69/117
(3)

COPY 3

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 117

Geology of the Ravenswood 1-mile Sheet area, Queensland

by

D.E. Clarke

(Geological Survey of Queensland)

GEOLOGY OF THE RAVENSWOOD 1-MILE SHEET AREA, QUEENSLAND

by

D.E. Clarke
(Geological Survey of Queensland)

RECORDS 1969/117

GEOLOGY OF THE RAVENSWOOD 1-MILE SHEET AREA,

QUEENSLAND

by

D.E. Clarke
(Geological Survey of Queensland)

RECORDS 1969/117

Contents

SUMMARY

The Ravenswood 1-mile Sheet area is about 50 miles south of Townsville in the Burdekin River region of northeast Queensland. It was selected for more detailed mapping in 1966 as a follow-up to recent 1:250,000 scale mapping of the Burdekin River region. The general objective was to obtain more information on the Ravenswood Granodiorite Complex, an early Palaeozoic batholith which contains gold and minor base metal mineralization.

The Ravenswood Granodiorite Complex occupies about 2,000 square miles of the Townsville hinterland, and most of the Ravenswood Sheet area. Early Palaeozoic country rocks of the complex are preserved in the east of the area. Several subunits of the complex ranging from gabbro to granite have been identified and some have been named. Isotopic dating carried out by B.M.R. at the Australian National University has shown that most of the Ravenswood Granodiorite Complex is Middle Ordovician, but it contains undelineated masses which are Upper Silurian or Lower Devonian. A separate Upper Silurian/Lower Devonian pluton has been mapped and named Barrabas Adamellite. Upper Carboniferous volcanics are intruded by two late Palaeozoic complexes. Cainozoic superficial sediments comprise early Tertiary sandstone and laterite in isolated mesas, and Pleistocene and Recent fluvial and outwash deposits.

Faulting and jointing are prominent in all early Palaeozoic rocks. A zone of shearing and brecciation up to 4 miles wide, the Mosgardies Shear Zone, extends west from near Ravenswood for over 20 miles.

The Sheet area includes most of the mines in the Ravenswood Gold and Mineral Field, which once had a population of more than 5,000. No mining is being carried out at present. Nearly all of the gold in the area occurs in the Ravenswood Granodiorite Complex and is almost certainly related to it. Although a relationship between the gold at Ravenswood and a particular subunit of the complex was indicated by the mapping, the isotopic dates conflict with this view. Occurrences of both disseminated and vein-type copper/molybdenum mineralization discovered in recent years are not currently economic, but are a hopeful sign that the area has potential for copper/molybdenum orebodies. The disseminated occurrence is associated with a small porphyry intrusion.

INTRODUCTION

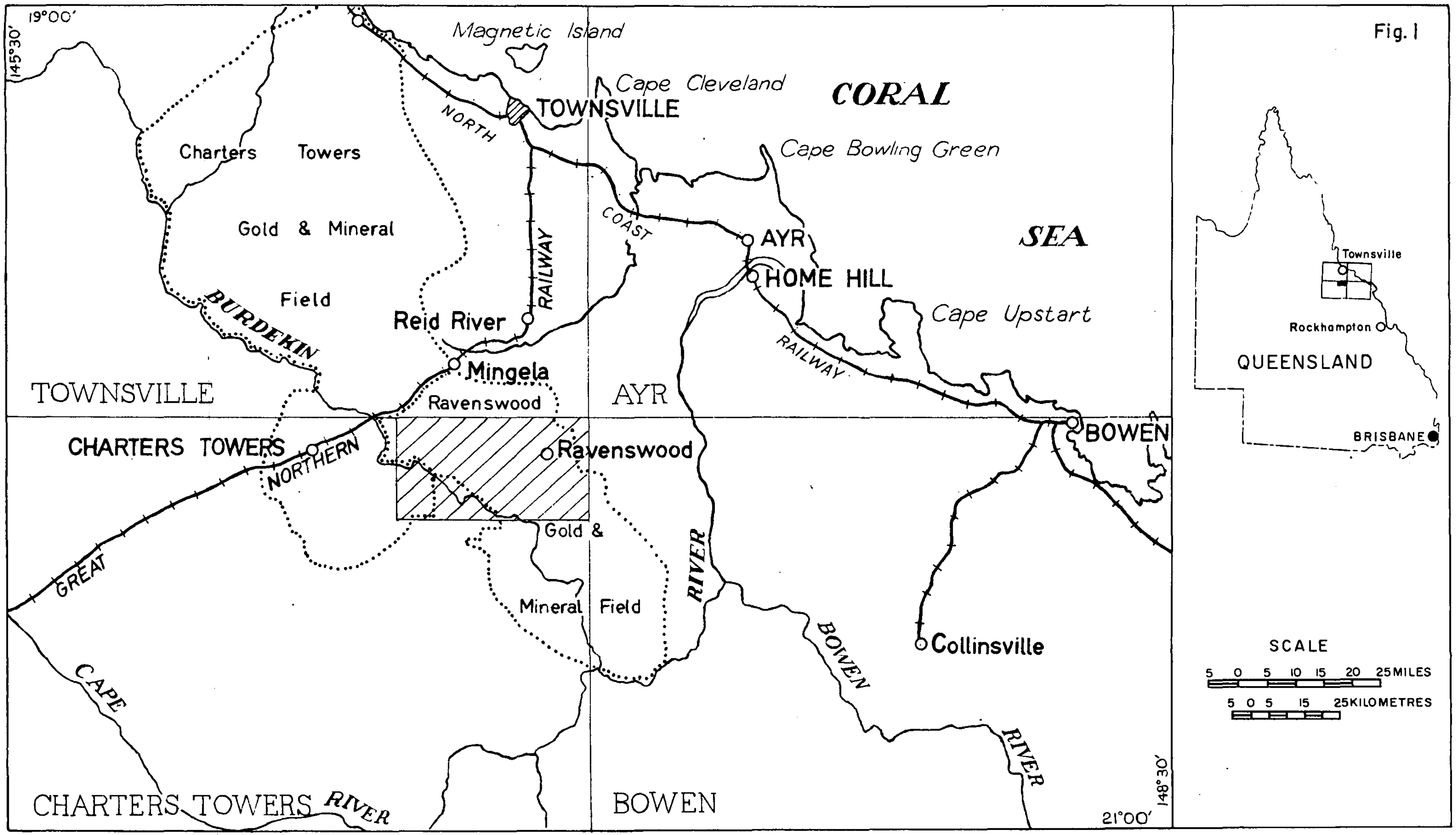
The Ravenswood 1-mile Sheet (Fig. 1) is bounded by latitudes 20° and $20^{\circ}15'$ south and by longitudes $146^{\circ}30'$ and 147° east. It was mapped by the author in 1966, using funds and equipment made available by the Bureau of Mineral Resources.

Field work for a joint Bureau of Mineral Resources - Geological Survey of Queensland regional mapping programme in the Burdekin River region was completed in 1965. Early in this programme (1963/64) mapping of the Townsville and Charters Towers 1:250,000 Sheet areas delineated an early Palaeozoic batholith with an area of 2,000 square miles, to which the name Ravenswood Granodiorite was given (Wyatt, et al., 1965; Wyatt, 1968). The regional mapping defined the extent and broad features of the batholith - enough to reveal that it is a complex body, and that detailed mapping would be needed to delineate the different phases. In view of the gold and minor base metal mineralization associated with the batholith at Charters Towers and Ravenswood, it was decided to follow up the regional work with detailed mapping, to investigate the structure, composition, and mineralization of the batholith in its type area around Ravenswood, and to try to relate the mineralization to a particular phase or phases. Accordingly during the winter of 1966 the Ravenswood 1-mile Sheet area, situated in the northeast of the Charters Towers 1:250,000 Sheet area, was mapped at 1-mile scale. As a result of the mapping, the name Ravenswood Granodiorite has been changed to Ravenswood Granodiorite Complex.

Complete air-photo coverage is available. Photographs at an approximate scale of 1:85,000 and 1:25,000 were flown by Adastra in 1961. Older photographs at a scale of about 1:32,000 ("40-chain"), flown in 1955 by the Royal Australian Air Force, also cover the entire area. Geological mapping and plotting were carried out using the 1:25,000 scale photographs.

The topographic base was compiled in 1955 by the Royal Australian Survey Corps from the 1:32,000 photographs. Four contoured sheets were

LOCATION OF RAVENSWOOD ONE MILE-SHEET AREA



Drawn by Geological Survey of Queensland

To accompany Record 1969/117

F55/A2/6

compiled at 40-chain scale but the final map at one-mile scale was not completed. As a result of the geological mapping, additional planimetric information has been added to the 1955 compilation sheets.

Ravenswood, the only township in the area, was once a flourishing mining town, but is now all but deserted. The present population in and around Ravenswood is about 200 but in its early days the mineral field had a population of at least 5,000. Ravenswood is connected by road to the port of Townsville 80 miles away, but the railway connecting Ravenswood to the Great Northern Railway was abandoned in 1932. There is an emergency landing strip near Ravenswood. A network of shire roads and station tracks provides good access to most parts of the area.

The climate is tropical. Two-thirds of the annual rainfall (20-25 inches) falls in the summer months from December to March; falls of rain are rare between June and November. At Charters Towers, the nearest town (pop. 8,000) 15 miles west of the Sheet area, the temperature ranges from 51.6° (average daily minimum) to 76.0° (average daily maximum) in July and from 69.7° to 94.7° in December.

Vegetation consists of woodland and tree savannah. However dense scrub is developed on small areas of sandy Cainozoic sediments at Rochford, Rishton, and south of the Kirk Range. Heteropogon contortus (spear grass) is the dominant grass.

Beef cattle grazing is the only industry.

The nomenclature of igneous rocks used in this report is that suggested by Morgan (1964). Constituent minerals are listed in order of increasing abundance. All isotopic age determinations in this report were carried out by A.W. Webb (B.M.R.) at the Department of Geophysics and Geochemistry at the Australian National University.

The geological time-scale followed in this report is that of Harland et al. (1964).

Previous Investigations

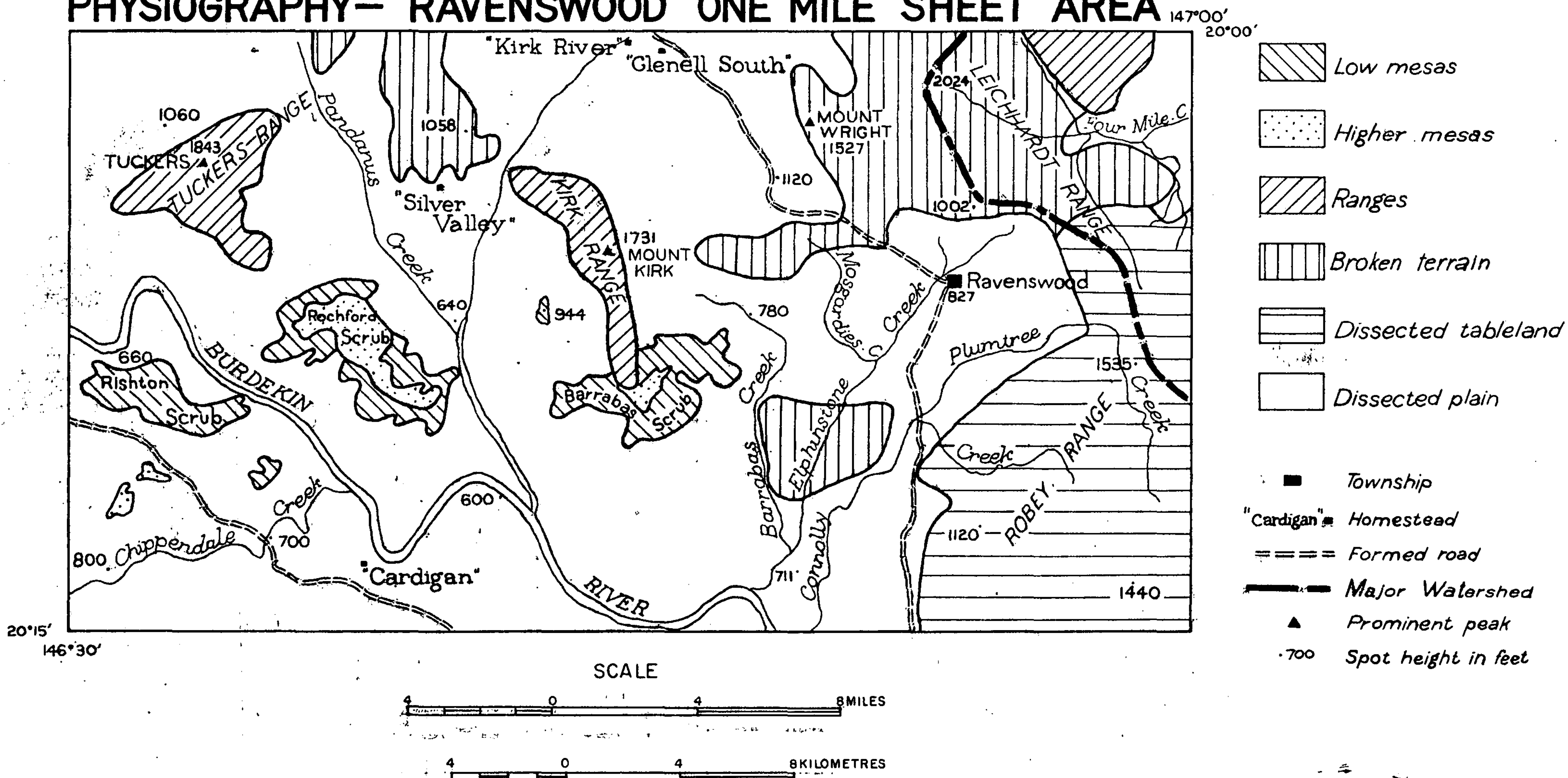
The first geological observations in this area were those of the explorer Leichhardt who in 1847 named a number of topographic features including the Robey Range, the Burdekin River, and the Thackers (Tuckers) Range. Leichhardt noted the occurrence of various granitic rocks in the area. Gold was discovered in the Ravenswood district in 1868, but this discovery was eclipsed by that at Charters Towers in 1871. Daintree (1870) briefly described the gold deposits at Ravenswood. In 1879 Jack described the Cainozoic sediments in the southwest of the area. Before 1900 very little was published about either the mineral occurrences or the regional geology of the area, although some information is present in the Annual Reports of the Queensland Department of Mines.

Maclaren (1900) published the only comprehensive geological map and report dealing with the geology and mineralization of the Ravenswood area. His regional map shows with fair accuracy the extent of the rock units now called Ravenswood Granodiorite Complex, Millaroo Granite, and Mount Windsor Volcanics. His maps are particularly useful in showing the positions and names of many of the mines and reefs. Reid (1934) reported on some of the Ravenswood mines and Morton (1938) described the mines at Kirk. In 1956 Connah published reports dealing with diamond drilling at Mount Wright and the geology of Kings silver mine in the Totley area.

During 1959-1960 North Broken Hill Ltd investigated and drilled Keans Prospect and Titov Prospect. Results of the investigations are set out in unpublished Authority Reports. Further prospecting, carried out by New Consolidated Goldfields Australasia Pty. Ltd in 1966, involved geochemical and induced polarization surveys in the area between the two prospects (Best, 1966). In 1967 two diamond drill holes were put down near the Titov Prospect. The results are set out in unpublished Authority Reports. In late 1966 and early 1967 Anaconda Australia Inc. investigated a number of small prospects in the Robey Range (Dalgarno, 1967) but subsequently relinquished their Authority to Prospect.

Fig 2

PHYSIOGRAPHY— RAVENSWOOD ONE MILE SHEET AREA



Drawn by Geological Survey of Queensland

To accompany Record 1969/117

F55/A2/7

The only systematic regional geological mapping of the area is that of Wyatt, Paine, Clarke, Gregory, and Harding (1967, and in press), who mapped the Charters Towers 1:250,000 Sheet area, which contains the Ravenswood 1-mile Sheet area. Regional mapping of the Townsville 1:250,000 Sheet area, immediately to the north, by Wyatt, Paine, Harding and Clarke (1965, and 1969) has proved helpful in the mapping of the Ravenswood Sheet area, because several of the rock units near Ravenswood extend north into the Townsville Sheet area.

Physiography

The physiography of the area is illustrated in Figure 2. Most of the area is gently undulating country between 700 and 1,000 feet above sea level. Differential weathering has been the major control in the development of the present topography and there is close correlation between the distribution of physiographic and geological units.

Dissected Plain

Most of the Ravenswood Granodiorite Complex forms undulating plains dissected by a close drainage pattern and interrupted by scattered granite tors and a few low ridges.

Dissected Tableland

The Robey Range in the east of the Sheet area is a closely dissected tableland consisting of coincident summits which are about 500 feet higher than the adjacent dissected plain. The stream pattern is closely controlled by joints. Slopes are steep and access is poor.

Broken Terrain

The granite and adamellite in the east and north of the Sheet area are more resistant to erosion than the adjacent granodiorite, and form broken terrain about 250 feet above the general level of the dissected plain.

Ranges

The Kirk and Tuckers Ranges are rugged, and are characterized by extensive slopes which are mantled by boulders and almost unvegetated. The rock slopes resemble screes but many blocks are in situ or close to their in situ position. Both ranges rise 800 to 1,000 feet above the dissected plain.

Higher Mesas

Flat lying lateritized Tertiary sediments form mesas in the Barrabas and Rochford Scrubs. Several smaller mesas occur in the southwest of the area. The mesas are up to 80 feet above the granite country and are bounded by cliffs. They rise about 60 feet above the surrounding or nearby low mesas. They are remnants of the early Tertiary land surface which is better preserved in the southeastern part of the Charters Towers 1:250,000 Sheet area.

Low Mesas

Heavily vegetated low mesas with poorly defined gently-sloping boundary scarps 10 to 15 feet high are formed on the flat-lying sediments of the Sellheim Formation (Pleistocene).

Drainage

Most streams flow inland to the Burdekin River but the remaining streams in the northeast flow towards the coast, joining the Burdekin in its lower reaches. The watershed coincides in places with an uneven scarp about 400 feet high. The Burdekin is 300 to 500 yards wide and is incised 40 to 60 feet into the dissected plain. Its banks are steep and on the outside of major bends they are vertical. Except during summer floods the river flow is restricted, and the sandy river bed contains only a string of long narrow waterholes connected by a thin stream. Minor watercourses flow only for a brief period in the summer months.

CAMBRIAN - ORDOVICIAN

Regional mapping of the Townsville and Charters Towers 1:250,000 Sheet areas by joint Government geological parties (Wyatt et al. 1965 and 1969; Wyatt et al. 1967 and in press) resulted in the subdivision of rocks older than the Ravenswood Granodiorite Complex into three units: the Cape River Beds, the Charters Towers Metamorphics, and the Kirk River Beds. All of these rock units are unfossiliferous and their ages are not precisely known. During the present survey only a little additional work was done on these units, the principal aim of the survey being to study the Ravenswood Granodiorite Complex. A preliminary isotopic age of 510$\pm$ 100 m.y. (Upper Cambrian) has been obtained from the Mount Windsor Volcanics in the Bowen 1:250,000 Sheet area (A.W. Webb pers. comm.) and until further work is done it seems reasonable to regard all three units as Cambrian - Ordovician in age.

CAPE RIVER BEDS (Є - Oc)

The Cape River Beds, which are chiefly metasediments, have been described from the Charters Towers and Hughenden Sheet areas (Wyatt et al. 1967 and in press; Paine et al. 1965, and in prep.). Belts composed mainly of acid volcanics can be mapped separately in places and these were named Mount Windsor Volcanics by Wyatt et al. (op. cit.).

A small roof pendant of quartz-feldspar-muscovite-biotite schist, gneiss, and quartzite extends across the southern boundary of the Ravenswood Sheet area in the headwaters of One Mile Creek. Quartz reefs and pegmatites with large andalusite crystals occur in the roof pendant. It was expected that detailed mapping would reveal other small roof pendants, but none were found. However, J.G. Best (pers. comm.) observed a very small roof pendant of metamorphics in the Ravenswood Granodiorite Complex near the Titov Prospect.

Mount Windsor Volcanics (Є-Ow)

The Mount Windsor Volcanics were defined by Wyatt et al. (1967 and in press) as a unit within the Cape River Beds.

The volcanics form the northern part of the Robey Range in the east of the Sheet area, an intricately dissected range with many coincident summits. Access is poor, the structure is complex, and photo-interpretation is unreliable.

Southeast of Ravenswood the Mount Windsor Volcanics consist of rhyolite flows, and minor acid pyroclastics, intermediate volcanics, and sediments. The rhyolite is generally light brown, and though spherulitic in some localities, is generally too fine-grained to show any structure in hand specimen. Flow banding is not common. Rhyodacite, dacite, andesitic agglomerate and fine micaceous sediments are present also. Maclaren (1900) described greywacke, slaty shale, altered sandstone and micaceous sandstone in the neighbourhood of Tuckers and Fish Creeks. C.R. Dalgarno (pers. comm.) found tuffaceous siltstone and quartzite near the Britannia goldmine. The proportion of sediments in the unit is unknown; photo-interpretation suggests it is small.

Quartz-plagioclase-hornblende amphibolite and biotite-feldspar-quartz granofels are developed from the intermediate and acid volcanics adjacent to the contact with the Ravenswood Granodiorite Complex. However the muscovite-biotite-quartz-feldspar gneisses which occur along the contact south of Brookville are probably metasediments.

No stratigraphic succession has been recognised within the Mount Windsor Volcanics. Little information about the attitude and thickness of the sequence can be gained because of the intense jointing and faulting, and the massive nature of the volcanics. The most prominent fault and joint system trends northeast; near north-south is another common fault direction. Jointing in a northwest direction is less well developed. The Mount Windsor Volcanics probably formed a rigid block which fractured extensively during repeated periods of stress, associated with the intrusion of the various phases of the Ravenswood Granodiorite Complex.

Intermediate dykes are particularly common. Large quartz reefs also occur; the largest has been traced for about four miles from near the Federation mine to the Britannia mine.

KIRK RIVER BEDS (Є-Ok)

The Kirk River Beds, which were originally described in the Townsville Sheet area (Wyatt, et al. 1965 and 1969) extend south into the Ravenswood Sheet area between Blue Mountain and Danes Hut where they consist of micaceous shale, and lithic sandstone and siltstone. They are intruded by the Millaroo Granite; anthophyllite-cordierite-mica hornfels and quartz-mica hornfels are developed from the finer sediments near the contact. The sediments are similar to the few sediments observed within the Mount Windsor Volcanics.

MIDDLE ORDOVICIAN and
UPPER SILURIAN OR LOWER DEVONIAN

RAVENSWOOD GRANODIORITE COMPLEX

An early Palaeozoic granodiorite batholith is exposed over 2000 square miles around and mainly east of Charters Towers. It has been known for many years that in the north it is overlain nonconformably by upper Middle Devonian sediments. The batholith was named Ravenswood Granodiorite in reports on the regional geology of the Townsville and Charters Towers 1:250,000 Sheet areas (Wyatt et al. 1965; Wyatt et al. 1967). The type area was designated as that part of the Ravenswood Gold and Mineral field which lies within the quadrilateral Ravenswood - Mingela - Macrossan - junction of Elphinstone Creek and Burdekin River. This lies mainly within the Ravenswood 1-Mile Sheet area. The name was applied to the whole batholith, although it was realised that several different phases or sub-units were present. Wyatt and others considered that the separate bodies of granite and adamellite throughout the batholith belonged essentially to a common period of intrusion, together representing the youngest phase of the batholith. The individual plutons were not named, but were mapped together as one unit, and referred to informally as the 'late acid phase'.

Detailed mapping of the Ravenswood Sheet area now indicates that the Ravenswood Granodiorite contains several other discrete intrusions, or sub-units, and so the name is amended to Ravenswood Granodiorite Complex. Besides being more realistic, the term 'complex' paves the way for naming of the individual sub-units of the batholith. The major part of the complex is referred to informally as the 'main granodiorite phase' (O-Dr). This forms about 60 percent of the complex in the Ravenswood 1-mile Sheet area. Wherever contacts have been seen the main granodiorite phase appears to be intruded by the other sub-units, which are now known to form discrete and petrographically distinctive masses. The 'late acid phase' rocks in the Ravenswood Sheet area are divided into the Mosgardies Adamellite (O-Dm), Millaroo Granite (P-Di), Kirklea Granite (O-Dk), and several unnamed masses (O-Da). These rocks show a trend towards alkali and silica enrichment, suggesting that they are differentiation products. In addition, a separate granodiorite sub-unit, the Glenell Granodiorite, has been distinguished. As distinct from the subdivisions of the complex itself, 3 other igneous rock units have been recognised within the type area of the former Ravenswood Granodiorite, and are separate from what is now called the Ravenswood Granodiorite Complex. These are the Upper Silurian or Lower Devonian Barrabas Adamellite, and the late Palaeozoic Tuckers and Boori Igneous Complexes. The revision is summarized here:

(1) <u>Upper Carboniferous or Lower Permian</u>
 - Tuckers Igneous Complex
 - Boori Igneous Complex

(2) <u>Upper Silurian or Lower Devonian</u>
 - Barrabas Adamellite

(3) <u>Middle Ordovician and Upper Silurian or Lower Devonian</u>
 - Ravenswood Granodiorite Complex
   - Granite (unnamed)
   - Kirklea Granite
   - Millaroo Granite
   - Mosgardies Adamellite
   - Adamellite (unnamed)
   - Glenell Granodiorite
   - Diorite and gabbro (unnamed)
   - Main granodiorite phase (unnamed)

Rubidium/strontium whole-rock isotopic dating of specimens from the batholith (Appendix) has provided two well-defined isochrons, 454 ± 30 m.y. (Middle Ordovician) and 394 ± 30 m.y. (Upper Silurian or Lower Devonian) (Webb, 1969; Wyatt et al. in press). Specimens from the Glenell Granodiorite, Mosgardies Adamellite, Millaroo Granite, and Kirklea Granite lie on the 454 m.y. isochron. Although field relationships suggest the main granodiorite phase as a whole is older than any of the other sub-units, specimens collected from it lie on both older and younger isochrons. In the Ravenswood Sheet area tonalites of the main granodiorite phase at Ravenswood and Sandy Creek give the younger age, and it seems that there must be an Upper Silurian/Lower Devonian tonalite intrusion (or intrusions) in that area which escaped recognition in the field. It is felt that rocks of the younger age ideally should be removed from the complex and given separate status, and that the concept 'Ravenswood Granodiorite Complex' should refer to rocks of Middle Ordovician age only. But it will only be possible to do this when all the younger intrusions are mapped. The Barrabas Adamellite is an example of one of these younger intrusions which can be mapped separately from the Ravenswood Granodiorite Complex.

Although the actual contact was not sighted in the field, in the author's opinion the field evidence north of Ravenswood indicates that the Millaroo Granite intrudes the main granodiorite phase. However, as mentioned above, tonalites at Ravenswood and Sandy Creek lie on the 394 m.y. isochron, and would therefore appear to be much younger than the Millaroo Granite, a specimen of which was one of those that defined the 454 m.y. isochron. Until further work is done it seems that the field relationships in this critical area must remain 'unproven'. So also must the origin of the Ravenswood gold mineralization which would have been tentatively ascribed by the author to the Millaroo Granite were the isotopic dates not in conflict with this view.

Gently dipping lower contacts are a feature of several subunits of the Ravenswood Granodiorite Complex.

Modal analyses of specimens collected from the different sub-units of the complex are represented in Table 2.

Main Granodiorite Phase (unnamed) (O-Dr)

The main granodiorite phase consists of several or many sub-phases in the granodiorite-tonalite range. The sub-phases have an overall similarity to each other and could only be mapped by very detailed work. Most contacts are probably gradational, because when seen in exposures in the Burdekin River the various sub-phases have diffuse rather than sharp contacts. The various sub-phases differ in mineral proportions, texture, and grain size. Tonalites are largely restricted to the Ravenswood/Sandy Creek area, although isolated hand specimens were described as tonalite from areas farther afield.

The granodiorites (e.g. Specimen 17, Table 2) are medium-grained, hypidiomorphic, granular rocks composed of andesine, quartz, hornblende, biotite, and microperthite. The proportion of quartz varies from 20 to 40 percent, and the alkali feldspar content is generally about 10 percent. Colour index ranges from 10 to 30, and either biotite or hornblende may be the dominant ferromagnesian mineral. Biotite is commonly partly chloritized and the feldspars are frequently sericitized. In a few places the texture is weakly porphyritic but most of the granodiorites are even grained.

Tonalite is the dominant rock type in the northeast in the area bounded approximately by Totley, Ravenswood, Sandy Creek, Plumwoods Homestead and Kirkton Homestead. Fine and medium-grained tonalite crops out northeast and south of Ravenswood township, and forms the host rock of the auriferous reefs in the town area. The tonalite in the town area (Specimens 19 and 20, Table 2) is a medium-grained rock composed of andesine (50-60 percent), quartz (20-40 percent), hornblende (5-15 percent), biotite (5-15 percent), minor alkali feldspar, and accessory apatite and magnetite. Hornblende, pleochroic from green to pale brown, forms subophitic crystals up to 1 cm long. Biotite is flexed and partially chloritized. Some larger andesine crystals are zoned, but zoning is not prominent. Andesine is mildly sericitized.

TABLE 2

Modal Analyses (Vol. %) of specimens from the Ravenswood Granodiorite Complex and the Barrabas Adamellite

	Rock Unit		Pl	Kf	Qz	Hb	Bi	CP	OP	Ma	Name
1	Barrabas Adamellite		26	31	38	-	5	-	-	<1	Adamellite
2			41	26	38	-	5	-	-	<1	Adamellite
3			16	38	41	-	4	-	-	<1	Calc-alkali granite
4			11	41	44	-	4	-	-	<1	Calc-alkali granite
5	Ravenswood Granodiorite Complex	Millaroo Granite	14	32	50	-	4	-	-	<1	Calc-alkali granite
6			18	40	34	-	2	-	-	<1	Calc-alkali granite
7			20	35	45	-	<1	-	-	-	Calc-alkali granite
8		Kirklea Granite	7	52	38	-	3	-	-	<1	Calc-alkali granite
9			26	42	30	-	2	-	-	-	Calc-alkali granite
10		Mosgardies Adamellite	25	28	41	-	6	-	-	<1	Adamellite
11			28	27	41	-	3	-	-	<1	Adamellite
12			22	31	41	<1	6	-	-	<1	Adamellite
13		O-Dc	25	27	40	-	7	-	-	1	Adamellite
14		Glenell Granodiorite	50	10	25	6	9	-	-	<1	Granodiorite
15			48	16	28	4	4	-	-	<1	Granodiorite
16		O-Dd	68	-	-	20	4	2	3	3	Gabbro
17		Main granodiorite phase	35	6	35	15	8	-	-	1	Granodiorite
18			49	11	28	6	6	-	-	<1	Granodiorite
19			52	3	25	8	11	-	-	1	Tonalite
20			58	-	21	14	7	-	-	<1	Tonalite
21		O-Dr	40	3	37	11	9	-	-	4	Tonalite

Key to symbols: Pl: plagioclase; Kf: alkali feldspar;
Qz: quartz; Hb: Hornblende: Bi: biotite;
CP: clinopyroxene; OP: orthopyroxene;
Ma: magnetite (includes all opaque minerals)

Key to analyses (Table 2)

1. G.S.Q./R. 2792*; $2\frac{1}{4}$ miles S.W. of Kirkton homestead.
2. 64150059+; 2 miles S. of Kirkton homestead.
3. G.S.Q./R.2791; 2 miles S. of Kirkton homestead.
4. G.S.Q./R.2783; $1\frac{1}{2}$ miles W.S.W. of Richards Mill.
5. G.S.Q./R.2773; 15 chains N.W. of Mt Wright.
6. G.S.Q./R.2772; $1\frac{1}{2}$ miles S.S.E. of Mt Wright.
7. G.S.Q./R.2771; 30 chains N.N.E. of Elbow Mill.
8. G.S.Q./R. 2766; 10 chains N.W. of the Morning Star Mine.
9. G.S.Q./R. 2756; Eastern edge of Birthday Hills, 3 miles N.E. of Black Soil Mill.
10. G.S.Q./R.2765; 2 miles S.W. of Elbow Mill.
11. G.S.Q./R.2763; 50 chains N.N.E. of the Old Man Mine.
12. G.S.Q./R.2786; $2\frac{1}{4}$ miles E.S.E. of Barrabas Hut.
13. G.S.Q./R.2761; 2 miles W. of Rochford.
14. G.S.Q./R.2785; $1\frac{1}{2}$ miles S.S.W. of Kirk River homestead
15. G.S.Q./R.2762; 10 chains S.E. of Elbow Mill.
16. G.S.Q./R.2774; 15 chains S.W. of mill on Wellington Spring Creek.
17. G.S.Q./R.2789; 1 mile E.S.E. of the Kirkers Mine.
18. G.S.Q./R.2746; $1\frac{1}{2}$ miles S.W. of the Quarrien Mine.
19. G.S.Q./R.2758; Elphinstone Creek, 10 chains S.W. from junction with Suhrs Creek.
20. G.S.Q./R.2747; Elphinstone Creek, 30 chains S.W. from junction with Suhrs Creek.
21. G.S.Q./R.2745; 20 chains S.S.E. of the Big Ben Mine.

* Geological Survey of Queensland Rock Specimen Number.

\+ Bureau of Mineral Resources Rock Specimen Number.

Quartz occurs interstitially and is generally microfractured and displays pronounced shadow extinction. Away from the immediate town area the tonalites contain increasing proportions of alkali feldspar and appear to grade to granodiorite.

Structure and relationships

Primary foliation is not a pronounced feature of the granodiorites and tonalites. Most foliation observed is of a cataclastic type, caused by post-crystallization shearing. Primary foliation is generally weakly developed and observable over only small areas. However exposure of the main granodiorite phase is poor, and foliation may be more widespread than the denseness of foliation symbols on the geological map would suggest. Poorly developed compositional banding has been observed in places, for example one mile north of Keans Prospect, but it is apparently of only local significance.

The contact of the main granodiorite phase with the Mount Windsor Volcanics is transgressive and sharply defined. Much of the contact is faulted. The volcanics along the contact have been metamorphosed to the hornblende hornfels facies of Turner and Verhoogen (1960). The degree of metamorphism decreases rapidly away from the contact. Along the contact volcanics have been converted to biotite-quartz-feldspar granofels and amphibolite, but volcanic textures are generally apparent in the hornfelses 200 feet from the contact. In contrast Paine, Clarke, and Gregory (in prep.) describe a six mile wide zone of schist and gneiss developed from the volcanics south of Rangview homestead about 20 miles south-southeast of Ravenswood. They interpret the contact there as dipping very gently. South of Rangeview homestead, the complex has been intruded forcefully judging from the schistose and gneissic structure of the hornfelses. However in the Ravenswood area the relatively narrow zone of metamorphism and the absence of strong shearing suggest that the contact there is moderately steep. The complex is believed to extend east beneath the Mount Windsor Volcanics and the tonalite and granodiorite exposed in First Pocket seven miles southeast of Ravenswood are interpreted as a cupola of the complex.

No large roof pendants have been found in the Ravenswood area. In contrast, at Charters Towers (Wyatt et al. 1967, and in press) and in the Bowen 1:250,000 Sheet area (Paine et al. in prep.) large roof pendants occur. This suggests that the present level of erosion in the Ravenswood Sheet area is considerably below the original roof of the batholith.

Dykes, generally of intermediate composition, are abundant throughout the main granodiorite phase. They are probably mostly of early Palaeozoic age as none have been found to intrude the late Palaeozoic Boori and Tuckers Igneous Complexes. Granite dykes and large masses of quartz cut the main granodiorite phase near its contact with the Millaroo Granite north of Ravenswood.

Gabbro and Diorite (Unnamed) (O-Dd)

Several small masses of gabbro and diorite have been mapped within the Ravenswood Granodiorite Complex. The contacts of these masses are generally not exposed and the relationships of the diorite and gabbro masses to the main granodiorite phase (O-Dr) are in most cases unknown. Wyatt et al. (1967, and in press) described similar gabbro and diorite masses south of Charters Towers. They described banding and orbicular structures in the basic rocks but could not determine conclusively the relationship of the basic rocks to the surrounding granodiorite. Reid (1917) mapped several small gabbro masses in the vicinity of Charters Towers as later than the main granodiorite.

Gabbro and diorite also occur in the Tuckers and Boori Igneous Complexes, so the possibility that some of the diorites and gabbros (O-Dd) are of late Palaeozoic age cannot be entirely discounted. However it is more probable that they are basic differentiates of the Ravenswood Granodiorite Complex.

Bosworth area

The southeastern portion of Rochford Scrub partly obscures an intrusion of olivine gabbro. The gabbro ranges from fine to coarse-grained and is finely banded in places. Banding is both textural and compositional. The general composition of the gabbro is labradorite (60 percent), clinopyroxene (20 percent), olivine (10 percent), hornblende (5 percent), and opaque minerals (5 percent). Olivine occurs as discrete, slightly altered grains averaging 1 mm. in diameter. Hornblende crystallized late and forms large poikilitic crystals up to two centimetres long enclosing pyroxene and labradorite. The contact of the gabbro was not found in outcrop but the absence of alteration in the gabbro adjacent to the surrounding granodiorite suggests the gabbro intrudes the main granodiorite phase.

Northwest of Barrabas Scrub

Three separate masses of basic rocks northwest of Barrabas Scrub may represent roof pendants in granodiorite. The southernmost body is formed from weakly banded gabbro and is intruded by dykes of hornblende-biotite granodiorite very similar to the surrounding granodiorite. The easternmost mass is hornblende gabbro which is intruded by biotite adamellite dykes possibly related to the Barrabas Adamellite. The gabbro is here strongly chloritized and epidotized. The western mass comprises medium and coarse-grained gabbro. One specimen (Specimen 16, Table 2) is a hypersthene gabbro composed of labradorite, hypersthene, hornblende, clinopyroxene, and minor biotite. Magnetite is an abundant accessory. Pale green hornblende occurs both as large crystals enclosing plagioclase and pyroxene crystals and as thin rims around the pyroxene crystals.

One mile west of Ravenswood

A small mass of fine and medium-grained diorite and gabbro, west of Ravenswood, forms a low rise covered with thick black soil. The mass is poorly exposed and no contacts were found.

Southern side of Barrabas Scrub

A narrow elongate mass of fine and medium-grained gabbro south of Barrabas Scrub probably intrudes the main granodiorite phase (O-Dr). It appears to have a fine-grained chilled margin, and the surrounding hornblende-biotite granodiorite is strongly chloritized and epidotized adjacent to the gabbro. The gabbro, which is finely banded in places, is intruded by a few microgranite dykes. The mass has the same trend as the Boori Igneous Complex and it is possible that the gabbro is also a late Palaeozoic intrusion localized by the same structural features.

Elphinstone Creek

Spectacularly banded dioritic rocks form an outcrop too small to map separately, near the mill on Elphinstone Creek, 2 miles southwest of Kirkton homestead.

Southwest of the Sheet area

Two areas of gabbro southwest of Rishton Scrub give rise to a distinctive heavy black soil which masks any contacts. The gabbro appears to be similar tothat near Bosworth.

Glenell Granodiorite (O-Dg)

The name Glenell Granodiorite is given to a petrographically distinct intrusion which cuts the main granodiorite phase. The name is derived from Glenell South Holding in which the granodiorite crops out extensively.

The most prominent characteristic of the Glenell Granodiorite is the abundance of quartz phenocrysts, which give the medium-grained rock a superficially coarse appearance, particularly when weathered. The granodiorite is texturally and compositionally uniform.

Distribution and Topography

Within the Ravenswood Sheet area the Glenell Granodiorite crops out over 35 square miles northwest of Ravenswood. It extends northwards into the Townsville 1:250,000 Sheet area, but it was not recognized in the course of the 1:250,000 scale mapping.

Outcrops are sparse, and fresh outcrops are particularly rare. However the coarse sandy soil and the distinctive photo pattern produced by the rejuvenated dendritic drainage allow determination of the limits of the Glenell Granodiorite with reasonable accuracy.

Lithology

The Glenell Granodiorite is a massive, medium-grained, porphyritic, grey, hornblende-biotite granodiorite. A typical specimen (No. 14, Table 2) collected 1.5 miles north of the Titov Prospect is a medium-grained granodiorite composed of strongly zoned plagioclase (An40-20), quartz, microperthite, biotite, and hornblende. Quartz forms "pools" up to 1.5 cm diameter, generally consisting of one large corroded quartz crystal surrounded by much smaller quartz grains with varying optical orientations. The small grains show shadowy extinction and are frequently slightly crushed. Hornblende, up to 1.0 cm long, is little altered, in contrast to the biotite which is ragged and chloritized along edges. Sphene and magnetite are common accessories.

In the Elbow Mill area the granodiorite (specimen 15, Table 2) contains up to 16 percent microperthite, and is considerably more altered. Quartz grains are moderately microbrecciated and the chloritization of biotite is far more advanced. Sericite and epidote are common products of alteration of the plagioclase.

The Glenell Granodiorite reveals little textural and compositional variation. The large quartz grains are absent in some areas; hornblende is almost always less abundant than biotite, but the ratio of hornblende to biotite may vary considerably. In most areas the granodiorite has been strongly sericitized, and the biotite is almost always strongly chloritized. Xenoliths are not common in the Glenell Granodiorite except near its contact with the main granodiorite phase.

Relationships

Contacts with the main granodiorite phase are sharply defined suggesting that the main granodiorite phase was nearly or completely solid when the Glenell Granodiorite was emplaced. The Glenell Granodiorite is intruded by the Millaroo Granite and probably also by the Mosgardies Adamellite. The contact with the Mosgardies Adamellite is sheared and the intrusive relationship is inferred from the occurrence of granite dykes in the Glenell Granodiorite near the contact.

Numerous felsite and microdiorite dykes intrude the Glenell Granodiorite. The Glenell Granodiorite is believed to be a differentiate of the complex which is little younger than the main granodiorite phase.

Mineralization

A few auriferous quartz reefs occur in the Glenell Granodiorite adjacent to the Millaroo Granite, and gold mines at Grass Hut in the Townsville 1:250,000 Sheet area are situated in the main granodiorite phase next to the contact of the Glenell Granodiorite. A few disseminated specks of molybdenite were observed in the Glenell Granodiorite at the mill three miles east of Shaggers Swamp Mill, but the extent of this molybdenum mineralization is unknown.

Adamellite (Unnamed) (O-Dc)

White medium-grained biotite adamellite crops out over two square miles at the southeastern end of the Tuckers Range. This adamellite (specimen 13, Table 2) is unlike any other rock type of the Ravenswood Granodiorite Complex in the Ravenswood area. Quartz forms lobate crystals up to 5mm diameter which are deeply embayed by microperthite. Tabular oligoclase is also corroded by cloudy microperthite which occurs interstitially and as pools enclosing quartz, plagioclase and biotite. Biotite is slightly chloritized. The lobate quartz crystals are most characteristic of the adamellite.

The adamellite intrudes the main granodiorite phase; it is intruded by granite dykes related to the small stock of granite (O-Dn) four miles west-southwest of Rochford. The Tuckers Igneous Complex intrudes the adamellite. No mineralization is known to be associated with this adamellite.

Mosgardies Adamellite (O-Dm)

Mosgardies Adamellite is a new name given to an intrusion of adamellite and granite which crops out in the headwaters of Mosgardies Creek.

Distribution and Topography

The Mosgardies Adamellite forms an east-west trending body 6 miles long and up to 2 miles wide, with an area of 6 square miles, due west of Ravenswood. Sparsely timbered rocky hills with a few high pinnacles characterize the unit. Relief above the surrounding units ranges from 50 to 400 feet.

Lithology

The chief rock type is a pink, porphyritic biotite adamellite. The texture is generally medium-grained, but quartz phenocrysts range up to 1.5 cm in diameter. The adamellite (specimen 10, Table 2) consists of quartz, microperthite, oligoclase, biotite and accessory opaque minerals. The quartz phenocrysts are ovoid, and have been extensively fractured; they consist of aggregates of strained quartz grains of varying optical orientations. The quartz grains are much corroded and are intergrown with microperthite to form a crudely graphic texture. Oligoclase occurs as strongly zoned, extensively saussuritized laths up to 4 mm long. Albitic margins on the plagioclase crystals are common. Biotite has recrystallized and occurs as felted aggregates of fine flakes which have replaced larger biotite grains. These felted aggregates are the characteristic feature of the Mosgardies Adamellite.

Small fine-grained biotite-rich dioritic xenoliths are scattered throughout the rock and it appears that the adamellite has been contaminated by assimilation of dioritic and granodioritic rocks, probably derived from the main granodiorite phase. The recrystallization of the biotite in the Mosgardies Adamellite is possibly associated with shearing which accompanied intrusion.

The adamellite along its northern margin grades to granitic quartz porphyry which consists of ovoid quartz phenocrysts up to 2cm in diameter enclosed in a very fine intergrowth of quartz and alkali feldspar.

A specimen (Specimen 12, Table 2) collected where the right hand branch of Barrabas Creek crosses the southern boundary of the adamellite, is a foliated biotite adamellite. The foliation, defined by the concentration of biotite into small lenticular aggregates of fine flakes, evidently was impressed on the adamellite before it had completely crystallized, because the quartz grains are only moderately fractured and strained. The specimen (Specimen 12, Table 2) is composed of quartz, microperthite, andesine, biotite, minor hornblende, and accessory magnetite and apatite. The microperthite is moderately sericitized. Biotite occurs generally as unaltered flakes in small aggregates, and rarely as large ragged chloritized flakes. Hornblende is light green, unaltered, and forms small irregular grains.

Although quartz-porphyritic adamellite is the general rock type, much microgranite and porphyritic microgranite and some granophyre and granite have been observed in the northwest part of the Mosgardies Adamellite. Most microgranite occurs as dykes, but a small irregular mass of fine even-grained granite intrudes sheared adamellite porphyritic in quartz. The granite itself is not sheared.

<u>Structure and relationships</u>

The southern contact of the Mosgardies Adamellite with the main granodiorite phase is inferred to dip moderately northwards because its outcrop is strongly affected by changes in topography. The main granodiorite phase, for at least 200 feet from this contact, has been strongly sheared and recrystallized to fine-grained amphibolite.

The porphyritic adamellite near the contact is strongly foliated, but the absence of severe crystal fracturing suggests the foliation is the result of forceful intrusion of only partly crystallized adamellite. The adamellite contains numerous small mafic xenoliths, especially near its southern margin.

In contrast, the contact of the Mosgardies Adamellite with the Glenell Granodiorite is rather straight and is probably nearly vertical. The northern part of the Mosgardies Adamellite is sheared in several places, and two major shears marked by mylonite zones up to 300 feet wide have been mapped. Although cataclastic effects are usually detectable throughout the adamellite in the field, and are always visible microscopically, evidence of cataclasis and recrystallization increases towards the northern contact. Cataclastically foliated adamellite, in which the quartz phenocrysts are flattened augen surrounded by granulated fragments, grades in places to fine-grained recrystallized mylonitic material. This recrystallized material macroscopically resembles microgranite, and in thin section it is seen to consist of a fine-grained allotriomorphic aggregate of quartz, feldspar, and rare biotite. It is suggested that shearing occurred before complete cooling of the adamellite and that the remaining heat in the intrusion was sufficient to recrystallize the mylonitic material. The Glenell Granodiorite adjacent to the contact is weakly shear-foliated and is intruded by microgranite dykes. The Mosgardies Shear Zone (Figure 3) which extends from near Rochford to Ravenswood, was probably formed by shearing which accompanied the emplacement of the Mosgardies Adamellite. A similar shear zone, the Alex Hill Shear Zone, is described by Wyatt (1968) from the Townsville 1:250,000 Sheet area. Intense cataclasis is also evident throughout an intrusion of biotite granite within the Alex Hill Shear Zone about eight miles north of the Ravenswood Sheet area. Development of these shear zones appears to be related to the emplacement of the granitic rocks.

Mineralization

Minor auriferous mineralization at Poddskles Mine is associated with both shearing and microgranite dykes. A number of small prospect pits were found both in and adjacent to the Mosgardies Adamellite, but none contained any obvious mineralization.

Millaroo Granite (O-Di)

Previous regional mapping (Wyatt et al. op. cit.) delineated a large mass of leucocratic biotite granite in the southeastern part of the Townsville 1:250,000 Sheet area and the northeastern part of the Charters Towers 1:250,000 Sheet area (Ravenswood 1-mile Sheet area). The granite is named here the Millaroo Granite, the name being derived from Millaroo Holding in which it crops out extensively.

Distribution and Topography

The Millaroo Granite occupies 40 square miles of the Ravenswood Sheet area north of Ravenswood. It forms a sparsely vegetated range about 400 feet above the general level of the main granodiorite phase. The sparse vegetation permits mapping of faults, major joints, intermediate dykes, and outcrop limits from aerial photographs.

Lithology

Near Mount Wright the granite (Specimen 5, Table 2) is coarse-grained and contains fractured, slightly strained quartz phenocrysts of maximum diameter 1 cm. The groundmass consists of microperthite which occurs as large "pools" enclosing numerous rounded quartz grains, of average diameter 2mm, and laths of oligoclase. Composition is quartz (50 percent), microperthite (22 percent), oligoclase (14 percent), and partly chloritized biotite (4 percent). Sphene, as subhedral crystals up to 1.5 mm long, is an accessory. Biotite occurs both as large flakes up to 5mm diameter which are slightly chloritized at the edges, and as smaller flakes up to 1 mm diameter which are completely chloritized.

One and a half miles south-southeast of Mount Wright, the granite (Specimen 6, Table 2) is a leucocratic medium-grained, hypidiomorphic-granular calc-alkali granite composed of quartz, microperthite, andesine, and minor biotite. Quartz occurs as slightly lobate grains; biotite is partly chloritized. North of Ravenswood very similar medium and coarse-grained leucocratic biotite granite is the dominant rock type. In places the granite grades to biotite adamellite, granophyre (e.g. Specimen 7, Table 2) and quartz-porphyritic microgranite. Quartz phenocrysts are commonly bipyramidal, but are mostly rounded or corroded. The groundmass is a micrographic intergrowth of quartz and alkali feldspar.

The Millaroo Granite is intruded by abundant acid (felsite) and intermediate dykes. Numerous graphic granite and microgranite dykes intrude the main granodiorite phase adjacent to the Millaroo Granite. Also, many thin leucratic granite dykes and veins intrude the main granodiorite phase in the Ravenswood town area, and a granite pegmatite dyke occurs beside the emergency landing strip. The proximity of these dykes to the Millaroo Granite suggests that they are possibly related to it. This idea however, conflicts with the isotopic dating results which indicate that the tonalite host rock (O-Dr) of the dykes is younger than the Millaroo Granite. Their origin therefore must remain problematical. For the same reason a small mass of medium-grained biotite granite which intrudes tonalite (O-Dr) beside Nolan Creek 2 miles southeast of Ravenswood is mapped as unnamed granite (O-Da), rather than as Millaroo Granite, which it closely resembles.

A low hill, half a mile south of the centre of Ravenswood township, is capped by a fine-grained even-textured rock macroscopically resembling quartzite. However it contains small amounts of white mica, feldspar, and a few specks of opaque minerals and is thought to be a silicified aplite. Similar silicified aplites and microgranite dykes occur near Bottom Windsor Mill in the northwest of the Ravenswood Sheet area. Maclaren's (1900) description of a specimen from the nearby Buck Reef closely resembles this silicified aplite, but his description seems puzzling because no rock such as he describes has been found by later mining of the Buck Reef. It is possible that he mistakenly described this silicified aplite as part of the Buck Reef.

Structure and relationships

The Millaroo Granite intrudes the Kirk River Beds, the Mount Windsor Volcanics, the main granodiorite phase, and the Glenell Granodiorite. The outcrop of the southwestern contact of the granite is strongly controlled by topography, and it is inferred that the contact here dips gently northeastward. This relationship is readily apparent near Elbow Mill where two 40 ft-thick sheets of medium-grained graphic granite, intruding the Glenell Granodiorite adjacent to the contact, also dip gently northeast beneath the Millaroo Granite. The base of the granite dips at the same angle as the sheets. The contact north of Ravenswood between the Millaroo Granite and the main granodiorite phase appears to dip gently southwards. The contacts of the Millaroo Granite are generally not sheared.

Both north and northwest faults are common in the Millaroo Granite.

Mineralization

Before the age-determination results were received, it seemed logical to suppose that the gold mineralization at Ravenswood was related to the Millaroo Granite. The contact of the Millaroo Granite appears to dip southwards, and it seemed reasonable to regard it as underlying the tonalite (O-Dr) of the town area at depth. It was also tempting to relate the leucogranite dykes and the large quartz masses, which intrude the tonalite, to the Millaroo Granite. However it now appears that the Ravenswood and Sandy Creek tonalites are very much younger than the Millaroo Granite, and therefore on the basis of isotopic dating the Millaroo Granite cannot be the source of the gold, nor can it be related to the dykes.

Kirklea Granite (O-Dk)

The granite which forms the Birthday Hills and the larger unnamed range immediately to the east was mapped by Wyatt et al. (1967) as part of the late acid phase of the Ravenswood batholith. In this report the granite, which forms a well defined intrusion into the main granodiorite phase, is named the Kirklea Granite.

Distribution and Topography

The Kirklea Granite forms two low ranges which rise about 300 feet above Pandanus Creek and the Kirk River. The sparse vegetation and absence of appreciable soil enable the Kirklea Granite to be readily distinguished on aerial photographs from the surrounding granodiorite.

Lithology

The Kirklea Granite is a uniform medium to coarse-grained leucocratic biotite granite. Fine-grained aplitic granite occurs near the margins in a few places. The granite (Specimen 8, Table 2) is an allotriomorphic granular rock composed mainly of microperthite (52 percent) and slightly strained quartz (38 percent). Oligoclase (7 percent) forms small laths extensively replaced by microperthite. Biotite, as small 1 mm diameter aggregates of fine flakes, forms about three percent of the granite. Magnetite is present in accessory amounts. In most areas the biotite is severely chloritized, and only near the Morning Star mine was the granite found to contain unaltered biotite.

Structure

The present topography strongly influences the limits of the Kirklea Granite. The contact, which is sharply defined, is deeply embayed where streams have eroded through the granite to the underlying granodiorite, and in some areas it is interpreted as dipping gently inwards. Immediately adjacent to the contact the surrounding hornblende-biotite granodiorite has been recrystallized to fine-grained amphibolite which is abundant on the dumps of the Morning Star mine. The granodiorite 50 feet or more from the contact is little altered apart from chloritization and epidotization.

A strong north-northwest trending fault system cuts both the granite and the surrounding hornblende-biotite granodiorite. Faults are marked by wide zones of brecciation and silicification. The siliceous reefs are generally auriferous and some individual reefs have been mined both in the Kirklea Granite and in the granodiorite. No dykes, other than aplite and microgranite, were found to intrude the Kirklea Granite.

Mineralization

The auriferous mineralization at Kirk is probably related to the Kirklea Granite. The mines occur both in the granite and adjacent to its contact. The mineralization is concentrated near the intersection of a system of north-south faults and the southern contact of the granite.

Granite (unnamed)(O-Da)

Several small granitic masses, most of which are probably related to the period of intrusion of the Kirklea and Millaroo Granites, occur in the Ravenswood Granodiorite Complex.

Four miles west of Rochford

In this area a stock of coarse red leucocratic alkali granite intrudes the main granodiorite phase. Three smaller intrusions and numerous dykes of red granite are associated with the intrusion. Some granite dykes intrude the unnamed adamellite (O-Dc) at the southeastern end of the Tuckers Range.

Northwest corner of the Sheet area

Here a small mass of coarse-grained biotite granite, very similar to the Kirklea Granite, intrudes the main granodiorite phase. Minor copper mineralization occurs close to the contact in the Townsville 1:250,000 Sheet area.

Four miles to the east, a small intrusion of medium-grained biotite granite is associated with several large northwest trending aplitic microgranite dykes. The microgranite dykes resemble large quartz reefs; almost all feldspar has been leached from them.

Kirk River homestead area

Three small masses of granite intrude the Glenell Granodiorite and the main granodiorite phase just west of Kirk River homestead. The biotite granite is leucocratic, and ranges from fine to coarse-grained.

Robey Range

Part of an extensive mass of biotite granite and adamellite extends into the southeast corner of the area, where it forms part of the Robey Range. It is considered by Wyatt et al. (1967 and in prep.) and Paine et al. (in prep.) to be a late granite phase of the Ravenswood Granodiorite Complex. It intrudes the Mount Windsor Volcanics and appears to be nonconformably overlain by probable Upper Carboniferous volcanics. A swarm of rhyolite dykes associated with the volcanics intrudes the granite.

Three small intrusions in the Mount Windsor Volcanics can be distinguished on aerial photographs eight miles southeast of Ravenswood, but they were not inspected in the field. The two westernmost masses form pockets, which is typical of granodioritic rocks in the Ravenswood area. The eastern mass is a small stock which gives high rugged topography typical of granite or adamellite. The ages of these three intrusions are unknown.

Age of Ravenswood Granodiorite Complex

The isotopic age-determinations of 17 specimens collected from the Ravenswood Granodiorite Complex and the Barrabas Adamellite are set out in the Appendix. Nine of these specimens were collected from the Ravenswood 1-mile Sheet area. The determinations were carried out by A.W. Webb (B.M.R.) at the Department of Geophysics and Geochemistry, Australian National University (Webb, 1969). Webb found that Rb/Sr whole-rock dating of specimens 44, 46, 48, 49, and 50 from the Townsville Sheet area, and specimens 19, 20, 24, 26 and 28 from the Charters Towers Sheet area gave an isochron of 454 $\pm$ 30 m.y. (Middle Ordovician). Specimen 47 from the Townsville Sheet area, and specimens 16, 22, 23, and 27 from the Charters Towers Sheet area gave an isochron of 394 $\pm$ 30 m.y. (near the Silurian/Devonian boundary). Webb states that the "isochrons have significantly different initial $^{87}Sr/^{86}Sr$ ratios of 0.7074 $\pm$ 0.0007 and 0.7053 $\pm$ 0.0006 respectively".

The Ravenswood Granodiorite Complex is nonconformably overlain by the Givetian Fanning River Group in the Townsville Sheet area. Isotopic ages of 454 m.y. have been obtained from all of the major subunits of the complex represented in the Ravenswood 1-mile Sheet area, and there is little doubt that most of the complex is of that age. Of the 3 specimens collected from the main granodiorite phase, one lies on the older isochron and 2 on the younger, despite the fact that, as a whole, on the basis of field relationships the main granodiorite phase is the oldest subunit of the complex. The two younger dates were obtained from tonalites in the Ravenswood town area and at Sandy Creek, which are the host for the gold mineralization.

Included in the younger isochron listed in the Appendix are specimens 4 and 6 which were collected from isolated granite masses in the west of the Charters Towers Sheet area. Although mapped as late granite phases of the then Ravenswood Granodiorite by Wyatt et al. (1967) they may, on the other hand, be related magmatically to the nearby Lolworth Igneous Complex, which has yielded about the same isotopic age (400 m.y.) (Wyatt, et al. 1967 and in prep.).

Specimen 47 is from a coarsely porphyritic diorite whose relationship to the other subunits of the complex is unknown.

UPPER SILURIAN OR LOWER DEVONIAN

BARRABAS ADAMELLITE (S-Db)

A discrete intrusion of adamellite grading to granodiorite and granite, here named the Barrabas Adamellite, is centred 7 miles southwest of Ravenswood.

Distribution and Topography

The Barrabas Adamellite forms 20 square miles of sparsely vegetated sandy country between Connolly Creek and Barrabas Scrub. Maximum relief is about 350 feet. Generally the adamellite is deeply weathered, and fresh rock is found only in a few scattered tors.

Its photo pattern on 1:25,000 photographs is distinctive and the boundary can be defined accurately in all areas except in the northwest, where it is obscured by superficial sand.

Lithology

Medium to coarse-grained biotite adamellite and calc-alkali granite are the chief rock types. The adamellite grades in places into granodiorite. Small masses of leucoadamellite and microgranite, which intrude adamellite, granite, and granodiorite near the eastern end of the intrusion, are also probably part of the Barrabas Adamellite.

Adamellite is the most common rock type. A specimen (Specimen 1, Table 2) collected between Elphinstone Creek and Barrabas Creek is a medium to coarse-grained hypidiomorphic-granular rock in which both quartz and feldspars are severely microfractured. Microperthite (31 percent) and oligoclase (26 percent) are moderately sericitized. Biotite (5 percent) occurs as slightly chloritized interstitial flakes. The adamellite in places grades to granodiorite and calc-alkali granite.

A specimen (Specimen 2, Table 2) collected $1\frac{3}{4}$ miles south of Kirkton homestead is typical of those rocks which approach or attain granodiorite in composition. The rock is porphyritic, the phenocrysts consisting of oligoclase and microperthite which range up to 3mm long, set in a groundmass with an average size of 0.4 mm. Quartz (28 percent) is poikilitic to interstitial and is moderately to severely strained. Oligoclase (41 percent) forms tabular slightly sericitized crystals showing oscillatory zoning. Microperthite (26 percent) is sub-tabular to anhedral. Biotite (5 percent) forms anhedral interstitial flakes that are pleochroic from pale straw to dark brown. Apatite and anhedral iron oxide are accessories.

Calc-alkali granite (Specimen 4, Table 2) occurs only in the southwestern part of the intrusion.

Specimens of granodiorite and adamellite examined from the eastern part of the intrusion show weak to moderate post-crystallization shearing. Quartz, in particular, is often crushed and recrystallized and a cataclastic foliation is generally apparent in thin section.

A narrow elongate body of adamellite southwest of the main intrusion is so similar to the main intrusion that it is also mapped as Barrabas Adamellite. Associated with this medium-grained even textured, biotite adamellite, are large irregular masses of quartz, which are a characteristic feature of the Barrabas Adamellite.

Fine-grained biotite leucoadamellite (S-Dbg) intrudes the main part of the Barrabas Adamellite two miles south of Kirkton homestead. A specimen collected near the age-determination sample point is inequigranular, the grain sizes ranging between 0.2 mm and 2 mm. It contains anhedral oligoclase (30 percent), anhedral strained quartz (40 percent), anhedral microcline-perthite (30 percent), and very minor quantities of ferruginized flexed biotite and muscovite. Iron oxide is accessory. The leucoadamellite is associated with numerous micro-adamellite and microgranite dykes which intrude the main part of the Barrabas Adamellite. Fine-grained leucoadamellite and microgranite are also commonly found as marginal phases of the Barrabas Adamellite. Coarse pegmatitic granite is normally associated with them in minor amounts.

Some of the numerous irregular masses of quartz associated with the Barrabas Adamellite contain feldspar crystals but most consist only of milky quartz. They are particularly common in marginal parts of the intrusion and in the adjacent country rocks. The most prominent is the White Blow, just south of the western end of the Barrabas Scrub. This mass, 150 feet in diameter and 50 feet high, occurs in the Ravenswood Granodiorite Complex (O-Dr), and consists mainly of milky quartz, but small slices of coarse acid granite occur near its margins. Numerous dykes of leucoadamellite intrude the granodiorite (O-Dr) nearby. No mineralization has been observed in the quartz masses but quartz reefs or veins in the granodiorite surrounding the Barrabas Adamellite contain copper-molybdenum-gold mineralization.

Adamellite and microadamellite dykes, notable for their abundance and widespread distribution, are associated with the Barrabas Adamellite. Similar dykes intrude the Ravenswood Granodiorite Complex near the western end of Rochford Scrub (Figure 3). Many dykes are distinctly banded, the banding resulting from variation in grain size rather than composition. Few dykes contain any ferromagnesian minerals, but minor biotite is present in some.

Structure

Numerous northeast or east-northeast trending breccia zones occur in the eastern part of the intrusion. They consist of crushed granite, quartz, and chlorite, and are up to 15 inches wide. In many instances shearing has been intense enough to produce mylonites. Quartz-tourmaline pegmatite dykes or veins are associated with these breccias. The adamellite near the breccia zones contains crushed, strained, and recrystallized quartz grains, and microfractured feldspar grains. The northeasterly trend of both the breccias and the dominant jointing is the same as that of the Plumwoods Fault which downfaults the Mount Windsor Volcanics against the Ravenswood Granodiorite Complex about five miles east of the intrusion.

Specimens collected towards the western margin of the Barrabas Adamellite, where breccia zones are absent, are medium-grained biotite adamellites which show only slight strain. The abundance of adamellite dykes southwest and west of the area of outcrop suggests that the Barrabas Adamellite may underlie the Ravenswood Granodiorite Complex at shallow depth under much of this area.

Age and Relationships

The Barrabas Adamellite is a discrete intrusion with sharply defined contacts. It is remarkably free of dykes, other than leuco-adamellite, microgranite, and pegmatite dykes which are thought to be genetically related to the adamellite itself.

A Rb/Sr isotopic age of 394 m.y. was obtained from two specimens of the adamellite, and the age is therefore Upper Silurian or Lower Devonian (Appendix). Lithologically the Barrabas Adamellite resembles parts of the western half of the Lolworth Igneous Complex in the Hughenden Sheet area, which is the same age (Paine et al. 1965 and in prep.).

Mineralization

The molybdenum and copper mineralization in quartz veins at Keans Prospect is probably related to the Barrabas Adamellite, because thin adamellite veins occur commonly in the Ravenswood Granodiorite Complex on the footwall side of the mineralized quartz veins. Molybdenite and secondary copper mineralization occur in shears in the Barrabas Adamellite near Scoop Holes Mill. Molybdenite-bearing quartz veins occur in granodiorite two miles west of Plumwoods homestead, a mile distant from the outcrop of the Barrabas Adamellite. Minor chalcopyrite occurs in a dyke or irregular intrusion of pink leucoadamellite which intrudes granodiorite (O-Dr) half a mile east of the junction of Poddskles and Barrabas Creeks. This leucoadamellite is probably related to the Barrabas Adamellite.

Exposure is poor south and west of the outcrop area of the pluton, and little mineralization has been recorded in this area. However the possibility that the Barrabas Adamellite may extend at shallow depth as far west as Rochford Scrub suggests that this area should be thoroughly prospected.

UPPER CARBONIFEROUS

VOLCANICS (Cuv, Cur)

A long period of erosion followed the emplacement of the Ravenswood Granodiorite Complex and Barrabas Adamellite. In the Middle Devonian the granite terrain became a provenance for sedimentation in the Burdekin Basin 50 miles northwest of Ravenswood, and in the Drummond Basin to the south. During the Upper Carboniferous, continental volcanic activity was widespread in the Burdekin River region.

In the Charters Towers Ravenswood area volcanics (Cuv) were erupted from isolated centres and were laid down on the eroded surface of the Ravenswood Granodiorite Complex. Intrusive phases (Cur) are mapped in places. There is no stratigraphic control to fix the age of the volcanics accurately. Wyatt et al. (1967 and in press) and Paine et al. (in prep.) have assigned a tentative Upper Carboniferous age to similar outcrops of volcanics, chiefly by analogy with the Bulgonunna Volcanics of the Bowen 1:250,000 Sheet area (Malone et al. 1966).

Western End of Tuckers Range

The volcanics are most extensive at the western end of the Tuckers Range, where they comprise andesite, andesitic breccia, rhyolite, rhyolitic agglomerate and breccia. A small plug of andesitic breccia and minor intrusions of rhyolite and rhyolite breccia (Cur), have been mapped southwest of the Tuckers Range. Dykes of rhyolite intrusion-breccia cut the Ravenswood Granodiorite Complex (O-Dr) close to the volcanics, and the largest can be traced for over two miles. Rhyolite intrusion-breccia is particularly well exposed in the Burdekin River north of Rishton, where a central zone of breccia is flanked by flow banded rhyolite. The granodiorite marginal to the dyke is strongly brecciated.

The volcanics are intruded by the Tuckers Igneous Complex; the sharply defined contact is well exposed at Copper Pinnacle where a small granodiorite boss is flanked by biotite hornfels. The volcanics appear to be nearly horizontal, but reliable attitudes within the unit are rarely found. Similar volcanics, to the southwest beyond the sheet boundary are associated with the rhyolite intrusive of Cornishman Hill (Wyatt et al., 1967 and in press).

Minor copper mineralization is present along faults through the volcanics. Secondary copper minerals occur as staining and small veins in the shattered volcanics over widths up to 6 inches. Mineralization may be related to the Tuckers Igneous Complex.

Eastern side of Kirk Range

Several small intrusives (Cur) of breccia and rhyolite occur near the eastern and northeastern margins of the Kirk Range. The small mass one maile northwest of Shaggers Swamp Mill consists of hornfelsed intrusive andesite and rhyolite breccia. The metamorphism is caused by the white leucogranite (C-Pb_1) of the Boori Igneous Complex. Dykes of medium-grained leucogranite intrude the breccia. The breccia consists of fragments averaging 2 inches in diameter of medium-grained hornblende-biotite granodiorite and more rarely rhyolite, in an aphanitic rhyolite matrix.

In a larger mass of rhyolite breccia 1.5 miles south of the Titov prospect, the fragments are chiefly rhyolite, but some are granodiorite. Just southeast of this mass is an irregular dyke of rhyolite breccia. Both masses are intruded by the tonalite phase (C-Pb_2) of the Boori Igneous Complex, and biotite hornfels is developed next to the contact.

The Titov prospect is situated on a low ridge formed by a small quartz porphyry intrusion which may be related to the two nearby breccia intrusions. Phenocrysts of bipyramidal quartz, chloritized biotite, and feldspar are set in a fine sericitized feldspathic groundmass.

Mount Wright

Mount Wright, a 400 feet high concial hill, is composed of volcanic breccia, explosion breccia, and intrusive rhyolite. It may represent the eroded remnant of a volcanic vent. Mount Wright is surrounded by medium to coarse-grained biotite granite (Millaroo Granite). On Mount Wright itself this granite is strongly brecciated and mixed with rare smaller angular blocks of acid volcanics. Matrix is sparse and consists of crushed granite. The breccia has been strongly hydrothermally altered and weakly mineralized. Mineralization is largely pyritic, but minor gold and base metal sulphides are also present.

A ridge projecting from the western side of the mountain consists of steeply flow banded intrusive rhyolite. Numerous flow banded rhyolite dykes also cut the brecciated granite. No flows were found in the area around Mount Wright.

Only one other such mineralized breccia, Mount Leyshon, is known in the Burdekin River region. Mount Leyshon, 15 miles southeast of Charters Towers, is described by Wyatt et al. (1967 and in press) as a mineralized volcanic vent.

Blue Mountain

Wyatt et al. (1967 and in press) suggested that Blue Mountain and the ridge to the southeast are possibly formed from Upper Carboniferous volcanics. This area was not visited during the present investigation.

Southeast Part of Sheet Area

Rhyolite, rhyolite breccia, welded tuff, and dacitic and andesitic breccias in the southeast of the Sheet area are associated with an extensive swarm of rhyolite dykes. The volcanics dip steeply east and resemble the Upper Carboniferous Volcanics of the Bowen Sheet area (Paine et al. in prep.).

UPPER CARBONIFEROUS or LOWER PERMIAN

Regional mapping has shown that widespread epizonal igneous activity took place in the Burdekin River region in the Upper Carboniferous or Lower Permian (Wyatt, et al.,op cit; Paine, et al., op cit.). Most of the intrusions are stocks (C-Pg) from 2 to 10 miles in diameter, which consist of massive granodiorite, adamellite, or more rarely granite. Dykes are not abundant in the intrusions, and only very minor mineralization is known to be associated with any of the stocks. Isotopic age-determinations have shown that stocks which occur in the northwesterly belt which now forms the Paluma, Hervey, and Leichhardt Ranges were intruded at or about the boundary between the Carboniferous and Permian periods. The names Tuckers Igneous Complex and Boori Igneous Complex are given to 2 composite intrusions of this age which have been mapped in the northwest and centre of the Sheet area.

GRANITE (C-Pg)

Two stocks have been mapped in the east of the Sheet area. Wyatt, et al. (1967, and in press) described a small stock of red and brown porphyritic biotite leucogranite in the Robey Range 10 miles south-southeast of Ravenswood. Large flow-banded felsite dykes, which are commonly associated with late Palaeozoic granites in the Burdekin River region, cut the Mount Windsor Volcanics nearby.

A composite intrusion (also described by Wyatt et al. op. cit.) forms high rugged terrain in the northeast corner of the Sheet area. The intrusion consists of an earlier complex of granodiorite, micro-granite, and granite, and a younger stock of medium-grained biotite adamellite (C-Pg_1). Minor molybdenum mineralization occurs in quartz veins in the adamellite in the headwaters of Molybdenite Creek.

TUCKERS IGNEOUS COMPLEX (C-Pt)

The Tuckers Igneous Complex forms a striking topographic feature, the boulder-strewn Tuckers Range, which has a local relief of 800 to 900 feet. The more basic rocks at the margin of the complex weather readily and form black soil plains. One phase (C-Pt_3) forms a prominent steep ridge, locally known as Middle Ridge, along the north-western side of the range. Extensive soil-free slopes covered with boulders are common in the Tuckers and Kirk Ranges formed by the Tuckers and Boori Igneous Complexes. The slopes consist of large blocks most of which are in situ or close to their in situ position. Their development appears to be due to several factors - rapidity of differential erosion, homogeneity of the rocks, regular jointing, and the geological structure of the complexes.

TABLE 3

Analyses (Vol. %) of specimens from the Tuckers and Boori Igneous Complexes

	Formation		Pl	Kf	Qz	CP	OP	Hb	Bi	Ma	Ol	Ac	Name
1	Tuckers Igneous Complex	C-Pt_1	70	-	-	18	-	3	0.5	6.5	2	<1	Gabbro
2		C-Pt_1	71	-	6	2.5	0.5	7.5	10	1.5	-	<1	Diorite
3		C-Pt_1	63	7.5	5.5	11.5	-	4	7	1.5	-	<1	Mangerite
4		C-Pt_2	46	9	19	-	-	12	9.5	1.5	-	<1	Granodiorite
5		C-Pt_2	54	14	16.5	-	-	7	7.5	1	-	<1	Granodiorite
6		C-Pt_2	50	11.5	22	-	-	8.5	7	1	-	<1	Granodiorite
7		C-Pt_2	55	9.5	15	-	-	15	3.5	2	-	<1	Granodiorite
8		C-Pt_2 (m)	56	9	20.5	3	<1	1	9.5	1	-	<1	Granodiorite
9		C-Pt_2 (m)	64.5	2	15	8	<1	<1	8.5	2	-	<1	Tonalite
10		C-Pt_2 (m)	46	5	21	5.5	-	8	11.5	3	-	<1	Granodiorite
11		C-Pt_3	51.5	8	22	2.5	-	8	5.5	2.5	-	<1	Granodiorite
12		C-Pt_3	50	9.5	22	9	-	1	6.5	3	-	<1	Granodiorite
13		C-Pt_3	58	11	15.5	9.5	-	-	4	2	-	<1	Granodiorite
14		C-Pt_3	42.5	21	22	6	-	-	7.5	1	-	<1	Granodiorite
15		C-Pt_3	46.5	21	21	1	-	4	5	1.5	-	<1	Granodiorite
16		C-Pt_3	45	19.5	16.5	-	-	10.5	6.5	2	-	<1	Granodiorite
17		C-Pt_3	52.5	12	17.5	7.5	1.5	3.0	3.5	1.5	-	<1	Granodiorite
18	Boori Igneous Complex	C-Pb_1	14	43	43	-	-	-	<1	<1	-	<1	Granite
19		C-Pb_2	55	3.5	12.5	5.5	<1	9	11.5	3	-	<1	Tonalite
20		C-Pb_3	55.5	9.0	11.5	<1	-	15	6.5	2	-	<1	Granodiorite
21		C-Pb_3	53.5	19.5	11.5	<1	-	2.5	1.5	1.5	-	<1	Granodiorite
22		C-Pb_3	51	10	19.5	<1	-	11	6.5	2	-	<1	Granodiorite
23		C-Pb_3	46	18	18	-	-	7.5	8.0	2.5	-	<1	Granodiorite
24		C-Pb_3	43.5	17.5	25	-	-	5	7.5	1.5	-	<1	Granodiorite
25		C-Pb_3	40	26	17	2.5	<1	8	5.5	1	-	<1	Adamellite
26		C-Pb_3	37	33	22	-	-	3.5	3	1.5	-	<1	Adamellite

Key to Symbols: Pl: plagioclase; Kf: alkali feldspar; Qz: quartz; CP: clinopyroxene; OP: orthopyroxene: Hb: hornblende; Bi: biotite; Ma: magnetite (includes all opaque minerals); Ol: Olivine; Ac: accessory minerals.
(m): marginal variant.

Key to Analyses (Table 3)

1. Gabbro (G.S.Q./R.2776)*; $\frac{3}{8}$ mile N.N.W. of Black Soil Mill.
2. Diorite (G.S.Q./R.2777); $\frac{5}{8}$ mile S.E. of Black Soil Mill.
3. Mangerite (G.S.Q./R.2778); $1\frac{5}{8}$ miles E. of Copper Pinnacle.
4. Granodiorite (G.S.Q./R.2768); 2 miles S.E. of Tuckers peak
5. Granodiorite (G.S.Q./R.2800); $1\frac{1}{2}$ miles N.W. of Amity homestead.
6. Granodiroite (G.S.Q./R.2801); $\frac{7}{8}$ mile N. of Tuckers peak
7. Granodiorite (G.S.Q./R.2769); Copper Pinnacle.
8. Granodiorite (G.S.Q./R.2749); $1\frac{5}{8}$ miles W.S.W. of Black Soil Mill.
9. Tonalite (G.S.Q./R. 2770); $1\frac{1}{2}$ miles W.S.W. of Black Soil Mill.
10. Granodiorite (G.S.Q./R.2760); $\frac{3}{4}$ mile S.S.E. of Saltpan outstation.
11. Granodiorite (G.S.Q./R.2781); $\frac{3}{4}$ mile E. of Saltpan outstation.
12. Granodiorite (G.S.Q./R.2780); $\frac{7}{8}$ mile E. of Saltpan outstation.
13. Granodiorite (G.S.Q./R.2779); $1\frac{1}{8}$ miles S.E. of Top Windsor Mill.
14. Granodiorite (G.S.Q./R.2767); Crest of Middle Ridge, 1 mile W. of Black Soil Mill.
15. Granodiorite (G.S.Q./R.2712); Foot of Middle Ridge, 1 mile W. of Black Soil Mill.
16. Granodiorite (G.S.Q./R.2782); $\frac{3}{8}$ mile N.E. of Tuckers peak
17. Granodiorite (G.S.Q./R.2787); $1\frac{1}{2}$ miles W. of Amity homestead.
18. Granite (G.S.Q./R.2790); $\frac{3}{4}$ mile E.N.E. of Mt Kirk.
19. Tonalite (G.S.Q./R.2750); $1\frac{1}{2}$ miles E.S.E. of Waterloo Mine.
20. Granodiorite (G.S.Q./R.2795); 1 mile S.E. of Waterloo Mine.
21. Granodiorite (G.S.Q./R.2784); $\frac{1}{2}$ mile S.S.E. of junction of Oaky Creek and Kirk River.
22. Granodiorite (G.S.Q./R.2796); $\frac{3}{4}$ mile E.N.E. of Spring Creek Mill.
23. Granodiorite (G.S.Q./R.2797); 1 mile N.E. of Spring Creek Mill.
24. Granodiorite (G.S.Q./R.2798); $1\frac{1}{2}$ miles N.E. of Spring Creek Mill.
25. Adamellite (G.S.Q./R.2751); $\frac{5}{8}$ mile N.E. of junction of Oaky Creek and Kirk River.
26. Adamellite (G.S.Q./R.2799); $1\frac{3}{8}$ mile N.E. of Spring Creek Mill.

---

* Geological Survey of Queensland Rock Specimen Number.

The Tuckers Igneous Complex consists of three major subunits (C-Pt_{1-3}) and one minor subunit (C-Pt_4). The lithology, mode of occurrence, and relationships of the subunits are summarized in the table of rock units (Table 1). Modal analyses of rocks from the Tuckers and Boori Igneous Complexes are presented in Table 3.

Gabbro-Diorite Phase (C-Pt_1)

Coarse-grained gabbro, which gives rise to thick black soil, occurs at the northeastern end of the complex. Chilled fine-grained gabbro occurs along the northern margin. The gabbro (Specimen 1, Table 3) ranges from fine-grained to coarsely pegmatitic; in places it is vaguely banded. Near the margins of the intrusion labradorite laths are strongly flow-aligned. Olivine occurs as anhedral grains up to 2mm in diameter, partly altered to yellow bowlingite and rarely completely replaced by talc, magnetite, and calcite. Near the contact with the Ravenswood Granodiorite Complex the gabbro grades to a melanocratic diorite (Specimen 2, Table 3) in which biotite and hornblende are the chief mafic constituents. Clinopyroxene is largely replaced by hornblende. The gabbro and diorite differ from the rest of the rock types in the Tuckers Igneous Complex in the absence of alkali feldspar. They form a discrete phase with moderately well defined contacts with the granodiorite-tonalite phase (C-Pt_2), and do not appear to be simply marginal variants of that phase.

At the western end of the complex the gabbro-diorite phase consists of fine to medium-grained diorite and mangerite which contain appreciable alkali feldspar (e.g. Specimen 3, Table 3), and which may be marginal variants of the granodiorite-tonalite phase. The diorite and mangerite contain andesine (An45), clinopyroxene, microperthite, hornblende, quartz, magnetite, and accessory sphene and zircon. Hornblende has extensively replaced the pyroxene. These rocks resemble those of the granodiorite-tonalite phase, but they contain more pyroxene and less quartz, microperthite, and hornblende. Gradational rock types however have been observed, and comparison of specimen 10 (a marginal rock of the granodiorite-tonalite phase) with specimen 3 suggests that the contact between the granodiorite-tonalite phase and the gabbro-diorite phase at the southwestern end of the complex is probably gradational.

Diorite, granodiorite, and mangerite form the gabbro-diorite phase in the upper reaches of Spring Creek. The $C\text{-}Pt_1/C\text{-}Pt_2$ contact appears to be gradational in this area too.

Granodiorite-Tonalite Phase ($C\text{-}Pt_2$)

The typical rock type of this, the largest phase of the complex, is a light grey, even textured, medium-grained biotite-hornblende granodiorite. Modal analyses of four normal granodiorite specimens and three specimens of granodiorite and tonalite collected near the margin of the phase are presented in Table 3.

All specimens except one examined in thin section are granodiorite and contain andesine, quartz, hornblende, microperthite, biotite, magnetite, and rarely remnant clinopyroxene. Quartz occurs interstitially as unstrained, somewhat lobate grains associated with microperthite. Pale green hornblende forms ragged fibrous laths, but also occurs as poikilitic crystals enclosing plagioclase and biotite. Generally the ferromagnesian minerals occur as clusters of poorly-shaped crystals associated with opaque minerals.

Fine-grained xenoliths are common in marginal parts of the intrusion. They are generally ovoid and average four inches in diameter. The only xenolith sectioned is a flow lineated porphyritic diorite in which alkali feldspar forms large poikiloblasts. The xenoliths are possibly derived from incorporation of fragments of an earlier phase of the complex, but their concentration in the granodiorite next to the Ravenswood Granodiorite Complex suggests that they were derived from that complex.

Reference to Table 3 reveals only minor compositional variation throughout the granodiorite-tonalite phase. At the margin of the intrusion the granodiorite grades to tonalite which contains more pyroxene but less microperthite and hornblende. The marginal rocks, e.g. specimens 8 and 9, are composed of andesine/labradorite, quartz, biotite, clinopyroxene, microperthite, hornblende, magnetite, minor hypersthene, and accessory apatite, sphene, and zircon.

Two small discrete stocks, one at Copper Pinnacle, the other at Rochford, have been mapped with this phase of the complex. The stock at Copper Pinnacle is formed of medium-grained biotite-hornblende granodiorite (Specimen 7), in which pale green hornblende forms narrow ragged laths and is identical with the hornblende of the granodiorite-tonalite phase in the Tuckers Range. The Rochford stock ranges from a hornblende-biotite granodiorite to a melanocratic tonalite. It varies from fine to medium-grained, and from even-grained to porphyritic. The more melanocratic rocks occur along the southeastern side of the intrusion. Xenoliths are common, and in a few places, are densely packed. The stock has intruded the Ravenswood Granodiorite Complex and has truncated the numerous microdiorite dykes which intrude that complex. Veins and dykes of leucoadamellite intrude the country rock adjacent to the intrusion.

Granodiorite Phase ($C-Pt_3$)

The granodiorite phase occurs as a discrete intrusion which forms a Y-shaped curvilinear ridge known locally as Middle Ridge, on the northwestern side of the Tuckers Range. The northern arm of the intrusion dips vertically or very steeply to the northwest. The southern arm however dips at about 45° to the north, north-northwest and northeast.

Compositional variation is illustrated by the modal analyses (Table 3) of seven specimens from various points within the intrusion.

Fine-grained porphyritic granodiorite occurs at the base of the intrusion at its southwestern end. This grades upwards to a medium-grained even-textured granodiorite (specimen 12) containing andesine (An40), quartz, microperthite, clinopyroxene, biotite, magnetite, and minor hornblende. The clinopyroxene occurs as weakly pleochroic grains up to 3mm in diameter only slightly replaced by hornblende. Microperthite occurs mainly interstitially, but also forms rare anhedral twinned crystals. Specimen 22 collected near the top of the intrusion is a similar granodiorite but the clinopyroxene has been largely replaced by hornblende. The upper margin of the intrusion is formed by fine-grained porphyritic granodiorite.

The intrusion is only 60 feet thick 1 mile southeast of Top Windsor Mill. At this point the rock is a medium-grained granodiorite (specimen 13) containing andesine/labradorite, quartz, microperthite, clinopyroxene, and magnetite. The clinopyroxene is unaltered, and hornblende is absent.

At the northeastern end of Middle Ridge the intrusion (specimens 14 and 15) consists of granodiorite which grades in places to adamellite. The higher proportion of alkali feldspar is expressed in the development of interstitial micrographic intergrowths of quartz and alkali feldspar. In the lower half of the intrusion pyroxene is only slightly replaced by hornblende, whereas in the upper half pyroxene forms only rare remnants. This reflects the progressive differentiation of the intrusion from the base upwards.

The southern arm of the Y-shaped intrusion consists of granodiorite (Specimen 16 and 17). Specimen 16 is dark grey, medium-grained, and consists of andesine (An35), microperthite, quartz, clinopyroxene, biotite, hornblende, and magnetite. The hornblende is partly replaced by biotite.

Leucogranite Phase ($C\text{-}Pt_4$)

Minor intrusions of leucocratic granite and adamellite ($C\text{-}Pt_4$) intrude all other phases of the complex. These generally occur as dykes and veins, but a small boss of medium-grained graphic granite occurs one mile southeast of Top Windsor Mill. Two larger granite bosses occur south of Spring Creek. The eastern boss consists of cream biotite granite, and it intrudes sheared, epidotized and locally mylonitized hornblende-biotite granodiorite (O-Dr). The western mass consists of medium-grained white leucogranite. Numerous smaller outcrops of leucogranite have been found, generally close to the margins of the complex, but these are too small to be shown on the map.

Structure and relationships

The Tuckers Igneous Complex is a composite epizonal intrusion emplaced into volcanics (Cuv) which rest on the eroded surface of the Ravenswood Granodiorite Complex. It consists of four phases, which show a progressive increase in the abundance of alkali feldspar and quartz, presumably due to differentiation.

The Ravenswood Granodiorite Complex adjacent to the intrusion is generally highly fractured and chloritized. In places it is strongly sheared. Biotite-bearing hornfelses are developed from the volcanics along the contact at Copper Pinnacle.

Age

The complex intrudes probably Upper Carboniferous volcanics. A K/Ar biotite age of 280 m.y. (Carboniferous/Permian boundary) has been obtained from the Complex (Webb, 1969).

Mineralization

Very little mineralization is known to be associated with the Complex. However the minor copper mineralization which occurs along faults in the Upper Carboniferous volcanics is possibly related to the complex, and a gold mine of very minor importance, the Mountain Maid, is reported to be located high in the Tuckers Range. The eastern boss of biotite leucogranite south of Spring Creek contains rare disseminated pyrite and chalcopyrite.

BOORI IGNEOUS COMPLEX (C-Pb)

The Boori Igneous Complex covers about 10 square miles and forms the Kirk Range, a prominent topographic feature 10 miles west of Ravenswood. The summits of the range are about 500 to 800 feet higher than the country underlain by the Ravenswood Granodiorite Complex. The tonalite-diorite phase ($C\text{-}Pb_2$) is more deeply eroded than the main granodiorite-adamellite phase ($C\text{-}Pb_3$), which forms steep hills and boulder-covered slopes.

The Boori Igneous Complex is a new stratigraphic unit which takes its name from Boori Holding, in which it is largely situated. Three major phases have been mapped. Their lighology, mode of occurrence, and relationships are summarized in the table of rock units (Table 1).

Leucogranite ($C\text{-}Pb_1$)

White medium-grained leucogranite intrudes the Ravenswood Granodiorite Complex and a small mass of probably Upper Carboniferous volcanics (Cur) immediately east of the Kirk Range. The granite (Specimen 18, Table 3) is almost completely leucocratic, consisting of quartz, microperthite, andesine, and traces of partly chloritized biotite and opaque minerals. It is strongly jointed, the south-east jointing being most prominent. Along its western side the granite has been strongly sheared, mylonitized, and recrystallized by the intrusion of the tonalite-diorite phase ($C\text{-}Pb_2$). It is possible that the leucogranite phase ($C\text{-}Pb_1$) is a separate late Palaeozoic intrusion which is not magmatically related to the other phases.

Tonalite-Diorite Phase ($C\text{-}Pb_2$)

Tonnalite and diorite crop out in an irregular belt extending along much of the eastern side of the Kirk Range. The belt forms low country but includes a few hills higher than those developed on the Ravenswood Granodiorite Complex.

The tonalite is generally medium-grained and even-textured, but fine-grained and porphyritic rocks have been observed at the margins of the intrusion. Specimen 19, Table 3, consists of andesine/labradorite (An50), quartz, hornblende, clinopyroxene, biotite, microperthite, and minor hypersthene, magnetite, and apatite. The clinopyroxene is largely replaced by hornblende, and the hypersthene forms prismatic crystals up to 3 mm long. Microperthite occurs interstitially.

The tonalite and diorite intrude the Ravenswood Granodiorite Complex (O-Dr), the probably Upper Carboniferous intrusion breccia in the headwaters of Coppermine Creek, and the leucognite phase ($C-Pb_1$). It is intruded by the granodiorite-adamellite phase ($C-Pb_3$), and the contact between the two phases is sharply defined.

Granodiorite-Adamellite Phase ($C-Pb_3$)

All rocks of this phase fall within the granodiorite-adamellite range. They are generally medium-grained rocks of average grain size 2mm. Coarse-grained varieties are rare, but fine-grained and porphyritic varieties are common near the western margin of the intrusion. Biotite-hornblende granodiorite is the most common rock type; its composition is variable (see Table 3), but in all rocks the feldspars are andesine and microperthite. The hornblende is a pale green variety similar to the hornblende occurring in the Tuckers Igneous Complex. Microperthite occurs interstitially and in places forms poikilitic "pools". The proportion of microperthite is variable, and the granodiorite commonly grades to adamellite (Specimens 25 and 26).

Dykes

Thin dykes and veins of leucoadamellite are common in marginal parts of the complex, and in the country-rock adjacent to the contact. These dykes intrude all phases of the complex and closely resemble the younger phase of the Tuckers Igneous Complex.

Structure

The shape of the Boori Igneous Complex is controlled to some extent by the pre-existing fracture pattern of the Ravenswood Granodiorite Complex. The boundaries south of Mount Kirk parallel the dominant north-northwesterly joint system. The contacts of the complex appear to be very steep. The complex is strongly jointed, and the most prominent joints trend north-northwest.

Age

The complex intrudes intrusion breccias (Cur) of probable Upper Carboniferous age. The similarity to the Tuckers Igneous Complex suggests strongly that the two complexes are comagmatic and belong to the same period of intrusion. Both complexes post-date the shearing and dyke intrusion so commonly observed in the Ravenswood Granodiorite Complex. These deductions have been supported by the isotopic dating results: Webb (1969) has obtained a K/Ar biotite age of 280 m.y. from the complex, identical with that obtained from the Tuckers Igneous Complex.

Mineralization

It is not definitely known whether any mineralization is associated with the Boori Igneous Complex. The northern contact of the complex truncates the reef of the Waterloo Mine.

CAINOZOIC

Cainozoic lacustrine and fluviatile deposits of at least two ages are present in the Ravenswood Sheet area. It is not possible to assign definite ages to the Cainozoic units, but tentative ages are given in the following table:

Recent	Alluvium (Qa)
Pleistocene	Semi-consolidated alluvial and outwash deposits (Qg) Sellheim Formation (Qe)
pre-Miocene	Laterite (Tl) Unnamed sediments (Tu)

SEDIMENTS (Tu)

Erosional remnants of an extensive superficial sequence of early Tertiary sediments are common in the Charters Towers 1:250,000 Sheet area, and are described by Wyatt et al. (1967 and in press). In the Ravenswood area they crop out at Barrabas, Rochford, and Rishton Scrubs, and in the headwaters of Englishman Creek in the south-west of the area. The sediments have been deeply lateritized, and the ferruginous zone of the laterite is preserved in places (Tl).

Argillaceous sandstone and sandy siltstone about 80 feet thick occupy 1 square mile in Barrabas Scrub. They are capped by laterite, and form a thickly, vegetated steep-walled mesa rising about 60 feet above the general level of the surrounding Sellheim Formation. The lateritic profile consists of a thin, highly ferruginous zone which grades downwards to a thick mottled zone consisting of brecciated and slickensied sandy claystone and ferruginous sandstone. The brecciation has probably resulted from the swelling and drying of the clayey sediments, and from volume changes due to leaching.

The Tertiary sediments at Rochford Scrub cover 5 square miles, but here very little of the laterite cap is preserved. The coarse argillaceous sandstones are flat lying, locally cross-bedded, and about 100 feet thick. The surrounding Sellheim Formation has been partly derived by erosion of the early Tertiary sediments, and the boundary between the two units is only approximate.

Silicified fossil wood was found at the base of a small mesa of early Tertiary sediments near the deserted Bosworth homestead. The lateritic cap is preserved on Tertiary sediments south of the Burdekin River, and forms sharply defined mesas.

The sediments are of fluviatile or lacustrine origin. The lithology suggests that their provenance is local.

SELLHEIM FORMATION (Qe)

The Sellheim Formation was first described and formally named by Wyatt et al. (1965, and 1969) from the Townsville Sheet area, but is more extensive in the Charters Towers Sheet area (Wyatt et al. 1967, and in press). The type area, south of Sellheim railway station, is west of the Ravenswood 1-mile Sheet area, but the unit is well represented in the Sheet area.

The Sellheim Formation forms low, thickly vegetated plateaus bounded by breakaways and poorly defined scarps. Only remnants of the formation remain, but their distribution suggests that the formation may be an old high-level alluvial deposit of the Burdekin River. At times the depositional area may have been a lake, as a result of damming or partial damming of the river.

The scarp which forms the southwestern edge of Barrabas Scrub in the headwaters of White Blow Creek is about 12 feet high. Except for the upper 2 feet the scarp consists of deeply weathered granodiorite. This is overlain by about 2 feet of conglomeratic sandstone and coarse ferruginous sandstone, which thicken back from the scarp. This deep weathering profile is not always present beneath the Sellheim Formation, but its presence indicates a period of deep weathering prior to the deposition of the formation, and after the early Tertiary sediments had been considerably eroded. At the western end of Barrabas Scrub, pebbly argillaceous sandstone 6 feet thick overlies deeply weathered granodiorite. The sediments at Barrabas Scrub are horizontal, and are generally less than 10 feet thick.

In the southwest of Rochford Scrub the sediments are 25 feet thick. The lowermost 2 to 3 feet of sandstone, directly overlying granodiorite, has been completely silicified to form quartzite ('billy'). The quartzite is overlain by a thin, highly ferruginous sandstone horizon, above which occurs abundant silicified wood. The upper 20 feet consists of ferruginous argillaceous sandstone and quartz pebble conglomerate. The development of billy is particularly prominent in this area; it is very resistant to weathering, and pieces of it are widely strewn across the granodiorite surface in those areas which were formerly overlain by the Sellheim Formation.

Fossil wood from the sediments in Rishton Scrub has been identified as Pataloxylon sp. by R.G. McKellar (1964), but the identification does not indicate a more precise age than Cainozoic. Jack (1879) reported the discovery of fragments of Diprotodon australis from grits on the right bank of the Burdekin River below Rishton, and it seems reasonable to regard the grits as belonging to the Sellheim Formation. This species is believed to be confined to the Pleistocene (M.Plane, pers. comm.)

SEMI-CONSOLIDATED ALLUVIAL AND OUTWASH DEPOSITS (Qg)

Southeast of Ravenswood interfluvial remnants of a sequence of weakly consolidated gravel, sand, and silt border Connolly Creek. These sediments are outwash deposits from the Plumwoods Fault scarp. Similar outwash deposits occur along the steep southern margin of First Pocket.

Remnants of argillaceous sandstones occur along divides in the ranges formed by the Kirklea and Millaroo Granites and Barrabas Adamellite. The sandstone is probably a Pleistocene alluvial deposit. Subsequent erosion has been sufficient to cause inverted topography in places, so that some of the sandstone now crops out on divides. The sandstone is argillaceous, feldspathic, and only moderately lithified; it evidently had a very local provenance. Maximum thickness preserved is only 5 feet.

Both the sandstone and the outwash deposits are believed to be broadly the same age as the Sellheim Formation.

ALLUVIUM (Qa)

Most of the major watercourses are flanked by some deposits of alluvium, but the strips of alluvium are narrow and the deposits thin, owing to recent rejuvenation and entrenchment of the streams.

STRUCTURE (Fig. 3)

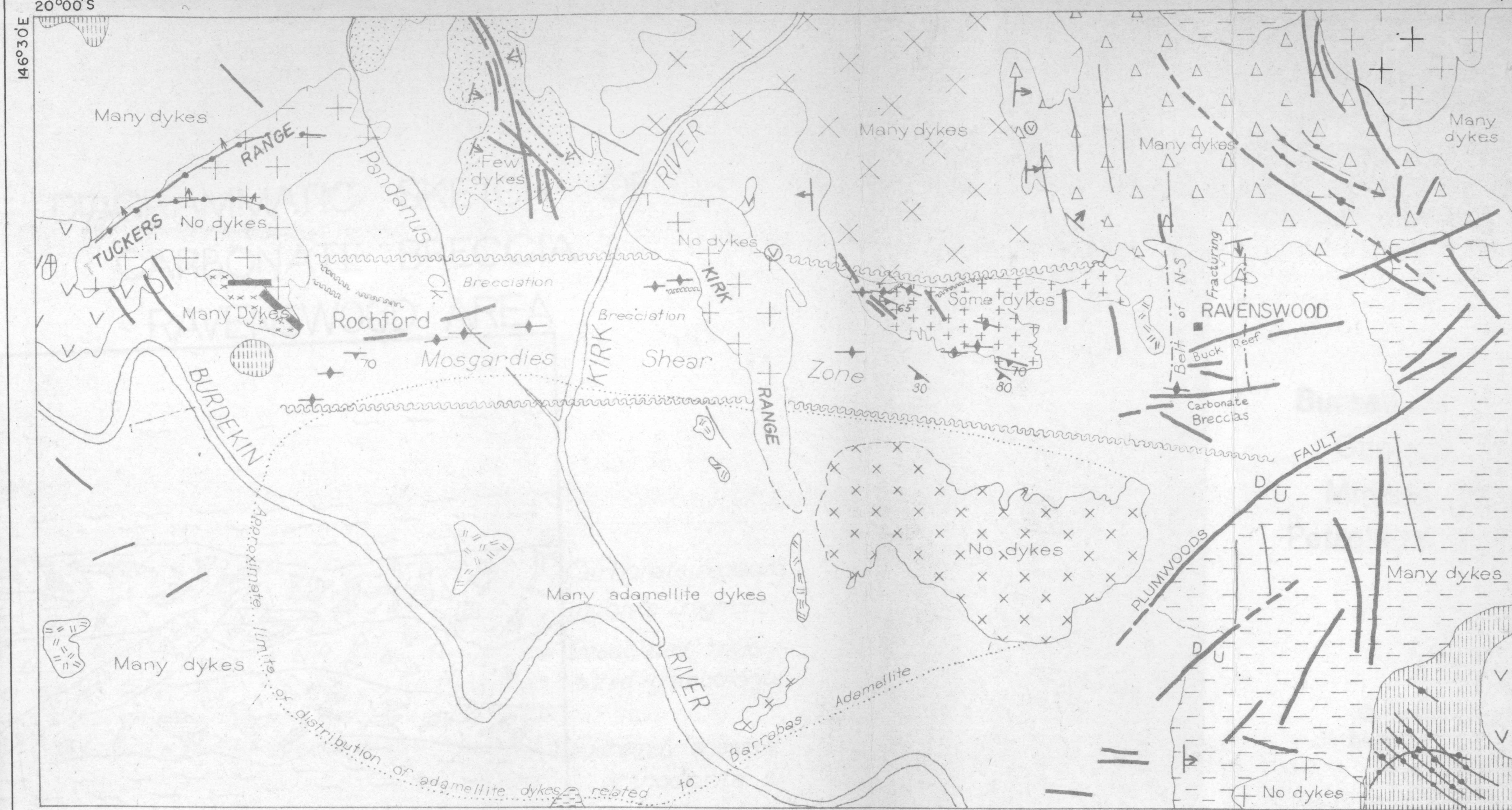
Primary Igneous Features

Primary foliation and mineral banding are not prominent in the rocks of the Ravenswood Granodiorite Complex. Primary foliation has been observed only in the main granodiorite phase (O-Dr); even there it is generally only weakly developed, and, where observed, appears to have only local significance. It is no more prominent in marginal parts of the batholith than elsewhere. Foliated and lineated tonalite (O-Dr) is exposed in Elphinstone Creek in the centre of Ravenswood. Most of the main granodiorite phase is poorly exposed, so that primary foliation may be more widespread than the limited exposures suggest.

Shearing

Foliation resulting from cataclasis is most prominent in the Mosgardies Adamellite, but is also common in the main granodiorite phase of the Ravenswood Granodiorite Complex. Most shearing is related to the Mosgardies Shear Zone (Figure 3), which extends east from near Rochford to near Ravenswood. The degree of shearing throughout the zone is highly variable, and may be expressed by intense mylonitization, or brecciation, or close jointing. Shearing is most intense along the northern margin of the Mosgardies Adamellite, where coarse-grained adamellite has been mylonitized and recrystallized to a variety of fine-grained rocks, which macroscopically resemble microgranite. Between Rochford and the Kirk Range the Ravenswood Granodiorite Complex is sheared, brecciated, epidotized and chloritized.

Numerous unusual carbonate breccias occur at the eastern end of the Mosgardies Shear Zone, and the larger breccias are shown as faults on the map. These breccias are found only in the main granodiorite phase of the Ravenswood Gransdiorite Complex and range in observed thickness from a few inches to 15 feet. One large breccia has been traced for 4 miles on aerial photographs as a low ridge. A typical breccia is sketched in plan in figure 4. The granodiorite on either side of the breccia passes inwards to mylonite, which commonly contains remnant quartz crystals and superficially resembles a felsite porphyritic in quartz. The banding of the weathered mylonite in some cases gives the mylonite the superficial appearance of a hornfelsed sedimentary rock. The mylonite towards the centre of the feature has been intensely brecciated, and abundant carbonate has been introduced. The central parts consist largely of reddish-brown, ferruginous carbonate, enclosing and replacing abandant fragments of mylonite. Bands of brecciated mylonite may occur between bands and lenses of carbonate breccia. In some outcrops veins and small lenses of white coarsely crystalline calcite transgress the breccia. The breccias are interpreted as shear zones in which the granodiorite was first mylonitized, and later brecciated in a different stress regime. Brecciation was accompanied by the introduction of abundant carbonate.



RAVENSWOOD 1:63,360 SHEET AREA

STRUCTURAL SKETCH MAP

2 0 2 4 6 MILES

2 0 2 4 6 KILOMETRES

Upper Carboniferous - Lower Permian
- Granite
- Volcanics

Upper Silurian - Lower Devonian
- Barrabas Adamellite

MIDDLE ORDOVICIAN & UPPER SILURIAN OR LOWER DEVONIAN — Ravenswood Granodiorite Complex
- Biotite granite (O-Da)
- Kirklea Granite
- Millaroo Granite
- Mosgardies Adamellite
- Biotite adamellite (O-Dc)
- Glenell Granodiorite
- Gabbro, diorite (O-Dd)
- Main granodiorite phase (O-Dr)

Cambrian - Ordovician
- Cape River Beds, Kirk River Beds

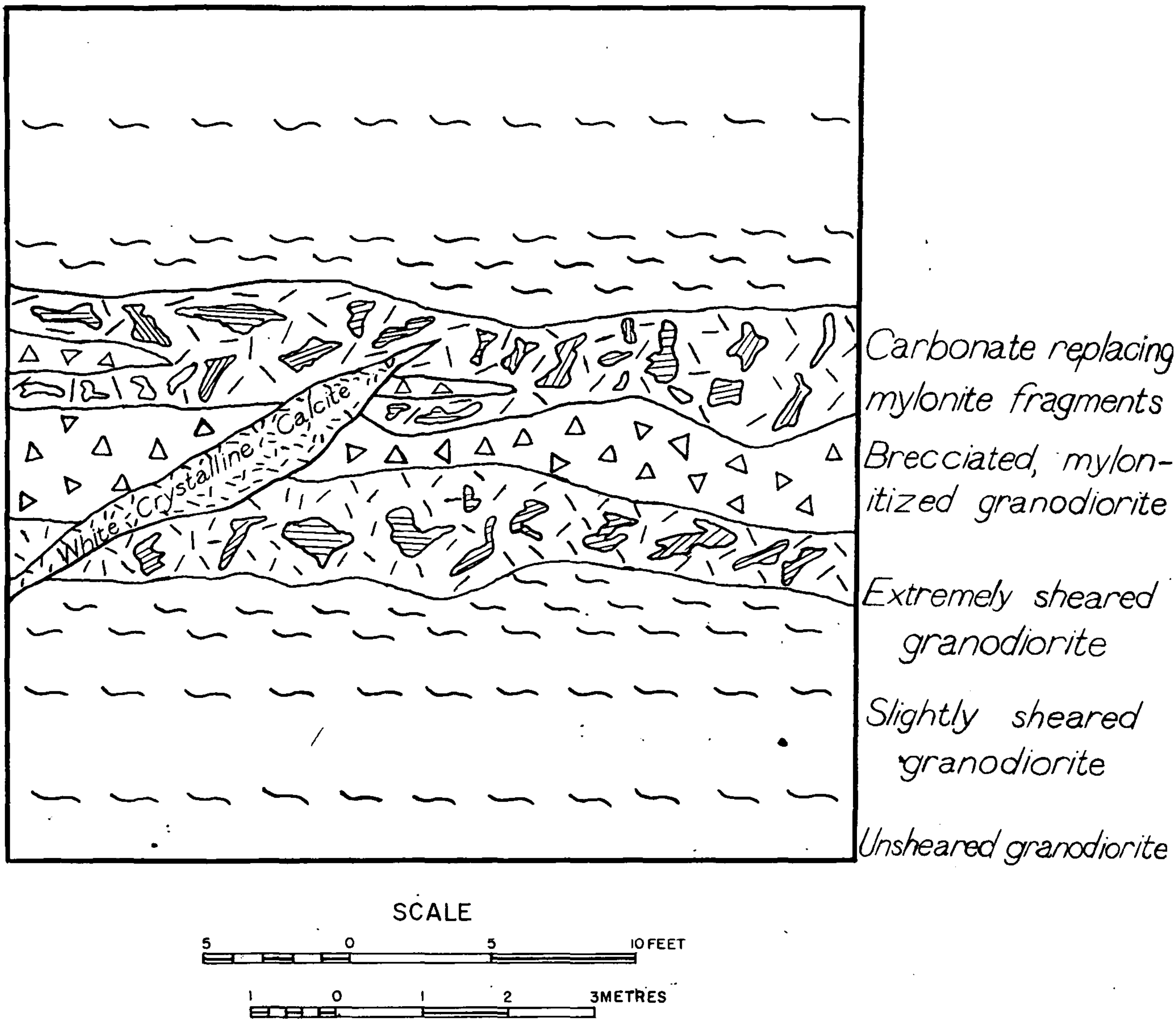
- Geological boundary
- Inferred attitude of granite contact
- Shear foliation, inclined
- Shear foliation, vertical
- Fault
- Lineament
- Boundary of zone of fracturing
- Major dyke swarm
- Sheet intrusion showing attitude
- Boundary of major shear zone
- Narrow zones of intense shearing

To accompany Record No 1969/117

Drawn by Geological Survey of Queensland

F55/A2/8

DIAGRAMMATIC SKETCH OF CARBONATE BRECCIA RAVENSWOOD AREA



Only the larger breccias are shown on the map, but the area south of Ravenswood, and the town area itself, are criss-crossed with innumerable carbonate breccias and calcite veins. The smaller breccias frequently displace one another, and can be traced for limited distances only.

Minor amounts of psilomelane have been exposed in a small costean along one of the breccias, 1.5 miles south-southeast of Ravenswood but no other mineralization has been noted. Best (1966) had specimens from the breccias analysed but results indicate that they contain no significant mineralization. It is not known whether or not the carbonate breccias have any connection with the gold mineralization at Ravenswood.

The development of the Mosgardies Shear Zone and the intrusion of the Mosgardies Adamellite appear to be related. The emplacement of the Mosgardies Adamellite was accompanied by intense shearing of the almost solid intrusion, with the resultant development of mylonitic rocks along the northern contact. The similar, but better developed Alex Hill Shear Zone, a few miles south of Mingela in the Townsville 1:250,000 Sheet area also trends nearly east-west. A sheared and mylonitized granite intrusion similar to the Mosgardies Adamellite occurs in the Alex Hill Shear Zone 2 miles south of Mingela. These shear zones are fundamental structures, formed at depth, late in the history of the emplacement of the Ravenswood Granodiorite Complex.

Faulting

Many faults in the Ravenswood Sheet area trend nearly north-south. Most auriferous reefs also trend between north-northwest and north-northeast. In the granitic terrain it is almost impossible to determine the nature and extent of faults. However, there is no evidence for large lateral movements, and most faults are probably normal faults of moderate displacement. These faults may postdate the Mosgardies Shear Zone, because north-trending reefs in the town area cut across the east-trending Buck Reef.

Southeast of Ravenswood, the Plumwoods Fault has downthrown Mount Windsor Volcanics against the Ravenswood Granodiorite Complex. This, and a similar fault to the south of Brookville, parallel a strong joint system in the Mount Windsor Volcanics.

The northwest faults in the northeast of the area are parallel to the dominant fault direction in the coastal areas about Townsville, and are associated with microdiorite dyke swarms.

General Features

On a regional scale it can be seen that the contacts of the Ravenswood Granodiorite Complex as a whole are gently dipping, and it is suggested that much of the batholith as exposed at present, particularly around Charters Towers, is not far beneath the original roof of the intrusion. The attitudes of the contacts between the various phases of the batholith are indicated in Fig. 3.

GEOLOGICAL HISTORY

An extensive sequence of sediments and volcanics, represented by the Cape River Beds and the Kirk River Beds, was deposited in the Burdekin River region in Cambrian/Lower Ordovician times. In the Middle Ordovician these formations were intruded and metamorphosed by a large late-synorogenic batholith, the Ravenswood Granodiorite Complex. In the Pentland district (Hughenden Sheet area), 100 miles west of Ravenswood, the complex is a synorogenic intrusion consisting of orthogneiss and foliated granodiorite, but in the Ravenswood area it is not prominently foliated. Associated metamorphism is not so severe as at Pentland, and emplacement may have occurred at a higher level. Emplacement of the greater part of the batholith ended with the intrusion of the Millaroo and Kirklea Granites and the Mosgardies Adamellite, all of which are late-stage differentiates of Middle Ordovician age, but the isotopic dating results indicate that other parts of the complex were intruded 60 m.y. later, at the same time as the Barrabas Adamellite. In the Upper Silurian or Lower Devonian the post-orogenic Barrabas Adamellite was intruded into the Ravenswood Granodiorite Complex.

These rocks were uplifted and eroded, and formed the source area for a sedimentary cycle which began in the Burdekin River region in the upper Middle Devonian and continued through to the Lower Carboniferous. These sediments are preserved in the Burdekin and Drummond Basins, to the north and south of the batholith respectively. After the Tournaisian, the region was uplifted, and the Devonian and Lower Carboniferous sediments were deformed. Upper Carboniferous acid to intermediate volcanics were erupted terrestrially throughout the region, and rest unconformably on the Devonian to Lower Carboniferous sediments and the granitic basement. Examples of these volcanics overlie the Ravenswood Granodiorite Complex in the Ravenswood Sheet area. In the Upper Carboniferous or Lower Permian, epizonal intrusions were emplaced into the Mount Windsor Volcanics, the Ravenswood Granodiorite Complex, and the Upper Carboniferous volcanics. Two of the intrusions, the Boori and Tuckers Igneous Complexes, have such close affinities with each other as to suggest that they are comagmatic.

The geological history from the Permian to the beginning of the Tertiary is not preserved in the Ravenswood Sheet area. It may have been a period of erosion, as the present exposure of the epizonal granitic rocks suggests 3,000 to 5,000 feet of erosion in post-Permian times. However the occurrence of a ?Triassic sandstone formation, the Collopy Formation, in the Townsville Sheet area 15 miles north of Ravenswood, shows that the Ravenswood district may have been a depositional area during at least the early part of the Mesozoic.

In the early Tertiary thin terrestrial sandstones (Tu) were deposited either before or concurrently with a period of widespread peneplanation. Climatic conditions produced a widespread laterite surface. The region was uplifted, and faulting caused blocks of the early Tertiary peneplain to be uplifted. Renewed erosion dissected the lateritized sediments, and produced outwash deposits along the Plumwoods Fault Scarp. The Robey Range in the east of the area is such a dissected uplifted peneplain. The Burdekin River probably originated on the early Tertiary laterite land surface. Since that time, downcutting has advanced to the stage at which the river is now several hundred feet beneath the top of the lateritized sandstones, and the river is superimposed upon a terrain of older rocks. The early Tertiary sediments were reduced gradually to isolated mesas. In the Pleistocene, the fluviatile and/or lacustrine Sellheim Formation was deposited in the valley of the Burdekin River. The formation was derived partly from the erosion of the early Tertiary sediments. In recent times drainage was rejuvenated, and renewed erosion has removed most of the Sellheim Formation.

ECONOMIC GEOLOGY

The Ravenswood 1-Mile Sheet area contains almost all the mines and mining centres within the Ravenswood Gold and Mineral Field, and also includes a small portion of the Charters Towers Gold Field (Fig. 1). Gold and silver are the only minerals which have been produced in any quantity. The area however has potential for copper and molybdenum mineralization. Most mines have been abandoned for more than sixty years, and none are currently operating. No workings are accessible.

Owing to the poor standard of reporting in the early days of the Ravenswood Field, only very incomplete production figures and little geological information is available for most mines. K.R. Levingston, District Geologist of the Geological Survey of Queensland at Charters Towers, is currently compiling two comprehensive reports on the economic geology of the Townsville and Charters Towers 1:250,000 Sheet areas.

These reports will incorporate whatever statistical information is available on the Ravenswood mines. In almost all instances production figures are unavailable for individual mines.

Mining History and Mineral Exploration

Gold was first discovered in the area in 1868, when allvuial gold was found at Trieste by Jessop, Buchanan, and party. Later prospecting led to the discovery of rich gold deposits on the east bank of Elphinstone Creek. A rush occurred in October 1869, forming Top Camp, the predecessor of the town of Ravenswood. Other reefs were soon discovered at Sandy Creek, Brookville, Four Mile, and Eight Mile.

By 1872 most of the oxidized parts of the Ravenswood reefs above the water table had been worked out, and it was found that the extraction of gold from the primary sulphide ore was extremely difficult. Many mines were abandoned for this reason and, when the nearby Charters Towers Field was discovered in 1872, most of the population left Ravenswood. Mining activity declined, and in 1882 only 8,711 ozs. of gold were produced. The principal reefs - the General Grant, Sunset, New England, Wild Irish Girl, Melaneur, and John Bull - were worked intermittently until 1893. English capital was introduced to a few mines in 1893, but by 1896 the principal Ravenswood mines were closed down. The silver mines in the Totley area were closed in 1891, but work continued at Brookville and at the Eight Mile (Premier mine). The Grant and Sunset Reefs, with the Black Jack and Shelmalier in the town area, were taken over in 1899 and vigorously developed by an English company. The success of this company led to the sinking of the Ravenswood Deep Shaft to the east of the company's workings. But although it was the deepest in the town area, the shaft failed to find extensive reserves of ore. The Erins Hope and Donnybrook Reefs at Brookville and the Morning Star and Himalaya Reefs at the Kirk Diggings were worked again at this time for a few years. When Maclaren reported on the field in 1900, all of the mines in the Ravenswood town area were closed down. However mining activity was revived, and between 1898 and 1912 more than half the total yield was produced. The Donnybrook Group of mines was worked intermittently to 1915, and work continued at the Sisters Group at Kirk until 1916.

The Mother Lode at Mount Wright was opened in 1917 and was worked intermittently until 1929. During the period 1930-1940 there was some renewal of activity in the field. The Mother Lode was reopened and produced from 1938 to 1942. Gold Mines of Australia actively prospected the Ravenswood town area and carried out some work on the Golden Hill lode. Between 1937 and 1941 a considerable quantity of gold was won by treating the dumps in the town area.

Since the war almost no mining has been carried on. Some unsuccessful exploratory work was done at Brookville, and the Queensland Mines Department drilled the Mother Lode at Mount Wright. In the early 1960's North Broken Hill Pty. Ltd. investigated and drilled Keans prospect and Titov prospect. In 1964 the Great Extended shaft at Totley was dewatered and examined by Silver Horizons N.L., but the results were disappointing. During 1965-66 New Consolidated Gold Fields Australasia Pty. Ltd. carried out induced polarization and geochemical surveys in the area between Keans prospect and Titov prospect. In late 1966 Anaconda Australia Inc. investigated a number of small mines in the Robey Range southeast of Ravenswood, but the company relinquished its Authority to Prospect.

Geological Setting

Gold is by far the most important mineral produced from the Ravenswood Sheet area. In addition to gold, minor quantities of silver have been mined, and a little copper was produced as a by-product of gold mining. Copper-molybdenum mineralization also occurs, but has not yet been found in commercial quantities.

All mineral deposits are of mesothermal type, the gold and silver in veins and generally intimately associated with base metal sulphides, and the copper and molybdenum either disseminated or in veins.

Although it can be stated confidently that all of the gold and silver deposits with the exception of Mount Wright are related to the early Palaeozoic plutonic rocks, in most cases it is still uncertain which particular plutons or phases are related genetically to particular deposits. Some copper and molybdenum was evidently introduced in the late Palaeozoic.

The several periods of mineralization represented in the area are listed below. The ascribing of the mineralization to particular units or sub-units is tentative in most cases.

(1) Brookville, Trieste, and possibly Robey Range

(Ravenswood Granodiorite Complex - main granodiorite phase)

Mineralization at Brookville is concentrated near the contact between the Ravenswood Granodiorite Complex and the Mount Windsor Volcanics. Cameron (1903) reported that the Donnybrook and Erins Hope reefs at Brookville contain only minor sulphides and the gold is coarse and easily amalgamable. This is in marked contrast to the majority of reefs in the Ravenswood town area, which are refractory and heavily mineralized with sulphides .

The mineralization appears to have been introduced by the main granodiorite phase of the complex.

(2) Buck Reef and possibly Four Mile

(Ravenswood Granodiorite Complex - Mosgardies Adamellite)

In the Ravenswood town area the Buck Reef is earlier than the main Ravenswood reefs (Maclaren, 1900). It appears to be an easterly extension of the Mosgardies Shear Zone, which was formed contemporaneously with the intrusion of the Mosgardies Adamellite. Mineralization at Four Mile (Old Man Reef) occurs in the main granodiorite phase of the complex, but the Mosgardies Adamellite crops out only 1000 feet from the mine.

(3) Kirk

(Ravenswood Granodiorite Complex - Kirklea Granite)

At Kirk the gold mineralization is concentrated close to the contact of the Kirklea Granite. Base metal sulphides are rare in the reefs.

(4) Ravenswood - Totley - Sandy Creek

(origin problematical)

The isotopic ages of the different sub-units of the Ravenswood Granodiorite Complex agree with the sequence deduced from geological mapping except for the tonalite which is the host rock of the mineralization at Ravenswood, Totley, and Sandy Creek. Geological mapping suggested that the Millaroo Granite intrudes the tonalite (mapped as main granodiorite phase) north of Ravenswood, and that the contact dips south beneath the Ravenswood town area. The Millaroo Granite was the inferred source of the mineralization, which is located in faults and fractures in the adjacent tonalite. Some support for this suggestion is given by the occurrence in the tonalite of numerous thin granite dykes and veins which resemble the Millaroo Granite. Subsequently age-determinations (Webb 1969) indicated a 394 ± 30 m.y. age for the tonalite and a 454 ± 30 m.y. age for the Millaroo Granite, negating the suggestion that the Millaroo Granite is the source of the mineralization. Further mapping and more age-determinations will be necessary to resolve the conflict between present mapping and age-determination data, and therefore the question of the origin of the mineralization remains open.

(5) Keans Prospect (possibly also Barrabas prospect)

(Barrabas Adamellite)

The vein-type copper-molybdenum mineralization at Keans prospect is almost certainly related to the Barrabas Adamellite. The Barrabas prospect is farther removed from the adamellite, and the relationship is inferred on the basis of similarity to the mineralization at Keans prospect.

(6) Titov Prospect

(?Upper Carboniferous porphyry)

The disseminated and veinlet-type copper-molybdenum mineralization at Titov prospect occurs in a small porphyry intrusion which is probably part of the ?Upper Carboniferous volcanic suite.

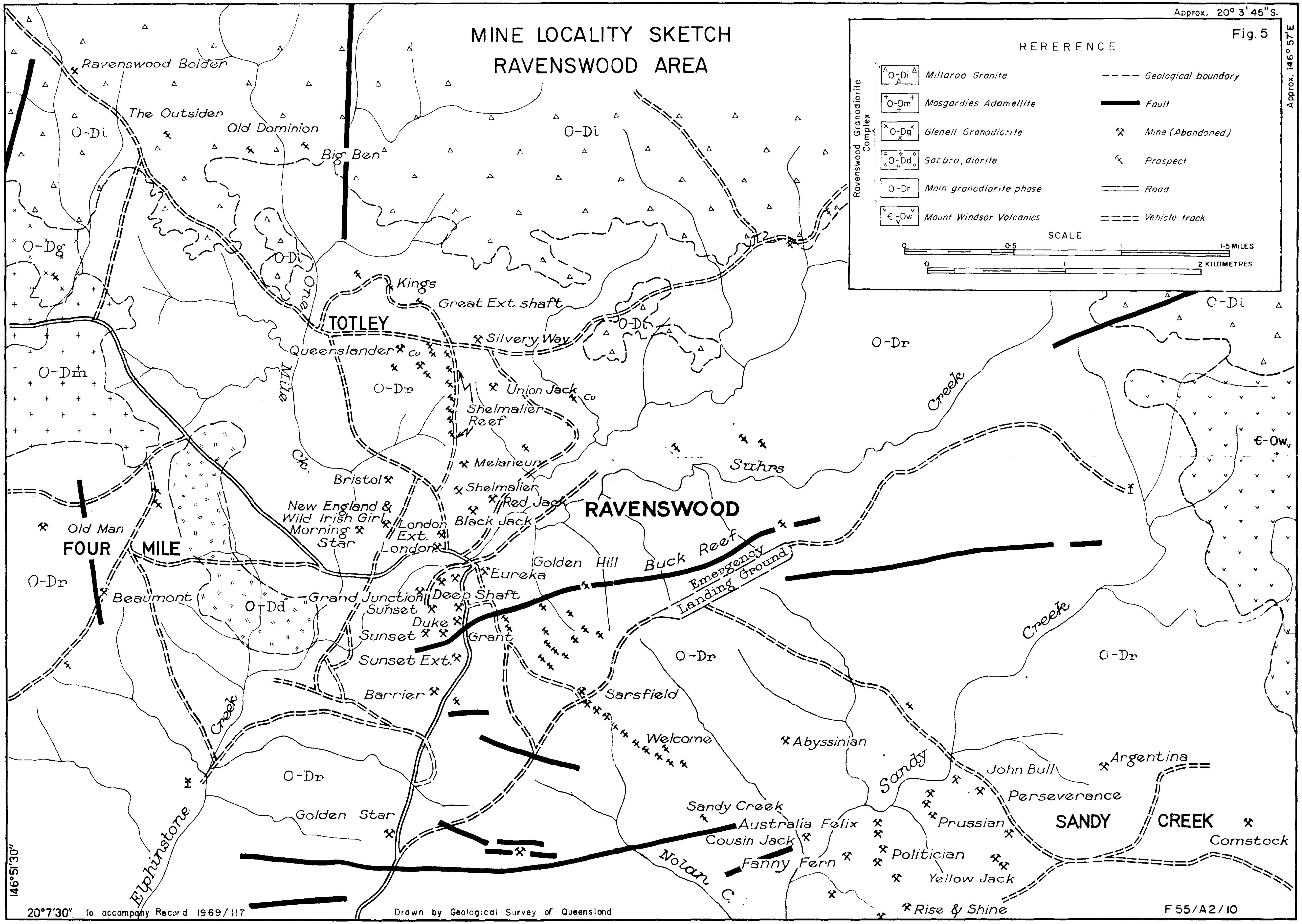
(7) Miscellaneous Mines and Prospects

Miscellaneous mines such as those at Rochford and some minor reefs south of the Burdekin River can not be related definitely to any particular source rock. At Mount Wright gold occurs in volcanic breccia of possibly Upper Carboniferous age. Minor copper mineralization occurs in ?Upper Carboniferous volcanics intruded by the Tuckers Igneous Complex (Upper Carboniferous or Lower Permian).

Gold

Town area (Fig. 5)

The total gold yield of the Ravenswood Gold and Mineral Field to the end of 1967 is about 900,000 fine ozs. Most of this production has come from reefs in the Ravenswood town area and at Sandy Creek.



MINE LOCALITY SKETCH
RAVENSWOOD AREA
Fig. 5
Approx. 20° 3'45"S.
Approx. 146° 57'E
RERERENCE
Ravenswood Granodiorite Complex
O-Di Millaroo Granite
O-Dm Mosgardies Adamellite
O-Dg Glenell Granodiorite
O-Dd Gabbro, diorite
O-Dr Main granodiorite phase
€-Ow Mount Windsor Volcanics
Geological boundary
Fault
Mine (Abandoned)
Prospect
Road
Vehicle track
SCALE
0 0·5 1 1·5 MILES
0 1 2 KILOMETRES
Ravenswood Bolder
The Outsider
Old Dominion
Big Ben
Kings
Great Ext. shaft
TOTLEY
Silvery Way
Queenslander Cu
Union Jack Cu
Shelmalier Reef
Melaneur
Bristol
Shelmalier
Red Jack
Black Jack
New England & Wild Irish Girl
Morning Star
London Ext.
London
Old Man
FOUR MILE
RAVENSWOOD
Golden Hill
Buck Reef
Emergency Landing Ground
Eureka
Beaumont
Grand Junction
Deep Shaft
Sunset
Duke
Grant
Sunset Ext.
Barrier
Sarsfield
Welcome
Abyssinian
Argentina
John Bull
Perseverance
Sandy Creek
Australia Felix
Cousin Jack
Prussian
SANDY CREEK
Comstock
Politician
Fanny Fern
Yellow Jack
Rise & Shine
Golden Star
Suhrs
One Mile Ck.
Elphinstone Creek
Nolan C.
Sandy Creek
O-Dr
O-Di
O-Dg
O-Dm
O-Dd
€-Ow
146°51'30"
20°7'30"
To accompany Record 1969/117
Drawn by Geological Survey of Queensland
F 55/A2/10

All lodes in the town area are mineralized quartz reefs in hornblende-biotite tonalite. Primary lode minerals are quartz, pyrite, chalcopyrite, sphalerite, galena, arsenopyrite, and gold. The sulphide ores are refractory, and metallurgical difficulties were experienced throughout the history of the field.

The Ravenswood town lodes strike between north-northwest and north-northeast, and dip eastwards at between 25° and 45°. A subsidiary system strikes between northeast and east, and dips south. The most comprehensive report on the mineralization is by Maclaren (1900); Cameron (1903) discussed some later developments.

The main reefs, General Grant, Sunset, Duke, London, New England, and Black Jack were worked to depths up to 700 feet. The reefs were up to three feet wide, but generally averaged about 18 inches. Most were heavily mineralized with pyrite, chalcopyrite, sphalerite, galena and pyrrhotite. In some reefs the dip decreases with depth. The northeast or east trending reefs are of minor importance.

The Shelmalier and Buck reefs appear to be different from the normal quartz reefs of the Ravenswood town area. The Shelmalier reef appears on the surface as a ridge of ferruginized altered tonalite. A few tons of copper have been produced from numerous small pits along the ridge. Maclaren (1900) reported that there was no defined reef showing quartz with hanging and footwalls. "Quartz is rarely present, and the ore body is contained in a formation of decomposed country rock, which must be several feet in width. The ore is mainly copper pyrites and zincblende". The Shelmalier reef probably represents a mineralized shear, rather than the normal quartz reef characteristic of the Ravenswood area. Unfortunately there is no information available about the grade of the mineralization. The severe alteration associated with this structure, and the known copper and zinc mineralization, suggest further prospecting of the Shelmalier reef may be warranted.

The Buck Reef trends east-northeast through the town area. It is intersected by the near north-south trending reefs. It was first described by Maclaren (1900) as a body of quartz 10 to 30 feet wide. In thin section he described it as consisting of subangular quartz grains, separated in places by a siliceous groundmass. Zircon and apatite are present as accessories. He concluded it was "probably a quartz reef of much older generation than other Ravenswood reefs, and one that has been subjected to dynamic and thermo-dynamic agencies inducing the present granular structure". Morton (1921) however reported that a close study of the reef, as revealed in the open cuts as well as several exposures underground in the workings on the General Grant reef, to a vertical depth of 400 feet, shows the Buck Reef to consist of country rock (tonalite) more or less highly altered and chloritized, and impregnated with pyrite, sometimes in small seams or veins, and sometimes replacing the original ferromagnesian minerals. Morton also stated that small veins and stringers of quartz cut the formation and cause local enrichment, and he noted that the Buck Reef differs from the other reefs in being free of sphalerite and arsenopyrite, which have made the ores of the other reefs so complex and refractory. Production on the Buck Reef, recorded by Morton (1921), is 6857 tons for 2091oz of gold.

Observations of the surface workings of the Buck Reef during the present investigation support Morton's interpretation rather than Maclaren's, whose report gives a false impression. It is possible that the specimen Maclaren described as the Buck Reef is a silicified aplite such as occurs 700 feet east of the Sunset Extended Shaft. The Golden Hill Mine, opened up by Goldfields of Australia in the mid 1930's, is situated on the Buck Reef. The reef here consists mainly of dark grey sheared and chloritized tonalite. In hand specimen the tonalite from the reef shows small quartz grains set in a fine-grained chloritic and sericitic groundmass. Quartz (35 percent) was interstitial in the original tonalite, and, in the altered rock, the quartz crystals maintain their irregular shape. Some microbrecciation of the quartz is visible in thin-section, but most quartz grains shown only slight strain. Plagioclase (originally about 45 percent) is completely replaced by a fine aggregate of sericite flakes. Some remnants of biotite occur, although biotite has been largely replaced by felted aggregates of fine greenish-brown chlorite. Similar chlorite has completely replaced the hornblende of the tonalite. Apatite and zircon are accessories, and small crystals of pyrite are scattered throughout the rock. This altered tonalite from the Golden Hill mine returned a few pennyweights of gold per ton. Reid (1934) estimated that 24,000 tons were mined from the Golden Hill lode for an average return of 6dwts per ton. He described the lode as "alternating bands of auriferous quartz, iron oxides, and diorite, the individual quartz veins varying from one inch to six feet in width". The primary ore contained pyrite and a little chalcopyrite. The Buck Reef is interpreted as a major shear with considerable associated hydrothermal alteration.

Sandy Creek

The reefs at Sandy Creek are very similar to the Ravenswood reefs. They also occur in tonalite, but strike near north-south, and dip west at moderate angles. Maclaren (1900) reported the principal reef, the John Bull, to be up to 20 feet wide with an average grade of 10 to 15dwt.

Rochford

Gold was discovered at Rochford in 1871. The first claim was the Hadleigh Castle, followed by Robinson Crusoe and Captain. The population rose to 700 and a township was surveyed, but the area is now completely deserted. The Assistant Mining Registrar in Ravenswood in 1933 estimated the total production of the Hadleigh Castle between 1874 and 1916 at 37,576 tons crushed for 21,487oz gold. More than 16,000ozs of this was produced between 1895 and 1902.

The country rock of the Rochford mines is a sheared, medium-grained hornblende granodiorite which is generally highly chloritized and epidotized. The shearing trends nearly east-west, and the cataclastic foliation dips vertically or steeply to the south. The Rochford mines occur at the western end of the Mosgardies Shear Zone. The main reef, the Hadleigh Castle, trends at 085° and dips 45° south. Most of the mines appear to be situated on the one major fissure, or smaller parallel fissures. The gold occurs in quartz veins which also contain pyrite, minor galena, and copper carbonates.

Brookville

Numerous small quartz reefs were mined in the district shortly after the first Ravenswood discovery. The reefs were small, but the Donnybrook and Erin's Hope reefs were richly mineralized. Most carried minor pyrite, galena and sphalerite. The Donnybrook, Brass Wire, and Erin's Hope reefs are in amphibolite and granofels derived from the Mount Windsor Volcanics adjacent to the Ravenswood Granodiorite Complex. The Donnybrook reef averaged 6 inches wide, and dipped at 25° to the east-southeast. The Erin's Hope reef, which contained large quantities of pyrite and galena, dips north at 65°.

Trieste

The Trieste mines, the oldest on the field, have been briefly described by Maclaren (1900), but production figures are not available. The reefs occupy fissures in biotite-hornblende granodiorite. Dykes of microdiorite and fine-grained graphic granite are common in the mine area, but do not appear to be connected with the mineralization. The Genoa, just northwest of the main group of Trieste mines, was a narrow reef which produced 1,557ozs of gold, but which became uneconomic to work below 100 feet. It was probably typical of the reefs in the Trieste area, all of which were only small producers.

Kirk

The major producers were the Three Sisters, Himalaya, Margaret and Morning Star mines. All are close to the contact of the Kirklea Granite with the main granodiorite phase. Some of the Ravenswood Granodiorite Complex reefs, e.g. the Margaret, cut across the contact. The reefs occur along prominent faults which trend almost north-south. The ore was low-grade and free-milling, consisting of massive quartz and pyrite, with traces of other sulphides. The gold mineralization appears to be structurally controlled, as it is concentrated at the intersection of the faults and the margin of the Kirklea Granite.

The Three Sisters, the biggest producer, was worked from 1900 to 1916 for production of approximately 25,000 ozs of gold. Half of the total production was won in the period 1910-1914. In 1913 the Three Sisters Extended workings reached a depth of 1375 feet, and are thus the deepest in the Ravenswood field. A little more work was done in 1931, but no production resulted. Attempts were made to open the Margaret and Himalaya mines in 1938, but no significant production was obtained.

Eight Mile

The Eight Mile Diggings, five miles northeast of Ravenswood, were worked in the earliest days of the Ravenswood Field. The Premier, which was the chief mine, yielded rich stone. The reef occurs as quartz lenses in a major fracture zone in the main granodiorite phase of the Ravenswood Granodiorite Complex. Mineralization is concentrated close to the contact of the Millaroo Granite and the granodiorite, and presumably is related to the intrusion of the Millaroo Granite. The gold was free-milling but total production from this area is not large, as the reefs, though rich, were small.

Four Mile

The Four Mile Diggings are located on Four Mile Creek, 2.2 miles west of Ravenswood. The principal reef, the Old Man, was reported by Maclaren (1900) to be up to 40 feet wide. No production figures are available, although several thousand tons, ranging from 8dwts, to 1oz per ton, were crushed. The host rock of the reef is a medium-grained hornblende-biotite granodiorite. The quartz veins also carry pyrite, sphalerite, and chalcopyrite. Much of the granodiorite on the mine dumps contains small amounts of disseminated chalcopyrite, even in specimens which appear little altered. The nearby Beaumont Reef consists of quartz veins and irregular masses of quartz containing secondary copper minerals. Mineralization at the Four Mile may be related to the nearby Mosgardies Adamellite.

Mount Wright

The gold mineralization at Mount Wright differs from the other gold mineralization in the Ravenswood district. The mineralization is low grade (about 4 to 5dwts. per ton), and occurs in a breccia pipe. The breccia consists chiefly of biotite granite, but also contains fragments of fine-grained volcanics or dyke rocks. It is hydrothermally altered; feldspars in the granite are strongly kaolinized, and mafic minerals are completely obliterated. Small masses of siderite occur throughout the pipe. Pyrite is disseminated irregularly in the pipe, and is associated with very minor sphalerite, molybdenite, and secondary copper. Breccia near the summit of Mount Wright consists chiefly of rhyolite and greisenized granite fragments. Rhyolite dykes intrude the breccia and the nearby granite; the largest dyke forms a ridge projecting from the west-northwest side of Mount Wright.

The mine, the Mother Lode, was opened in 1917, but was not worked estensively until 1923. From then until 1927 various small parties worked the deposit, but without success. Mother Lode Gold Mines Ltd. was formed in 1927, but it too was unsuccessful, and the mine was abandoned in 1929. The mine was reopened and worked with moderate success during the period 1938 to 1942. Total production is approximately 1,300 fine ozs. gold.

The Queensland Mines Department drilled the deposit, and Connah (1956) concluded that the zone of appreciable gold values is restricted to an annular area, from 70 to 100 feet in diameter, surrounding a core of unaltered granite. He also concluded that the drilling has shown beyond doubt that the zone of appreciable gold values is too small for large scale exploitation.

Robey Range Area

Several small mines are situated on auriferous quartz reefs in the Mount Windsor Volcanics southeast of Ravenswood. The Britannia Mine occurs on a prominent fault in quartzite and tuffaceous siltstone. Production between 1913 and 1916 amounted to 250 ozs of gold; a further crushing in 1935 gave 9 ozs. The New Chum mine is situated on a very prominent quartz reef which can be traced intermittently for about four miles. Dalgarno (1967) reports production at the New Chum of about 350 ozs. The Queen of Sheba lode, which consists of small quartz leaders, produced approximately 500 ozs. between the years 1894 and 1902 (Dalgarno, 1967). The Standard, Revival, Killarney, and Federation are very small prospects.

Miscellaneous Mines

Numerous other small gold mines and prospects are scattered throughout the area. All are fissure veins in granodiorite.

Silver

Silver is the only other metal which has been produced from the Ravenswood area in appreciable quantities. The chief lodes are situated at Totley (One Mile), a little over a mile north-northwest of Ravenswood. There are three roughly parallel lodes, but only the Kings lode is important. Production figures are not available, but in 1891 more than 22,600 tons, valued at more than $224,000, was raised. King's lode strikes northwest and dips northeast at angles of about 30 to 35 degrees in the shallow workings, increasing in lower levels to about 50°, with local variations (Connah 1953). The lode ranges from 2 to 25 feet thick and consists of crushed tonalite containing veins and lenses of massive sulphide ore, rich in silver. The ore veins are up to 12 inches thick. High silver values are reported to have occurred in some of the wider galena bands, which were rich in tetrahedrite and contained small amounts of pyrargyrite and possible proustite and argentite. The narrow galena veins carried little tetrahedrite. Sphalerite, pyrite, chalcopyrite, arsenopyrite, stibnite, gold, stephanite, and a lead-antimony sulphide have also been identified in the ore. The footwall is a sharply defined slickensided surface, but the hanging wall is seldom as well defined. Mineralization is known to occur over a length of 2,000 feet (Connah 1953). The Queenslander Mine is probably situated on an extension of Kings lode; production from it has been negligible.

The Great Extended Shaft on Kings lode was reopened in 1964 by Silver Horizons N.L., and the lode was sampled. No development work followed this investigation. Levingston (1969) inspected the workings, and in his opinion the characteristics of the lode are those of the outer fringes of a zone of mineralization, and the lode holds little possible economic interest.

Copper and Molybdenum

In recent years prospecting for both copper and molybdenum has been carried out in an area southwest and west of Ravenswood, first by North Broken Hill Ltd., and later by New Consolidated Gold Fields (Australasia) Pty. Ltd.

After the company's attention had been drawn to Keans prospect by a local prospector, North Broken Hill Ltd. carried out a regional geochemical survey, covering 200 square miles, of all streams between the Kirk River and Connolly Creek (Lissiman, Baker, and Marshall 1965). The survey showed anomalies at Keans prospect and Titov prospect, where copper mineralization was already known to exist, and a weaker anomaly in the headwaters of Barrabas Creek (Barrabas Creek prospect). Six diamond drill holes totalling 2734 feet were drilled at the northern end of Keans prospect. Subsequently, detailed geochemical sampling was undertaken at Keans prospect and Titov prospect, and four large costeans were put in at Keans prospect. Further diamond drilling at both prospects totalled 2046 feet. Drilling at Titov established the presence of disseminated copper mineralization in granodiorite, with grade ranging from 0.19 percent to 0.25 percent over several hundred feet. The Authority to Prospect was abandoned in 1965.

Late in 1965 New Consolidated Goldfields Australasia Pty. Ltd. carried out detailed geochemical sampling in the area between Titov and Keans prospects. The investigation revealed geochemical anomalies about Titov, Keans and Barrabas Creek prospects, but indicated no other prospective areas. Later an induced polarization survey defined an anomaly near Titov prospect, and this was drilled (two holes totalling 1279 feet). However, the drilling indicated that the mineralization is mainly pyritic, and has a very low copper and molybdenum content. Chalcopyrite is restricted to narrow quartz veins, not disseminated, as is the pyrite. Scheelite occurs in pyritic veins. The Authority was subsequently relinquished.

Titov prospect is centred on a low bare rise formed by a very small intrusion of feldspar-quartz porphyry (Cur?) in medium-grained hornblende-biotite granodiorite. Quartz veins bearing copper and molybdenum mineralization intrude both the porphyry and the granodiorite. Chalcopyrite and pyrite are disseminated throughout the granodiorite, and also form thin films and veins. Molybdenum grade is about one tenth of the copper grade, i.e. about 0.02 percent.

Keans prospect is situated within the main granodiorite phase of the Ravenswood Granodiorite Complex, about a mile from the northern contact of the Barrabas Adamellite. Marginal areas of the adamellite contain many large quartz outcrops, and there can be little doubt that the extensive quartz-veining which characterises Keans prospect is related to the adamellite. The quartz veins are up to 10 feet thick and carry molybdenite, secondary copper minerals, and gold. The country rock, a medium-grained hornblende-biotite granodiorite, is extensively fractured on the footwall side of the veins. Thin veins of medium-grained adamellite or granite similar to the Barrabas Adamellite commonly intrude the granodiorite in the footwall.

Other molybdenite bearing quartz veins have been found near Kirkton homestead, and 2 miles west of Plumwoods homestead. Traces of molybdenite occur in a faulted area of the Barrabas Adamellite near Scoop Holes Mill, and minor copper mineralization occurs near the junction of Turkey Gully and Barrabas Creek. Exposures south and west of the Barrabas Adamellite are poor, which possibly explains why neither molybdenum nor copper minerals have been recorded from this area. However the multitude of adamellite dykes and the occurrence of large quartz outcrops (e.g. the White Blow) between Richards Mill and Bosworth, suggests that the Barrabas Adamellite may underlie the area at reasonably shallow depth (see Figure 3). Accordingly this area offers scope for further prospecting for molybdenum and copper.

Barrabas Creek prospect was discovered by geochemical prospecting. Its geochemical anomaly is less intense than that of Titov prospect, and it has not been drilled. Barrabas Creek prospect occurs in medium-grained hornblende granodiorite, which, just to the west of the anomaly centre, carries a few specks of disseminated chalcopyrite. Microgranite and adamellite dykes which intrude the granodiorite between here and Keans prospect contain rare grains of chalcopyrite.

The copper prospects near Copper Pinnacle consist of minor secondary copper mineralization along faults in volcanics (Cuv). The mineralization is probably related to the Tuckers Igneous Complex, which intrudes the volcanics.

The Quarrien Mine, 3 miles east of the junction of Pandanus Creek and the Kirk River, is situated on a fissure in granodiorite. The two-feet-wide cupriferous lode is reported to have contained from 6dwts to 1½ozs of gold and about 12oz of silver per ton, but there was not significant production.

Reefs in the Ravenswood town area contained up to one percent copper. A little was produced as a by-product of the gold mining, but no mine has been worked primarily for copper. A number of secondary copper occurrences between Ravenswood and Totley are shown on the map, and deserve further prospecting. A few tons of copper ore have been won from the surface along the Shelmalier reef, which extends north-northwest from the centre of the town.

Future Prospects

No new gold deposits have been found in the Ravenswood area for many years, and all mines have been worked out in their oxidized parts. Prospecting would be difficult and expensive, and at present there is little likelihood that the Ravenswood gold mines will be reopened.

The silver lodes at Totley were reprospected and once again abandoned in 1964. Although the lode formation is wide and the grade high in places,Levingston (1969) considers that the lode has little economic potential.

The occurrence of disseminated and veinlet copper-molybdenum mineralization at Titov prospect directs attention to the late Palaeozoic volcanics, and all occurrences of these should be carefully prospected, particularly the intrusive phases (Cur). Furthermore the Barrabas Adamellite and the adjacent granodiorite (O-Dr) should be thoroughly prospected, with emphasis on the search for the same kind of quartz-vein type molybdenum mineralization as occurs at Keans prospect.

Other areas of interest are the Old Man mine at Four Mile, the Mosgardies Shear Zone, and the Ravenswood town area. The Old Man reef ranged up to 40 feet wide, which is much wider than the normal Ravenswood reefs. Disseminated chalcopyrite occurs in the granodiorite country rock. Areas of brecciation within the Mosgardies Shear Zone, between Rochford and the Kirk Range, are potentially suitable environments for mineralization. The brecciated granodiorite is severely chloritized and epidotized in places, and minor copper mineralization has been observed within the Shear Zone. Scattered copper mineralization occurs in the Ravenswood town area, and the auriferous reefs were heavily mineralized with base metal sulphides. The Shelmalier reef, which is a major shear containing abundant sulphides, is associated with a wide zone of hydrothermal alteration. No disseminated mineralization has been observed, but exposure in the area is poor. The extent of base metal mineralization in the town area is poorly known, and until it is more precisely determined the area must remain prospective.

The work carried out in recent years by exploration companies has shown that geochemical soil and stream sediment surveys are very effective in defining anomalies in the Ravenswood area. The terrain presents few access difficulties, and surveys can be carried out rapidly and economically.

REFERENCES

BEST, J.G., 1966 - Copper/molybdenum prospects, Ravenswood, North Queensland. A. to P. 277M. Geol. Surv. Qld Auth. Rep. 1838 (unpubl.).

CAMERON, W.E., 1903 - Recent mining developments on the Ravenswood Goldfield. Geol. Surv. Qld Publ. 183.

CONNAH, T.H., 1953 - Totley (King's) Silver Mine, Ravenswood. Qld Govt Min. J., 54, 171-6.

CONNAH, T.H., 1956 - Mount Wright gold deposits, Ravenswood, diamond drill exploration. Ibid., 61, 461-3.

DAINTREE, R., 1870 - On the Ravenswood, Mount Wyatt, Cape River Gold Fields, etc. Votes Proc. Legislative Assembly, 1870.

DALGARNO, C.R., 1967 - Geological report on Authority to Prospect 360M. Ravenswood area, North Queensland. Geol. Surv. Qld. Auth. Rep. 2141 (unpubl.).

HARLAND, W.B., SMITH, A.G., & WILCOCK, B., 1964 - The Phanerozoic time scale. Quart. J. Geol. Soc. Lond., 120.

JACK, R.L., 1879 - Report on the geology and mineral resources of the district between the Charters Towers Goldfield and the coast. Geol. Surv. Qld Publ., 1.

LEICHHARDT, L., 1847 - JOURNAL OF AN OVERLAND EXPEDITION IN AUSTRALIA. T. and W. Boone, London.

LEVINGSTON, K.R., 1969 - Great Extended Silver Mine, Ravenswood. Qld Govt. Min. J. 70, 248-9.

LISSIMAN, J.C., BAKER, W.E., and MARSHALL, N.J., 1965 - Geochemical prospecting by North Broken Hill Limited with special reference to molybdenum. In EXPLORATION AND MINING GEOLOGY 8th Emp. Min. Metall. Congr., 2, 90-5.

MACLAREN, J.M., 1900 - Report on the geology and reefs of the Ravenswood Goldfield. Geol. Surv. Qld Publ., 152.

McKELLAR, R.G., 1964 - Palaeontological report on six collections of fossil plants and fish remains from the Charters Towers 4-mile Sheet. Unpubl. Rep. to Chief Govt Geologist, 21/8/64.

McKELLAR, R.G., 1967 - Idem, Appendix in WYATT, et al. 1967

MORGAN, W.R., 1964 - The nomenclature of igneous and metamorphic rocks. Bur. Miner. Resour. Aust. Rec. 1964/182 (unpubl.).

MORTON, C.C., 1920 - Reapplication from the Golden Hill Development Syndicate Ltd for a subsidy. Unpubl. Rep. to Chief Govt Geologist 5/8/1920.

MORTON, C.C., 1928 - The Mother Lode - Mt. Wright - Ravenswood Goldfield. Unpubl. Rep. to Chief Govt Geologist.

MORTON, C.C., 1938 - Kirk Diggings. Qld Govt Min. J., 39, 157-9.

NORTH BROKEN HILL LTD, 1959 - Mount Wright, Ravenswood. Geol. Surv. Qld Auth. Rep. 466 (unpubl.).

NORTH BROKEN HILL LTD, 1960 - Keans Prospect, Ravenswood, A. to P. 140M., Ibid., 465 (unpubl.).

NORTH BROKEN HILL LTD, 1960 - Keans Ravenswood area, A. to P. 140M. Ibid, 476 (unpubl.).

NORTH BROKEN HILL LTD, 1960 - Keans Molybdenite Prospect, A. to P. 140M. Ibid., 488 (unpubl.).

NORTH BROKEN HILL LTD, 1960 - Keans Molybdenite Prospect, A. to P. 140M. Ravenswood. Ibid., 494 (unpubl.).

PAINE, A.G.L., HARDING, R.R., and CLARKE, D.E., 1965 - The Geology of the northeastern part of the Hughenden 1:250,000 Sheet area, North Queensland. Bur. Miner. Resour. Aust. Rec. 1965/93 (unpubl.).

PAINE, A.G.L., HARDING, R.R., and CLARKE, D.E., in prep. - Idem. Bur. Miner. Resour. Aust. Rep. 126.

PAINE, A.G.L., GREGORY, C.M., and CLARKE, D.E., 1966 - The Geology of the Ayr 1:250,000 Sheet area, Queensland. Bur. Miner. Resour. Aust. Rec. 1966/68 (unpubl.).

PAINE, A.G.L., GREGORY, C.M., and C.ARKE, D.E., in press - Idem. Bur. Miner. Resour. Aust Rep. 128.

PAINE, A.G.L., CLARKE, D.E., and GREGORY, C.M., in prep. - The Geology of the northern part of the Bowen 1:250,000 Sheet area, Queensland (with additions to the geology of the southern half). Bur. Miner. Resour. Aust. Rec. (unpubl.).

REID, J.H., 1917 - The Charters Towers Goldfield. Geol. Surv. Qld Publ., 256.

REID, J.H., 1934 - Some Ravenswood Mines. Qld Govt Min. J., 35, 77-8.

SPIELVOGEL, L.N., 1963 - Progress report A. to P. 140M., Ravenswood area - North Queensland. Geol. Surv. Qld Auth. Rep. 1096 (unpubl.).

TURNER, F.J., and VERHOOGEN, J., 1960 - IGNEOUS AND METAMORPHIC PETROLOGY. McGraw Hill, New York.

WEBB, A.W., 1969 - Metallogenic epochs in eastern Queensland Proc. Aus. Inst. Min. Metall. 230, 29-38.

WYATT, D.H., 1968 - Townsville, Qld - 1:250,000 Geological Series Bur. Miner. Resour. Aust. explan Notes, SE/55-14.

WYATT, D.H., PAINE, A.G.L., HARDING, R.R., and CLARKE, D.E., 1969 - Iden. Bur. Miner. Resour. Aust. Rep. 127.

WYATT,D.H., PAINE, A.G.L., CLARKE, D.E., GREGORY, C.M., and HARDING, R.R., 1967 - The geology of the Charters Towers 1:250,000 Sheet area, Queensland. Bur. Miner. Resour. Aust. Rec. 1967/104 (unpubl.).

WYATT, D.H., PAINE, A.G.L., CLARKE, D.E., GREGORY, C.M., and HARDING, R.R., in press - Idem. Bur. Miner. Resour. Aust. Rep. 137.

APPENDIX

Isotopic age-determination from the Ravenswood Granodiorite Complex and the Barrabas Adamellite, Townsville and Charters Towers 1:250,000 Sheet areas.

Sheet area Reference No.	Military grid reference Eastings	Northings	Rock Type	Method	Age ($\times 10^6$ years)	Remarks
Townsville 1:250,000 Sheet						Equivalent unit in Ravenswood Sheet area
44	473200	2511400	Granodiorite	K/Ar	Biotite 440 ± 3%	Main granodiorite phase
44	"	"	"	"	Hornblende 420 ± 3%	" " "
44	"	"	"	Rb/Sr (whole rock)	*	" " "
46	475200	2507500	Granite	"	*	Millaroo Granite
47	476400	2505500	Diorite	"	+	Possibly O-Dd
48	485700	2503700	Adamellite	"	*	Millaroo Granite
49	488500	2504200	"	"	*	Millaroo Granite
59	430700	2499800	"	"	*	Possibly Millaroo and Kirklea Granites.
Charters Towers 1:250,000 Sheet						Unit sampled
4	358000	2450600	Granite	"	+	Uncertain
6	346900	2421600	"	"	+	Uncertain
16	505700	2482400	Tonalite	"	+	Main granodiorite phase
19	496100	2489500	Granite	"	*	Millaroo Granite
20	496600	2487500	Granodiorite	"	*	Glenell Granodiorite
22	498100	2476600	Adamellite	"	+	Barrabas Adamellite
23	494900	2477600	"	"	+	Barrabas Adamellite
24	492400	2483000	Granodiorite	"	*	Mosgardies Adamellite
26	485600	2493500	"	"	*	Glenell Granodiorite
27	501500	2483800	Tonalite	"	+	Main Granodiorite phase
28	477100	2488900	Granite	"	*	Kirklea Granite

* 454 ± 30.   + 394 ± 30

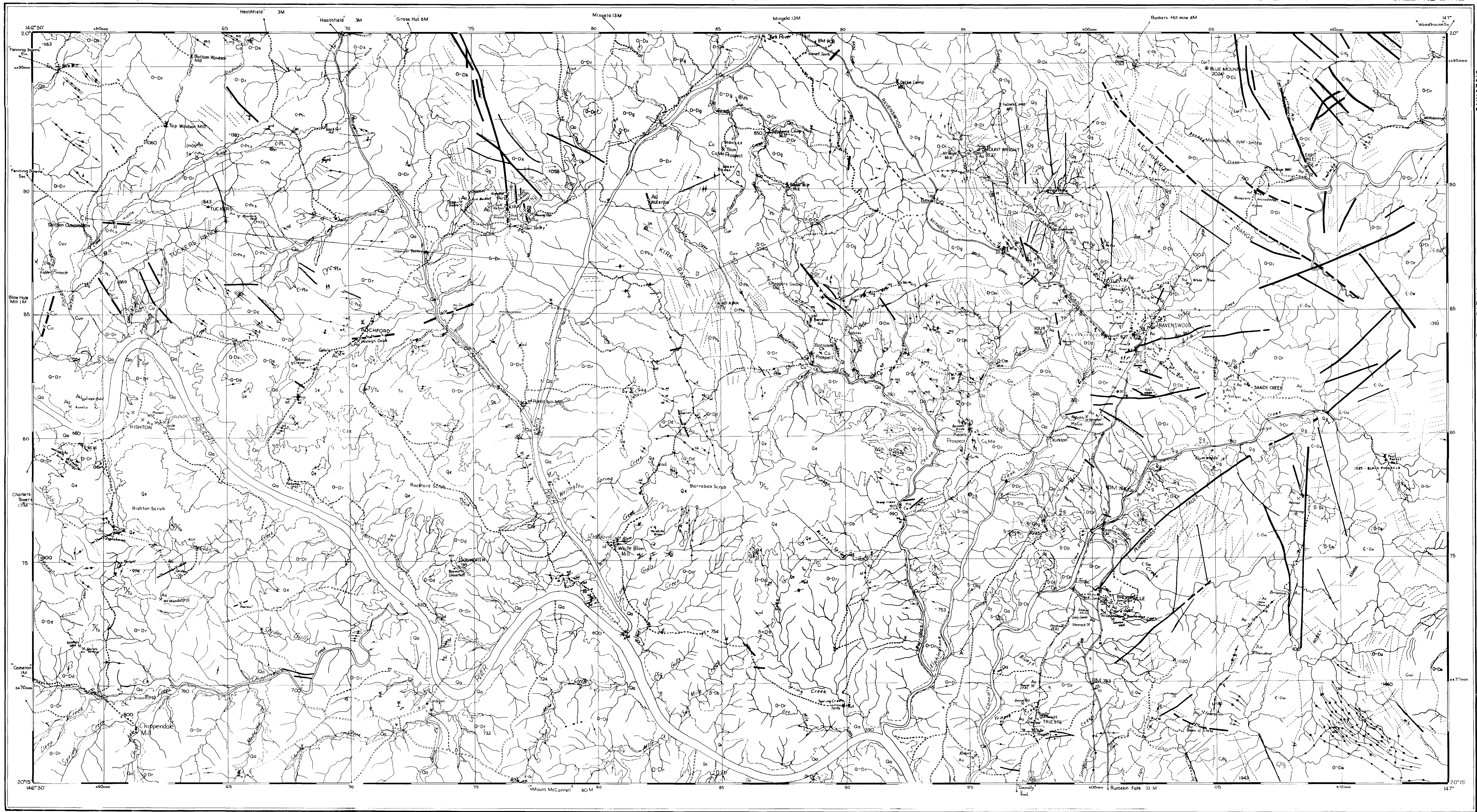
PRELIMINARY EDITION, 1969
SUBJECT TO AMENDMENT

AUSTRALIA 1:63,360

RAVENSWOOD

QUEENSLAND

1 MILE GEOLOGICAL SERIES — SHEET 142 ZONE 7



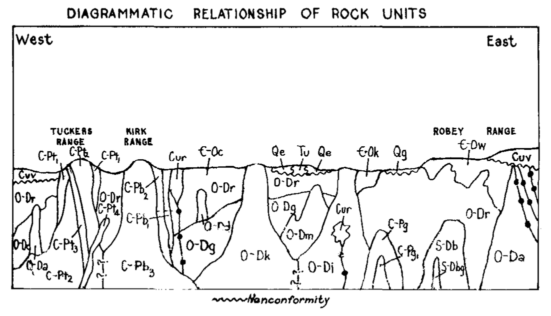
Reference

Era	Period	Unit	Symbol	Description
CAINOZOIC	QUATERNARY		Qa	Sand, silt, gravel.
			Qg	Semi-consolidated gravel, sand and silt, argillaceous sandstone
		Sellheim Formation	Qe	Argillaceous sandstone, ferruginous sandstone, pebble conglomerate, minor siltstone.
	EARLY TERTIARY		Tl	Laterite
			Tu	Argillaceous sandstone, feldspathic sandstone, pebbly sandstone, siltstone, claystone
PALAEOZOIC	UPPER CARBONIFEROUS TO LOWER PERMIAN	Boori Igneous Complex	C-Pb$_3$	Biotite-hornblende granodiorite, adamellite
			C-Pb$_2$	Tonalite, minor diorite.
			C-Pb$_1$	Leucogranite
		Tuckers Igneous Complex	C-Pt$_4$	Leucogranite, leucoadamellite.
			C-Pt$_3$	Granodiorite, minor adamellite
			C-Pt$_2$	Biotite-hornblende granodiorite, minor tonalite.
			C-Pt$_1$	Gabbro, diorite, mangerite, minor granodiorite
			C-Pg	Leucogranite, granodiorite, microgranite
			C-Pg$_1$	Biotite adamellite
	UPPER CARBONIFEROUS		Cuv	Andesitic and rhyolitic flows and pyroclastics
			Cur	Intrusive rhyolite, rhyolite breccia, and minor andesite
	U. SILURIAN OR L. DEVONIAN	Barrabas Adamellite	S-Db	Biotite adamellite and granodiorite, some leucocratic biotite granite
			S-Dbg	Leucoadamellite, microgranite
	MIDDLE ORDOVICIAN AND U. SILURIAN OR L. DEVONIAN	Ravenswood Granodiorite Complex	O-Da	Leucocratic biotite granite
		Kirklea Granite	O-Dk	Leucocratic biotite granite
		Millaroo Granite	O-Di	Leucocratic biotite granite and adamellite; microgranite
		Mosgardies Adamellite	O-Dm	Porphyritic adamellite, granite, microgranite
			O-Dc	Biotite adamellite
		Glenell Granodiorite	O-Dg	Porphyritic hornblende-biotite granodiorite
			O-Dd	Gabbro, diorite
			O-Dr	Complex of hornblende-biotite granodiorites and tonalites, minor diorite
	CAMBRIAN TO ORDOVICIAN	Kirk River Beds	Є-Ok	Micaceous shale, lithic sandstone siltstone
		Cape River Beds	Є-Oc	Biotite schist, gneiss, and quartzite
		Mt Windsor Volcanics	Є-Ow	Acid to intermediate volcanics; minor labile sediments

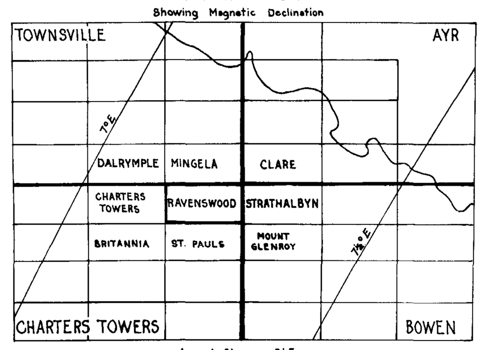
Symbol	Meaning
	Geological boundary, line broken where approximate, dotted where concealed
	Fault, line broken where approximate
	Lineament (air-photo interpretation)
25	Strike and dip of strata
	Joint pattern (air photo interpretation)
5	Strike and dip of foliation
	Vertical foliation
	Shear
	Age determination sample site with 1:250,000 Sheet locality number
	Fossil wood
10	Dyke or vein showing dip where inclined; mg-microgranite, g-granite, ad-adamellite, grd-granodiorite, f-felsite, q-quartz, rh-rhyolite, d-microdiorite, p-pegmatite, hp-hornblende porphyry. Absence of letter symbol indicates photo interpretation
Oq	Quartz or siliceous pegmatite masses
KIRK	Old mining township now deserted
	Mines (all abandoned) — Costean
	Prospect, little or no production
·Cu	Minor mineral occurrence
	Abandoned battery
Au	Gold
Ag	Silver
Cu	Copper
Mo	Molybdenum
Pb	Lead
D.D.H.I.	Diamond drill hole
	Tank.
	Wind pump
	Dam
	Road
	Vehicle track
	Abandoned Railway
	Telephone line
"Kirkton"	Homestead
·	Dwelling
Yd	Yard
E.L.G.	Emergency landing ground
Δ	Trigonometrical station
·720	Height in feet; instrument levelled; datum mean sea-level
B.M. 708	Bench mark

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Topographic photo compilation supplied by Royal Australian Survey Corps. Aerial photography by Adastra Airways Pty. Ltd.; complete vertical coverage at 1:24,000 scale. Transverse Mercator Projection.

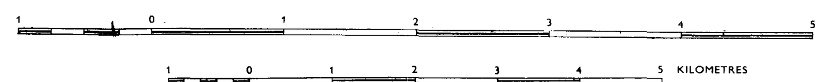
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



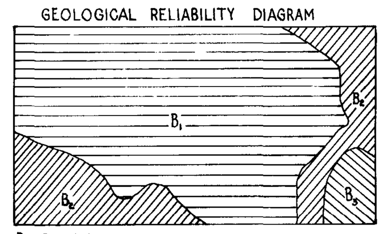
INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



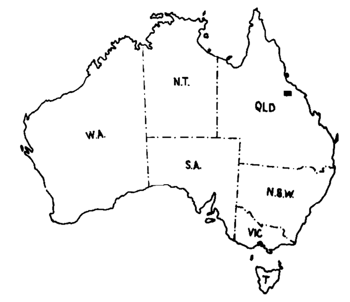
Scale
1 Mile to 1 Inch

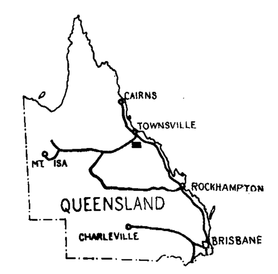


GEOLOGICAL RELIABILITY DIAGRAM



B1 Detailed reconnaissance, numerous traverses
B2 Reconnaissance with air photo interpretation
B3 Mainly air photo interpretation



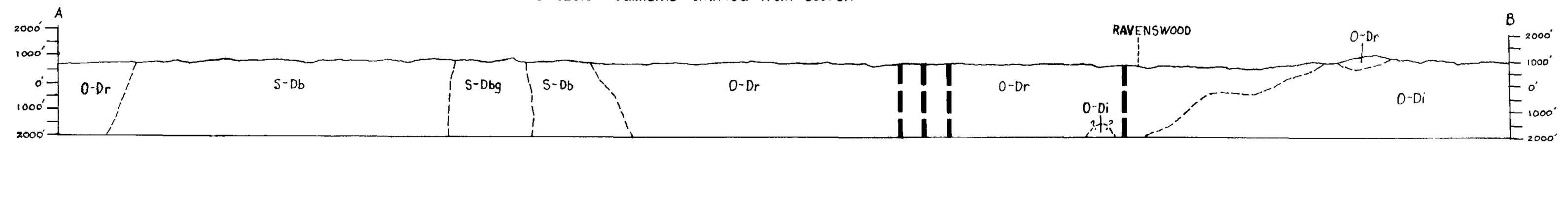


Geology 1963 & 1966 by: D.E. Clarke, G.S.Q.
Compiled 1967 by: D.E. Clarke
Drawn by: D.E. Clarke & T.J. Egan

RAVENSWOOD
SHEET 142 ZONE 7

Note: For more detailed location and naming of mines in Ravenswood area see Fig 5 in accompanying report

Scale $\frac{V}{H} = 1$
Cainozoic sediments omitted from section



Scale $\frac{V}{H} = 1$
Cainozoic sediments omitted from section

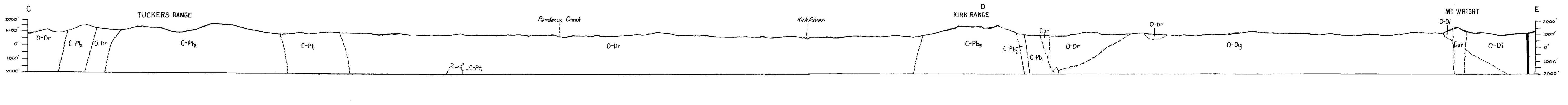


TABLE 1 - SUMMARY OF ROCK UNITS

Hard copy of Table 1 is missing from all copies of 1969/117 held by the library.

ERA	PERIOD OR EPOCH	ROCK UNIT NAME OR SYMBOL	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
CAINOZOIC	QUATERNARY	Qa	Sand, silt, gravel	Narrow flats bordering the larger streams	Superficial	Alluvium	Main source of underground water
		Qg	Semi-consolidated gravel, sand, silt, argillaceous sandstone	Low dissected mesas	Superficial	Outwash deposits; also alluvium deposited in hollows in the higher country	Probably a time-equivalent of the Sellheim Formation. Strongly dissected by present drainage
		Sellheim Formation Qe	Argillaceous sandstone, ferruginous sandstone, pebble conglomerate, minor siltstone	Low mesas	Superficial	Probably high-level deposits of the ancestral Burdekin River. Environment possibly lacustrine at times	Silicified wood locally abundant. Possibly of Pleistocene age (Wyatt et al. 1965, and 1969; 1967, and in press)
	EARLY TERTIARY	Tl	Laterite	Mesa tops	Preserved only on Tertiary sediments (Tu)		
		Tu	Argillaceous sandstone, feldspathic sandstone, pebbly sandstone, siltstone, claystone	Mesas up to 80 ft high	Superficial	Probably lacustrine, with intermittent fluviatile sedimentation	Formed during a period of widespread peneplanation
PALAEOZOIC	UPPER CARBONIFEROUS OR LOWER PERMIAN	Boori Igneous Complex: C-Pb$_3$	Biotite-hornblende granodiorite, adamellite	Rugged Kirk Range, rising to 800 ft. above adjacent country	Intrudes Ravenswood Granodiorite Complex, and C-Pb$_2$	Epizonal composite stock	Resembles C-Pt$_2$ phase of Tuckers Igneous Complex
		C-Pb$_2$	Tonalite, minor diorite	Low broken terrain on eastern side of the Kirk Range	Intrudes C-Pb$_1$ with strong shearing at contact. Intruded by C-Pb$_3$		Resembles C-Pt$_1$ phase of Tuckers Igneous Complex
		C-Pb$_1$	Leucogranite	Low sandy ridge east of the Kirk Range	Intrudes Ravenswood Granodiorite Complex and Carboniferous volcanics (Cur)		Possibly magmatically related to C-Pb$_2$ and C-Pb$_3$ phases
		Tuckers Igneous Complex: C-Pt$_4$	Leucogranite, leucoadamellite	Low rises	Intrudes all other phases of Tuckers Igneous Complex	Epizonal composite stock	Small dykes and veins. Other small masses marginal to the complex
		C-Pt$_3$	Granodiorite, minor adamellite	Forms "Middle Ridge" - a long steep curvilinear ridge	Intrudes C-Pt$_1$ and C-Pt$_2$. Intruded by C-Pt$_4$		Y-shaped sheet intrusion
		C-Pt$_2$	Biotite-hornblende granodiorite, minor tonalite	Forms main part of Tuckers Range	Intrudes Ravenswood Granodiorite Complex and Carboniferous intrusion breccia (Cur). Intruded by C-Pt$_3$ and C-Pt$_4$		
		C-Pt$_1$	Gabbro, diorite, mangerite, minor granodiorite	Mostly black soil flats bordering Tuckers Range	Intrudes Ravenswood Granodiorite Complex and Carboniferous volcanics (Cuv). Intruded by, or possibly gradational to C-Pt2		Gabbro similar to gabbroic rocks (O-Dd) of doubtful age which form small masses throughout the Ravenswood Granodiorite Complex

ERA	PERIOD OR EPOCH	ROCK UNIT NAME OR SYMBOL	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
PALAEOZOIC	UPPER CARBONIFEROUS OR LOWER PERMIAN	C-Pg	Granite, granodiorite	Rugged hills. Relief up to 1000 ft	One stock intrudes the Mt. Windsor Volcanics. A twofold intrusion in the northeast of the area (in which $C\text{-}Pg_1$ intrudes C-Pg) intrudes the Ravenswood Granodiorite Complex	Epizonal stocks	
		$C\text{-}Pg_1$	Biotite adamellite				
	UPPER CARBONIFEROUS	Cuv	Andesitic and rhyolitic flows and pyroclastics	Dissected plains	Overlie or intrude the Ravenswood Granodiorite Complex. Intruded by the Boori and Tuckers Igneous Complexes	Extrusives and associated intrusives	Not appreciably folded. Gold mineralization in intrusive breccia at Mt. Wright
		Cur	Intrusive rhyolite, rhyolite breccia, and minor andesite	Isolated hills			
	UPPER SILURIAN OR LOWER DEVONIAN	Barrabas Adamellite S-Db	Biotite adamellite, granodiorite; some leucocratic biotite granite	Sandy rises, isolated hills	Intrudes Ravenswood Granodiorite Complex (O-Dr)	Post-tectonic intrusion	Associated copper and molybdenum mineralization at Keans prospect. Isotopic 394± 30 m.y.
		S-Dbg	Leucoadamellite, microgranite	Rocky hills	Intrudes S-Db	Differentiate of S-Db	Numerous associated microgranite dykes
	MIDDLE ORDOVICIAN AND UPPER SILURIAN OR LOWER DEVONIAN	Ravenswood Granodiorite Complex: O-Da	Leucocratic biotite granite	Varied; some form rugged ranges and hills, others small depressions	Small separate unnamed intrusions. Some intrude the Mount Windsor Volcanics, others O-Dr, and some O-Dg	Late stage differentiates	Small granitic masses related to the O-Dk/O-Dg period of intrusion
		Kirklea Granite O-Dk	Leucocratic biotite granite	Ranges, relief 300 ft	Intrudes O-Dr	Late stage differentiate	Lower intrusive contacts mostly gently dipping. Gold mineralization at Kirk. Isotopic age 454± 30 m.y.
		Millaroo Granite O-Di	Leucocratic biotite granite and adamellite; microgranite	Ranges, relief 400 ft	Intrudes Kirk River Beds, O-Dr, O-Dg. Intruded by breccia (Cur) at Mt Wright	Late stage differentiate	Contacts shallowly or moderately dipping. Some gold mineralization at Ravenswood. Intruded by numerous dykes. Isotopic age 454± 30 m.y.
		Mosgardies Adamellite O-Dm	Porphyritic adamellite, granite, microgranite	Hills 50 to 400 ft high	Intrudes O-Dr; probably intrudes O-Dg, but shearing obscures relationship; intruded by microgranite and microdiorite dykes	Probably a contaminated differentiate	Southern contact flatly dipping beneath O-Dr. Minor associated gold mineralization. Isotopic age 454± 30 m.y.
		O-Dc	Biotite adamellite	Hills at S.E. end of Tuckers Range	Intrudes O-Dr. Intruded by granite dykes related to nearby O-Dn mass, and by Tuckers Igneous Complex	Possible differentiate	No known associated mineralization

ERA	PERIOD OR EPOCH	ROCK UNIT NAME OR SYMBOL	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
PALAEOZOIC	MIDDLE ORDOVICIAN AND UPPER SILURIAN OR LOWER DEVONIAN	Ravenswood Granodiorite Complex: Glenell Grano-diorite O-Dg	Porphyritic hornblende-biotite granodiorite	Dissected plains	Intrudes O-Dr		Minor associated gold mineralization. Isotopic age 454± 30 m.y.
		Ravenswood Granodiorite Complex: O-Dd	Gabbro, diorite	Generally low hills surrounded by black soil	Most masses intrude O-Dr, but some possibly older. Contact relationships generally obscure	Differentiates	No known associated mineralization
		Ravenswood Granodiorite Complex: O-Dr	Hornblende-biotite granodiorite and tonalite; minor diorite	Dissected plains	The initial and most widespread phase(s) of the complex		Host to almost all Au, Ag, Mo, Cu mineralization. Isotopic ages of 454± 30 and 394± 30 m.y. (see Appendix)
	CAMBRIAN-ORDOVICIAN	Kirk River Beds Є-Ok	Micaceous shale, lithic sandstone, siltstone	Broken, hilly terrain	Intruded by Millaroo Granite	Poorly sorted; graded bedding and turbidity structures	Gold mineralization at Bunkers Hill in Townsville 1:250,000 Sheet area
		Cape River Beds Є-Oc	Biotite schist, gneiss, quartzite	Low ridges	Roof pendant in main granodiorite phase of Ravenswood Granodiorite Complex (O-Dr)		Contact with main granodiorite phase (O-Dr) moderately dipping
		Mount Windsor Volcanics Є-Ow	Acid to intermediate volcanics; minor labile sediments	Dissected hills and ranges	Intruded by O-Dr, O-Da, O-Dn, C-Pg. Contact with O-Dr generally faulted		Gold mineralization at Brookville and at various points in Robey Range