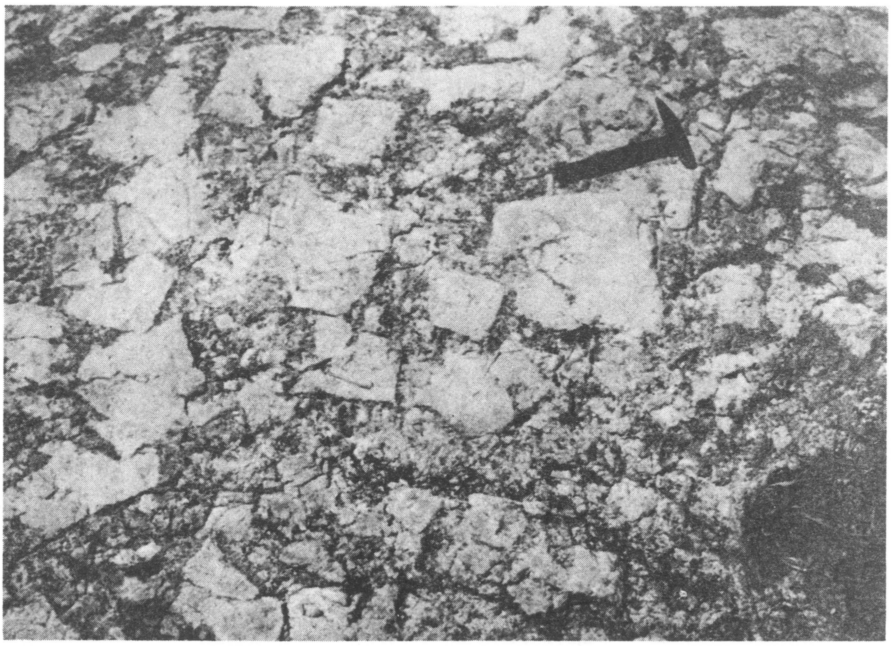

Fig. 19. Blocky feldspar in pegmatite in Kintore Adamellite.

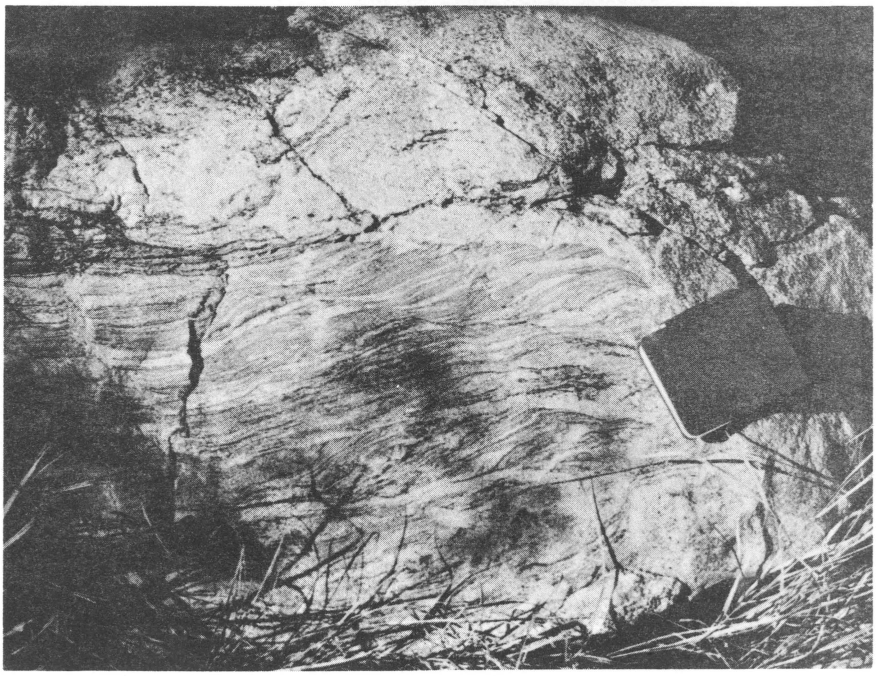

Fig. 20. Contact between gneiss and garnet-bearing aplite of Kintore Adamellite.

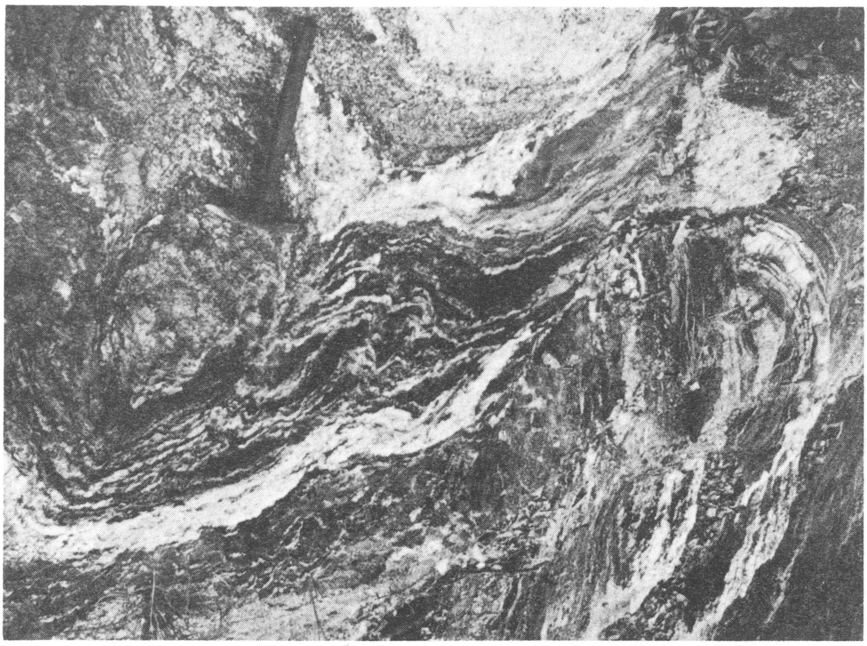

Fig. 21. Migmatite.

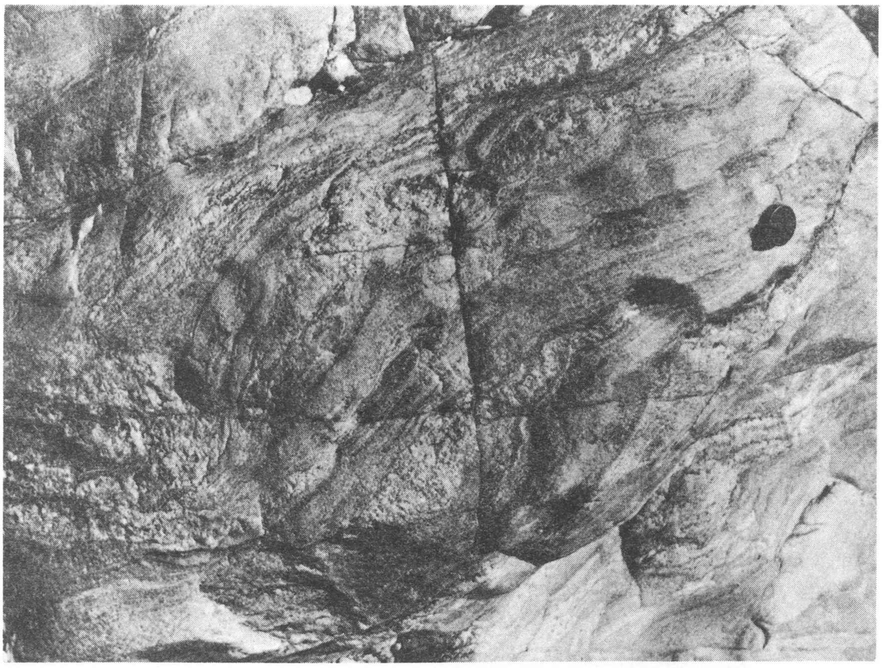

Fig. 22. Migmatite of Saraga Schist and
Adamellite.

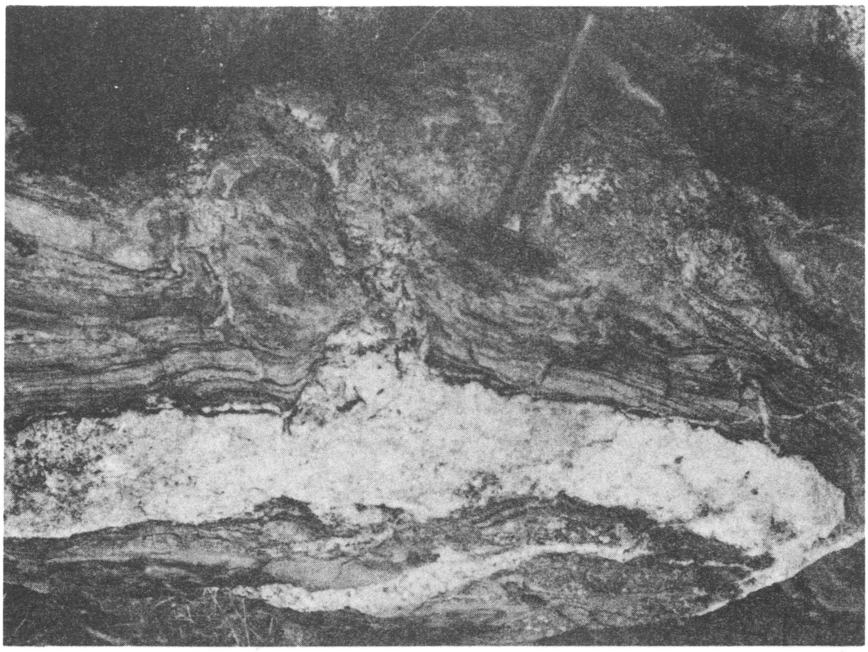

Fig. 23. Pegmatite band in migmatite.

Fig. 24. Mesa of Wrotham Park Sandstone.

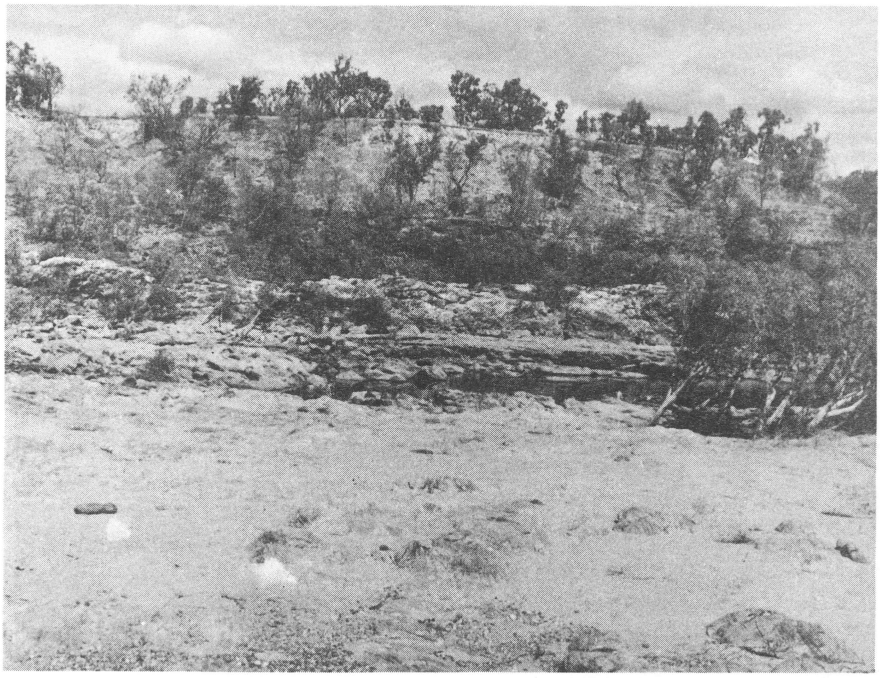

Fig. 25. Bluff of Blackdown Formation, overlying Arkara Gneiss.

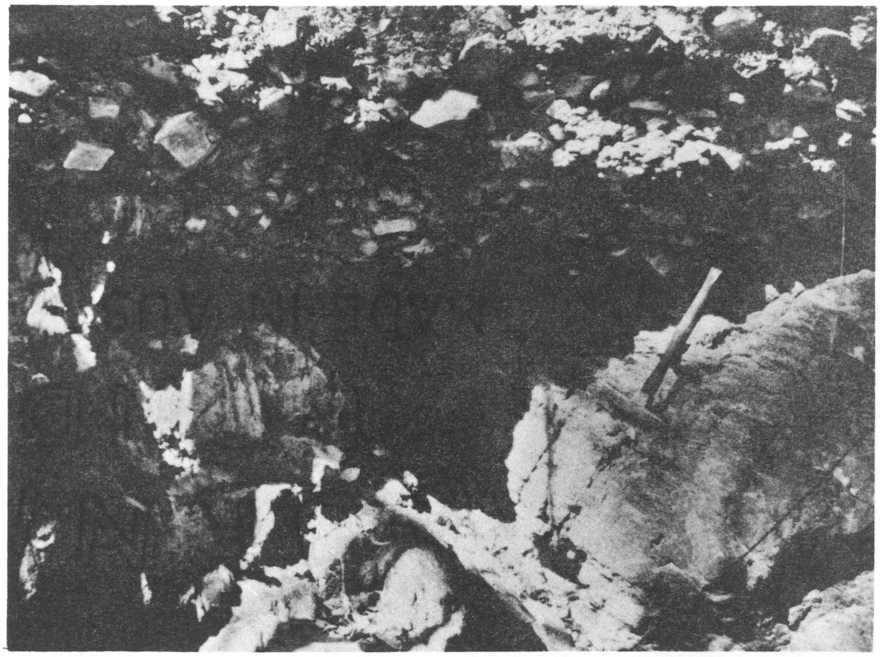

Fig. 26. Lilyvale Beds overlying Lukin Schist.

Fig. 27. Lateritic ironstone overlying Lukin Schist.

Fig. 28. Sand beach overlying mud, Princess Charlotte Bay.

Fig. 29. Shelly sand of beach ridge lying on Clay.

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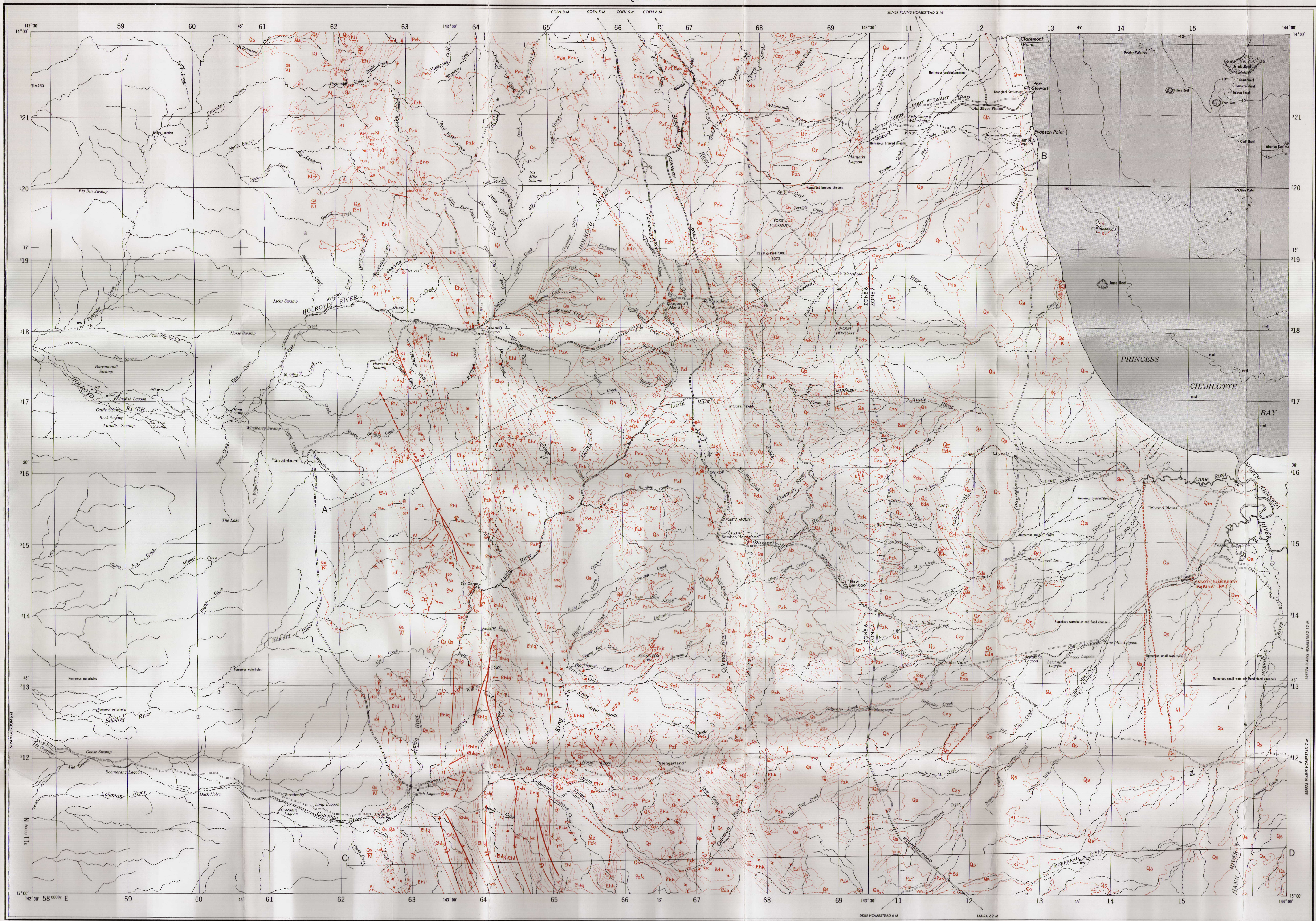

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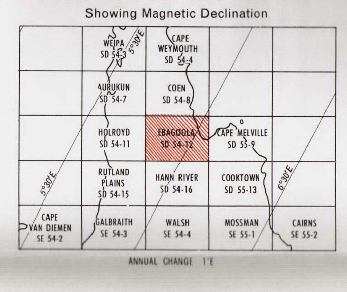


ANNUAL CHANGE 1'E

Scale 1:250,000

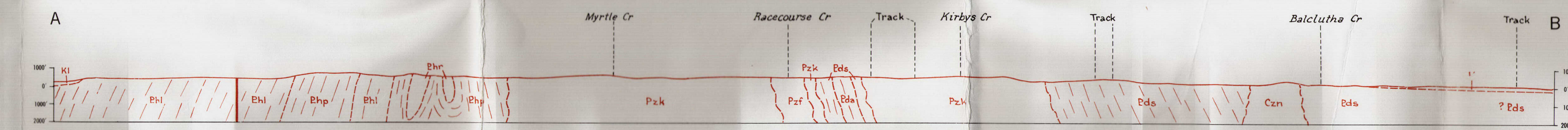
5 0 5 10 15 MILES

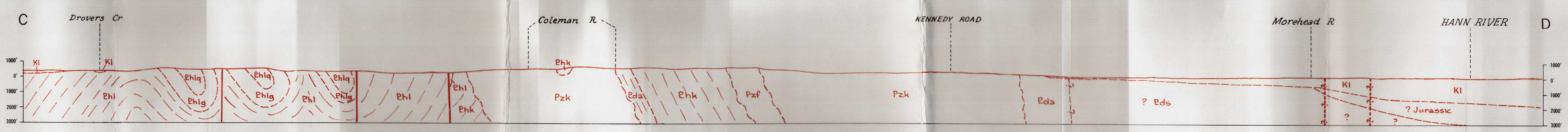
5 0 5 10 15 20 25 KILOMETRES

Sections

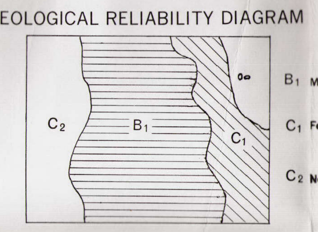
Cainozoic sediments omitted from section

Scale: $\frac{V}{H} = 4$





GEOLOGICAL RELIABILITY DIAGRAM



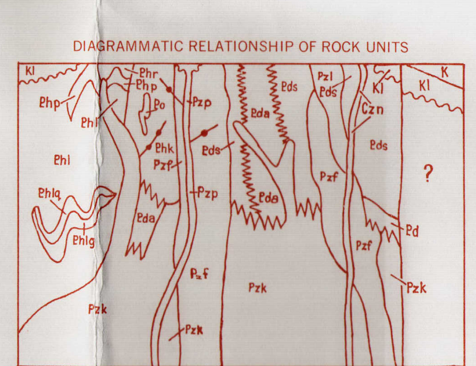
B1 Many traverses and air-photo interpretation

C1 Few traverses and air-photo interpretation

C2 No traverses, limited air-photo interpretation

Geology, 1963, by: K.G. Lucas
1966, by: D.S. Trail, I.R. Pontifex, W.D. Palfreyman, W.F. Willmott, (B.M.R.). W.G. Whitaker, (G.S.Q.)
Compiled, 1966, by: D.S. Trail
Drawn by: W.W. Webb

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity

Gradational boundary

Reference

CAINOZOIC

	Qm	Sand, beach ridges
	Qa	Alluvium, mainly silty
	Qs	Sand, mainly residual
	Qr	Sand, red, micaceous
	Ql	Clay, residual
Lilyvale Beds	Czy	Soft pebbly sandstone, some gravel
	Czn	Olivine nephelinite

MESOZOIC

CRETACEOUS	K	Pebbly sandstone and conglomerate
LOWER CRETACEOUS	Kl	Mudstone and siltstone, sandstone near base

PALAEOZOIC

	Pzp	Feldspar porphyry, quartz porphyry
Kintore Adamellite	Pzk	Even-grained, biotite-muscovite adamellite
Lankelly Adamellite	Pzl	Porphyritic biotite adamellite
Flyspeck Granodiorite	Pzf	Biotite granodiorite, hornblende-biotite tonalite

PRECAMBRIAN

		Eo	Dolerite, some amphibolite
Holroyd Metamorphics	Pretender-type schist	Ehr	Feldspar-biotite-muscovite-quartz schist
	Pollappa-type schist	Ehp	Quartzite, muscovite-quartz schist with andalusite and sillimanite, graphite in places
	Lukin-type schist	Ehl	Muscovite-quartz schist, phyllite, indurated siltstone and mudstone
		Ehlg	Greenschist
		Ehlq	Quartzite
	Kalkah-type schist	Ehk	Muscovite-quartz schist, muscovite-biotite-feldspar-quartz schist
Dargalong Metamorphics	Saraga-type schist	Eds	Muscovite-quartz schist and quartzite, sillimanite in places
	Arkara-type gneiss	Eda	Biotite-quartz-feldspar gneiss
	Undifferentiated	Ed	Muscovite-quartz schist, muscovite-biotite-feldspar-quartz schist, biotite-quartz-feldspar gneiss, some amphibolite

Geological boundary

Anticline, showing direction of plunge

Syncline, showing direction of plunge

Overturned anticline

Overturned syncline

Fault, showing relative horizontal movement

Normal fault

Shear zone

Where location of boundaries and faults is approximate, line is broken; where inferred, queried; where concealed, faults are shown by short dashes

70 Strike and dip of strata

Prevailing strike and dip of strata

Dip < 15°

Dip > 45°

Trend lines

Joint pattern

(Dip < 15°, Dip > 45°, Trend lines, Joint pattern: air-photo interpretation)

30 Strike and dip of foliation

Prevailing strike and dip of foliation

Vertical foliation

Horizontal foliation

Strike of foliation, dip indeterminable

Horizontal lineation

Plunge of lineation

40 70 Strike and dip of foliation, with trend of lineation

30 Strike and dip of banding in igneous rocks

Horizontal banding in igneous rocks

80 Strike and dip of joints

Prevailing strike and dip of joints

Vertical joint

Fossil wood

Dyke; a — acid, b — basic, q — quartz

and Andalusite-rich marker band

Mine, abandoned

Battery, smelter abandoned

Au Gold

Exploratory oil well, dry, abandoned

WH Waterhole

Road

Vehicle track

"Strathburn" Homestead

Telephone line

Astronomical station

778 Trigonometrical station, height in feet

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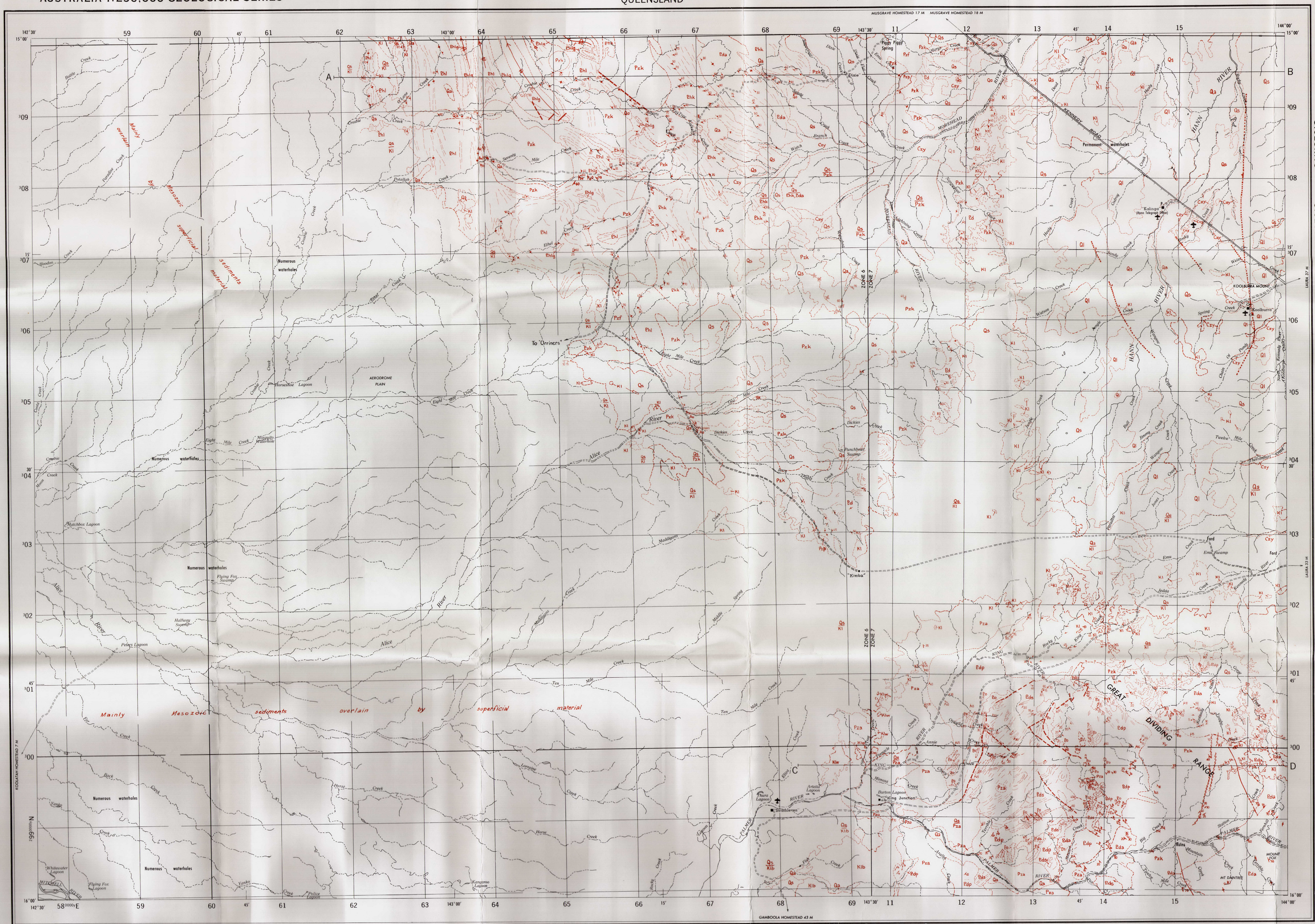

Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium, mainly silty
			Qs	Sand, mainly residual
			Ql	Clay, residual
		Lilyvale Beds	Czy	Soft pebbly sandstone, some gravel
MESOZOIC	LOWER CRETACEOUS	Blackdown Formation	Klb	Grey siltstone, mudstone, shale, calcareous lenses
		Wrotham Park Sandstone	Klw	Pebble conglomerate, feldspathic pebbly sandstone
			Kl	Mudstone and siltstone, sandstone near base
PALAEOZOIC			Pzp	Feldspar porphyry
		Kintore Adamellite	Pzk	Even-grained, biotite-muscovite adamellite
		Aralba Adamellite	Pza	Porphyritic biotite-muscovite adamellite
		Flyspeck Granodiorite	Pzf	Biotite granodiorite, hornblende-biotite tonalite
PRECAMBRIAN			Ꝑo	Dolerite, some amphibolite
	Holroyd Metamorphics	Lukin-type schist	Ꝑhl	Muscovite-quartz schist, phyllite, indurated siltstone and mudstone
			Ꝑhlg	Greenschist
			Ꝑhlq	Quartzite
		Kalkah-type schist	Ꝑhk	Coarse-grained muscovite-quartz-schist, fine-grained muscovite-biotite-feldspar-quartz schist
	Dargalong Metamorphics	Pombete-type schist	Ꝑdp	Muscovite-quartz schist, muscovite-biotite-quartz-feldspar schist
		Saraga-type schist	Ꝑds	Muscovite-quartz schist and quartzite, sillimanite in places
		Arkara-type gneiss	Ꝑda	Biotite-quartz-feldspar gneiss, amphibolite and quartzite in south
		Undifferentiated	Ꝑd	Muscovite-quartz schist, muscovite-biotite-feldspar-quartz schist biotite-quartz-feldspar gneiss, some amphibolite

Geological boundary, position approximate
Overturned anticline, showing direction of plunge
Overturned syncline, showing direction of plunge
Fault, showing relative horizontal movement
Normal fault
Lineament
Shear-zone
Where fault is approximate, line is broken; where inferred queried; where concealed, shown by short dashes
Strike and dip of strata
Prevailing strike and dip of strata
Horizontal bedding
Strike and dip of foreset beds
Trend lines
Strike and dip of foliation
Prevailing strike and dip of foliation
Vertical foliation
Horizontal foliation
Strike of foliation, dip indeterminable
Foliation with plunge of lineation
Horizontal lineation
Strike and dip of banding in igneous rock
Horizontal banding in igneous rock

Dyke, a - acid, b - basic, q - quartz
Mine, abandoned
Au Gold
Battery, abandoned

Spring
Swamp
Road
Vehicle track
Landing ground
"Kimba" Homestead
Yd Yard
Telegraph line

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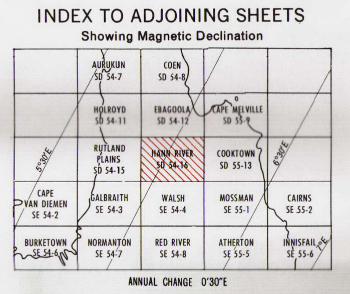

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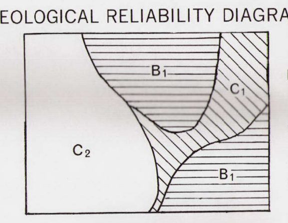
GEOLOGICAL RELIABILITY DIAGRAM



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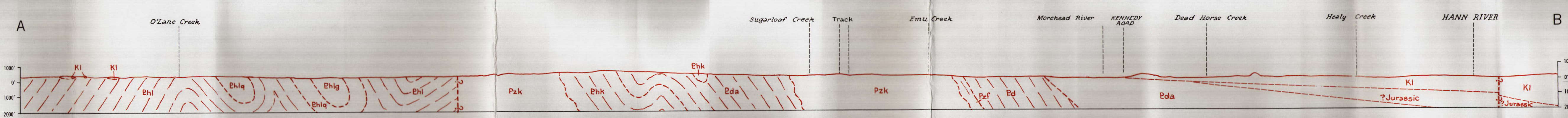
C2 No traverses, limited airphoto interpretation

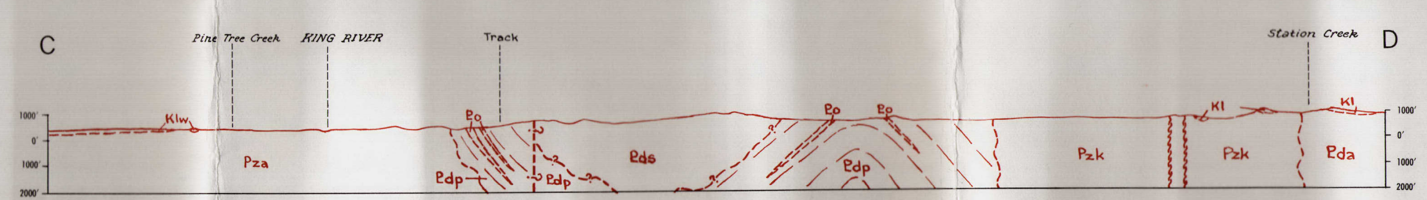
Geology, 1963, by: K.G. Lucas
1966, by: D.S. Trail, I.R. Pontifex, W.D. Palfreyman, W.F. Willmott, (B.M.R.); W.G. Whitaker (G.S.Q.)
Compiled, 1966, by: D.S. Trail
Drawn by: W.W. Webb

Sections

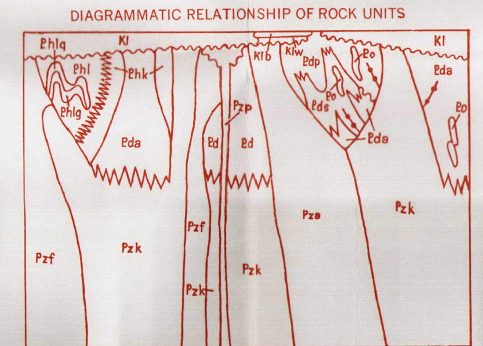
Cainozoic sediments omitted from section

Scale: V/H = 4





DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity
Gradational boundary

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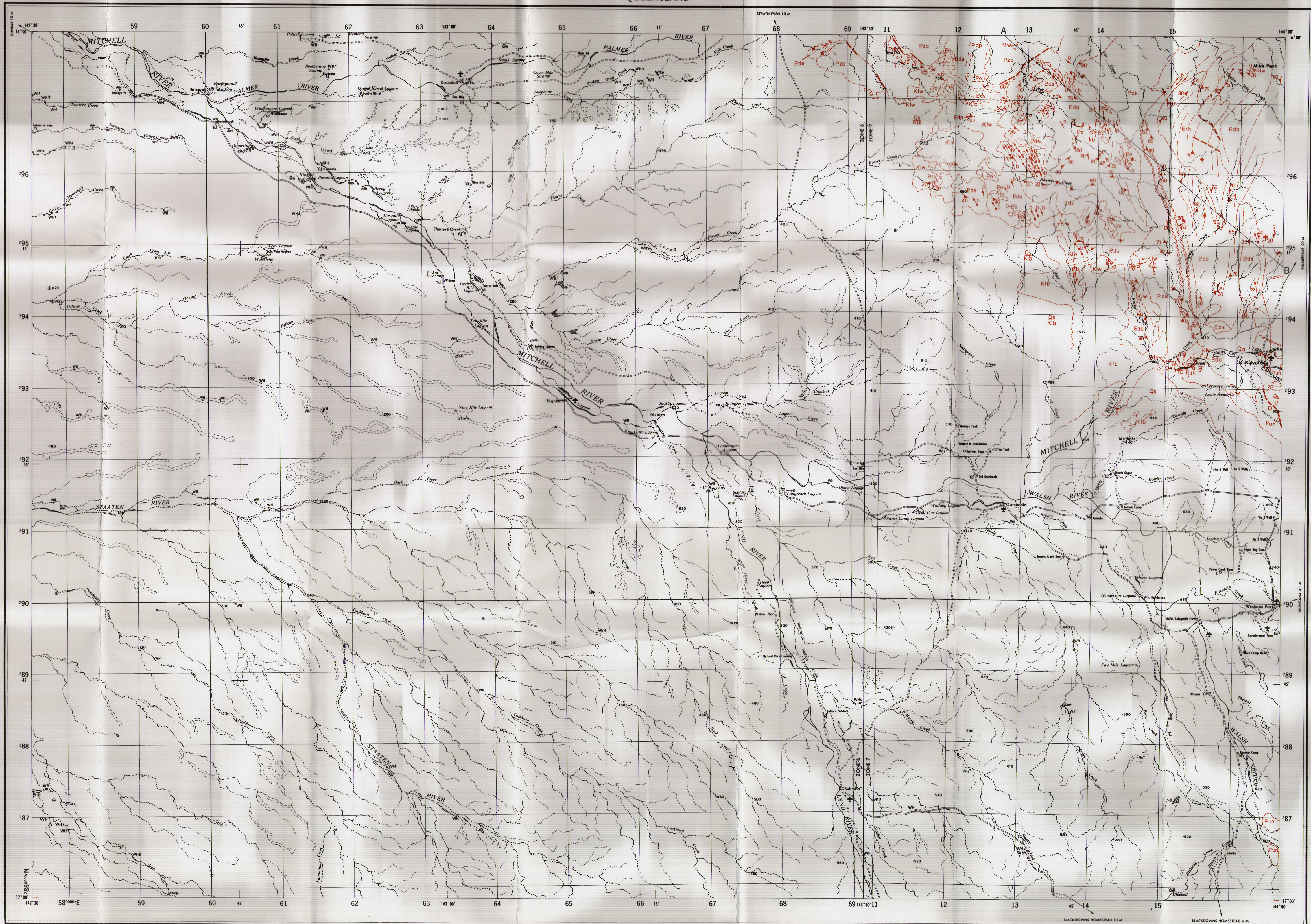


Reference

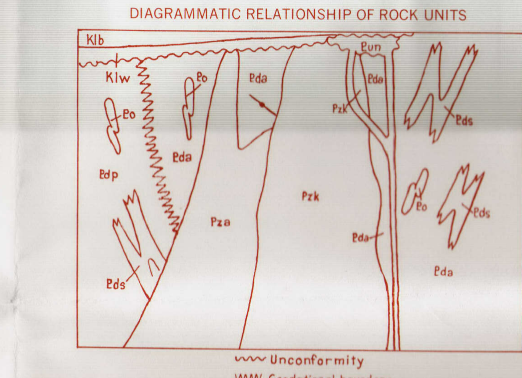
CAINOZOIC	QUATERNARY		Qa	Alluvium, mainly silty
			Qs	Sand, mainly residual
			Czx	Gravel, mainly residual
MESOZOIC	LOWER CRETACEOUS	Blackdown Formation	Klb	Grey siltstone, mudstone, shale, calcareous lenses. Large sandstone lenses
		Wrotham Park Sandstone	Klw	Pebble conglomerate, feldspathic pebbly sandstone
PALAEOZOIC	UPPER PERMIAN	Nychum Volcanics	Pun	Acid flows and pyroclastics. Subordinate basic flows
PRECAMBRIAN TO PALAEOZOIC		Kintore Adamellite	Pzk	Even-grained biotite-muscovite adamellite
		Aralba Adamellite	Pza	Porphyritic biotite-muscovite adamellite
PRECAMBRIAN			Ꞓo	Dolerite
	Dargalong Metamorphics	Pombete-type schist	Ꞓdp	Muscovite-quartz schist, muscovite-biotite-quartz-feldspar schist
		Saraga-type schist	Ꞓds	Medium-grained muscovite-quartz schist, sillimanite in places
		Arkara-type gneiss	Ꞓda	Biotite-quartz feldspar gneiss, amphibolite and quartzite

Geological boundary, position approximate
15 Plunge of minor syncline
U D Fault (D,U indicate relative movement down, up) position approximate
Shear-zone
5 Strike and dip strata
Horizontal strata
Trend lines. Air-photo interpretation
75 Strike and dip of foliation
Vertical foliation
Strike of foliation, dip indeterminable
Horizontal lineation
20 Plunge of lineation
40 Strike and dip of banding in igneous rock
10 Strike and dip of foreset beds
Dyke, a-acid, b-basic

•WH Waterhole
WH Waterhole on stream
Windpump

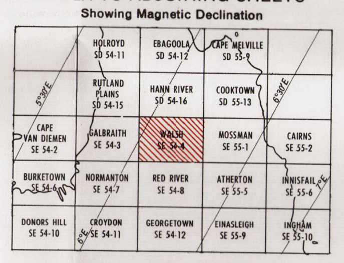
Road
Vehicle track
Telephone line
"Bulimba" Homestead
Landing ground
Astronomical station
.620 Height in feet; datum mean sea level

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Base map compiled by the Royal Australian Survey Corps and the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Aerial photography by Adastra Airways Pty. Ltd. Complete vertical coverage at 1:50,000 and 1:86,000 scale. Transverse Mercator Projection

INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



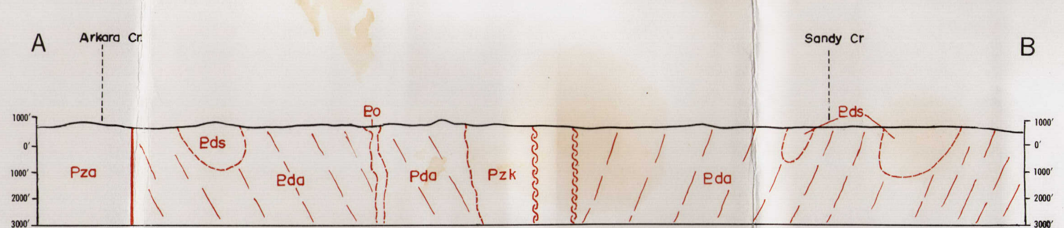
Scale 1:250,000

15 MILES

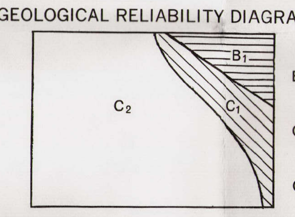
25 KILOMETRES

Section

Scale: $\frac{V}{H} = 4$



GEOLOGICAL RELIABILITY DIAGRAM



B_1 Many traverses and airphoto interpretation

C_1 Few traverses and airphoto interpretation

C_2 No traverses, limited airphoto interpretation

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1966 by: D.S.Trail, I.R.Pontifex, W.D.Palfreyman, W.F.Willmott, (B.M.R.) W.G.Whitaker (G.S.Q.)
Compiled, 1966 by: D.S.Trail, W.W.Webb
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