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Igneous rocks of the Ebagoola 1:250 000 sheet area, Cape York Peninsula, north Queensland: field, petrographic, and geochemical data

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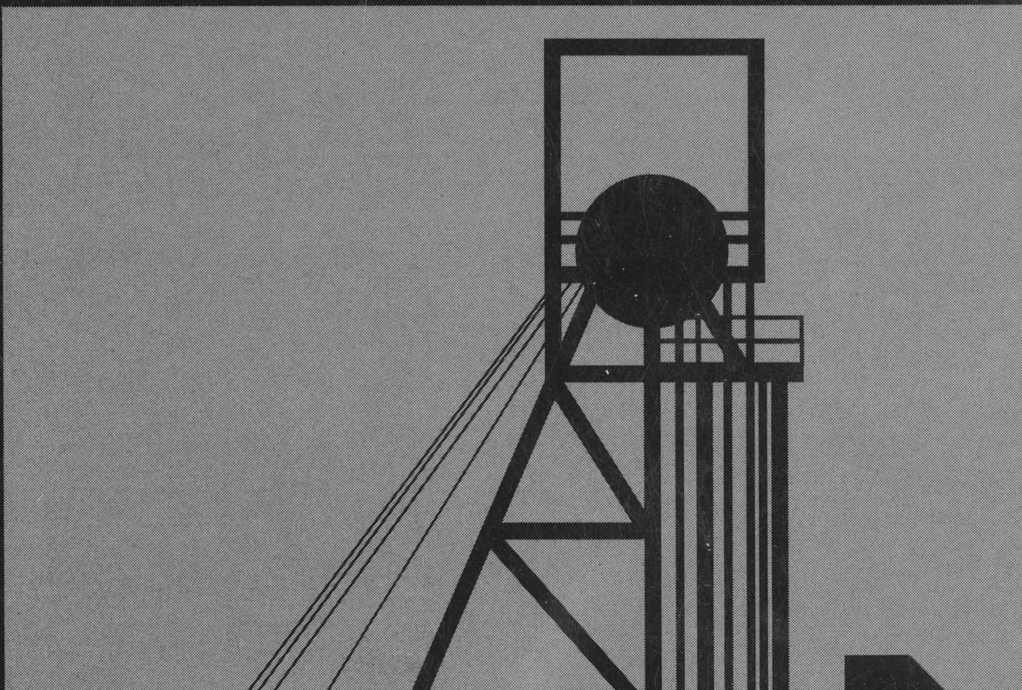

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D E Mackenzie and J Knutson

MINERALS AND LAND USE PROGRAM
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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AUSTRALIAN GEOLOGICAL
SURVEY ORGANISATION

DEPARTMENT
OF RESOURCE
INDUSTRIES

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A contribution to the National Geoscience Mapping Accord
NORTH QUEENSLAND PROJECT

R9207501

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Minerals and Land Use Program

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
(formerly BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS)

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GEOLOGICAL SURVEY OF QUEENSLAND

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ISSN 0811-062X
ISBN 0 642 18437 2

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SUMMARY

The igneous geology of the Ebagoola 1:250 000 Sheet area (EBAGOOLA) is dominated by granitoids of the Siluro-Devonian Cape York Peninsula Batholith (CYPB). The CYPB may be divided into two major groups, one of S-type character (Kintore Supersuite), the other of I-type character (Flyspeck Supersuite).

The Kintore Supersuite is divided into Ebagoola Suite (Kintore, Barwon, Leconsfield, Warner, Lindalong, Burns, Heneage, Tadpole, and Ebagoola Granites) and Lankelly Suite (Lankelly and Kendle River Granites). The Lankelly Suite is more generally porphyritic (and flow(?)-aligned) than the Ebagoola Suite, and the Ebagoola Granite is leucocratic and contains abundant pegmatite and aplite; the S-type granites otherwise differ only subtly from one another.

The Flyspeck Supersuite comprises Glen Garland Granodiorite, Tea Tree Granodiorite and Peringa Tonalite (all biotite + [major] hornblende), Flyspeck Granodiorite (mostly biotite + [minor] hornblende), Two Rail Monzogranite (minor hornblende in places), and Artemis Granodiorite and Carleton and Kirkwood Monzogranites (all biotite only). Allanite, in the form of prisms up to 1.5 cm long, is a conspicuous and characteristic minor phase in most of the I-types.

The principal geochemical differences between the two Supersuites are higher aluminium saturation index (ASI) and K_2O/Na_2O in the S-types; all the granitoids are very iron-poor and strongly reduced.

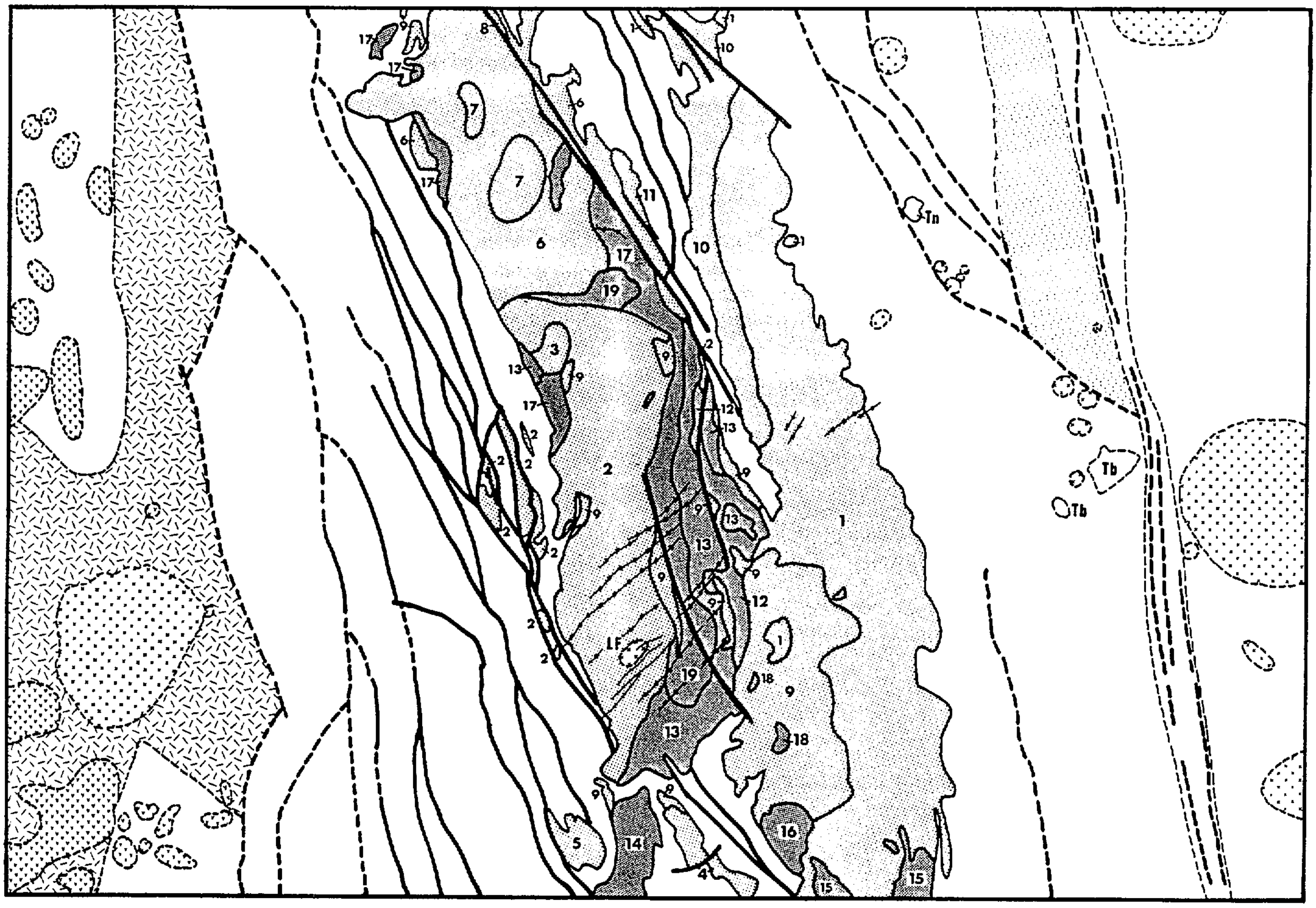
The CYPB is emplaced into metamorphic rocks of the Coen Inlier: its eastern margin against the Newberry Metamorphic Group is near vertical; it partly underlies the Coen Metamorphic Group, and dips beneath the Holroyd Group in the west and south. Geophysical data indicate that equivalent rocks probably intrude (at depth) the Edward River Metamorphic Group in the west and the Newberry Metamorphic Group in the east.

Emplacement of the CYPB took place during the peak of metamorphism, probably *via* dilational jogs in major north-northwesterly trending sinistral transpressional shear zones such as the Ebagoola and Coen Shear Zones. Granitoids of the Flyspeck Supersuite were emplaced first, then shouldered aside as the S-type granitoids followed.

Intruding the CYPB and host metamorphic rocks are numerous, mostly north-northeast-trending, rhyolitic to andesitic and doleritic dykes, a rhyolite plug, and a small microgranite stock (Lindsay Flat Microgranite). These rocks are geochemically similar to, and probably coeval with, Late Carboniferous-Early Permian rocks elsewhere in north Queensland. Aeromagnetic and gravity data suggest that felsic extrusive and intrusive rocks of the same age occur extensively beneath Mesozoic and Cainozoic cover in the east and west of EBAGOOLA.

A highly silica-undersaturated nephelinite (Silver Plains Nephelinite) of Early Pliocene age crops out near Balclutha Creek in the northeast of EBAGOOLA; aeromagnetic data indicate that similar rocks occur beneath thin Quaternary cover to the east of the southern end of Princess Charlotte Bay.

Airborne radiometric imagery was useful in mapping the CYPB: the principal discriminant was the deep red to brownish-red tones of the Flyspeck Supersuite compared to the brighter orange-reds to pinks/purples of the Kintore Supersuite.



Tertiary

Tn - Silver Plains Nephelinite

Tb - Unnamed basalt (from geophysics)

Carboniferous-Permian

Volcanics (interpreted from geophysics)

Granitoids

LF = Lindsay Flat Microgranite

dykes

Silurian-Devonian

CAPE YORK PENINSULA BATHOLITH

KINTORE SUPERSUITE

EBAGOOLA SUITE

1 Kintore Granite
2 Barwon Granite
3 Leconsfield Granite
4 Warner Granite
5 Lindalong Granite
6 Burns Granite
7 Heneage Granite
8 Tadpole Granite
9 Ebagoola Granite

LANKELLY SUITE

10 Lankelly Granite
11 Kendle River Granite

Unnamed granitoid(s) (from geophysics)

FLYSPECK SUPERSUITE

12 Flyspeck Granodiorite
13 Glen Garland Granodiorite
14 Peringa Tonalite
15 Artemis Granodiorite
16 Tea Tree Granodiorite
17 Two Rail Monzogranite
18 Carleton Monzogranite
19 Kirkwood Monzogranite

Proterozoic

Granitoids (interpreted from geophysics)

Figure 1. Distribution of igneous rocks in EBAGOOLA. Generalised from Blewett & others (1992) - Ebagoola - basement geology (1:250 000 map).

INTRODUCTION

This report describes the Cape York Peninsula Batholith (CYPB) and other igneous rocks in the area covered by the EBAGOOLA 1:250 000 Sheet in the southern Coen Inlier. The work was undertaken during 1991 by the North Queensland Project of the Australian Geological Survey Organisation (then Bureau of Mineral Resources, Geology and Geophysics) and the Geological Survey program of the Queensland Department of Mines and Energy (then Department of Resource Industries) as part of the National Geoscience Mapping Accord.

EBAGOOLA is located near the southern end of the Coen Inlier, extending from Princess Charlotte Bay in the east (144°E) to the upper Edward River (142° 30'E) in the west. The town of Coen, which is the main supply and communication centre of the region, is 5 km north of the northern margin of the sheet. Coen is served by the Peninsula Developmental Highway (earth formation), which traverses EBAGOOLA from southeast to north, and by regular air services from Cairns. Other public roads in EBAGOOLA are the Musgrave-Edward River road in the south, the Yarraden-Aurukun road, and the Coen-Port Stewart road, which is linked to the Peninsula Highway by the old Peninsula road. Several station and mineral exploration tracks traverse the Sheet, particularly in the central area.

Vegetation cover is a generally moderate to moderately dense savannah woodland, dominated by eucalypts and *Melaleuca spp*. Relics of rainforest persist along some stream channels, particularly in the east. Off-road driving is slow and difficult, or not possible, over most of the area, except along the beds of larger streams (when dry). Climate is dry and warm to hot from May to October, and wet and hot from November to April. Most roads are impassable during the wet season, and the Peninsula Highway is closed periodically during this time.

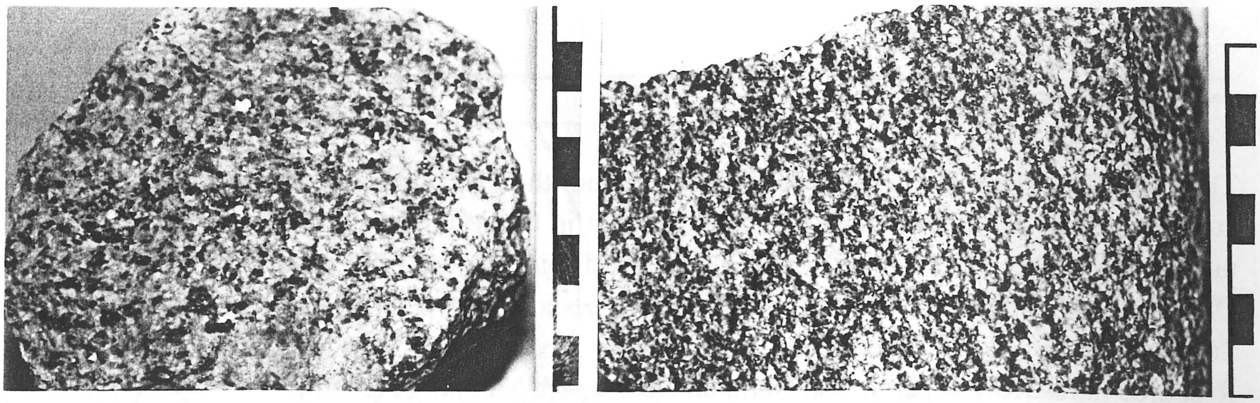
Generalised distribution of the igneous rocks of EBAGOOLA is shown in Figure 1, and Plates 1A and 1B illustrate hand specimens of some of the main granitoid types.

Previous investigations

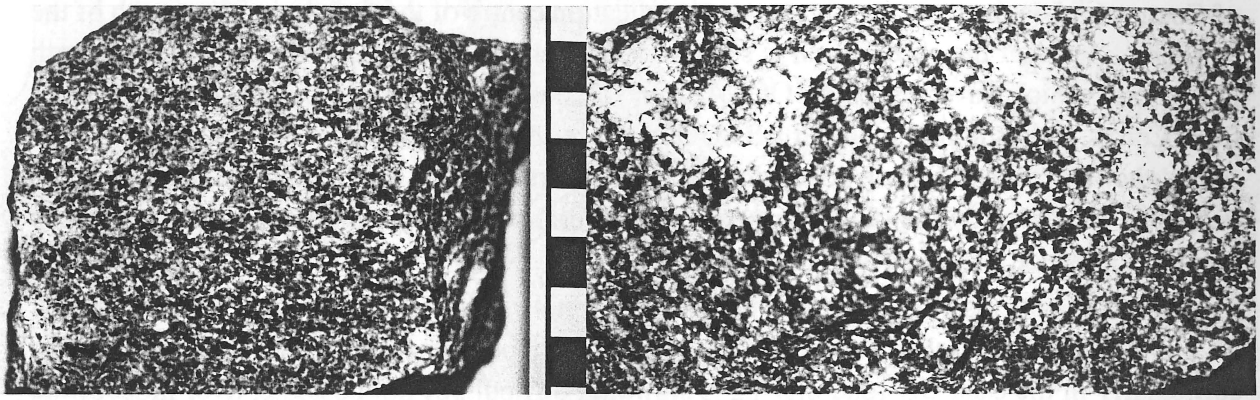
The earliest published geological observations of graitoids in EBAGOOLA were made in connection with geological investigations of the Coen and Hamilton (Ebagoola) Mining Fields (*e.g.* Jack, 1881; Ball, 1901; Cameron, 1906). A systematic survey of the Coen Inlier, which included a reconnaissance geochemical study of the CYPB, was carried out by BMR (now AGSO) and GSQ in the late 1960s (Trail & others, 1968: Whitaker & Willmott, 1968; Willmot & others, 1973; Whitaker & Gibson, 1977). BMR also carried out reconnaissance gravity surveys (Goodspeed & Williams, 1959; Dooley, 1965; Shirley & Zadoroznyj, 1974), and airborne magnetic and gamma-ray spectrometric surveys.

Nomenclature

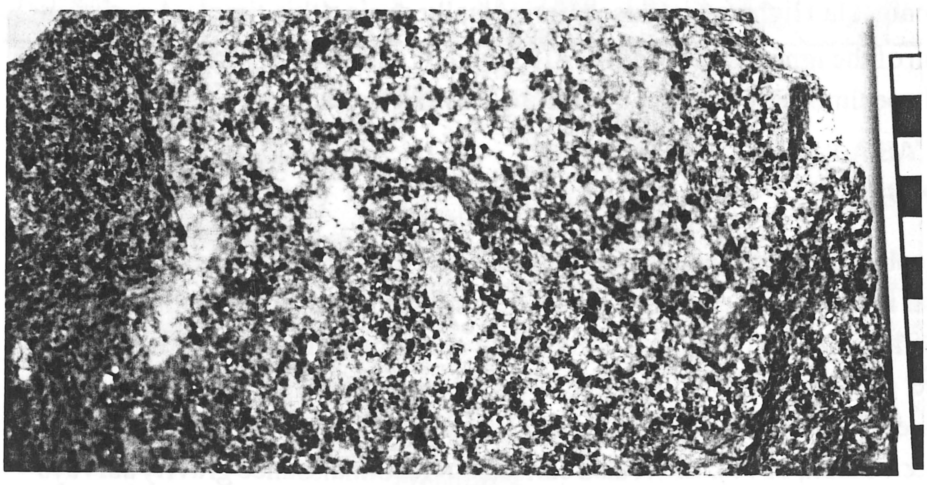
The term Supersuite is applied to groups of granitoids that are associated geographically, and broadly similar to one another in general appearance, petrographic and mineralogical characteristics, and chemical composition – *e.g.,* S-type, two-mica granites *versus* I-type hornblende-biotite granites/granodiorites. The term Suite is applied to subdivisions within supersuites that show a considerable degree of textural, mineralogical, and chemical similarity and coherence, such as a group of S-type, porphyritic, two-mica granites that consistently plot on identical or similar (close and parallel) chemical trends.



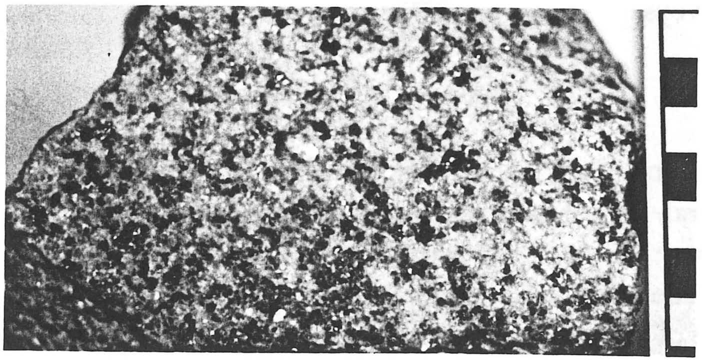
KINTORE GRANITE



BURNS GRANITE



LANKELLY GRANITE



EBAGOOLA GRANITE

PLATE 1(A). Photographs of typical hand specimens from some units of the **Kintore Supersuite**. Scale bar is in centimetres.

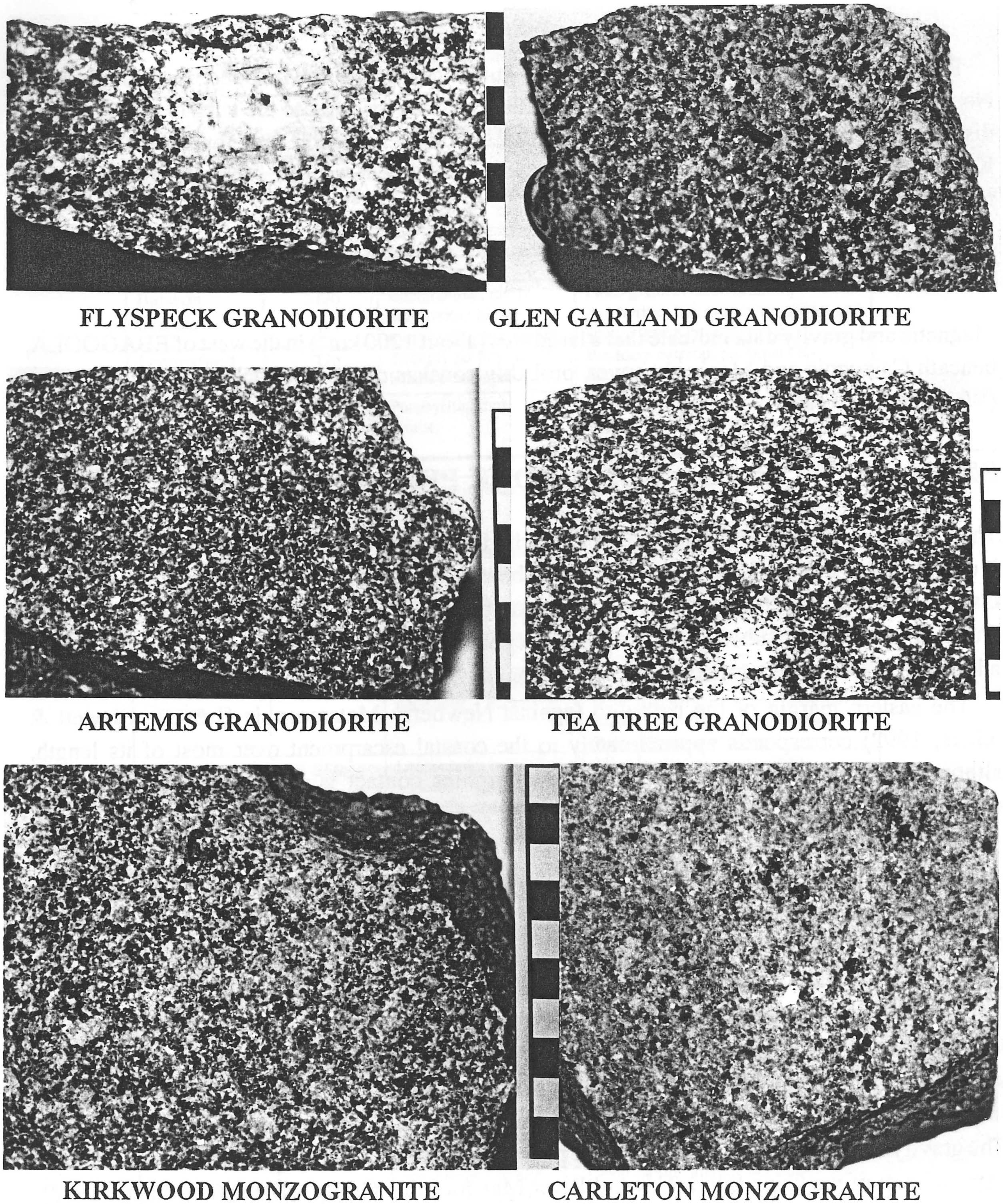


PLATE 1(B). Photographs of typical hand specimens from some units of the **Flyspeck Supersuite**. Scale bar is in centimetres.

Rock nomenclature generally follows the guidelines of the IUGS Subcommission on the Nomenclature of Igneous Rocks (Le Maitre, 1989). However, we use the term monzogranite to distinguish the more plagioclase- (and biotite ± hornblende)-rich granites from those with K-feldspar to plagioclase ratios greater than 65:35 - *i.e.,* syenogranites, which for simplicity are referred to as granites.

PROTEROZOIC(?)

Magnetic and gravity data indicate that a large area (about 1200 km^2) in the west of EBAGOOLA, beneath Cainozoic and Mesozoic cover, probably consists of granitic rocks of Proterozoic age (Wellman, in press).

SILURO-DEVONIAN — CAPE YORK PENINSULA BATHOLITH

The Cape York Peninsula Batholith (CYPB) is by far the largest igneous mass in the Coen Inlier: it extends over a total north-south length of about 400 km, from 80 km south of the southern margin of Ebagoola Sheet to the Cape Weymouth area in the north, and is up to 60 km wide. Outcrop and known subcrop (beneath thin regolith cover) area is about 5500 km^2, and an additional 4000 km^2 is probably concealed beneath Cainozoic sediments (Fig. 1).

The eastern margin of the batholith (against Newberry Metamorphic Group – Blewett & others, 1992) corresponds approximately to the coastal escarpment over most of its length, although in detail much of the granite-metamorphics contact is concealed beneath detritus derived from the escarpment.

A large mass of schist and gneiss – the Coen Metamorphic Group of Blewett & others (1992) – entirely enclosed within the batholith extends from COEN into north-central EBAGOOLA. It is bounded in the northeast by the Coen Shear Zone, and in the west by the Ebagoola Shear Zone; much of its northeastern sector and southern end are underlain by granitoids, as indicated by gravity data (Wellman, in press).

The western margin of the batholith at the surface corresponds to the eastern margin of the Holroyd Group. However, several small bodies of granite are exposed within the eastern Holroyd succession, and geophysical data (aeromagnetic and regional gravity – Wellman, in press) indicate that the granite-metamorphics contact dips at about 30° to the west beneath these rocks. The gravity data are also consistent with the presence of granitoid bodies beneath the westernmost exposed part of the Coen Inlier (Edward River Metamorphic Group – Blewett & others, 1992).

Gravity data indicate that the area of metamorphic rocks to the south of the western lobe of the batholith (Fig. 1) is almost entirely underlain by granitoids, although only a fraction of this granitoid is exposed at the surface. Therefore, the CYPB in effect extends the entire length of the Coen Inlier.

The CYPB within EBAGOOLA may be divided into two major petrographic-geochemical groups: the I-type Flyspeck Supersuite and the S-type Kintore Supersuite. Both are of Early Devonian age (Black & others, 1992), and both have been emplaced at moderately deep crustal levels, as indicated by the abundance of pegmatites, a close association with migmatites, and the upper-amphibolite metamorphic grade of the host rocks.

The main distinguishing characteristics of, and differences between, the components of the CYPB are summarised in Table 1.

TABLE 1. Principal characteristics of and differences between units of the Cape York Peninsula Batholith

UNIT	MAP SYMBOL	PRINCIPAL PROPERTIES	DISTINGUISHING CHARACTERISTICS
KINTORE SUPERSUITE			
EBAGOOLA SUITE			
Kintore Granite	SDk	Equigranular; porphyritic in part; muscovite + biotite • garnet	Leucocratic; relatively large muscovite crystals.
Barwon Granite	SDb	Equigranular, rarely porphyritic; biotite + muscovite • rare garnet	Finer-grained, less commonly porphyritic, less muscovite, garnet and apatite than Kintore Granite.
Leconsfield Granite	SDc	Strongly porphyritic; biotite + muscovite	Bouldery outcrop; prominent K-feldspar phenocrysts to 4 cm.
Warner Granite	SDw	Porphyritic, muscovite + biotite.	Variably porphyritic; phenocrysts commonly aligned; more porphyritic and muscovite-rich than Barwon Granite.
Lindalong Granite	SDi	Leucocratic; muscovite + biotite.	Much more muscovite-rich than Barwon Granite; leucogranite and pegmatite common.
Burns Granite	SDu	Locally porphyritic; biotite + muscovite • scarce garnet.	Generally slightly coarser than Barwon Granite; more plagioclase; relatively coarse apatite.
Heneage Granite	SDh	Porphyritic; alkali-feldspar granite in part.	Much more porphyritic, more alkalic (particularly K_2O), more evolved than Burns/Barwon Granite.
Tadpole Granite	SDt	Porphyritic, biotite • muscovite + garnet.	Relatively melanocratic (biotite-rich); sheared in part. Similar to Two Rail Monzogranite but contains garnet and lacks allanite and titanite.
Ebagoola Granite	SDe	Leucocratic; muscovite • biotite • garnet; pegmatite and aplite common.	More leucocratic, more alkali-feldspar-rich, more muscovite and garnet, more pegmatite and aplite, than Kintore/Barwon/Burns Granites.
LANKELLY SUITE			
Lankelly Granite	SDl	Variably porphyritic; biotite + muscovite.	Phenocrysts generally abundant, commonly aligned; biotite-rich relative to typical Kintore Granite
Kendle River Granite	SDn	Variably porphyritic; biotite + minor muscovite + rare garnet.	Patchily porphyritic - areas crowded with phenocrysts up to 10 cm long; phenocrysts not aligned.
FLYSPECK SUPERSUITE			
Flyspeck Granodiorite	SDf	Mesocratic; biotite • hornblende + allanite + titanite.	K-feldspar megacrysts up to 7 cm long relatively coarse-grained; foliated in places.
Glen Garland Granodiorite	SDg	Mesocratic/melanocratic biotite + hornblende + allanite + titanite.	Elongate prismatic hornblende phenocrysts up to 1.5 cm long; allanite needles up to 1 cm.
Peringa Tonalite	SDp	Melanocratic; hornblende+ biotite +titanite + allanite	Hornblende generally predominates over biotite; allanite not as prominent as in Glen Garland Granodiorite.
Artemis Granodiorite	SDa	Variably porphyritic (feldspars); mesocratic; biotite + allanite + rare titanite.	Lacks hornblende; feldspar phenocrysts more common and prominent than in otherwise comparable units.
Tea Tree Granodiorite	SDtt	Mesocratic; porphyritic; biotite + hornbende + allanite + titanite.	More obviously porphyritic (plagioclase) than Glen Garland Granodiorite; more biotite-rich; foliated in part; allanite to 4 mm.
Two Rail Monzogranite	SDr	Mesocratic; biotite • hornblende + allanite; weakly porphyritic in part.	Hornblende scarce or absent; allanite much coarser (to 1.5 cm) than Artemis Granodiorite and Carleton Monzogranite; scattered K-feldspar phenocrysts to 1.5 cm long in places; less biotite-rich and porphyritic than Artemis Granodiorite.
Carleton Monzogranite	SDc	Mesocratic; biotite + allanite; rare phenocrysts	More felsic than Artemis Granodiorite and typical Two Rail Monzogranite; allanite also much less prominent.
Kirkwood Monzogranite	SDo	Mesocratic; porphyritic in part; biotite + (minor) allanite.	More porphyritic and biotite-rich than Two Rail Monzogranite; allanite less abundant and conspicuous.

Field Relationships and Petrography

Granitoids of the CYPB, especially in the Kintore Supersuite, commonly appear to grade into one another, and from relatively mafic to more felsic compositions. Relatively sharp intrusive boundaries are more common in the Flyspeck Supersuite, but these also change laterally into gradational boundaries in places.

Granitoids in and near the Coen and Ebagoola Shear Zones are variably sheared or foliated, and mylonite is present in places; alteration is in these rocks widespread, and generally much more intense than in granitoids remote from the shear zones. There is also extensive development of phenocryst alignment, due to the effects of regional tectonic strain during emplacement, magma flow at or near pluton margins, or, locally, post-emplacement tectonic strain.

Outcrop is generally poor to extremely poor, and very patchy. Isolated tors and rock platforms up to 10-30 metres across are common over wide areas in some parts of the batholith, particularly in the eastern half. Weathering is intense and deep almost everywhere, with products ranging from weathered but still competent boulders through structured and unstructured saprolite to widespread, residual, coarse, quartz-rich sand.

KINTORE SUPERSUITE

The Kintore Supersuite is the most extensive granitic supersuite in EBAGOOLA, extending from the northern to the southern margin of the sheet, and constituting about 70% of the total exposed (and subcropping) area of granitic rocks. The Kintore Supersuite consists of the granites listed below.

Ebagoola Suite	**Lankelly Suite**
Kintore Granite	Lankelly Granite
Barwon Granite	Kendle River Granite
Leconsfield Granite	
Lindalong Granite	
Warner Granite	
Burns Granite	
Heneage Granite	
Tadpole Granite	
Ebagoola Granite	

The Ebagoola and Lankelly Suites are separated from one another on the basis of textural (Lankelly Suite rocks are more generally and more conspicuously porphyritic) and subtle geochemical (see GEOCHEMISTRY) differences.

Ebagoola Suite

Kintore Granite (SDk) (redefined)

The name "Kintore Adamellite" was used by Willmott and others (1973) to describe the muscovite-bearing granites (both even-grained and porphyritic), leucogranites, pegmatites, and aplites which make up a large proportion of the CYPB. As defined here, the Kintore Granite is a muscovite-biotite ± garnet granite, distinguished from other granites included by Willmott &

others (1973) in the "Kintore Adamellite" by its mostly non-porphyritic texture, variably garnet-bearing composition, and geographical continuity.

Distribution. The Kintore Granite is the most widespread rock type of the CYPB in EBAGOOLA: it traverses the sheet from north to south (110 km), and averages 10-12 km in width. It crops out as scattered tors throughout the area; more extensive exposures are mostly confined to gullies in the coastal escarpment.

Type area. Excellent exposures of the typical Kintore Granite can be seen in road cuttings and as tors where the Peninsula Developmental Road ascends the coastal escarpment 1 km north of New Bamboo Homestead (GR7568-644817). Other good exposures can be seen at the Big Coleman River crossing on the Peninsula Developmental Road (GR7568-618870).

Lithology. The Kintore Granite is a medium to coarse-grained muscovite-biotite ± garnet granite, typically light-grey, buff to cream, and even-grained. In some areas, particularly in the vicinity of the escarpment, it grades into a strongly porphyritic variant with K-feldspar phenocrysts averaging 1-2 cm long but ranging up to 6-8 cm long. It shows in most outcrops some evidence of deformation, which ranges from incipient development of strained quartz through to a strongly foliated texture with some recrystallisation of quartz. Typical modal proportions are quartz 30-35%, K-feldspar 15-25%, plagioclase 20-30%, muscovite 3-8%, biotite 2-7%. Apatite, which forms stumpy prisms up to 2 mm long, is a prominent minor mineral. Other accessory minerals are garnet and ilmenite.

K-feldspar phenocrysts are euhedral orthoclase or microcline microperthite, commonly with inclusions of rounded quartz, biotite flakes, and strongly zoned, sericitized plagioclase euhedra mostly less than 0.25 mm long. Phenocrysts are aligned in some outcrops. Groundmass K-feldspar is typically "cross-hatched" microcline, but some rocks also contain microperthitic orthoclase in the groundmass. Some of the subhedral plagioclase grains (An_{30-19}) have strongly zoned rims, and cores that are strongly altered to sericite. Graphic quartz-feldspar intergrowths are common at feldspar grain boundaries. Muscovite forms plates, up to 2 mm long, which commonly show some evidence of strained extinction. Biotite (Mg/Mg+Fe = 28-32) is pleochroic from pale straw to deep foxy-red, and contains abundant zircon inclusions with dark haloes. Biotite is replaced by a secondary assemblage of muscovite and chlorite in the more strongly altered samples. The distribution of pink euhedral garnet is highly variable from sample to sample, but in general it is rare to absent in much of the northern part of the Batholith, and becomes more abundant and conspicuous southwards.

Rhyolite, quartz and garnet-bearing pegmatite veins and dykes up to 2 m across are common in some areas and trends are variable (*e.g.* 235°, 250°, 280°, 322°, 335°; all steeply dipping). Prominent platforms of coarse-grained pegmatite mostly about 15 metres across crop out within the Kintore Granite particularly in the area to the south and west of the New Bamboo Homestead. Localized shear zones in the vicinity of the Stewart River are 2-3 m across and trend about 360°. Angular gneissic xenoliths are rare and mostly less than 20 cm long.

Alteration is variable. In areas away from the shear zones there is mostly only minor surface weathering; however, the more strongly sheared outcrops are markedly altered and friable throughout. K-feldspar mostly shows little to no alteration, but plagioclase invariably has strongly sericitized cores. Secondary minerals include sericite, muscovite, chlorite, epidote, calcite, and titanite.

Relationships. The actual relationships between the Kintore Granite and other rock units of the CYPB are mostly equivocal. In the Little Stewart Creek area a dyke of muscovite-biotite granite cuts the Lankelly Granite, suggesting that at least in some areas the Kintore Granite intrudes the Lankelly Granite.

Topographic Expression. In the vicinity of the Great Escarpment the Kintore Granite is well exposed in stream cuttings and on the steep slopes crops out as abundant boulders 1-3 metres in diameter. Away from the escarpment the Kintore Granite forms low-relief country mostly with scattered boulders ranging up to about 3 m. Occasional massive outcrops cover areas in excess of 50 metres across and up to 8-10 m high. Vegetation cover is light to medium to savannah woodland, and soil/surface tones are very pale on air photographs due mainly to the extensive cover of coarse, quartzose sand derived mostly (if not entirely) from deep weathering.

Age. A pooled U-Pb zircon emplacement age of 406 ± 7 Ma has been determined for two samples of the Kintore Granite, one from the Peninsula Developmental Road crossing of Kirbys Camp Creek (Kendle River), the other from a site on the same road 1 km north of New Bamboo Homestead (Black & others, 1992).

Barwon Granite (SDb) (new unit)

Derivation of name. The name Barwon is taken from Barwon Creek, a tributary of the King River. Barwon Creek flows from east to west across most of the southern part of the unit (between GR7568-440707 and -306699).

Distribution. The main body of Barwon Granite extends from near the Edward River road west-southwest of "Glen Garland" homestead 60 km northward to Sandalwood Creek; it covers a total area of about 640 km^2. Small, largely fault-bounded bodies of granite equated with Barwon Granite crop out adjacent to or near the Ebagoola Shear Zone near the Lukin River (around GR7569-485055, and around -485080) and on Station Creek (around GR7569-482115. A number of small bodies of granite similar to the Barwon Granite also intrude the Holroyd Group to the west of the main pluton. These are all partly fault-bounded, especially on their eastern or western sides, or both, and include:

- a body 21 km long and up to 3 km wide, extending from GR7569-220025, north of Dingo Creek, to the southern side of the Lukin River near GR7568-280825;
- a body 10.5 km long and up to 2.5 km wide on the eastern side of the Lukin River Shear Zone, extending from GR7569-212967 to 7568-228860 – it is extensively disrupted at the surface by faults, and contains roof pendants of Holroyd Metamorphic Group;
- a ~1 km^2 body centred on GR7569-210050;
- a ~3 km^2 body, bounded on the east-northeast by the Lukin River Shear Zone, centred on GR7568-250815;
- a 2.5 km^2 body within the Lukin River Shear Zone, centred on GR7568-285750; and
- a 1 km^2 body, also within the Lukin River Shear Zone, centred on GR7568-301708.

Type area. The most accessible, reasonably persistent, exposures of Barwon Granite are along the Lukin River, from about 4 km below the crossing on the Ebagoola-Spion Kop track. More extensive, less weathered outcrop may be found along lower Bamboo Creek, but this is easily accessible only *via* a very poorly marked track from Ebagoola to the Lukin River-Bamboo Creek junction (and on to Entire Yard).

Lithology. Barwon Granite is a fine to medium-grained muscovite-biotite granite which is weakly to moderately porphyritic in places (notably most of the isolated bodies in the Holroyd Metamorphic Group), but otherwise relatively uniform in appearance and in modal mineralogy when compared to granitoids of the Flyspeck Supersuite. It consist typically of 35% quartz, 40-45% microcline, 15% plagioclase, 5% biotite, and 2-3% muscovite; the range of observed modal compositions is:

30-35% quartz, 35% microcline, 20% plagioclase, 5-6% biotite, and 1-2% muscovite to

45% quartz, 45% microcline, 10% plagioclase, 5% biotite, and 3% muscovite.

The least potassic, most plagioclase-rich rocks are in the southern and northern extremities of the main pluton, the most siliceous and potassic in its north-central portion. Accessory minerals are abundant fine zircon, abundant, commonly coarse, apatite, and rare ilmenite and monazite; garnet and allanite(?) are very rare and sporadically distributed.

A characteristic of the Barwon Granite is the common occurrence of gently dipping (mostly westward), tabular bodies of pegmatite and aplite, up to 3 m thick (averaging about 1-1.5 m thick), in which the pegmatite and aplite are commonly rhythmically interlayered. The pegmatite commonly contains large crystals of quartz and K-feldspar that have grown perpendicularly inward from the walls, and the aplite is commonly laminated, with some laminae rich in garnet. These pegmatite-aplite bodies could be local differentiates of the Barwon Granite, or part of the Ebagoola Granite, derived more distally.

Microcline in the Barwon Granite is moderately poikilitic, and typically includes small (up to 0.1 mm) grains of quartz, plus minor plagioclase and biotite. Quartz is anhedral, commonly highly strained, and recrystallised in places; it forms small (3-5 mm, rarely 1 cm) phenocrysts in some rocks. Plagioclase shows strong to very strong oscillatory zoning, and commonly has broad, mottled (under cross-polarized light) cores of relatively uniform composition that are probably restite. Biotite is pleochroic from very pale yellow-brown or straw to medium-deep or deep red-brown or reddish-brown; it contains numerous very small inclusions of zircon, and fewer, but larger, apatite crystals. Muscovite is faintly pleochroic (shades of faint brown or pink) in parts of the unit, and may be lithium-bearing; in some rocks, particularly those richest in muscovite, much of this mineral is of secondary/post-magmatic origin.

A characteristic of the Barwon (and Burns) Granite is the presence of abundant (up to 0.5% in some rocks), relatively large (up to 0.5 mm, very rarely 1 mm) equant and/or rounded grains or stumpy prisms of apatite. Pink to pinkish-purple, Mn-rich garnet is present in trace amounts in some parts of the granite, mainly in more evolved (relatively K-feldspar and muscovite-rich, plagioclase and biotite-poor) rocks near or adjacent to bodies of Ebagoola Granite. Small (<0.1 mm) rounded grains of monazite included in biotite were noted in a few samples.

Alteration in the Barwon Granite is slight to (locally) moderate; more intense alteration is restricted to granite close to the Ebagoola Shear Zone. The alteration products are sericite ± muscovite + chlorite + hematite ± epidote ± calcite; some hematite is the result of weathering. The minerals most affected by alteration are plagioclase, particularly the restite(?) cores (altered to ± sericite ± muscovite ± epidote ± calcite), and biotite (altered to chlorite ± sericite/muscovite ± epidote).

Relationships. Barwon granite intrudes the Holroyd Group and the Coen Metamorphic Group, and intrudes Two Rail Monzogranite, Kirkwood Monzogranite, Glen Garland Granodiorite, and Flyspeck Granodiorite. It is intruded by Ebagoola Granite, and is either intruded by, or grades into, Leconsfield Granite. It is also intruded by the Lindsay Flat Microgranite, by several dykes of rhyolite, dacite, andesite, and dolerite/gabbro of uncertain, but probable Carboniferous-

Permian, age. Isolated small stocks or apophyses of Barwon Granite are cut by the Ebagoola Shear Zone, the Lukin River Shear Zone, and several other fracture systems in the Holroyd Group.

Topographic expression. The Barwon Granite typically forms low-lying, low-relief terrain with very little outcrop and extensive areas of thick residual deposits (mainly sand). Where the granite does crop out – mainly in river channels, very rarely on interfluves – it forms rounded, commonly exfoliated boulders or, very rarely, tors. Except where outcrop is exposed to regular fluvial erosion, it is typically deeply weathered, with a characteristic pale brown surface colour, and grades imperceptibly into structured saprolite, saprolite, and finally residual sand. Most tors, such as those in the headwaters of Myrtle Creek (GR7569-334086), are also intensely and very deeply weathered, presumably owing their existence to jointing that is locally relatively widely-spaced.

Age. The Barwon Granite is inferred to be of Early Devonian age because of its relationship to the Glen Garland and Flyspeck Granodiorites, both of which are about 400 Ma old (see below).

Synonymy. Willmott & others (1973) included the Barwon Granite into their "Kintore Adamellite", which has now been subdivided into several separate granites comprising the Kintore Suite (as listed above), and part of the Lankelly Suite (Kendle River Granite).

Leconsfield Granite (SDc) (new unit)

Derivation of name. Leconsfield is derived from the Parish of Leconsfield, County of Kalkah (Ebagoola 1:250 000 Cadastral Map): the unit crops out in the central-western part of this Parish.

Distribution. Leconsfield Granite crops out over an area of about 20 km^2 in the headwaters of Wallaby Creek (centred on GR7569-295075).

Type area. Unlike most other granitoids in the region, the Leconsfield Granite is very well exposed: the most accessible (from the old Ebagoola-Aurukun track) typical outcrop is around GR7569-289072.

Lithology. The Leconsfield Granite is a strongly porphyritic muscovite-biotite granite consisting of moderately abundant, conspicuous, euhedral phenocrysts of microcline typically 3-4 cm long and 1 cm wide set in a medium to coarse groundmass of microcline, quartz, plagioclase, biotite, muscovite, and accessory zircon, apatite, rare monazite(?), and very rare ilmenite. Typical modal proportions are: microcline 45-50%, quartz 30%, plagioclase 10-15%, biotite 3-5%, muscovite 3-5%. Irregular, finer-grained patches occur sporadically, and sills or dykes of rhythmically interlayered pegmatite and laminated aplite with garnet-rich laminae, possibly representing Ebagoola Granite, cut the granite in places. The granite also contains rare, scattered, biotite-rich schistose enclaves (restite?) and very rare quartz xenocrysts/restite crystals up to 2 cm across.

Microcline phenocrysts are strongly poikilitic, with numerous inclusions of other minerals including common muscovite, much of which may be post-magmatic, aligned parallel to the C-axis. Quartz is anhedral, strained, and incipiently recrystallised. Plagioclase shows strong to very strong oscillatory zoning, and many of the mostly subhedral crystals contain small, "mottled" (under cross-polarized light) cores of possible restite origin. Biotite is euhedral to subhedral and pleochroic from very pale yellow-brown to reddish amber-brown. Most of the muscovite is coarse, euhedral, intergrown with biotite, and almost certainly of primary magmatic origin. However, there is also a significant amount of post-magmatic/secondary muscovite: it forms small, euhedral to anhedral crystals cross-cutting primary muscovite (and biotite), and enclosed in plagioclase and microcline. Zircon, apatite, ilmenite and monazite(?) are very fine-grained, in contrast to the abundant, relatively very coarse, rounded apatite and abundant, relatively coarse zircon of the Barwon Granite (and Burns Granite).

Alteration is slight to moderate, with plagioclase, particularly the cores, partly altered to sericite ± muscovite, some of the biotite altered to chlorite ± sericite or muscovite, and microcline made slightly turbid by finely disseminated hematite.

Relationships. The relationship between Leconsfield Granite and Barwon Granite is uncertain: the contact between the two may be gradational, and it is possible that Leconsfield Granite is part of a differentiated upper/roof zone of the Barwon Granite. However, there are sufficient differences between the two (the distinctive outcrop pattern, the prominent K-feldspar phenocrysts, paucity and fine grainsize of apatite, *etc.*) to suggest that Leconsfield Granite is a distinct intrusive phase intruding Barwon Granite.

Leconsfield Granite intrudes Glen Garland Granodiorite and Two Rail Monzogranite, and is intruded by dykes of pegmatite (equivalent to Ebagoola Granite) and dykes of dacite of possible Carboniferous-Permian age.

Topographic expression. Most of the known outcrop area of the Leconsfield Granite is characterised by a very conspicuous outcrop style, unique in the region, comprising an almost continuous array of large tors and boulders in a semi-regular, strongly joint-controlled, rectangular pattern. Unlike tors and boulders of the Barwon Granite, outcrop of Leconsfield Granite is mainly unweathered or little weathered, although extensive surface etching has resulted in microcline phenocrysts standing out prominently from the outcrop surfaces. Relief is considerably greater (partly because of its coincidence with the Holroyd Scarp (Pain & Wilford, 1992) and vegetation cover sparser (mainly because of the amount of outcrop) than on the Barwon Granite.

Age. The Leconsfield Granite is presumed to be approximately the same age as the Barwon Granite, *i.e.*, about 400 Ma (Early Devonian).

Synonymy. Leconsfield Granite was included in the "Kintore Adamellite" by Willmott & others (1973).

Warner Granite (SDw) (new unit)

Derivation of name. The name Warner is derived from the County of Warner, which overlaps the southern boundary of EBAGOOLA and includes most of the outcrop area of the unit.

Distribution. Warner Granite extends from 5 km south of "Glen Garland" homestead 15 km south-southeast to the boundary of EBAGOOLA. It ranges in width from 2 to 3 km, and underlies an area of about 35 km^2. The southern part of the pluton is offset to the east relative to the northern portion by an east-northeasterly trending fault along the Coleman River.

Type area. The best exposures of typical Warner Granite are along the Coleman River, between GR7568-469440 and -490452. Outcrop in this area includes excellent exposures with abundant, aligned K-feldspar phenocrysts.

Lithology. Warner Granite is a muscovite-biotite granite similar in some respects to the Barwon Granite; however, it differs from the latter in being variably porphyritic, richer in K-feldspar and muscovite, and poorer in plagioclase. It contains up to 30% by volume of K-feldspar phenocrysts up to 3 cm long and 1 cm wide; in places these phenocrysts are strongly aligned parallel to the Lucy Swamp Shear Zone which bisects the northern portion of the pluton. Modal composition of the granite is: K-feldspar 45-50%, quartz 35-30%, plagioclase 15-20(?)%, biotite 2-5%, muscovite 3-5%; accessory minerals are very fine-grained zircon and apatite, and very rare ilmenite.

Relationships. Warner Granite intrudes the Holroyd Group, and contains a number of roof pendants(?) of hornfelsed and highly oxidised/ferruginised Astrea Formation (Pko). It is intruded by leucogranite and pegmatite equated with Ebagoola Granite, and is probably equivalent to the Barwon Granite in both composition and time of emplacement. Gravity and airborne magnetic data suggest that it may be an apophysis of the Barwon Granite, which appears to extend beneath the metamorphic rocks at least to the boundary of EBAGOOLA.

Topographic expression. Warner Granite is for the most part characterised by low-lying, low-relief terrain with very little outcrop, similar to that developed on the Barwon Granite. However, at the northern end of the pluton, the low relief is broken up by a number of steep-sided small hills with dark-toned soils formed by Astrea Formation (Pko).

Age. Warner Granite is probably the same age as Barwon Granite – *i.e.* ~400 Ma, or Early Devonian.

Synonymy. Warner Granite north from the Coleman River was included in the "Kintore Adamellite" by Willmott & others (1973).

Lindalong Granite (SDl) (new unit)

Derivation of name. Lindalong Granite underlies much of the upper catchment of Lindalong Creek, a tributary of the Coleman River.

Distribution. The granite underlies an area of about 30 km^2 in upper Lindalong Creek, 15 km southwest of "Glen Garland" homestead (around GR7568-360450).

Type area. Lindalong Granite is well exposed in the headwaters of Lindalong Creek (GR7568-337449). It also crops out in a tributary of Lindalong Creek, at GR7568-308490; elsewhere, outcrop is very rare, and deeply weathered.

Lithology. Lindalong Granite is a biotite-muscovite granite consisting of 35-40% quartz, 35-40% microcline, 10-20% plagioclase, 7-10% muscovite, 1% to 3% biotite, and rare, accessory apatite and zircon. At GR7568-308490 it grades into garnet-muscovite leucogranite, which contains less than 1% biotite, and pegmatite. It is variably deformed and/or foliated, especially along the western margin, with a foliation parallel to the Lindalong Shear Zone. It is slightly altered, to sericite and iron oxide(s), and variably weathered to clay(s) and hematite.

The unit is intermediate in composition and mineralogy between Barwon Granite and Ebagoola Granite.

Relationships. While Lindalong Granite is a discrete body intruding the Holroyd Group, its petrological affinity with Barwon Granite and Ebagoola Granite suggest a genetic link. That possible link, combined with the geophysical evidence of the southward extension of the CYPB beneath the Holroyd Group in the area, suggest that Lindalong Granite may represent a cupola of relatively differentiated Barwon Granite.

The granite has been affected by movement and stress on the Lindalong Shear Zone, but does not appear to have been otherwise deformed.

Topographic expression. Like the Barwon Granite, Lindalong Granite underlies an area of very low relief, extensive residual, sandy deposits, and very little outcrop. Tree cover is medium to light, and surface (grass cover and soil) tones are characteristically pale on air photographs.

Age. Lindalong Granite is probably the same age as Barwon Granite – about 400 Ma.

Synonymy. Willmott & others (1973) included Lindalong Granite in the "Kintore Adamellite".

Burns Granite (SDu) (new unit)

Derivation of name. The name Burns is derived from Burns Creek, which joins the Holroyd River at GR7569-277179, near the southern end of the pluton.

Distribution. Burns Granite underlies an area between 8 and 18 km wide, extending from the Burns Creek-Brumby Creek catchments, on the southern side of the Holroyd River, 39 km north-northwestward to the margin of EBAGOOLA. It also extends eastward across the Ebagoola Shear Zone in places, and extends northwestward into the Lagoon Creek area, west of "Crystal Vale" homestead. Total area (within EBAGOOLA) is about 650 km^2.

Type area. Outcrop of the Burns Granite is very scarce, and most is deeply weathered; however, large boulders of slightly atypical, porphyritic granite are exposed in the Holroyd River at GR7569-339255. More typical, but weathered outcrop is exposed in Brumby Creek, at GR7569-185336.

Lithology. Burns Granite is a medium to coarse-grained muscovite-biotite granite similar to the Barwon Granite in some respects, but differs from it significantly in being richer in plagioclase and apatite, and poorer in K-feldspar and quartz; apatite is an even more conspicuous feature of the Burns Granite than of the Barwon Granite. Burns Granite is not generally porphyritic, but some parts of the pluton, particularly those near Heneage Granite, contain scattered phenocrysts of microcline up to 2 cm long. A typical modal composition (range in brackets) of the Burns Granite is: 30% (25-35%) quartz, 35% (30-45%) microcline, 30% (20-35%) plagioclase, 4% (2-5%) biotite, and 3% (1-4%) muscovite; accessory minerals are apatite (up to 1%), zircon, sporadic garnet, rare monazite, and very rare ilmenite.

Most mineral grains in the Burns Granite are anhedral or subhedral. Quartz is mostly irregular, variably strained, and commonly incipiently recrystallised. Microcline shows well-developed "tweed" texture, and most larger grains, especially phenocrysts, are poikilitic; phenocrysts are subhedral to euhedral, but most other crystals are irregular. Plagioclase is mostly subhedral, strongly zoned (oscillatory), and commonly has altered restite(?) cores. Biotite is pleochroic from pale yellow-brown to deep amber-brown or reddish-brown, and contains numerous inclusions of zircon, some apatite, and rare monazite. Apatite forms stumpy, rounded prisms, up to 0.5 mm long, many of which are crowded with mineral and fluid inclusions. The garnet is pale pink-purple to violet, spessartine-rich variety.

The Burns Granite is slightly to moderately altered to combinations of sericite and/or muscovite, chlorite, epidote, calcite, and hematite (or other Fe [hydr]oxide). Plagioclase, particularly the restite(?) cores, and biotite are the minerals most affected by alteration. Near the Ebagoola Shear Zone, the granite is moderately to intensely foliated or sheared, and generally more intensely altered.

Relationships. Burns Granite intrudes Holroyd Group, Coen Metamorphic Group, Two Rail Monzogranite, Kirkwood Monzogranite, and, probably, Kendle River Granite and Tadpole Granite. Its relationship to Barwon Granite is uncertain: the two are probably contemporaneous, but the less differentiated composition of Burns Granite, and the (apparent) shape of the contact suggest that Barwon Granite may intrude Burns Granite. Heneage Granite either intrudes Burns Granite, or represents part of a relatively differentiated roof(?) zone of the Burns Granite. Ebagoola Granite is partly faulted against, and partly intrusive into, the Burns Granite.

The Ebagoola Shear Zone cuts the Burns Granite, and separates it from the Tadpole and Kendle River Granites.

Topographic expression. The surface expression of the Burns Granite is similar to that of the Barwon Granite: low-lying, low-relief terrain with virtually no outcrop except in patches along the channels of (larger) streams, very extensive residual and transported sediment cover, and an even, medium to medium-dense cover of grassy woodland. Most of the unit is very deep weathered, with extensive exposure of saprolite and structured saprolite along drainage channels.

Age. The Burns Granite has not been isotopically dated: it is probably about the same age as the Barwon Granite – *i.e.* about 400 Ma.

Synonymy. Willmott & others (1973) included most of the Burns Granite, along with the Barwon Granite, in the "Kintore Adamellite".

Heneage Granite (SDh) (new unit)

Derivation of name. Heneage is the name of the Parish within the County of Coen that contains one of the two bodies of Heneage Granite.

Distribution. Heneage Granite forms two rounded bodies in northern EBAGOOLA, within the Burns Granite. The more northerly body is located in the headwaters of Dead Horse and Goose Creeks, and is 7.5 km long and 3 km wide. The more southerly body straddles lower Six Mile and Station Creeks, and is about 8 km long and 5.5 km wide. Total outcrop/subcrop area is about 50 km^2; however, because the boundaries of these bodies are almost entirely unexposed, and have been inferred from a combination of ground observations and interpretation of airborne gamma-ray spectrometrics, their size and shape should be regarded as indicative only.

Type area. Abundant outcrop of typical Heneage Granite is exposed in the hills at the head of Dead Horse Creek, on or close to the road from Coen to Crystal Vale (*e.g.* GR7569197406 and -196399).

Lithology. Heneage Granite is a strongly porphyritic muscovite-biotite granite grading into biotite-muscovite alkali-feldspar granite. It consists of conspicuous phenocrysts of microcline set in a medium-coarse to coarse groundmass of quartz, microcline, plagioclase, biotite, muscovite, and accessory apatite (moderately abundant) and zircon. Microcline phenocrysts are euhedral, stumpy to elongate prisms ranging up to 7 cm long and 2 cm wide, averaging about 3-4 cm x 1 cm, and generally containing abundant inclusions of muscovite. The phenocrysts constitute about 10-15% of the rock by volume in the type area and in the centre of the southern body (in Six Mile Creek), but gradually decrease in size and abundance near the inferred margins. Modal composition of the northern body of Heneage Granite ranges from 55% microcline, 20% quartz, 15% plagioclase, 5% biotite, and 2% muscovite to 75% microcline, 20% quartz, <5% plagioclase, <1% biotite, and 2% muscovite. The southern body appears to be less differentiated, and contains about 45-50% microcline, 25-30% quartz, 15-20% plagioclase, 5% biotite, and 2% muscovite.

Microcline phenocrysts and larger groundmass crystals are moderately (in the alkali-feldspar granite) to strongly poikilitic, with rounded inclusions of quartz, and subhedral inclusions of feldspar and micas. Some crystals contain tabular (secondary?) muscovite crystals up to 1 mm across, and some contain small, irregular cores of orthoclase or microcline which lack the "tweed" texture of the rim, and are more altered. Plagioclase shows strong oscillatory zoning, and also commonly contains muscovite crystals up to 0.7 mm across; however, restite cores are not apparent. Biotite is pleochroic from pale yellow-brown to deep red-brown, and contains abundant very small inclusions of zircon (with wide, dark haloes) and apatite. Muscovite also contains numerous small zircon and apatite inclusions.

Alteration is slight: plagioclase, notably the central parts of crystals, is partly altered to sericite or muscovite, biotite is partly (slightly) altered to chlorite, and microcline, particularly the cores, is dusted with hematite(?).

Relationships. Heneage Granite is a mappable entity, in the form of apparently discrete bodies within the Burns Granite. Its relationship to the Burns Granite may be similar to that of the Leconsfield Granite with the Barwon Granite – that is, a separate intrusive phase, possibly differentiated from the Burns Granite, or part of a differentiated roof-zone cupola(?) within the host granite.

Topographic expression. Its topographic and airborne gamma-ray spectrometric expression are the characteristics that initially distinguish Heneage Granite from Burns Granite. The northern body forms relatively elevated, dissected terrain with relatively abundant outcrop. Both bodies appear very bright orange-pink on combined gamma-ray spectrometric images (see discussion below), due to their high K_2O and Th contents relative to those of the Burns Granite. Areas not covered by a thick blanket of residual sand appear pale on airphotographs, and are characterised by relatively sparse vegetation cover, abundant sand and pale, deeply weathered outcrop, and pale, sandy soils.

Age. Heneage Granite is inferred to be about the same age as the dated components of the CYPB – *i.e.* about 400 Ma, or Early Devonian.

Synonymy. Heneage Granite was not distinguished from the surrounding granite by Willmott & others (1973), and was included in the "Kintore Adamellite".

Tadpole Granite (SDt) (new unit)

Derivation of name. Tadpole Granite is named from Tadpole Creek, a tributary of the Coen River; its eastern tributaries cut through the area underlain by the granite.

Distribution. The unit underlies a narrow, wedge-shaped area about 6 km long and up to 2 km wide to the east of Tadpole Creek, on the northern margin of EBAGOOLA.

Type area. Typical Tadpole Granite is exposed in a creek crossing on the Coen-Crystal Vale track at GR7569-229503. Intensely sheared, foliated Tadpole Granite is well exposed on a small but prominent hill east of this track at GR7569-230499.

Lithology. The Tadpole Granite is a variably sheared and/or foliated, variably recrystallised, porphyritic (muscovite-)biotite granite. It consists of abundant phenocrysts, up to 1.5 cm long, of K-feldspar and plagioclase set in a medium to fine-grained groundmass of quartz, K-feldspar, plagioclase, biotite, muscovite, and accessory garnet, zircon, apatite, and monazite. Approximate modal composition is quartz 20-30%, K-feldspar 35-45%, plagioclase 25-30%, biotite 6-8%, and (secondary) muscovite up to 1%.

The K-feldspar, a microperthitic microcline, is subhedral, and, although it contains some inclusions (mostly subhedral plagioclase prisms up to 1 mm long), it is not strongly poikilitic as is K-feldspar in the Burns and Heneage Granites. Quartz is very strained and extensively recrystallised, forming the main component of the foliation. Plagioclase is mostly subhedral, and very strongly zoned (oscillatory). Biotite is pleochroic from pale yellow-brown to deep red-brown, and contains abundant inclusions of zircon, common inclusions of apatite, and rarer inclusions of monazite; the zircon and monazite have broad (at least as wide as the encircled inclusion), dark haloes. Muscovite contains similar, but less abundant, inclusions. The garnet, which forms small (up to 0.5 mm) euhedral to subhedral crystals and clumps of anhedral to subhedral crystals, is pale pinkish-purple to violet in hand specimen, and colourless in thin section: it is probably spessartine-rich.

Alteration is moderate, with partial replacement of plagioclase, particularly the cores, by sericite and/or muscovite, partial alteration of biotite to chlorite and iron oxide(s), and some clouding of microcline by hematite.

Relationships. Tadpole Granite intrudes the Coen Metamorphic Group. It is separated from the Burns Granite by a splay of the Ebagoola Shear Zone, and their relationship to one another is uncertain: Tadpole Granite may represent a relatively less-differentiated precursor of the Burns Granite. Ebagoola Granite (or its equivalent) intrudes Tadpole Granite, and the latter is cut by the Ebagoola Shear Zone, and has been extensively deformed by stresses associated with the fault.

Topographic expression. The Tadpole Granite is expressed at the surface by low-relief, moderately low-lying terrain with little outcrop, moderate to moderately sparse tree cover, and soil/regolith tones on airphotographs slightly darker than the Burns Granite.

Age. The age of the Tadpole Granite is not known with any certainty, but it is probably about 400 Ma, the age obtained for components of the CYPB for which reliable isotopic ages have so far been obtained.

Synonymy. Willmott & others (1973) included Tadpole Granite in the "Kintore Adamellite".

Ebagoola Granite (SDe) (new unit)

Derivation of name. Ebagoola is the name of the main mining settlement of the Ebagoola Goldfield (Hamilton Mining District): all that remains is a derelict tavern. It is also the name of a present-day grazing-lease homestead, and the name of a Parish within the County of Sidmouth. Ebagoola Granite underlies most of the area of the old town site, and the homestead.

Distribution. Bodies of leucogranite and pegmatite assigned to the Ebagoola Granite are widespread throughout EBAGOOLA. By far the extensive area underlain (predominantly) by Ebagoola Granite is about 37 km long and up to 15 km wide, and extends from the headwaters of Emu Creek in the south to the Water Resources Commission track, about 1 km north of the Big Coleman River-Little Coleman River junction, and extends between about 143° 20' E and 143° 28' E.

Bodies of Ebagoola Granite peripheral to the Barwon Granite are located between Swamp and Barwon Creeks (GR7568-425870 to -450715), near the junction of Bamboo Creek and the Lukin River (around GR7568-337883), near the junction of Ryans Creek and Bullock Creek (around GR7568-440080), and between Crawfish and Myrtle Creeks (around GR7568-315050).

Ebagoola Granite also occurs extensively along the western margin of the Coen Metamorphic Group, and, in particular, along the Ebagoola Shear zone. Small, discrete bodies intruding other units are located to the north and south-southeast of Opera Hill, 2 km northeast of "Glen Garland", in the Stew Creek-Coleman River area, and in the old "Bamboo" homestead area. A small body of foliated leucogranite at the northern end of the Warner Granite is also assigned to the Ebagoola Granite.

Type area. Numerous large tors of typical Ebagoola Granite crop out along the base of the Great Escarpment, near the Musgrave-Edward River road (between GR7568-594627 and -606627). Similar granite is well exposed along the road to the Telecom microwave repeater tower near the Peninsula Developmental Road, west of New Bamboo homestead (GR7568-625782). Excellent outcrops, mainly of pegmatite and garnet-bearing aplite intruding, and including rafts of, wallrock schists/gneisses are exposed in a tributary of the Coleman River, close to the Musgrave-Edward River road crossing, at GR7568-541632.

Lithology. Ebagoola Granite consists of pale grey to white, medium to coarse, mostly even-grained, muscovite and biotite-muscovite leucogranites, muscovite and biotite-muscovite pegmatites, and muscovite aplite (some with a trace of biotite). All varieties contain garnet in places: garnet is especially common (up to 5%) in the muscovite leucogranites and aplites. The leucogranites are mainly in the form of extensive, relatively homogeneous masses, but there are numerous small pods, dykes, and veins intruding other units. The pegmatites and aplites are rhythmically interbanded in many places, and form gently-dipping, sheet-like bodies, and dykes from 15 cm to 3 m wide. Dykes are especially common near the margins of the main (southeastern) mass. The pegmatites are commonly zoned, with the outer parts dominated by inward-projecting quartz crystals, and the inner parts containing abundant K-feldspar and mica. Larger pegmatite masses, particularly in the Coleman River area, are extremely coarse-grained and porphyritic, with phenocrysts of K-feldspar (microcline), up to 20 cm long, containing graphic intergrowths of quartz. The aplite is generally laminated, with garnet-rich and garnet-poor layers.

Parts of the Ebagoola Granite, particularly those along and close to the Ebagoola Shear Zone, are strongly sheared and/or foliated, with extensive recrystallisation of quartz.

Typical modal composition of the leucogranite is 30-35% quartz, 40-45% K-feldspar, 15% plagioclase, 5-10% muscovite, up to 1% biotite, and up to 1 % garnet. Compositional range is 30-55% quartz, 25-50% K-feldspar, 10-30% plagioclase, 2-10% muscovite, 0-3% biotite, 0-2%garnet. Accessory minerals are apatite (up to 1-2% in some rocks), zircon (commonly metamict), and very rare ilmenite.

The K-feldspar is microperthitic to non-perthitic microcline, and is mostly poikilitic in habit, enveloping small (up to 0.2 mm), rounded quartz grains, and prisms of zoned plagioclase (up to 1 mm long). Plagioclase is subhedral, 1-2 mm long, and oscillatory zoned in the range An_{19-11}; the cores are commonly sericitised, and much more intensely so than the rims. Muscovite forms plates 1-2 mm across (up to several centimetres in the pegmatites), and is mostly colourless, but in some rocks it is pleochroic to very faint pink-brown, suggesting high lithium content. Biotite is similar in grainsize to muscovite (although not so coarse in pegmatites), and is pleochroic from pale straw to foxy red. Apatite, as in the Barwon and Burns Granites, forms stumpy prisms up to 0.5 mm long. Garnet is pale pink-purple to violet in the leucogranite hand specimens, and pink to red-brown or orange in the aplites; it is probably spessartine-rich.

A very leucocratic variant of Ebagoola Granite forms small hills and crops out as tors to the east of the coastal escarpment, near Eel Creek (GR7568-707996). It is a pale grey to white, fine to medium, garnet-muscovite leucogranite consisting of 30-40% variably deformed quartz, about 30% orthoclase (variably microperthitic) and/or microcline, 20% euhedral laths (av. 1 mm long) of unzoned plagioclase, about 7% muscovite (0.5-1 mm), and about 5% euhedral garnet (0.15-0.5 mm).

Relationships. Field relationships suggest that the Ebagoola Granite is gradational into, and in many instances marginal to, the Kintore Granite and probably also the Barwon and Burns Granites. It also intrudes these granites, as well as granitoids of the Flyspeck Supersuite. Ebagoola Granite also appears to have a gradational contact with the Holroyd Group in the vicinity of the Coleman River crossing of the Musgrave-Edward River road. In this area, extensive rock platforms (up to 50 m across) consist of rhythmically banded garnet-rich aplite and pegmatite, containing schlieren and blocks of gneiss up to 20 metres across, grading into massive gneiss. Bands, dykes, and veins of pegmatite, leucogranite, and aplite are abundant in the gneisses.

Topographic Expression. The Ebagoola Granite at the Great Escarpment forms boulder slopes made up of prominent rounded boulders 2-4 metres in diameter. On the low-relief terrain to the west of the escarpment, the Ebagoola Granite typically forms extensive low-lying platforms with widely scattered boulders mostly less than 2 metres diameter. Vegetation cover is perhaps a little sparser than, but otherwise similar to, that on the other granitoids, but the Ebagoola Granite is characterised over most of the area by very pale (virtually white) surface tones on aerial photographs due to residual sand.

Age. By association with the Kintore Granite, the Ebagoola Granite is approximately 400 Ma old.

Lankelly Suite

The Lankelly Suite comprises Lankelly Granite and Kendle River Granite. It is distinguished from the Ebagoola Suite on the basis of textural (the Lankelly Suite rocks are more consistently and abundantly porphyritic) and geochemical (discussed below) differences.

Lankelly Granite (SDl) (redefined)

The name "Lankelly Adamellite" was used by Willmott and others (1973) to describe the strongly porphyritic rocks cropping out in the southern part of COEN and northern part of EBAGOOLA. The name Lankelly is retained for these granitic rocks, but in accord with recommendations of the International Union of Geological Sciences Subcommission on the Systematics of Igneous Rocks (Le Maitre, 1989) the term adamellite is discarded in favour of granite. Lankelly Granite extends along the eastern margin of the Coen Metamorphic Group, 48 km southward from the southern margin as mapped by Willmott and others (1973), in an area mapped by them as "Kintore Adamellite".

Distribution. The Lankelly Granite crops out in the Little Stewart Creek-Station Creek area in the northeast of EBAGOOLA, and in a 3-6 km-wide belt extending from the Stewart River approximately 50 km southward along the eastern margin of the Coen Metamorphic Group.

Type area. Excellent bouldery exposures of typical Lankelly Granite are found in Lankelly Creek, 1 km northeast of Coen (GR 7384-84577). Another excellent exposure can be seen at the Little Stewart Creek crossing of the Coen-Port Stewart Road, GR 7501-84434. An example of a slightly more mafic variant crops out near the old Coen Road at GR 7467-84416.

Lithology. Typically the Lankelly Granite is a light to medium grey, coarse-grained, strongly porphyritic biotite-muscovite granite which crops out as scattered, dark grey tors. In the Stewart River gorge it forms massive platforms, boulders and cliff sections over a distance of about 2 km. Biotite-rich inclusions up to 6 cm in diameter are common in some areas. Muscovite content is variable, and in some areas the rock is essentially a biotite granite. K-feldspar phenocrysts, typically 3 x 1 cm but ranging up to 8 cm long, commonly show some degree of alignment (trending 330°, 340°, 350°, 010°) resulting either from flow alignment or deformation at the time of granite emplacement. Extensive outcrops of the Lankelly Granite in the vicinity of the Stewart River-Little Stewart Creek confluence enclose subrounded to rounded microdioritic enclaves up to several metres across. Pegmatite veins up to 30-50 cm are also well exposed in the Stewart River area. In one area the Lankelly Granite is cut by a 10-15 cm vein of granite similar to the Kintore Granite.

The average modal composition is quartz 20-30%, K-feldspar (phenocrysts and groundmass) 25-35%, plagioclase 20-25%, biotite 10-15%, muscovite <5%. Accessory minerals are apatite, which is up to 0.5 mm long but generally less abundant than in the Kintore Granite, zircon, and rare ilmenite. Secondary minerals include muscovite, sericite, chlorite, carbonate (calcite?) and titanite.

Polygranular quartz typically shows evidence of deformation in the form of marked strained extinction and areas of incipient recrystallisation. Euhedral phenocrysts of microcline and microperthitic orthoclase range up to 8 cm long, although most are 4-6 cm long, and are commonly aligned. These phenocrysts contain inclusions of zoned and sericitized euhedral to subhedral plagioclase up to 3 mm long, and, less commonly, rounded quartz grains up to 0.25 mm across. Groundmass plagioclase (An_{39-28}) is mostly subhedral to anhedral, with variably altered and sericitized core and zoned rims. Strongly altered cores with ghost mottling in some crystals may represent a restite component. Vermicular intergrowths with quartz at K-feldspar grain boundaries are present in places. Plates of biotite (Mg/Mg+Fe = 37-26), pleochroic from pale straw to foxy-red, 0.5 to 1.50 mm across contain numerous zircon crystals with dark haloes. Muscovite, generally less than 0.5 mm across and sparsely distributed, is commonly associated with biotite and plagioclase and is mostly if not entirely secondary. Alteration of the Lankelly Granite is mostly minor, and confined mainly to sericitic alteration of plagioclase and limited chloritization of biotite. However, much more intense sericite-chlorite alteration is present along and near the Coen Shear Zone.

Relationships. The Lankelly Granite intrudes Coen Metamorphic Group, and is intruded by aplite and pegmatite dykes probably related to the Ebagoola Granite. In one location it is cut by a muscovite-biotite granite similar to the Kintore Granite. Elsewhere, the Lankelly and Kintore Granites appear to have a gradational relationship, although no actual contacts were seen in outcrop. In the vicinity of the Stewart River gorge, the Lankelly Granite intrudes a small diorite/microdiorite stock, which forms a prominent small hill adjacent to the river, and several large, angular enclaves within the granite. The diorite is an I-type rock, possibly related to the Flyspeck Supersuite.

Topographic Expression. In the vicinity of the Stewart River and Little Stewart Creek, where the topography is relatively hilly and well vegetated, the Lankelly Granite commonly crops out as large, rounded boulders mostly 2-4 m diameter. Elsewhere, relief is slight, outcrop is very sparse, and Lankelly Granite is distinguishable from Kintore Granite only on airborne radiometrics images (as discussed below).

Age. U-Pb zircon emplacement ages for the Lankelly Granite have been determined at 407 ± 7 to 408 ± 6 Ma (Black and others, 1992).

Kendle River Granite (SDn) (new unit)

Derivation of name. The unit is named from the Kendle River, a major tributary of the Holroyd River. The Kendle River crosses the granite between GR7569-387280 and -419244.

Distribution. Kendle River Granite underlies an area up to 3 km wide and 12 km long along the eastern side of the Ebagoola Shear Zone, extending from Thompsons Creek (GR7569-427223) to Spring Creek (GR7569-380337).

Type area. The type area of the Kendle River Granite is along the Kendle River between GR7569-400273 and -409252, where there is mostly patchy, but locally very fresh and well exposed, outcrop.

Lithology. Kendle River Granite is a porphyritic muscovite-biotite granite (or monzogranite), superficially similar to porphyritic variants of the Burns and Barwon Granites. It differs from these rocks, however, in being richer in plagioclase and highly variable in texture: some areas are equigranular, some contain abundant, aligned K-feldspar phenocrysts 2-4 cm long, while other, highly irregular, areas are crowded with K-feldspar megacrysts up to 10 cm long. The phenocrysts are microperthitic orthoclase variably inverted to microcline. They are set in a medium to medium-coarse groundmass of subhedral, oscillatory-zoned plagioclase (An_{20-30}), anhedral quartz and microcline (rarer orthoclase), reddish amber-brown (tan) biotite, muscovite, and accessory apatite, zircon, and rare, violet, Mn-rich, garnet. The granite is slightly to moderately altered to sericite and/or muscovite, and chlorite. Estimated modal composition is: 25-30% quartz, 30-35% K-feldspar, 30-35 % plagioclase, 3-5% biotite, 1% primary muscovite, up to 1% secondary muscovite.

Relationships. Kendle River Granite intrudes Coen Metamorphic Group, and is apparently intruded by Burns Granite, although contacts between the two are mostly faulted (including the Ebagoola Shear Zone. It is also intruded by Ebagoola Granite.

Topographic expression. Most of the Kendle River Granite is blanketed by a thick cover of transported regolith related to the ancestral Holroyd River (*i.e.* before the upper Holroyd River was captured by the Stewart River: Wilford, in press). These deposits, which range up to 15-20 m thick, slope gently and thin gradually to the west; the granite is exposed only where the larger streams, such as the Kendle River, Thompsons Creek, and Twelve Mile Creek have cut through the overlying gravels.

Age. Kendle River Granite is probably about the same age as the Lankelly and Kintore Granites, *i.e.* about 400 Ma.

Synonymy. The area underlain by the Kendle River Granite was mapped as undivided Pliocene to Holocene by Willmott & others (1973).

FLYSPECK SUPERSUITE

The Flyspeck Supersuite consists of Flyspeck Granodiorite, Glen Garland Granodiorite, Peringa Tonalite, Artemis Granodiorite, Tea Tree Granodiorite, Two Rail Monzogranite, Carleton Monzogranite, and Kirkwood Monzogranite (see also Fig. 1). It includes all of the rocks assigned by Willmott & others (1973) to the Flyspeck Granodiorite.

Flyspeck Granodiorite (SDf) (redefined)

Flyspeck Granodiorite was used by Willmott and others (1973) to include all known, presumed Siluro-Devonian, hornblende-bearing granodioritic rocks in the CYPB. It is redefined here as the very characteristically strongly porphyritic, inhomogeneous, hornblende-biotite granodiorite to monzogranite that crops out in the Flyspeck Creek area and extends 26 km northward along the western margin of the Coen Metamorphic Group (Blewett & others, in press) to the Lukin River.

Type area. Excellent bouldery exposures of typical Flyspeck Granodiorite crop out on the southern side of the Water Resources Commission track, 12 km west of the Peninsula Developmental Road, around GR7568-510840.

Lithology. Flyspeck Granodiorite is a dark-grey, fine to coarse-grained (typically coarse-medium), strongly porphyritic hornblende-biotite granodiorite grading into biotite monzogranite and biotite granite. Its most characteristic feature is the presence of conspicuous, white, stumpy prismatic phenocrysts (or megacrysts) of potash feldspar up to 5 cm, or even 7 cm, long; they are concentrated into irregular patches, randomly and unevenly scattered, or, in some outcrops or parts of outcrops, apparently absent. Modal proportions of the major minerals are typically in the range quartz 30%, plagioclase 40%, K-feldspar 15-25%, biotite 7%, hornblende 5% to quartz 35%, plagioclase 20-25%, K-feldspar 30-35%, biotite 5%. Accessory minerals are allanite (abundant, and up to 1 cm long, as in Glen Garland Granodiorite), titanite, zircon, apatite, and rare monazite.

K-feldspar forms large phenocrysts/megacrysts, as mentioned above, and large, subhedral to anhedral crystals in the groundmass, all of which generally have a very pronounced poikilitic habit, enclosing numerous euhedral to subhedral crystals of the other minerals. Smaller crystals are intersertal, anhedral, and non-poikilitic. The larger phenocrysts are mostly orthoclase microperthite, while the smaller crystals, and some smaller phenocrysts, are microcline microperthite. Plagioclase is generally subhedral and has moderate to strong normal (or weakly oscillatory) zoning; unzoned/"mottled" (restite?) cores are not as common or as pronounced as in Glen Garland Granodiorite. Quartz forms multi-granular, anhedral clumps, which in some areas appear as (relatively) small phenocrysts. Biotite (subhedral to euhedral, up to 4 mm) also tends to clump together, and is pleochroic from pale yellow-brown to very deep brown. Hornblende forms euhedral to subhedral crystals up to 3-4 mm long, and has the pleochroism scheme α = very pale brown, β = medium-deep blue-green to greenish blue, γ = deep brownish green to olive-green; this indicates a composition close to ferrohastingsite (Deer & others, 1966).

Alteration, to sericite + chlorite + epidote-clinozoisite ± calcite + opaque(s), ranges from slight to intense, the most intensely altered rocks being near Lapunya Mount and 4 km west-southwest of Mount Ryan. Plagioclase, especially the cores, is partly altered to sericite ± epidote-clinozoisite ± calcite, and biotite to chlorite + sericite ± opaques ± epidote ± titanite; K-feldspar is dusted with hematite, and hornblende remains essentially unaltered.

The Flyspeck Granodiorite is intensely sheared and foliated along the Spion Kop Fault. To the east of the fault, the sheared fabric gives way to a foliated or gneissic fabric, oriented parallel to the fault; this fabric is particularly evident immediately east of Spion Kop, and within 2-3 km to the north and south.

Relationships. Flyspeck Granodiorite intrudes Coen Metamorphic Group, is intruded by Ebagoola Granite (or its equivalents), and is probably intruded by Glen Garland Granodiorite, Two Rail Monzogranite, and Barwon Granite. It is also cut by dykes of rhyolitic, dacitic, and andesitic/dioritic to doleritic composition that are probably Carboniferous-Permian in age.

It is cut, or bounded, by faults/shear zones parallel to the Ebagoola Shear Zone, including the Spion Kop Fault; this aspect is discussed elsewhere (Blewett & others, 1992; in press).

Topographic expression. Flyspeck Granodiorite has a topographic expression that differs only subtly from that of the Glen Garland Granodiorite: it is slightly less recessive and has slightly greater relief (on the scale of a few metres), and has slightly paler soil tones. However, it is characterised in many areas (*e.g.*, the type area) by prominent rounded boulders, up to 6-7 m in diameter, on the surface of which white K-feldspar megacrysts (up to 7 cm long) are plainly visible from distances of up to a hundred metres.

Age. A zircon U-Pb emplacement age of 398 ±10 Ma obtained for the Glen Garland Granodiorite (Black & others, in press) implies that the Flyspeck Granodiorite was emplaced about 400 Ma ago.

Glen Garland Granodiorite (SDg) (new unit)

Derivation of name. The name Glen Garland is derived from "Glen Garland" homestead, in the south of Ebagoola sheet area, at GR7568-447570.

Distribution. Glen Garland Granodiorite crops out extensively over the southeastern portion of the western lobe of the CYPB on EBAGOOLA. The main outcrop area extends from about 7 km west-southwest of "Glen Garland" 60 km northward to the Station Creek area: outcrop area is about 105 km^2. A small body of Glen Garland Granodiorite crops out around GR7568-525870, southwest of Lapunya Mount, and a partly fault-bounded, lenticular mass crops out between GR7568-510926 and 7569-490048 between Battery Creek and Station Creek. Glen Garland Granodiorite also crops out in upper Wallaby Creek (around GR7569-270070) on the western margin of the Batholith.

Type area. The type area is immediately north, and to the northeast, of "Glen Garland" homestead, where numerous large boulders and tors of typical hornblende-biotite granodiorite crop out. A reference area for more mafic granodiorite is 1.5 km north-northwest of the old "Bamboo" homestead site, at GR7568-495880.

Lithology. The predominant rock type comprising Glen Garland Granodiorite is mesocratic, weakly porphyritic, biotite-hornblende granodiorite which in many outcrops contains scattered, well-rounded, very dark grey, microdioritic enclaves generally 5-20 cm (rarely up to 1 m) in length. The granodiorite is most mafic in the central and eastern parts of the main outcrop area and in the two smaller bodies farther east, where mineralogical composition is typically 30% quartz, 35-45% plagioclase, 10% orthoclase, 5-8% biotite, and 5% hornblende; compositions become gradually more felsic to the southwest, west, and, in particular, north. Parts of the northern end of the main body contain 35% quartz, 35% orthoclase, 20% plagioclase, 8% biotite, and 1% hornblende: traverses across the main belt of Glen Garland Granodiorite near upper Bamboo Creek and along the Lukin River show general westward increases in the abundances of K-feldspar and biotite, and decreases in the abundances of plagioclase and, most noticeably, hornblende. The boundary between Glen Garland Granodiorite and Two Rail Monzogranite to the west is subtle and gradational, over a few hundred metres, in this area, but is more abrupt in most, if not all, other areas: it is taken as the point of disappearance of hornblende. This boundary also has a very subtle signature on airborne radiometric images, as discussed below.

The granodiorite is composed of phenocrysts up to 1-1.5 cm across of plagioclase and quartz, and, commonly of hornblende up to 1-1.5 cm long, in a medium to medium-coarse groundmass of the same minerals plus K-feldspar and biotite. Allanite and titanite are abundant accessory or minor minerals, and zircon and apatite are moderately abundant, generally fine-grained, accessory phases; monazite is very rare. Plagioclase forms stumpy prismatic crystals with very strong oscillatory zoning and abundant small inclusions, mostly of biotite and hornblende. Broad, mottled, rather than concentrically zoned, cores in some crystals may represent restite. K-feldspar is typically "cross-hatched" microcline, although microperthitic orthoclase is present in some rocks. Grains are generally anhedral, intersertal, and contains numerous rounded inclusions, mostly of quartz and plagioclase; some larger crystals are subhedral. Biotite (up to 5 mm) is pleochroic from pale straw to deep red-brown, and contains numerous small crystals of zircon with dark haloes. Hornblende forms elongated prisms up to 1.5 cm x 3 mm; its pleochroic scheme is: α = very pale yellow-brown/straw, β = medium-deep green to blue-green, γ = deep olive-green to brownish-green. Allanite is conspicuous in some parts of the unit, forming vitreous, partly metamict, acicular prisms commonly up to 1 cm long and 2 mm thick, with a characteristic "rusty" halo of alteration and/or radiation damage. Titanite is common in the more mafic parts of the unit (along the eastern margin of the main body), and most is spatially associated with hornblende or biotite.

Alteration of the Glen Garland Granodiorite is generally slight, but more intense alteration was noted in parts of the type area, and in the Battery Creek-Lukin River area. Typically, up to 10% of the biotite is altered to chlorite + sericite ± epidote ± titanite/anatase/brookite, and plagioclase is slightly to moderately altered to sericite ± calcite ± chlorite ± epidote; K-feldspar is unaffected or only slightly affected (partly dusted with hematite). In the most altered rocks, plagioclase is intensely altered to, or completely replaced by, sericite, *etc.* and biotite is 50% to 100% altered, but K-feldspar remains only slightly affected.

Relationships and structure. Glen Garland Granodiorite intrudes, or, in places, is faulted against, rocks of the Holroyd Group and Coen Metamorphic Group. It probably intrudes Flyspeck Granodiorite, but its relationship to Two Rail Monzogranite is unclear: the latter either intrudes the former or is a differentiate of it, with gradational contacts. The granodiorite is certainly cut by dykes and small stocks of Ebagoola Granite, but the relationship with Barwon Granite is equivocal. Dykes of granite similar to Barwon Granite cut the granodiorite in places, but the contact between the main bodies of the two units near, and to the south of, "Glen Garland" is not exposed, and of uncertain nature. Glen Garland Granodiorite is also cut by several rhyolitic to andesitic or doleritic dykes, and, in the Stew Creek area (GR7568-497810), by dykes of andesite/diorite, of probable Carboniferous-Permian age.

The granodiorite is cut by several north-northwesterly trending faults parallel to the Ebagoola Shear Zone. In places, such as near the old "Bamboo" homestead site, the contact between Glen Garland Granodiorite and adjacent granitoids are formed by these faults, including the Spion Kop Fault, and they may be largely responsible for the banded pattern over the area seen on airborne gamma-ray spectrometric images (see below). The sense of movement on these faults is unknown, except in the case of the Napabina Fault, where there is clear evidence of sinistral movement.

Topographic expression. Glen Garland Granodiorite forms low-lying, low-relief terrain characterised by moderately dark soils, deep to very deep weathering, and, mainly in the southeast, scattered surface boulders generally 0.5-2 m in diameter.

Age. Rb-Sr mineral and whole-rock isotopic dating (Cooper & others, 1975), and ion microprobe zircon U-Pb dating (398 ±10 Ma: Black & others, 1992) of the Glen Garland Granodiorite indicate a *ca.* 400 Ma (Early Devonian) age; this age is also consistent with the Sm-Nd data (Black & others, 1992) which show that εNd values for Glen Garland Granodiorite are similar to those for granites (Kintore, *etc.*,) with well-documented 400 Ma ages.

Synonymy. Glen Garland Granodiorite was included in the Flyspeck Granodiorite of Willmott & others (1973).

Peringa Tonalite (SDp) (new unit)

Derivation of name. The name Peringa is derived from the Parish of Peringa, County of Warner, on the southern boundary of EBAGOOLA. The southern portion of the Peringa Tonalite crops out within this Parish.

Distribution. Peringa Tonalite forms a gently arcuate, approximately parallel-sided body about 5 km wide, extending from 7 km southwest of "Glen Garland" homestead 12.5 km southward to the margin of Ebagoola Sheet. Gravity data (Wellman, in press) suggest that Peringa

Granodiorite may be connected, beneath a thin 'cap', or roof pendant of Holroyd Group, with the Glen Garland Granodiorite.

Type area. The least weathered and most accessible outcrops of Peringa Tonalite are in the Coleman River, 11.5 km southwest of "Glen Garland" (GR7568-380477 to -383475). Weathered outcrop may be found 2 km to the south, at GR7568-378452, but elsewhere the unit is unexposed or extremely poorly exposed and very deeply weathered.

Lithology. Peringa Tonalite is a medium-grained, sparsely and weakly porphyritic (hornblende phenocrysts up to 1 cm x 4 mm), biotite-hornblende tonalite, possibly grading into (mafic) granodiorite. It is petrographically similar in some respects to the Glen Garland Granodiorite, but contains less K-feldspar, more plagioclase and hornblende, and generally more hornblende than biotite; allanite is a less conspicuous accessory mineral. A typical approximate modal composition is plagioclase 55%, quartz 25-30%, K-feldspar up to 5%, hornblende 5-9%, biotite 5-6%; accessory minerals are titanite, zircon, apatite, allanite, and rare Fe-Ti oxide. Plagioclase shows very pronounced oscillatory zoning, in many cases surrounding mottled, calcic cores (as in Glen Garland Granodiorite). Quartz is anhedral, polygranular, and variably recrystallised and/or strained. Hornblende is subhedral to euhedral, typically elongate, and pleochroic from pale yellow-brown (α) to bluish-green (β) or mottled green and brown-green (γ); the mottling is caused by irregularly-shaped, 'dirty' patches crowded with tiny, unidentifiable, dark inclusions oriented parallel to the C axis. This texture is suggestive of partial reaction of the magma with oxyhornblende(?), and its overgrowth by 'normal' hornblende. Biotite is red-brown, similar to that in the Glen Garland Granodiorite. K-feldspar (microcline or orthoclase microperthite) is intersertal.

Alteration is moderate to moderately intense: plagioclase is strongly to intensely altered to sericite/illite ± epidote, and biotite is slightly to moderately altered to chlorite + sericite/illite ± epidote ± titanite. Hornblende and K-feldspar are only slightly affected.

Relationships. Peringa Tonalite intrudes Holroyd Group. Geophysical data indicate that it also abuts rocks correlated with Ebagoola Granite, but no actual contacts are exposed.

Topographic expression. Peringa Tonalite is characterised by terrain of very low relief, deep weathering, very little outcrop, and deep, dark-toned soils. In the north, it is partly obscured by colluvium and alluvium derived from the surrounding metasedimentary rocks.

Age. By inference, the Peringa Tonalite is assumed to be approximately coeval with the Glen Garland Granodiorite, dated at 398 ± 10 Ma.

Synomymy. Willmott & others (1973) included Peringa Tonalite in the "Kintore Adamellite".

Artemis Granodiorite (SDa) (new unit)

Derivation of name. The name Artemis is derived from "Artemis" homestead in the southwest of Marina Plains 1:100 000 sheet area where the Artemis Granodiorite crops out extensively.

Type area. Rounded tors of the Artemis Granodiorite form a small hill near O'Briens Creek, to the west of the Peninsula Developmental Road at GR7668-710471. A porphyritic example crops out in a creek bank on the road to New Dixie Homestead at GR7668-758414.

Lithology. The Artemis Granodiorite is a medium to coarse-grained, mid-grey biotite-allanite granodiorite, which is porphyritic in part and has an average grain size of 2-4 mm. It contains subrounded to rounded dioritic and microdioritic xenoliths up to 30 cm diameter. Approximate modal mineral proportions are plagioclase 35-40%, perthite/microcline 10%, quartz 20%, biotite

20-25%. Allanite is a prominent minor mineral. Accessory minerals include apatite and zircon, and secondary minerals are sericite, chlorite and titanite.

Euhedral to subhedral plagioclase ranges from being strongly zoned to essentially unzoned, and mostly has only minor sericitic alteration. The zoned plagioclase typically has broad mottled cores suggestive of a restite origin. Quartz shows a degree of strained extinction through to incipient recrystallisation, and is polygranular and intersertal in part. Mostly intersertal, clear, anhedral K-feldspar consists mainly of perthite, although relatively fine-grained microcline is present locally. Subhedral to anhedral plates of pale straw to dark red-brown biotite are mostly about 1 mm across, but in places form aggregates 3 mm across. Apatite laths up to 0.25 mm long and zircons with pleochroic haloes are common inclusions in biotite. Euhedral prisms of metamict allanite, commonly closely associated with biotite, range up to 1.5 mm long, are characterised by alteration haloes and/or radiation damage. Overall the Artemis Granodiorite shows only minor evidence of alteration, mostly in the form of limited sericitic alteration to plagioclase and rare titanite lamellae in biotite.

Relationships. The Artemis Granodiorite crops out in close spatial association with the Kintore and Ebagoola Granites, and is cut by aplite and garnet-bearing pegmatite dykes and veins similar to components of the Ebagoola Granite. It is also cut by rhyolite dykes of possible Late Carboniferous-Early Permian age.

Topographic Expression. The Artemis Granodiorite is not distinguishable topographically from the adjacent Kintore Granite. Both form areas of low relief as well as small hills strewn with boulders up to 2-4 m in diameter. However, the Artemis Granodiorite is may be distinguished by significantly darker soil tones where not overlain by thick residual sand.

Age. Zircon U-Pb emplacement age for the Artemis Granodiorite is 406 ±10 Ma (Black & others, 1992).

Synonymy. Part of the Artemis Granodiorite was included in the Flyspeck Granodiorite by Willmott and others (1973), but most of it was included in the "Kintore Adamellite".

Tea Tree Granodiorite (SDtt) (new unit)

Derivation of name. Tea Tree Creek is an alternate name for Kalkah Creek which flows eastward from a plateau between the Coleman River and the Peninsula Developmental Road in the southeastern part of the Kalkah 1:100 000 sheet area. Large, dark grey, rounded tors of the Tea Tree Granodiorite are scattered sparsely throughout this area.

Type area. Good exposures of the Tea Tree Granodiorite can be seen on Tea Tree (Kalkah) Creek at GR7568-604516, where it is in contact with a more felsic rock similar to Carleton Monzogranite, and at GR7568-591458 where it crops out in close association with Kintore Granite.

Lithology. The Tea Tree Granodiorite is a mid-grey, mesocratic, coarse-grained (average grainsize about 3-4 mm), weakly to moderately porphyritic biotite-hornblende-allanite granodiorite which texturally and mineralogically is very similar to the Glen Garland Granodiorite. It contains fine-grained, biotite-rich microdioritic schlieren and enclaves up to 0.5 m long and 15 cm thick, and is cut by pegmatite veins about 3 cm across. It is also in contact with a more leucocratic phase which probably equates with the Carleton Monzodiorite.

Phenocrysts of plagioclase (up to 1.5 cm long), hornblende (up to 1 cm long), and allanite (up to 2 cm long) are set in a groundmass of plagioclase prisms, intersertal K-feldspar and strained quartz, biotite flakes/books, hornblende prisms, scattered allanite needles and prisms, and accessory titanite, apatite and zircon. Modal mineral composition is quartz 30%, plagioclase 35%, perthite/microcline 10%, biotite 10-15%, hornblende 3-8%.

Plagioclase forms stumpy, euhedral to subhedral prisms with variable zoning (An_{44-40}); some have broad, mottled, commonly strongly sericitized cores which may represent restite crystals. Quartz occurs as intersertal pools up to 4 mm across, and shows evidence of variable strain and/or extensive incipient recrystallisation. K-feldspar is mostly microcline, with minor remnant microperthitic orthoclase; it forms patchy vermicular intergrowths with quartz at some grain boundaries. Biotite (Mg/Mg+Fe = 51-48) plates and 'books' average about 0.5-1 mm across and are pleochroic from straw yellow to deep red-brown. Inclusions of apatite, and of zircon with dark haloes, are irregularly distributed; apatite also forms stumpy euhedra up to 1 mm long. Elongate, euhedral to subhedral, blue-green hornblende (Mg/Mg+Fe = 50-49) prisms are up to 4 mm long, and contain numerous small, rounded inclusions, mostly of quartz, apatite and zircon. The pleochroic scheme is α = very pale yellow-brown/straw, β = medium to deep green to blue-green, γ = deep olive-green to brownish-green. Hornblende is irregularly distributed and commonly forms aggregates with biotite, strongly metamict euhedral allanite, and primary pink titanite. Allanite forms prominent vitreous acicular prisms, commonly up to 2-4 mm long. It generally has conspicuous reaction rims: where in contact with biotite, there is generally a broad reaction rim of epidote.

Alteration of the Tea Tree Granodiorite is slight, and mainly confined to sericitization of plagioclase cores. There is minor development of epidote, titanite and chlorite in the mafic minerals, particularly biotite.

Relationships. The Tea Tree Granodiorite crops out in close association with both the Kintore and Ebagoola Granites, but no contact relationships have been observed. Aplite and pegmatite veins cut rocks of the Flyspeck Supersuite in other areas, suggesting that the Tea Tree Granodiorite is slightly older than the Ebagoola Granite. Relationships at contacts between the Tea Tree Granodiorite and the Carleton Monzogranite are equivocal, although comparison with the relationship between their equivalents, Glen Garland Granodiorite and Two Rail Monzogranite, suggest that the monzogranite most likely intrudes the granodiorite.

Topographic Expression. The Tea Tree Granodiorite underlies terrain of low to moderate relief, mostly with very poor outcrop – typically of rounded boulders 2-3 m in diameter – and a characteristic deep red-brown soil/regolith cover.

Age. The Tea Tree Granodiorite is probably the about same age as the petrologically similar Glen Garland Granodiorite, which is isotopically dated at 398 ± 10 Ma old.

Synonymy. Willmott and others (1973) included part of the Tea Tree Granodiorite in the Flyspeck Granodiorite, and part (approximately the northern half) in the "Kintore Adamellite".

Two Rail Monzogranite (SDr) (new unit)

Derivation of name. The name is derived from Two Rail Creek, a tributary of Swamp Creek/King River. The monzogranite crops out in the headwaters of Two Rail Creek around GR7568-460790.

Distribution. Two Rail Monzogranite extends from the southern branch of Barwon Creek (GR7568-460640) to the northern side of the Holroyd River, about 66 km to the north-northwest. Several smaller, separate bodies equated with Two Rail Monzogranite crop out extremely poorly and were mapped mainly on the basis of airborne radiometric signature. One of these is located on the eastern side of the Ebagoola Shear Zone, in upper Six Mile Creek (between

GR7569-300260 and -313345); its area is about 13 km^2. The others are on the western side of the batholith: the largest (about 50 km^2) is in the upper north branch of Little Rock Creek and extends northwestward into Dead Horse and Lagoon Creeks (GR7569-161255 to 7469-070420); a second (24 km^2) is in the Crawfish Creek area, between GR7569-280056 and 7568-293950; two small ($\leq$= 1 km^2) bodies, separated by a narrow screen of Holroyd Group, are centred on GR7568-325860 and -315860.

Type area. The best exposures of typical Two Rail Monzogranite are in upper Bamboo Creek (northern branch and main channel), to the west-southwest of Spion Kop (between GR 7568-925448 and -921412). The monzogranite is also sporadically exposed in the Lukin River and Station Creek, downstream from the Ebagoola-Spion Kop track, and near the Ebagoola-Holroyd River track around GR7569-373260.

Lithology. Two Rail Monzogranite is a sparsely and weakly porphyritic biotite monzogranite to granite, grading into hornblende-bearing biotite monzogranite to granodiorite in places adjacent to Glen Garland Granodiorite. It consists of equant, rounded to prismatic phenocrysts, up to 1.5 cm long, of K-feldspar in a medium-fine to medium-grained groundmass of quartz, K-feldspar, plagioclase, biotite, and accessory allanite, titanite, zircon, apatite, and very rare Ti-Fe oxide. In some outcrops, allanite is sufficiently coarse-grained (up to 1.5 cm long) and abundant (up to ~1%) to be classed as a minor rather than an accessory phase. An average modal composition is approximately 30% quartz, 30% plagioclase, 30% K-feldspar, 10% biotite, but composition ranges widely: quartz varies from 25% to 40%, plagioclase from 15% to 45%, K-feldspar from 10% to 45%, and biotite from 5% to 15%. The main body of monzogranite is zoned from east to west: hornblende occurs only in the west, while contents of plagioclase and biotite decrease, and content of K-feldspar increases, westward.

As in the Glen Garland Granodiorite, plagioclase is characterised by strong to very strong oscillatory zoning and probable restite cores. The K-feldspar is predominantly microperthitic microcline, with some orthoclase microperthite in the most mafic rocks; as in the Glen Garland Granodiorite, larger crystals and phenocrysts are poikilitic. Quartz is variably recrystallised – to mosaics of anhedral grains with sutured boundaries – and/or strained. Biotite, which forms small "pseudo-phenocrysts" (equant crystals that are large – up to 6-8 mm – relative to most of the biotite), is very pale yellow-brown to very deep reddish-brown or foxy red. Hornblende, which is rare, and occurs only adjacent to the Glen Garland Granodiorite, is pale yellow-brown to deep bluish- or brownish-green. Allanite occurs as elongate prisms (up to 1.5 cm x 3 mm) which in many parts of the main intrusion are rimmed and partly replaced (or pseudomorphed) by epidote.

Most of the Two Rail Monzogranite is affected by slight to moderate propylitic alteration, with plagioclase (particularly the cores) partly altered to sericite ± calcite ± epidote and biotite partly altered to chlorite ± sericite or muscovite ± epidote ± titanite. More intense propylitic alteration is localised to areas near the contacts with the Barwon and Ebagoola Granites (*e.g.* in Bamboo Creek and near Ryans Creek), and near the Ebagoola Shear zone (*e.g.* GR7569-392245).

Relationships. A small body of Two Rail Monzogranite intrudes the Holroyd Group in the north of EBAGOOLA. The monzogranite has a gradational relationship with Glen Garland Granodiorite, from which it may have been derived by fractional crystallisation; there is also evidence in places of intrusion of the granodiorite by the monzogranite (*e.g.* dyke at GR7568-542856). The monzogranite is intruded by Barwon, Leconsfield, Burns, and Ebagoola Granites, by dykes of rhyolite, dacite, and andesite/diorite of probable Carboniferous-Permian age. Its relationship to the Kirkwood Monzogranite is uncertain, although the convex apparent shape of the eastern margin of this granite suggests that it is younger. Two Rail Monzogranite is cut by the Ebagoola Shear Zone in the north (Kendle River-Holroyd River area, and head of Six Mile Creek).

Topographic expression. The Two Rail Monzogranite has a similar topographic expression to that of the Glen Garland Microgranite, except that soils are generally slightly paler in tone and boulders (or corestones) are generally smaller and less common.

Age. The age of the Two Rail Monzogranite is assumed to be about the same as that of the Glen Garland Granodiorite, *i.e.* 398 ± 10 Ma.

Synonymy. Most of the main body of Two Rail Monzogranite was included by Willmott & others (1973) in the "Flyspeck Granodiorite", along with the Kirkwood Monzogranite. The smaller bodies in the north, northwest and west were not distinguished from "Kintore Adamellite" (now mainly Barwon and Burns Granites).

Carleton Monzogranite (SDm) (new unit)

Derivation of name. The name Carleton is derived from the Parish of Carleton, County of Hann, in the south of the EBAGOOLA. The Carleton Monzogranite crops out in the northern part of this Parish.

Type area. Large tors of the Carleton Monzogranite can be seen approximately 1 km south of the Musgrave-Edward River road, 3 km east of the Coleman River at GR7568-575615.

Lithology. The Carleton Monzogranite is a pale grey, weakly porphyritic, medium grained (average grainsize 1-2 mm), felsic biotite-allanite-microcline granite. Approximate modal abundances are quartz 30-40%, plagioclase 20-25%, microcline 25-40%, biotite 5-15%. Allanite is a conspicuous minor phase, and apatite and zircon are moderately abundant accessory minerals. Secondary minerals include muscovite, sericite, chlorite, and epidote.

Quartz is anhedral, polygranular, and has variably strained extinction with some recrystallisation along grain boundaries. Plagioclase (An_{31-23}) forms mostly equant euhedra less than 2 mm across, but there are some grains more than 4 mm across. It is zoned, and commonly has relatively little-altered, strongly-zoned rims mantling distinct, weakly-zoned or mottled, sericitized cores which are probably of restite origin. Microcline also ranges up to about 4 mm, but is mostly less than 1 mm across; it tends to be intersertal, and shows only minor alteration. Myrmekitic intergrowths at grain boundaries are sometimes present. Both feldspars contain abundant, rounded, exsolved(?) quartz grains mostly less than 0.25 mm diameter. Euhedral to anhedral crystals of biotite (Mg/Mg+Fe = 30-17) with foxy-red to straw-yellow pleochroism range up to 2 mm across, and commonly contain inclusions of zircons with dark haloes and, less commonly, apatite. Prominent euhedral metamict allanite up to 0.5 mm long is mostly associated with biotite.

Relationships. An equivocal contact with the Tea Tree Granodiorite is the only contact observed. However, the more evolved chemical composition of the Carleton Monzogranite suggests its derivation from a Flyspeck Supersuite granodioritic parent.

Topographic Expression. The Carleton Monzogranite has a similar topographic expression to that of the Tea Tree Granodiorite, except that soils are paler toned on airphotographs, and more quartz rich.

Age. Carleton Monzogranite is probably about the same age as other, isotopically dated rocks of the Flyspeck Supersuite – *i.e.* about 400 Ma.

Kirkwood Monzogranite (SDo) (new unit)

Derivation of name. Kirkwood Creek is a tributary of the Holroyd River; the junction is at GR7569-338239. Kirkwood Monzogranite crops out in the upper catchment of this creek.

Distribution. Kirkwood Monzogranite crops out in the upper catchments of Kirkwood, Burns, Brumby and Sandalwood Creeks, and extends in a narrow "neck" along the main channel of Sandalwood Creek; outcrop area is about 31 km^2.

Type area. Boulders of typical Kirkwood Monzogranite are exposed close to the Aurukun road at GR7569-378171 and -383160; however, best exposure is along Sandalwood Creek, between 7569-289150 and -320150.

Lithology. The Kirkwood Monzogranite is a sparsely porphyritic biotite monzogranite, similar in most respects to the more mafic parts of the Two Rail Monzogranite. However, it is generally more obviously porphyritic, with K-feldspar phenocrysts up to 3 cm long and plagioclase phenocrysts up to 1.5 cm long, and is richer in biotite and poorer in allanite. Approximate modal analyses range from 35% quartz, 20% plagioclase, 35% K-feldspar and 8-10% biotite to 30% quartz, 45% plagioclase, 15% K-feldspar, and 10% biotite; the K-feldspar/plagioclase ratio decreases westward. Accessory minerals are apatite and zircon (abundant), allanite, titanite, and ilmenite(?).

Mineralogy is also similar to that of the Two Rail Monzogranite: larger microcline (and rare orthoclase micoperthite) crystals are strongly poikilitic; plagioclase has strong oscillatory zoning and restite(?) cores that are generally much more altered than the remainder; and biotite is pleochroic from very pale yellow-brown to moderately deep or deep red-brown. The most notable differences are the abundance and size of apatite crystals (up to 0.3 mm across), the abundance of zircon, especially as small inclusions in biotite, and the presence in places (*e.g.* middle reaches of Sandalwood Creek) of up to 1% coarse post-magmatic(?) muscovite.

Alteration is slight to moderate: plagioclase is slightly to intensely (very locally) altered to sericite ± muscovite ± epidote, biotite is very slightly to slightly altered to chlorite + sericite/muscovite + Ti-Fe oxide ± epidote, and allanite is variably replaced and/or mantled by epidote. Muscovite crystals up to 1 mm long and superficially of magmatic appearance cut across other minerals and generally contain trains of opaque oxide grains parallel to the cleavage; they are probably of post-magmatic (sub-solidus) origin.

Relationships. Kirkwood Monzogranite is similar to Two Rail Monzogranite, and may have crystallised from the same body of magma. However, the subtle petrographic differences outlined above, together with a coincident apparent airborne gamma-ray spectrometric anomaly (which corresponds to higher observed total-count scintillometer readings than in the Two Rail Monzogranite – see below), suggest that Kirkwood Monzogranite intrudes Two Rail Monzogranite. Kirkwood Monzogranite is intruded by Barwon and Burns Granites, and is cut by dykes and pods of pegmatite and leucogranite equated with Ebagoola Granite.

Topographic expression. The Kirkwood Monzogranite underlies terrain that is generally higher and more dissected than that formed on the Two Rail Monzogranite, but this may be an artefact of a coincidence of erosional processes not related to any inherent difference between the two granitoids.

Age. The Kirkwood Monzogranite is probably about the same age as the Two Rail Monzogranite, and therefore the same age (actually slightly younger, but the difference would probably not be resolvable) as the Glen Garland Granodiorite.

Synonymy. Willmott & others (1973) included some of the Kirkwood Monzogranite in the "Flyspeck Granodiorite", but about two thirds of the outcrop area was not distinguished from "Kintore Adamellite" (now Barwon and Burns Granites).

OTHER SILURO-DEVONIAN(?) GRANITOIDS

Interpretation of gravity and airborne magnetic data (Wellman, in press) indicate the likely presence of a body of granitic composition, about 50 km long and 11 km wide, beneath Cainozoic and Mesozoic cover along the western coastline of Princess Charlotte Bay. It appears to be bounded to the east by the Palmerville Fault Zone, and is separated from the CYPB, to which its relationship is unknown, by an extensive area of Newberry Metamorphic Group.

LATE CARBONIFEROUS—EARLY PERMIAN

Outcropping igneous rocks of probable or possible Late Carboniferous-Early Permian age are rare in EBAGOOLA: those recognised are a small microgranite stock (Lindsay Flat Microgranite), two narrow dykes of microgranite, and several dykes of rhyolitic, dacitic, and andesitic composition.

However, AGSO aeromagnetic data (Wellman, in press) indicate the existence at shallow depth (beneath regolith cover) of a number of east-northeasterly trending dykes, probably of andesitic (or basaltic?) composition, cutting the southern part of the CYPB. These data also indicate the presence, beneath Mesozoic and Tertiary sedimentary cover to the east and the west of the exposed Coen Inlier, of numerous bodies of intrusive and extrusive rocks(Fig. 1); their magnetic character indicates that they are probably of Late Carboniferous-Early Permian age (Wellman, in press).

The concealed igneous bodies in the east include:

- a circular mass, about 21 km in diameter, beneath the Saltwater Creek-North Kennedy River junction, and two much smaller bodies near its southwestern margin (2 km diameter) and 8 km to the south (5 x 2 km);
- a body at least 15 km in diameter offshore beneath Beaby Patches, overlapping the northeastern margin of EBAGOOLA;
- a pluton about 8 km in diameter beneath Station Creek, overlapping the southeastern edge of EBAGOOLA;
- a 5 km-diameter body beneath Dinner Creek, 17 km west of Port Stewart;
- a cluster of four small (up to 2.3 km diameter) bodies beneath the northern headwaters of Gorge Creek;
- a group of six intrusive bodies (up to 3 km diameter) and two areas of probable extrusive rocks (one 8 x 4 km, the other 2.5 x 1.7 km) beneath the area between "Lilyvale" homestead and the coast.

Lindsay Flat Microgranite (CPg) (new unit)

Derivation of name. Lindsay Flat is the name given to the low, flat interfluve between Barwon and Flying Fox Creeks, around GR7568-428725; the microgranite crops out at its southwestern end.

Distribution. Lindsay Flat Microgranite comprises two small stocks of porphyritic biotite microgranite in the Flying Fox Hill area, between Flying Fox and Barwon Creeks. The more southerly of the two stocks is 500 m in diameter; the more northerly, which forms Flying Fox Hill itself (GR7568-394706), is 1 km x 700 m. Interpretation of AGSO aeromagnetic data indicates that the two stocks merge into a single body at shallow depth (a few hundred metres) below the surface; this body is elliptical in plan, about 4 km long and 2 km wide.

Type area. The type area is on the southwestern end of Flying Fox Hill; a reference area (altered rocks) is a small hill to the southwest of Flying Fox Hill, at GR7568-393695.

Lithology. The southern stock comprises biotite microgranite which is very to extremely altered, variably pyritised, and contains abundant phenocrysts of quartz (up to 4 mm), sanidine/orthoclase (up to 1.5 cm long) and plagioclase (up to 6 mm long – typically An_{25}). The phenocrysts, along with crystals of (altered) biotite up to 2.5 mm across, are set in a fine to very fine-grained mosaic of quartz and feldspar. Unaltered biotite, preserved as inclusions in quartz, is extremely deep red-brown to pale yellow-brown/straw, and constitutes about 5% by volume of the rock. Accessory minerals are zircon, apatite, and rare Fe-Ti oxide (titaniferous magnetite?). Alteration is to sericite, muscovite, pyrite, and hematite: K-feldspar is moderately to strongly altered to hematite, sericite and/or muscovite, and calcite; plagioclase is intensely altered to, or completely replaced by, sericite/muscovite and calcite, and biotite is almost entirely replaced by muscovite/sericite. The rock is also cut by veinlets of calcite and quartz. Clumps (to 5 mm) of small (up to 0.5 mm) pyrite cubes comprise about 2-3% of the rock by volume.

The northern body is made up of porphyritic biotite microgranite which is less conspicuously porphyritic and much less altered than the southern body. Phenocrysts of simply-twinned sanidine (variably – mostly slightly – inverted to orthoclase) up to 1cm long and phenocrysts of quartz and plagioclase up to 5-6 mm long are set in a medium-fine groundmass mosaic of quartz and feldspar. Biotite flakes up to 2 mm in diameter make up about 5% by volume, and are pleochroic from pale yellow-brown to very deep reddish-brown (cores) grading outward to brownish-green. Feldspars, particularly plagioclase, are slightly altered to sericite, and some biotite (less than 10%) is chloritised.

Relationships. Lindsay Flat Microgranite intrudes Barwon Granite, and is closely spatially related to several dykes of porhyritic rhyolite with which it may also be genetically related.

Topographic expression. Unlike the surrounding granites, Lindsay Flat Microgranite forms prominent, steep-sided, bouldery hills. This morphology is a common characteristic of Carboniferous-Permian granites in north Queensland, especially those that are shallow-emplaced or subvolcanic.

Age. The observations that Lindsay Flat Microgranite intrudes Barwon Granite, and that it is similar petrographically and geochemically to high-level Carboniferous Permian granitoids that are common throughout north Queensland suggest a Carboniferous-Permian age.

Minor intrusives

The southwestern portion of the CYPB on EBAGOOLA is cut by a number of dykes of rhyolitic to andesitic or doleritic composition (Fig. 1), and by a plug of rhyolite (CPr) at Spion Kop. The most common exposed lithologies are (1) sparsely, weakly porphyritic rhyolite (to rhyodacite), with phenocrysts of quartz, sanidine(?), plagioclase, and, rarely, biotite up to 1 mm, and (2) sparsely porphyritic to aphanitic dacite or andesite with plagioclase phenocrysts to 2 mm.

The prominent hill at Spion Kop is formed by a rounded plug, about 150-200 m in diameter, of very fine-grained to (ex-)glassy (now devitrified and very finely recrystallised) rhyolite which intrudes foliated Flyspeck Granodiorite adjacent to the Spion Kop Fault. Related(?) rhyolite dykes extend to the north and south from Spion Kop along, or subparallel to, this fault. Lapunya Mount also owes its topographic prominence to two dykes of extremely altered (sericitised), very sparsely porphyritic, very fine rhyolite.

Andesite to dolerite dykes are mostly narrow (up to 30 m wide) and crop out extremely poorly or not at all; most were detected only by their aeromagnetic signature (Wellman, in press) However, an andesite dyke in the Stew Creek area (GR7568-497810) is lenticular in plan, up to about 200 m wide, and relatively well exposed: its central portions are mainly medium-coarse (diorite), and the margins andesitic to doleritic in texture. It consists of extremely altered (to calcite + sericite ± muscovite) calcic plagioclase, ferromagnesian mineral(s) completely replaced by chlorite, about 5-10% quartz, abundant accessory magnetite and titanite, and less abundant accessory apatite.

Both the rhyolites/rhyodacites and the dacites/andesites are highly to extremely altered to sericite + calcite ± chlorite ± hematite (or other opaque phase) ± pyrite. Pyrite is conspicuous at Spion Kop, in the dykes extending northward from it, and at Lapunya Mount.

Most of the dykes are east-northeasterly trending, parallel to a very well-developed regional fracture pattern. However, some, including the dykes associated with the rhyolite plug at Spion Kop, are subparallel to the Ebagoola Shear Zone, and one group, which cuts the Leconsfield Granite and adjacent Barwon Granite, trends north-northwest. The dykes cut across all other rock units and all structures, with the exception of the Barwon Creek Fault, which apparently offsets one dolerite dyke, and truncates another. Rhyolite dykes in the vicinity of the Lindsay Flat Microgranite appear to be genetically related to the granite. The dykes clearly postdate the CYPB, and are compositionally distinct from the Tertiary Silver Plains Nephelinite. The only other isotopically dated rocks in the region are Late Carboniferous-Early Permian, an age consistent with the field relationships of these dykes and the plug at Spion Kop.

TERTIARY

Silver Plains Nephelinite

Derivation of name. The name Silver Plains is derived from the name of the pastoral holding where this rock units crops out.

Distribution. The Silver Plains Nephelinite forms a prominent, flat topped hill near Balclutha Creek, approximately 24 km SW of Port Stewart, on Princess Charlotte Bay 1:100 000 sheet. Two or three benches, each representing a lava flow 2-3 m thick, are exposed near the top of the hill; total thickness of the lava is estimated to be about 40 m, and the area underlain by nephelinite is about 2 x 3 km. Interpretation of the aeromagnetic data (Wellman, in press) indicates that rocks similar in composition and age to the Silver Plains Nephelinite occur beneath the Dinner Creek-Fifteen Mile Creek area, 40 km to the south-southeast (Fig. 1).

Type area. The outcrop and type area of the Silver Plains Nephelinite is centred on about GR7669-747262, near Balclutha Creek, 24 km southwest of Port Stewart.

Lithology. The Silver Plains Nephelinite is a black, very fine-grained olivine-pyroxene nephelinite which contains relatively sparse, small (mostly less than 5 mm diameter) green, mantle-derived peridotite xenoliths of vitreous appearance. Phenocrysts are rare, and most if not all represent fragments of xenoliths. The peridotite xenoliths are mostly deformed olivine

(Mg/Mg+Fe = 89), with some brown spinel. Fine mosaic olivine (Mg/Mg+Fe = 83?) associated with xenoliths suggests a possible reaction product from orthopyroxene. A second generation of olivine (Mg/Mg+Fe = 83) forms numerous small (mostly about 0.1 mm across, but some up to 0.4 x 0.2 mm) microphenocrysts in a very fine-grained groundmass. The groundmass consists mainly of microcrystalline clinopyroxene (Mg/Mg+Fe = 83), nepheline, and a fine dusting of opaque minerals.

Relationships. Field relationships suggest that the Silver Plains Nephelinite comprises two or three flow units; the nephelinite is overlain by Quaternary sand, but the base is not exposed. The concealed basaltic rocks in the Dinner Creek-Fifteen Mile Creek area probably overlie, or are emplaced into, Newberry Metamorphic Group, and are overlain by Quaternary (and perhaps older) sand derived from the CYBP (Pain & Wilford, 1992).

Topographic Expression. The Silver Plains Nephelinite forms a prominent, densely vegetated hill which rises about 100 m above the surrounding coastal plain, and is characterised by vine-covered bouldery slopes and deep red-brown soil. Boulders range up to about 0.5 metres diameter, but are mostly about 0.25 metres diameter.

Age. Potassium-argon dating of the Silver Plains Nephelinite (Sutherland, 1991) produced a 3.72 ± 0.06 Ma, or Early Pliocene, age.

GEOCHEMISTRY

Mean/representative major- and trace-element analyses of igneous rock rocks from EBAGOOLA are listed in Appendix 1.

Cape York Peninsula Batholith

Classification of granitoids into Supersuites is based on mineralogical and chemical similarities and general coherence of compositional trends. The twofold subdivision of the CYPB into S- and I-types on mineralogical grounds (*i.e.* the presence of muscovite and/or garnet in the former, hornblende and/or allanite and/or titanite in the latter) is supported by the analytical data (Appendix 1; Mackenzie & others, 1992), which allow division into two Supersuites. These data show that the I-type Flyspeck Supersuite has ASI values of 1.1 or lower, and the Kintore Supersuite has a broad range of ASI values above 1.1, increasing significantly in rocks with more than 71.5% SiO_2 (Fig. 2). The Flyspeck Supersuite also has a greater range of SiO_2 contents, ranging from 64 to 73%, while the Kintore Supersuite ranges from 66% to 75% SiO_2. The S-types are also generally slightly higher in K_2O/Na_2O and P_2O_5 (on average), and lower in Fe_{total} as FeO. Ba, Sr, Nb, and Zr all show flat trends with increasing SiO_2 in the I-types, but steeply decreasing trends, along with Ce, in the S-types. Other differences are summarised by Mackenzie & others (1992)

Both Supersuites are very iron-poor and highly reduced, resulting in their having very low magnetic susceptibility (typically in the range 1-15 x 10^{-5} SI units). These properties are normal for S-type granitoids, but unusual for I-types (*e.g.* Chappell & White, 1984), and reflect unusually reduced source compositions.

The S-type Ebagoola and Lankelly Suite granites have εNd values (at 400 Ma) of -13.8 to -14.7 and -13.4 to -14.1 respectively, and, although there is some overlap of values, Lankelly Suite granites tend to be the more radiogenic. A single value on a Flyspeck Supersuite granodiorite is marginally less evolved (εNd -12.7), but the data do not show a clear distinction

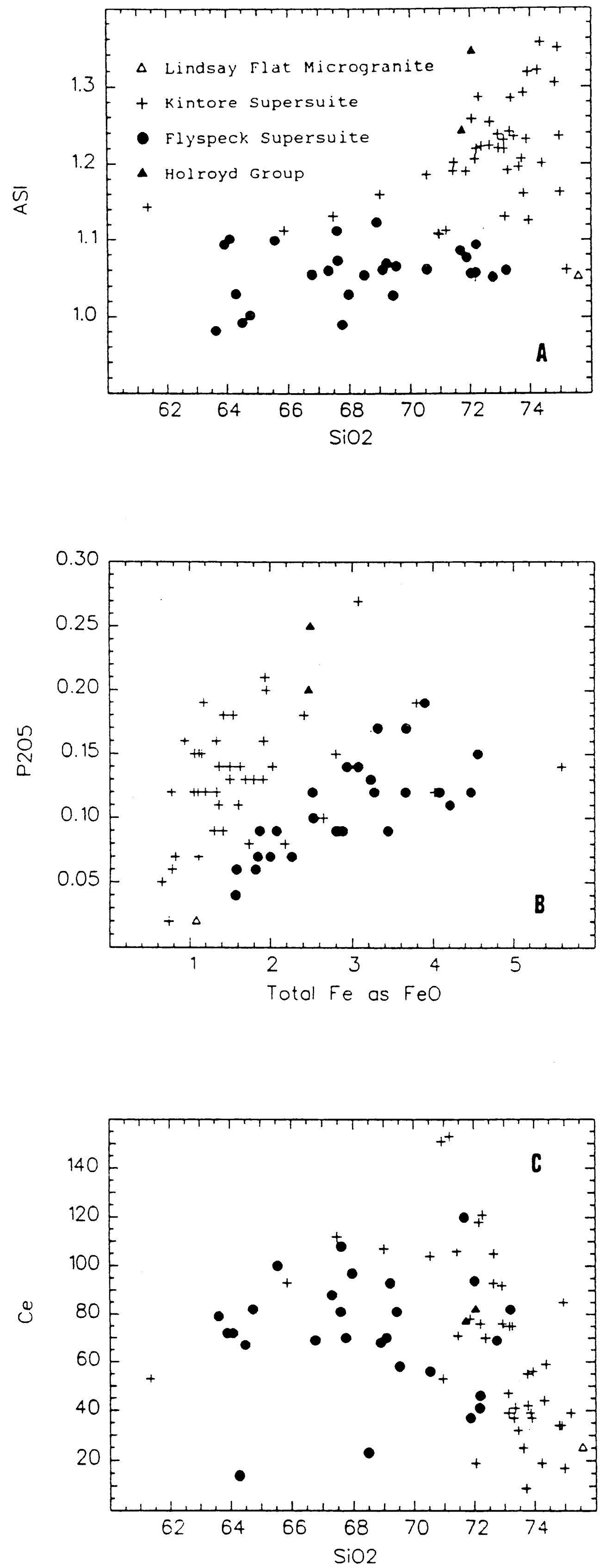


Figure 2. Selected chemical variation diagrams showing grouping of S- and I-type granitoids in the CYPB. Includes analyses of the Lindsay Flat Microgranite (Carboniferous-Permian) and Holroyd Group (Proterozoic) for comparison.

between the various granite suites. However, the preliminary Sm-Nd results, along with zircon U-Pb chronology, do indicate that all the Early Devonian granitoids were derived by partial melting of relatively old (Precambrian) crust at about 400 Ma. Restite zircon (cores) document an earlier thermal or tectonothermal event at approximately 1600 Ma. An older (*ca.* 2500 Ma) crustal component is also present (Black & others, 1992). Model age for mantle depletion is about 2700 Ma.

KINTORE SUPERSUITE

Division of Supersuites into Suites is principally on the basis of granitoid bodies, or groups of bodies, showing separate, generally sub-parallel compositional trends within the compositional envelope of a Supersuite. Accordingly, the Kintore Supersuite is divided into Ebagoola Suite and Lankelly Suite.

Ebagoola Suite

Apart from their characteristically high ASI values, rocks of the Ebagoola Suite are predominantly high in SiO_2 (>70%). Most components (*e.g.* TiO_2, FeO, MgO, CaO, K_2O, P_2O_5, Ba, Sr, Zr, Nb, Y, and Ce) decrease linearly with increasing SiO_2; a few (*e.g.* Na_2O [weakly], Rb, Pb, and U[?]) increase. These variations are consistent with compositional evolution by means of separation of restite composed of plagioclase + biotite + zircon, and fractionation of K-feldspar. Other components show little or no discernable systematic variation relative to one another.

Lankelly Suite

In most variation diagrams, Ebagoola Suite granitoids and Lankelly Suite granitoids form distinct, commonly well-separated, trends. The main differences are the generally lower SiO_2 contents and more extended compositional range (to more mafic compositions) and relatively high Zr and Ce contents, and the contrasting trends in Sr, Rb, Ce, those in the Ebagoola Suite being much steeper than in the Lankelly Suite.

FLYSPECK SUPERSUITE

Members of the Flyspeck Supersuite are less compositionally diverse than those of the Kintore Supersuite, but there are several differences between the various granitoid units. On most variation diagrams, Two Rail Monzogranite, Carleton Monzogranite, and Flyspeck Granodiorite form a single coherent trend, while Peringa Tonalite, commonly along with Artemis Granodiorite and Tea Tree Granodiorite, form trends that are clearly separate from those of the other units, and generally separate from each other; Kirkwood Monzogranite also shows some differences from the other granitoids. Details of differences between individual units are summarised by Mackenzie & others (1992).

Compositional variation in the members of the Flyspeck Supersuite is probably due mainly to restite separation, involving a plagioclase – and hornblende-rich residue. Fractional crystallisation, involving predominantly the same minerals, is indicated by curvilinear trends on plots of Sr, Rb, and Pb *vs* SiO_2, and P_2O_5 *vs* Fe_{total} as FeO, notably in the Two Rail Monzogranite, but was probably not a major factor in the evolution of the Supersuite as a whole.

Late Carboniferous Early Permian

The only chemical data available for probable Late Carboniferous-Early Permian rocks are from the Lindsay Flat Microgranite, from the andesite/diorite dyke at Stew Creek (Appendix 1), from a dacite dyke cutting Leconsfield Granite, and from a rhyolite dyke cutting Burns Granite. The microgranite has a fractionated I-type composition, characterised by a low alumina saturation index (ASI) and Al_2O_3, low Fe_{total}, CaO, P_2O_5, Ba, Sr, Y, high Na_2O, and low primordial mantle-normalised Ba, La, Ce, Sr, P, and Ti relative to the CYPB I-types. The andesite is a highly altered and reduced iron-rich, K-poor rock of calc-alkaline aspect (*e.g.* high Al_2O_3, low TiO_2, Nb); the diorite is similar but more evolved (lower Fe, Mg, Sr, *etc.*; higher Na, K, Ba, Rb, *etc.*). The dacite resembles a yet more evolved derivative of the same magma type in major-element composition, but differs from the andesite and diorite in several trace-element contents (notable Ba, Li, Rb, Sr, Sc, and Cr). The rhyolite is a highly evolved I-type rock, poorer in alkalis and Rb, richer in Ba and Sr, but otherwise similar to the Lindsay Flat Microgranite.

Tertiary

Silver Plains Nephelinite

The Silver Plains Nephelinite is a basanitic nephelinite with a SiO_2 content of 39%, and 20.79% normative olivine, 20.59% normative nepheline, and 10.95% normative leucite; it is one of the most silica-undersaturated rocks of the extensive Cainozoic eastern Australian volcanic province (*cf* Johnson, 1989). The Mg value ($Mg/[Mg + Fe^{2+}] = 68$, based on $Fe^{3+}/[Fe^{2+} + Fe^{3+}]$) and the presence of peridotite xenoliths indicate that the rock originated as a primary, upper mantle-derived melt. It is relatively high in Sr (1601 ppm) and Ba (912 ppm), and low in Cr (213 ppm) and Ni (176 ppm).

GEOMETRY AND EMPLACEMENT OF THE CAPE YORK PENINSULA BATHOLITH

The three-dimensional geometry – as deduced from surface geology and geophysical data – and an interpretation of the probable mode of emplacement of the CYPB are discussed in detail by Mackenzie & others (1992).

The most pertinent observations and interpretations are:

- The Batholith and most of its components are long and narrow at the surface.
- The CYPB has been emplaced into a sinistral transpressive tectonic regime (Blewett, in press).
- The presence of migmatites and gradations from leucosome-bearing gneisses through pegmatite/granite-veined gneisses and granite/pegmatite containing abundant rafts of gneiss to relatively homogeneous granite indicate syn-metamorphic magma generation and emplacement.
- Regional gravity anomalies and anomaly changes indicate that the depth extent of the granitoids as seen at the surface is about 6 km in the east (Kintore Granite) and between 8 and 11 km in the west (Barwon and Burns Granites).

It is proposed that the CYPB was emplaced by means of dilational jogs in pre-existing northerly to north-northwesterly trending transpressive fracture zones such as the Coen and Ebagoola Shear Zones (*cf.* Hutton, 1988; D'Lemos & others, 1992; McCaffrey, 1992). In this model, the Flyspeck Supersuite rocks were emplaced first, then shouldered aside as the jog widened and the Kintore Supersuite rocks were intruded.

It is also proposed, in the light of the above observations and evidence of the importance of restite in the compositional evolution of the granitoids, that the plutons of the CYPB grade at depths of 6 to 11 km into mixtures, similar in density to the metamorphic country rocks, of magma and restite (*e.g.* Chappell & others, 1987), where the restite ranges from crystals and polygranular aggregates to blocks or schlieren up to several kilometres across. With increasing abundance and size of these blocks/schlieren the mix grades with increasing depth into migmatite, granitoid-veined metamorphics and, finally, massive metamorphic rocks.

NOTES ON THE APPLICATION OF AIRBORNE GEOPHYSICS TO MAPPING OF GRANITOIDS

Magnetics

Images of airborne magnetic data obtained by AGSO (Wellman, in press) were valuable in determining the positions of granitoid-country rock contacts, particularly in areas where these were concealed beneath thick sedimentary and/or regolith cover. Such areas included the eastern margin of the Kintore Granite, which is mostly concealed beneath detritus from the Great Escarpment, parts of the western margin of the Coen Metamorphic Group, and the northwestern margin of the Burns Granite. In the last case, the magnetic greyscale image clearly shows the presence of granite beneath an appreciable thickness of Mesozoic sedimentary rocks west of "Crystal Vale". Other features revealed, or enhanced, by the magnetic data include:

- slivers of metamorphic rocks along the Ebagoola Shear Zone;
- a dyke-like body of metasediments within the Kintore Granite northeast of "Yarraden";
- probable rafts of metasediments within the main mass of Ebagoola Granite;
- subcrop of the Lindsay Flat Microgranite beneath the Barwon Granite;
- a "septum" of metasedimentary rock projecting into the Glen Garland Granodiorite at "Glen Garland".

Magnetic data also revealed the presence of several non-outcropping dykes, probably of andesitic to doleritic composition, cutting the southern end of the Barwon Granite and adjacent Flyspeck Supersuite granitoids, and cutting the Kintore Granite northeast of Lapunya Mount.

Magnetic susceptibility data for the CYPB are presented in Appendix 2.

Gamma-ray spectrometry

Hardcopy images of combined (potassium, thorium and uranium) airborne gamma-ray spectrometrics proved invaluable in recognising different granitoid types, assessing the true positions of boundaries between them, and between granitoids and the host metamorphic rocks. An example of such an image, combined with some geological information, is reproduced in

Figure 3. Appendix 2 presents hand-held total-count scintillometer data for most granitoid units of the CYPB.

Distinguishing between areas underlain by Flyspeck Supersuite and those underlain by Kintore Supersuite was relatively straightforward in most cases. Flyspeck Supersuite rocks, because of their relatively lower total K + Th + U and high K/(Th + U) are generally represented by deep to bright red or pinkish-red pseudocolour tones. The Kintore Supersuite, in contrast, produces a stronger response, with bright orange-pink, pink, and white tones on the combined image.

Discrimination between units within each Supersuite is much more difficult and equivocal. An apparent tonal banding, striking north-northwest, in the area between the Coleman River and Battery Creek, led, upon field checking, to the division of the Flyspeck Granodiorite of Willmott & others (1973) into Glen Garland Granodiorite, Two Rail Monzogranite, and Flyspeck Granodiorite. Glen Garland Granodiorite is characterised, where relationships are clearest (such as in the old "Bamboo" homestead area), by deep orange-red to medium pinkish-brown tones, Flyspeck Granodiorite by deep red to pinkish red tones, and Two Rail Monzogranite by brighter red to pink-red tones. Artemis and Tea Tree Granodiorites are similar to Glen Garland Granodiorite, but, because they are relatively more differentiated, tend to the redder tones. Carleton Monzogranite is equivalent to differentiated Two Rail Monzogranite, and appears a relatively bright red to pink-red. Kirkwood Monzogranite appears a very bright, pale pink grading to red-brown. This is partly because of the relatively elevated terrain that it underlies, and partly because of a thinner regolith cover due to its location on and below the Holroyd Escarpment; however, the primary reason is its high U content and low K/(Th + U) relative to the Two Rail Monzogranite.

Discrimination between components of the Kintore Supersuite is even more difficult and uncertain than in the case of the Flyspeck Supersuite. Larger (>200 m wide), discrete bodies of Ebagoola Granite are relatively easily distinguished by their bright pink or purplish pink to white colours, but other units appear a fairly consistent salmon pink to orange-pink. A small (*ca.* 3 km^2), bright-toned, kidney-shaped area to the east of the Coleman River and adjacent to the Main body of Carleton Monzogranite is interpreted as predominantly pegmatite (Ebagoola Granite) with possible rafts of Holroyd Group schists.

Lankelly Granite may be distinguished from Kintore Granite in the south by slightly paler/brighter, more neutral, tones; in the north it appears much paler and brighter because of a relatively greater amount of outcrop and/or thinner regolith cover. A narrow band of darker red tones separates the two granites over much of their length, and extends 5-6 km south-southeastward beyond the contact. However, the exact nature of this band remains obscure, mainly because of the extreme paucity of outcrop along it.

Superimposed on all these subtle tonal changes is an almost continuous blanket of varying opacity caused by regolith. The effect of this cover ranges from a slight reduction in intensity of response (pseudocolour) by thin soil and/or saprolite cover to nil response (black) from thick residual quartz sand, or blue-green tones from transported material (*e.g.*, along the Holroyd River). Most of the Kintore Supersuite is covered by moderate to thick residual sand, and its true radiometric response is only seen along the coastal escarpment, along some of the stream channels, and from the hills at the head of Dead Horse Creek, east of "Crystal Vale". A detailed account of the relationship between regolith and gamma-ray spectrometric response is presented by Wilford (in press).

FIGURE 3. Pseudocolour gamma-ray spectrometric image of the Cape York Peninsula Batholith, EBAGOOLA showing geological boundaries (white), faults (black), and dykes (dark blue). Boundaries and faults in purple are from geophysics, as are most dykes.

Despite only sparse, sporadic outcrop and deep weathering, the radiometric signature of the Flyspeck Supersuite is generally distinct south of about 14° 24' S. However, it is much more diffuse and equivocal farther north because of thicker, more extensive residual regolith and extensive transported regolith associated with the Holroyd River and the Thornbury Creek-Goose Creek system. Boundaries of the Two Rail Monzogranite in the northeast (Holroyd River, upper Six Mile Creek) were delineated mainly from ground observation data. The body of Two Rail Monzogranite in the upper Lagoon Creek-upper Little Rock Creek area (northwestern margin of the Batholith on Ebagoola) was not detected by earlier mapping (Willmott & others, 1973). However, its boundaries are clearly delineated by the red pseudocolour radiometric response, despite a cover of residual material, deep weathering, and an almost total lack of outcrop. The location of its eastern boundary was confirmed (with reassuring precision) by the only outcrop that was located – a few corestone boulders in the channel of upper Lagoon Creek.

ACKNOWLEDGEMENTS

We thank Tas Armstrong for his invaluable support as field operations manager in 1991. We are also indebted to all those who provided us with field assistance and technical and culinary support, especially John Pye and Lewis Roberts, who assisted us with sampling, and Alan Tate for his untiring and cheerful provision of sustenance. The cooperation and hospitality of landholders who allowed access and provided information, particularly Frank Campbell of "Glen Garland", is gratefully acknowledged. The technical input in the laboratory of Bill Pappas and John Pyke is also acknowledged with thanks.

R9207505

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APPENDIX 1. AVERAGE AND REPRESENTATIVE ANALYSES OF IGNEOUS ROCKS FROM EBAGOOLA

1. CAPE YORK PENINSULA BATHOLITH

	KINTORE GRANITE	BARWON GRANITE	LECONS-FIELD GRANITE	WARNER GRANITE	BURNS GRANITE	HENEAGE GRANITE	TADPOLE GRANITE	EBAGOOLA GRANITE	LANKELLY GRANITE
(No. of analyses)	(19)	(2)	(1)	(2)	(1)	(2)	(1)	(4)	(6)
SiO_2	73.22	72.91	73.88	74.70	73.14	72.61	70.97	74.14	70.26
TiO_2	.20	.21	.14	.22	.20	.30	.31	.07	.47
Al_2O_3	14.56	14.40	14.48	13.67	14.82	14.67	14.60	14.79	15.06
Fe_2O_3	.36	.30	.23	.39	.32	.55	.50	.24	.41
FeO	1.10	1.13	.90	1.05	1.22	1.27	2.20	.59	2.25
MnO	.03	.03	.03	.02	.03	.02	.06	.05	.03
MgO	.40	.33	.27	.27	.40	.42	.52	.17	.83
CaO	1.44	1.23	1.21	.80	1.30	1.07	1.70	.91	2.25
Na_2O	3.14	3.05	3.41	2.61	3.72	3.03	3.00	3.61	2.87
K_2O	4.14	4.86	3.91	4.67	3.68	4.66	4.99	4.39	4.35
P_2O_5	.13	.12	.12	.12	.13	.14	.10	.09	.18
LOI	.99	.81	.85	.95	.90	.95	.88	.72	1.10
Rest	.18	.19	.16	.15	.15	.20	.18	.11	.22
Total	99.90	99.57	99.59	99.62	99.91	99.89	100.01	99.86	100.28
Ba	734	643	599	337	483	732	261	219	727
Li	31	73	74	80	53	52.5	117	50	23
Rb	193	224	196	255	211	229	301	247	210
Sr	158	127	152	68	135	140	87	69	180
Pb	34	40	34	45	33	41	47	57	35
Th	17	21	6.0	15	8	24.5	21	7.5	36.5
U	3.0	2	.2	5.3	2.5	1.5	4.5	8.25	2.5
Zr	85	102	52	73	79	107	116	27.5	190
Nb	12	12.5	10	20	13	11	17	12.5	16
Y	15	13.5	12	21	12	9.5	42	26	21
La	30	41.5	21	26	22	54	23	8.75	56
Ce	62	84	39	54	39	106.5	53	17.5	117
Nd	26	33.5	15	23	18	45.5	25	7.75	49
Pr	6.0	9.0	5	5.3	5.0	11	6	1.75	12
Sc	3.7	3.0	4	5	3	2	10	4.0	6.7
V	8	5.5	3	5.3	7	6	25	1.0	27
Cr	2.3	.7	.5	4	2	1.25	4	1.0	4.8
Co	1.1	3.0	1	2	1	1.5	4	-	2.2
Ni	2.0	2.0	2	2	2	2	3	1.0	3.3
Cu	.8	<1	.5	.5	.5	.5	3	.88	1.8
Zn	50	52.5	47	56	60	75.5	53	38.5	74
Sn	2.7	2	5	5.3	4	2	14	3.0	2.3
W	1.9	<3	<3	<3	3	<3	<3	2.4	<3
Mo	-	<2	<2	<2	<2	<2	<2	1.0	1.2
Ga	20	20.5	20	17	22	23.5	19	19.5	22
As	1.2	1.2	1.0	2.0	1.0	1.25	2.0	2.25	1.2
S	30	25	50	17	30	25	40	32.5	43
Be	1.05	3.0	3.0	19	2	2	5	2.0	1.0
Ag	1.6	1.0	2.0	2.0	2	2	2	1.75	1.8
Hf	5.0	2.5	2.0	2.0	3.0	3.5	4.0	1.5	5.8
Ta	2.8	2.5	<2	3.0	4.0	3.0	6.0	2.75	2.0
Bi	1.1	<2	<2	1.5	<2	<2	<2	2.0	<2
Cs	2.6	5.5	<3	26.5	3	<3	41	6.3	2.7
Ge	1.4	1.0	2.5	2.25	2	1.6	2	1.6	1.4

APPENDIX 1 (cont.)

CAPE YORK PENINSULA BATHOLITH (cont.)

(No. of analyses)	KENDLE RIVER GRANITE (2)	FLYSPECK GRANO-DIORITE (2)	PERINGA TONALITE (3)	ARTEMIS GRANO-DIORITE (3)	TWO RAIL MONZO-GRANITE (12)	TEA TREE GRANO-DIORITE (1)	CARLETON MONZO-GRANITE (2)	KIRKWOOD MONZO-GRANITE (2)
SiO_2	73.62	68.54	64.30	66.06	69.71	67.98	72.99	68.26
TiO_2	.14	.41	.60	.55	.42	.43	.16	.60
Al_2O_3	14.84	15.40	16.22	16.82	15.07	15.45	13.97	15.66
Fe_2O_3	.44	.52	.59	.53	.42	.70	.39	.51
FeO	.67	2.35	3.72	3.20	2.29	2.31	1.22	3.03
MnO	.02	.05	.07	.06	.05	.06	.04	.05
MgO	.34	1.17	2.38	2.02	.98	1.61	.39	1.14
CaO	1.63	3.59	5.11	4.50	2.85	3.78	1.70	3.38
Na_2O	3.22	2.72	3.08	3.38	3.00	3.22	3.03	3.16
K_2O	3.95	3.58	2.10	1.96	3.89	2.93	4.86	2.82
P_2O_5	.09	.09	.12	.15	.10	.14	.05	.17
LOI	.82	1.03	1.36	1.05	1.02	.95	.58	-
Rest	.16	.23	.24	.18	.19	.22	.19	.22
Total	99.95	99.67	99.89	100.45	99.99	99.78	99.59	99.01
Ba	703	859	566	314	628	675	722	620
Li	17.5	61.5	71	43	56	87	35	66
Rb	147	138	82	98	164	97	200	172
Sr	215	200	305	302	205	307	133	244
Pb	43	25.5	20	16	36	16	44	28
Th	8.0	26	14	14	18.7	23	25.5	17
U	1.75	3.0	1.6	2.2	2.3	1	3.75	3
Zr	53	136	120	126	123	121	105	176
Nb	7.5	11.5	10	13	12	9	15	17
Y	16.5	17	19	12	19	15	16	24
La	15	50.5	37	40	36	53	40	35
Ce	34	94	76	65	70	97	75	74
Nd	13	39.5	29	25	30	33	26	29
Pr	2.0	9	5	6	6.8	7	5.5	7.5
Sc	3.5	10	17	13	9	10	5	8.5
V	6.5	49	96	71	41	53	7.5	50
Cr	2.25	15.5	46	25	7.2	28	2	5.5
Co	1.5	5	11	6.7	5.3	8	2	6
Ni	2.0	4.5	8	9	3.3	13	2.5	2.5
Cu	.5	3	10	4	1.9	2	.5	.75
Zn	38	43	64	65	51	53	41	76
Sn	<2	2.5	4.7	4.3	4.6	3	6.5	7
W	<3	1.5	3.8	2.7	1.6	1.5	1.5	4.5
Mo	<2	<2	2.3	<2	2	<2	<2	2.5
Ga	19	17.5	20	22.7	19	19	16	24
As	1.25	1.25	1.7	.5	1.5	1	2	1.75
S	30	40	257	97	41	30	25	40
Be	2.0	2.5	3.0	2.3	2.5	4	3	2.5
Ag	2.0	2	1.7	2.0	1.4	2	2	1.5
Hf	2.0	3.5	2.7	3.0	3.3	3	4.0	4.5
Ta	3.5	1.5	1.7	2.7	2.8	6	1.5	2.5
Bi	<2	<2	1.7	1.0	1.25	<2	<2	1.5
Cs	<3	7	9.3	6.0	9.2	5	7	9
Ge	1.0	1.5	1.5	1.7	1.5	1.5	1.75	2.5

APPENDIX 1 (cont.)

CARBONIFEROUS-PERMIAN AND TERTIARY; MICRODIORITE ENCLAVES IN LANKELLY GRANITE

	MAFIC DYKE	DACITE DYKE	LINDSAY FLAT MCGRNT	RHYOLITE DYKES	SILVER PLAINS NEPHEL	MICRO-DIORITE ENCLAVE
(No. of analyses)	(2)	(2)	(2)	(2)	(1)	(2)
SiO_2	52.15	69.49	73.85	73.69	39.04	63.62
TiO_2	1.28	.41	.10	.12	2.38	.90
Al_2O_3	14.91	14.98	13.23	14.77	11.36	16.82
Fe_2O_3	1.35	.55	.66	.25	6.10	.61
FeO	9.49	2.20	.70	.75	6.47	4.26
MnO	.16	.05	.02	.03	.18	.05
MgO	3.07	1.10	.16	.33	11.43	2.17
CaO	4.74	2.06	1.24	1.24	11.82	4.69
Na_2O	3.71	4.13	2.97	3.46	4.45	2.55
K_2O	.84	2.68	4.72	2.80	2.34	2.31
P_2O_5	.27	.19	.04	.07	1.29	.13
LOI	7.83	1.18	1.35	1.90	2.54	1.95
Rest	.37	.16	.48	.12	.60	.20
Total	100.17	99.18	99.53	99.54	100.00	100.26
Ba	263	286	230	387	912	420
Li	135	66	23	50	13	31.5
Rb	41	188	221	122	34	170
Sr	160	125	57	182	1601	231
Pb	7.5	24.5	44	20.5	5.0	13
Th	8.5	19	15	5.0	11	17
U	1.0	3.3	5.8	2.25	2.0	2
Zr	176	154	88	71	298	174
Nb	9	20	9.5	5.5	140	12.5
Y	27	24	40.5	13	30	17
La	19	29	14	9	71	31
Ce	39	64	30	19	113	73
Nd	20.5	26	15.5	7.5	54	32
Pr	4.5	7	2.5	1.0	10	6
Sc	20	9	4.5	3.0	24	15.5
V	89	36	5	2.0	224	90
Cr	1.5	19	.75	.5	213	24
Co	30	5	2.5	2.5	48	8.5
Ni	5	7	1.75	1.5	176	7.0
Cu	45	6.8	51	.75	46	7.0
Zn	124	77	53	34	118	80
Sn	7.5	5	15	3	9	2.5
W	2.25	-	6.25	3.25	-	1.5
Mo	4	-	<2	<2	6	<2
Ga	20.5	21	19	19	24	23
As	1.25	4	7.25	1.75	1.5	.75
S	1985	45	3635	40	770	135
Be	1.5	1.75	2.5	2.0	3	2.0
Ag	2	1.5	1.5	1.0	4	2.0
Hf	4.5	5.0	3.0	2.0	7	5.5
Ta	1.5	<2	3.5	2.0	<2	2.0
Bi	1.5	2.5	<2	2.0	<2	<2
Cs	5.0	12	5.0	5.5	<3	<3
Ge	1.25	1.5	1.75	1.5	<1	1.50

NOTE: A complete listing of analyses may be purchased in digital form from the Information Officer, AGSO.

APPENDIX 2. **Magnetic susceptibility (x 10^{-5} SI units) and total-count gamma-ray spectrometric readings for the Cape York Peninsula Batholith.**

Scintillometer and Magnetometer Readings -Ebagoola 250000 Sheet Ebagoola Suite					
Kintore Granite					
Sample No	Total counts	Magnetic suscept.	Sample No	Total counts	Magnetic suscept.
91836164	50-70	5	91836179	50-80	5
91836183	100-140	5	91836187	20-40	2
91836188	30-80	2	91836189	50-60	2-4
91836190A	40	2	91836190B	20-40	5-12
91836191	50-90	5	91836192	70-100	4
91836195	70-80	2-4	91836196	40-60	5-10
91836197	30-50	5	91836198	40-50	5-6
91836199	40-50	5	91836202	20-40	2-4
91836208	20-40	4	91836212	40-80	4
91836215	20-40	2-4	91836217	80	10
91836219	20-40	5-8	91836219	20-40	5-8
91836221	40-50	11	91836232	52	7
91836233	40	5	91836234	56	2
91836235	45	7	91836236	72	8
91836237	72	8	91836238	55	7
91836239	85	7	91836244B	54	3
91836245	52	3	91836246	53	3
91836250	40	4	91836262A	78	4
91836265	56	1	91836273A	46	3
91836273B	65	6	91836275	65	4
91836276	60	4	91836279	72	5
91836281	60	5	91836282A	42	3
91836283	60	5	91836292	64	4
91833313	50-70	5	91836314	55-60	5
91836317	44-48	6-10	91836318	50	5
91836326	55	2-3	91836329	45-50	2
91836331	30	0	91836333	40-55	2
91836334	50-55	0-2	91836336	55-60	5
91836380	55-60	3-4	91836383	65	3-5
91836397	55-65	0-3	91836400	45-50	5
Mean ± 1σ	53 ± 20	4.6 ± 2.5			

Scintillometer and Magnetometer Readings - Ebagoola 250000 Sheet Ebagoola Suite (cont.)					
Ebagoola Granite					
Sample No	Total counts	Magnetic suscept.	Sample No	Total counts	Magnetic suscept.
918322011	50-52	3.8-4.2	91832038		2-5
91832039		3	91832073	64	2
91832110	75	2.5-5.2	91832112	38,39;82	5-6; 1.5
91832163	60	0.5	91832180	40	3
91832201	35	4	91832211	50	4-5
91832220	60	3-4	91832236	40	2
91832241	50-80	2-5	91832243	40	4
91836240	56	4	91836241	54	4
9183626B	76	3	91836263	67	3
91836264	62	1	91836266	60	4
91836268	80	2	91836270A	140	0
91836270B	70	4	91836272	60	2
91836277	64	3	91836280B	42	1
91836282B	60	0	91836290	50	0
91836344	125	0-2	91836327	40-50	2
Mean ± 1σ	61 ± 23	2.9 ± 1.6			

Scintillometer and Magnetometer Readings - Ebagoola 250000 Sheet Ebagoola Suite (cont.)					
Barwon Granite					
Sample No.	Total counts	Magnetic Suscept.	Sample No.	Total counts	Magnetic suscept.
91832004	60	7-10	91832005	60	2-10
91832018	45	1.2-3	91832019		1.5
91832063		5.5-6.0	91832064		15-16
91832076	75-80	3-3.5	91832084	50	11.5
91832102	40-60		91832103	75-85	10
91832104	40-50		91832105	55	10-13
91832106	47	4.4-5.5	91832108	55-60	4.0-4.5
91832130	40	4-6	91832135	54; 60-65	5; 0-1
91832146	60-65	10	91832149	42	4-5
91832150	50	10	91832152	40-50	4-5
91832153	50	4-6	91832154	50	4-6
91832155	50	4-5	91832157	40-45	6-8
91832159	50	4	91832176	30	3-4
91832179	30	5	91832180	40	3
Mean ± 1σ	51 ± 15	6.0 ± 3.6			
Leconsfield Granite					
91832184	35	4-5	91832185	42	5

Scintillometer and Magnetometer Readings - Ebagoola 1:250000 Sheet					
Ebagoola Suite (cont.)					
Warner Granite					
Sample No.	Total counts	Magnetic suscept.	Sample No.	Total counts	Magnetic suscept.
91832041		2-3	91832043		6
91832051		11-14	91832052		4-6
Lindalong Granite					
91832059		16			
Burns Granite					
91832206	30-35	3-5	91832212	45	5
91832218	30-35	2-4	91832228	50	5
91832231	50	3-5	91832233	48-50	2-6
91832244	50-60	5	91832245	36	3-4
91832248	30	6	91832251	50	4
91832254	55	5-6	91832260	45	5
91832261	50	4-5	91832262	45	5
91832263	40	1	91832273	40-50	4-5
Mean ± 1σ	41 ± 12	4.1 ± 1.4			
Heneage Granite					
91832197	55	6-10	91832198	50	8-10
91832199	66	6-8	91832246	55-65	3-5
91832247	50-60	5	Mean ± 1σ	49 ± 22	6.8 ± 2.4
Tadpole Granite					
91832239	50-52	8-10	91832242	60-65	10

Scintillometer and Magnetometer Readings - Ebagoola 250000 Sheet Lankelly Suite					
Lankelly Granite					
Sample No	Total counts	Magnetic suscept.	Sample No	Total counts	Magnetic suscept.
91836166	50	3	91836170	80-100	8-15
91836171	50-80	10	91836172	50-100	10-14
91836173	80	10	91836175	80	10
91836176	50	5	91836178	90	10
91836180	80-100	6-8	91836184	30	24
91836185	70-110	6-14	91836222	60-80	7-10
91836223	30-60	9-11	91836225	50-60	12
91836249	72	9	91836259	54	13
91836261	55-60	10	91836308	35-40	10-12
91836309	60	15	91836310	75-95	10
91836320	55-70	10-20	91836321	75-80	15-20
91836316	70-80	10-15	Mean ± 1σ	62 ± 26	10.6 ± 4.5
Microdiorite enclaves in Lankelly Granite					
91836169	30	35	91836177	40-80	30-40
91836310	55-65	20	91836322	40	10-15
Mean ± 1σ	52.5 ± 21	25 ± 13			
Kendle River Granite					
91832213	45-50	5	91832215	50	5

Scintillometer and Magnetometer Readings -Ebagoola 250000 Sheet Flyspeck Supersuite					
Sample No	Total counts	Magnetic suscept.	Sample No	Total counts	Magnetic suscept.
Artemis Granodiorite					
91836285	65	20	91836303*	75	15
91836305*	40	15	91836306*	40	12
Mean ± 1σ	55 ± 18	15.5 ± 3.3			
Glen Garland Granodiorite					
91832001	50-60	10-25	91832013		5
91832031		3	91832123	48	4-8
91832124	40	14-18	91832129	50	14-22
91832142	50-60	15-22	91832145	45-50	10
91836353	60-65	10-12	91836356	55-60	15
91836493A	55-60	16-20	Mean ± 1σ	50 ± 15	13.5 ± 6.4
Flyspeck Granodiorite					
91832009	65-80	5-10	91832010	60-80	5-8
91832021	50	20	91832022	50	10
91832126	40	6-8	91832140	54	10
91836358	50-55	10	91836403B	40-50	8-10
Mean ± 1σ	56 ± 13	9.2 ± 3.9			
Tea Tree Granodiorite					
91836398	35-40	16-18			
Carleton Monzogranite					
91836348		10	91836349	56	10
Two Rail Monzogranite					
91832006	40	8	91832020	42	0.3-0.5
91832030		2	91832097	40	6.6-10.4
91832098	55	3-5	91832099	40	10
91832134		13-14	91832158	54	14
91832162	38-48	15-18	91832171	55-60	10
91832173	40-50	10	91832186	50	15-20
91832187	45-50	14-18	91832188	50	10
91832200	35-40	10-18	91832202	40	20
91832203	30	20	91832207	30	20
91832219	35	15-22	91832253	40-50	3-5
91832256	30	18-20	91832257	46	10-13
91832259	40-50	10	Mean ± 1σ	44 ± 8	12 ± 6
Kirkwood Monzogranite					
91832033	80		91832034	75	
91832267	60-70	13-15	91832271	50-70	11-14
91832274	65-72	14-15	Mean ± 1σ	68 ± 9	9.3 ± 6.6
Peringa Tonalite					
91832056		1-2	91832057		2
91832078	38	4-6	Mean ± 1σ	38	2.3 ± 1.3