COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1965/93

THE GEOLOGY OF THE NORTH-EASTERN PART OF THE HUGHENDEN 1:250,000 SHEET AREA, NORTH QUEENSLAND.

by

A.G.L.Paine, R.R.Harding, & D.E.Clarke*
*(GEOLOGICAL SURVEY OF QUEENSLAND).

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ENCLOSURE

HUGHENDEN 1:250,000 Geological Sheet, Preliminary Edition.

NOTE

Some of the rock-unit symbols referred to in the text of this report differ from those on the geological map, as follows:

Qrt(report)	=	Qt (map)		Toomba Basalt
Dlg(")	=	Pzd (")		Dumbano Granite
Dli(")	=	Pzl (")		Lolworth Igneous Complex
Sa (")	=	Pzy (")	)	
Sg (")	=	Pzr (")	) -	Ravenswood Granodiorite
Sn (")	=	Pzn (")	)	
Pzc(")	=	p€m (")	) -	Cape River Beds
Pzq(")	=	p€q (")	)	

SUMMARY

The north-eastern part of HUGHENDEN,* which consists chiefly of igneous and metamorphic rocks, was mapped in 1963 by a combined Bureau of Mineral Resources and Geological Survey of Queensland field party. The remainder of the Sheet area (consisting chiefly of sediments of the Eromanga Basin) was mapped concurrently by another B.M.R. - G.S.Q. field party (see Vine, et al., 1964). The north-eastern margin of the Eromanga Basin was the dividing line between the areas mapped by these two field parties.

The Cape River Beds (probably early Palaeozoic, but possibly Precambrian) are the oldest rocks in the Sheet area. Extensive areas of foliated and gneissic granodiorite and adamellite are correlated with the Ravenswood Granodiorite (Silurian) of CHARTERS TOWERS and TOWNSVILLE. They were intruded syntectonically in the closing stages of the orogeny which folded the Cape River Beds. The Lolworth Igneous Complex, a large post-tectonic batholith, was intruded in the Lower Devonian (based on one age-determination only). Similar Lower Devonian absolute ages have been obtained from the Dumbano Granite (CLARKE RIVER) which extends into the northern part of HUGHENDEN.

Igneous activity was resumed in the Upper Permian when acid volcanics with associated sediments (Puv) were laid down, and the Mundic Igneous Complex (an epizonal complex associated with volcanics) was intruded.

No record of Mesozoic sedimentation has been preserved in the north-eastern part of HUGHENDEN, but thin piedmont deposits of (?)Pliocene age are widespread. Extensive outpourings of plateau basalt (Nulla Basalt) took place in the late Tertiary. More basalt (Toomba Basalt) was erupted, probably in Recent times.

Most of the gold mineralisation, discovered and worked in the late nineteenth and the early part of this century, can be related to the Lolworth Igneous Complex. Some can be related to the Dumbano Granite and to the Mundic Igneous Complex.

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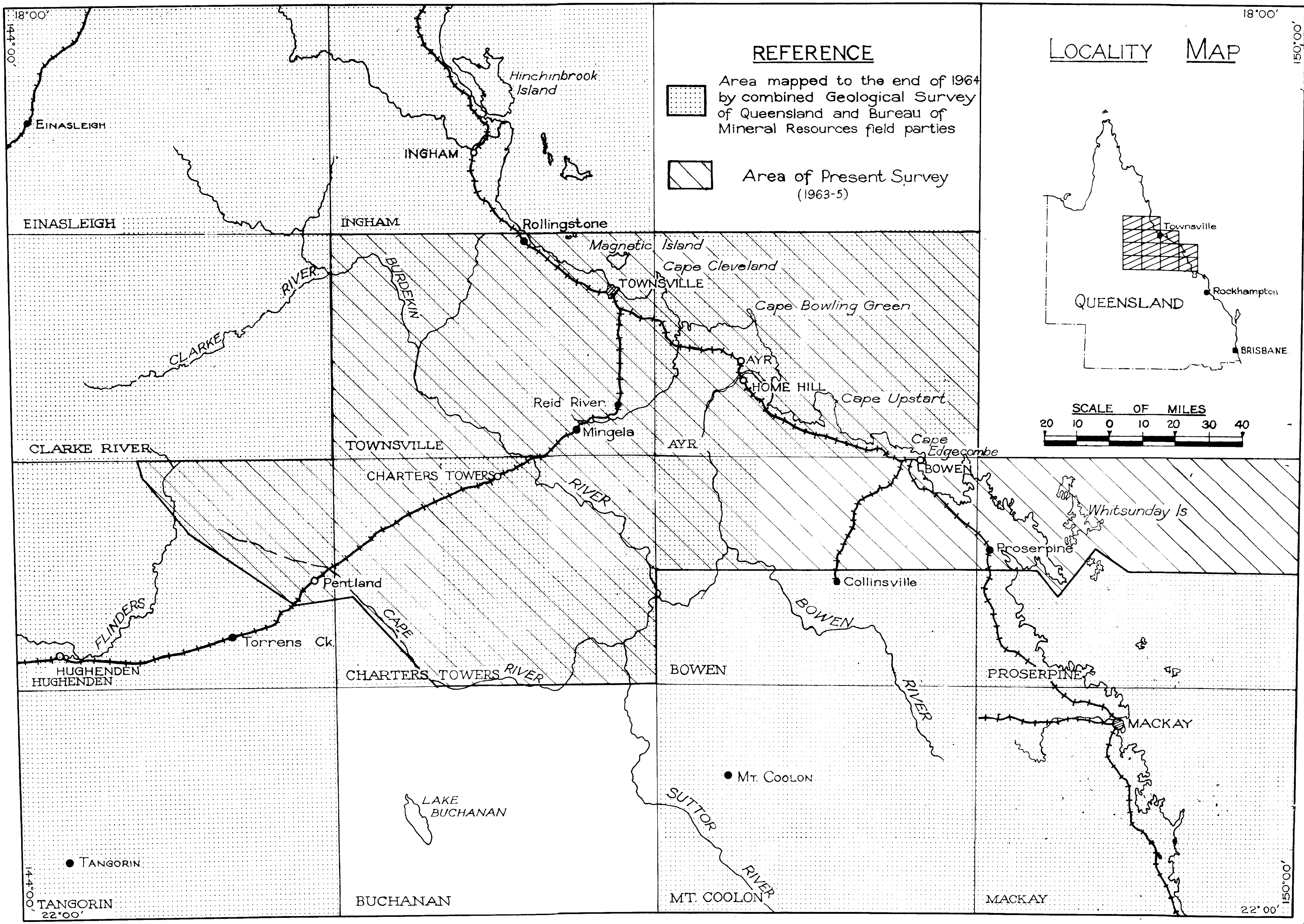
*In this report 1:250,000 Sheet areas will be referred to by their names only, in capitals; for example, instead of the phrase "in the Hughenden 1:250,000 Sheet area", the phrase "on HUGHENDEN" will be used for the sake of brevity.

FIG. 1



REFERENCE
Area mapped to the end of 1964 by combined Geological Survey of Queensland and Bureau of Mineral Resources field parties
Area of Present Survey (1963-5)
LOCALITY MAP
Townsville
Rockhampton
QUEENSLAND
BRISBANE
SCALE OF MILES
20 10 0 10 20 30 40
18°00'
144°00'
150°00'
22°00'
EINASLEIGH
INGHAM
Hinchinbrook Island
Rollingstone
Magnetic Island
Cape Cleveland
TOWNSVILLE
Cape Bowling Green
AYR
HOME HILL
Cape Upstart
Cape Edgecombe
BOWEN
Whitsunday Is.
Proserpine
Collinsville
Reid River
Mingela
CHARTERS TOWERS
Pentland
Torrens Ck.
HUGHENDEN
CLARKE RIVER
BURDEKIN
RIVER
FLINDERS
CAPE
BOWEN RIVER
SUTTOR RIVER
MACKAY
Mt. COOLON
LAKE BUCHANAN
TANGORIN
BUCHANAN
MT. COOLON
PROSERPINE

INTRODUCTION

HUGHENDEN (Australia 1:250,000 Series SF55-1) is bounded by latitudes 20° and 21° south and by longitudes 144° and 145° 30 minutes east (see Fig.1).

The north-eastern part of HUGHENDEN, comprising mainly igneous and metamorphic rocks, was mapped during 1963 by a combined Bureau of Mineral Resources and Geological Survey of Queensland field party led by D.H. Wyatt (G.S.Q.). The results of the mapping are contained in this Record. In 1963 this field party also completed mapping TOWNSVILLE, and mapped about half of CHARTERS TOWERS. In 1964 the same party completed mapping CHARTERS TOWERS, and mapped AYR and the north-western part of BOWEN. Records on the geology of TOWNSVILLE, CHARTERS TOWERS, and AYR are in preparation. CLARKE RIVER Geological Sheet was published in 1962 (White et al., 1962).

Another combined Bureau of Mineral Resources - Geological Survey of Queensland field party led by R.R. Vine (B.M.R.) mapped the remainder of HUGHENDEN (mainly sedimentary rocks) during 1962 and 1963 as part of the regional mapping of the Eromanga Basin (Vine et al., 1962; Vine et al., 1963). The boundary of the area mapped by Wyatt's party is shown in Fig.1; it follows approximately the north-easterly limit of outcrops of the Eromanga Basin sediments.

The 1:250,000 scale geological map of HUGHENDEN was compiled as follows: the geology was plotted in the field onto transparent overlays of 1:46,500 scale air-photos (taken in 1951 by the Royal Australian Air Force). The information was traced from the photo-overlays onto controlled, slotted-template, photo-scale transparencies of each one-mile Sheet area (½° x ¼°), prepared by the Royal Australian Survey Corps. The photo-scale sheets were reduced to 1:250,000 scale, and the geology was fairdrawn from these reductions, using as a control the 1:250,000 scale topographic base-map compiled in 1959 by the Royal Australian Survey Corps.

The area dealt with in this Record is a region of hills and ranges bordered by plains in the north and south-east; it ranges from 1200 feet to 3300 feet above sea-level. The average annual rainfall is between

20 and 25 inches. Rainfall in the area is monsoonal; the average rainy season extends from December or January until March or April. Rare thunderstorms occur between April and November (especially in October and November), but generally no significant rain falls during that period.

According to the Atlas of Australian Resources January is the hottest month, with a normal daily maximum of 95°F, and a mean temperature of 82°F. July is the coldest with a normal nightly minimum of 48°F, and a mean of 63°F. Frosts are very rare.

The only village in the area is Pentland, which has an estimated population of 80 to 100. It has several shops, a hotel, a railway station, and a garage. The rest of the inhabitants of the area live in isolated homesteads (mainly cattle stations).

Access to the area is provided by the Great Northern Railway and by the Flinders Highway. Both Charters Towers (68 miles north-east of Pentland by road) and Hughenden (94 miles south-west of Pentland by road) are served by regular air-line flights. The railway (Queensland Government Railways) is single track and of narrow gauge (3 feet 6 inches). It has recently been reconstructed to fit in with the expansion programme of Mount Isa Mines Ltd.. The transporting of base metal concentrates from Mount Isa to Townsville, and of coal from Collinsville to Mount Isa, is the chief activity of the railway. Passenger services, both local and long-distance, call at Pentland. The Flinders Highway within the mapped area is a wide gravel road. It is being reconstructed as a first class all-weather highway, and tar-sealing is proceeding in a south-westerly direction. During 1963 and 1964 eighteen miles were completed between Balfes Creek and Homestead (on CHARTERS TOWERS, 46 miles south-west of Charters Towers); the section between Homestead and Pentland was begun late in 1964.

The main access within the area is provided by the mail road from Pentland to Lolworth and Cargoon Homesteads, and by the road from Charters Towers to Glencoe Homestead. These are graded roads with a loose surface. In the northern and south-eastern parts of the area minor roads and vehicle tracks are quite plentiful; these open up the basalt plains and the low-lying country around Pentland. In the Great Dividing Range and Lolworth Range access by vehicle is restricted to two tracks: one turns west off the Pentland-Lolworth mail road at Gypsy Pocket, and leads to an old coal mine at Oxley Creek; the other branches north-west from the Flinders Highway, east of the Cape River, follows the Campaspe River upstream, climbs the Lolworth Range, and ends at the Brilliant Brumby Gold Mine.

By far the most important industry in the area is beef-cattle raising. A small meat-works at Cape River employs a score or so men. A few men work on the railway; still fewer gain seasonal or intermittent employment timber-getting (mainly for railway sleepers) and small-scale gold-mining. In 1963 a crop of lucerne was growing at Ballabay Homestead, presumably on water drawn from the alluvium of the Cape River. There are several sizeable citrus orchards and vineyards on the alluvial flats of the Cape River between Capeville and Kiora Homesteads; some of these have been abandoned.

PREVIOUS INVESTIGATIONS

Until the present regional geological survey was carried out in 1963 all other geological work had been closely concerned with gold discoveries which had been made in the area from time to time.

In 1868 and again in 1870 R. Daintree reported on the first gold discoveries near Pentland. Rands (1891) briefly described the geology of all mines then operating, and gave (1894) a detailed account of the Pentland Deep Lead. Between 1910 and 1941 Marks, Cameron, Russell, Morton, Shepherd, and Ball reported on the discovery and mining of further gold occurrences. Most of these reports contained brief references to the local geology.

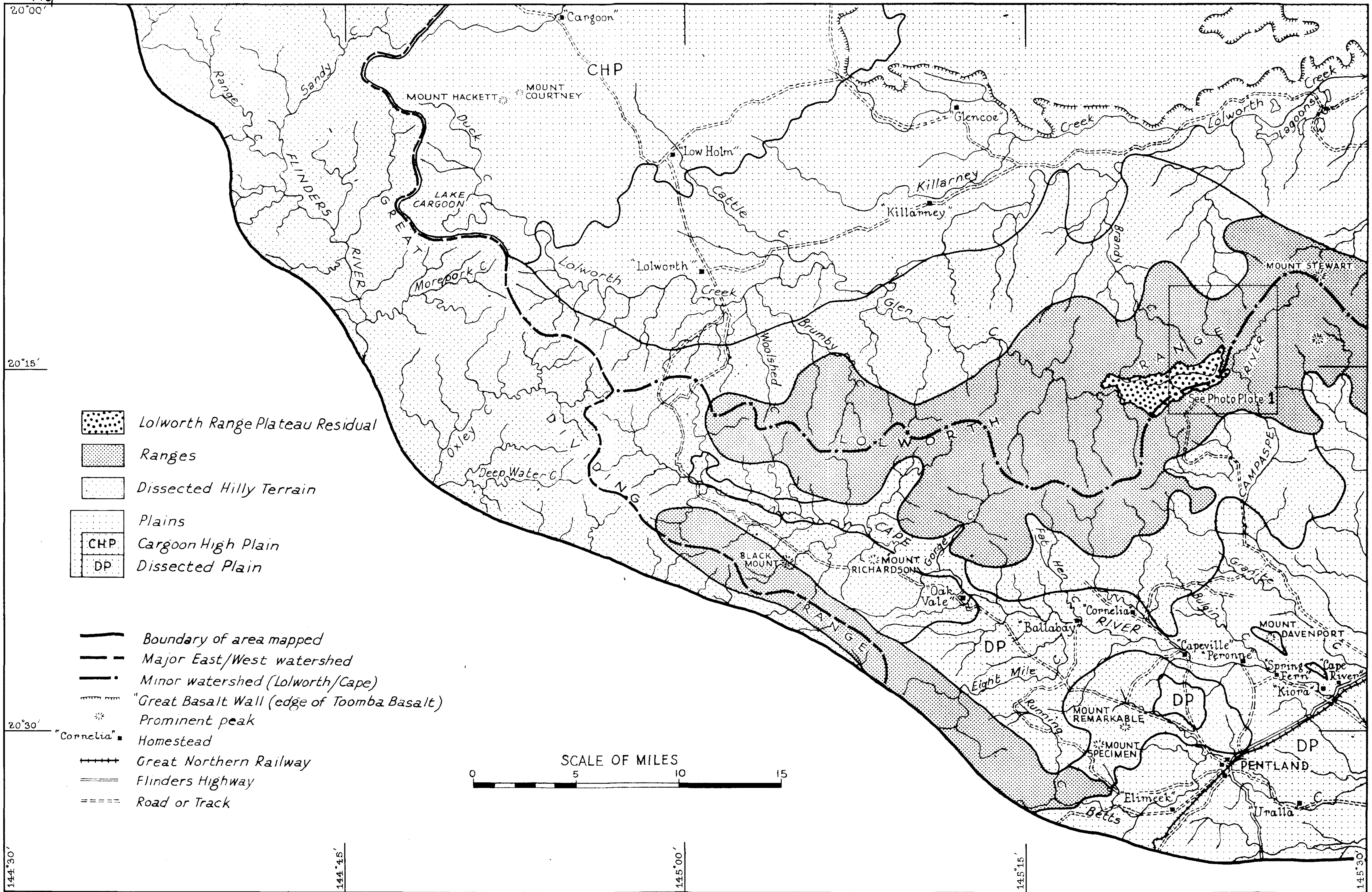
Twidale (1956) gave a general account of the Cainozoic basalts of North Queensland.

ACKNOWLEDGEMENTS

Miss B.R. Houston of the Geological Survey of Queensland made brief petrological descriptions of numerous thin sections. The results of her work are incorporated in the text.

In 1964 D.J. Casey, of the Geological Survey of Queensland, compiled the production statistics of the mines and information on their history of development. In 1965 K.R. Levingston, District Geologist at Charters Towers, made further suggestions on the chapter on Economic Geology, and provided recent production figures for some of the mines.

FIG. 2



PHYSIOGRAPHIC SKETCH MAP
of the north-eastern portion of the HUGHENDEN sheet (SF 55-1)

PHYSICAL FEATURES

The major physical features of the north-eastern part of HUGHENDEN are shown in Figure 2 (Physiographic Sketch Map).

Much of the area is more than 2000 feet above sea-level; it rises to 3300 feet at Mount Stewart in the east, and to 3000 feet in the headwaters of Range Creek in the north-west.

The streams within the area belong to three main systems, (1) Flinders River System, which drains the western part of the area, and flows into the Gulf of Carpentaria, (2) Lolworth Creek System, which drains the northern part of the area, and (3) the Cape-Campaspe River System, draining the south-eastern part. Lolworth Creek and the Cape and Campaspe Rivers drain towards the Pacific Ocean via the Burdekin River.

In Figure 1 the term Ranges indicates simply elevated areas of rugged relief, which in places contrast strongly with the adjacent plains and hills; it does not imply areas surrounded on all sides by country of markedly lower elevation; the average elevation of the Cargoon High Plain and of much of the Dissected Hilly Terrain in the north-west is about the same as that of part of the Ranges.

The Ranges occupy two areas, the west-south-west trending Lolworth Range, which is the dominant physical feature of the area, and a narrow, north-west-trending belt of rugged metamorphic strike ridges (referred to as "the quartzite belt" in this report), which forms part of the Great Dividing Range. (N.B. the term "Great Dividing Range" is used on maps of eastern Australia to mark the main divide which separates streams flowing east towards the Pacific Ocean from those flowing west towards the Gulf of Carpentaria, and the interior of the continent. In places this divide does not coincide with any marked range of hills).

The summit of the Lolworth Range consists of an undulating elongate plateau. Although elevated, it is of rather low relief, and poorly defined. The summit zone becomes more distinct towards the north-east, where it culminates in Mount Stewart, the highest peak in the Sheet area. Mount Stewart rises abruptly 1500 feet above the plain to the north-east, but it and its immediate neighbours rise only 600 to 700 feet above the general summit level of other hills in the Lolworth Range. To the north the Lolworth Range falls gradually away through low dissected hills to the basalt plain. The southern slopes of the range are steeper, and consist of a succession of adjacent rounded spurs, separated by narrow valleys and gorges where relief ranges from 500 to 800 feet.

The quartzite belt, which forms the remaining area of Ranges, has an average local relief of 700 to 800 feet (up to 1000 feet near Gorge Creek); in places the ridges themselves rise to 2800 feet above sea-level. On its north-eastern margin the belt rises abruptly from the plain, but to the south-west the summits of the ridges are only slightly higher than the neighbouring country. The ridges become gradually less distinct towards the north-west, and eventually merge into hilly country with disoriented drainage; to the south-east they gradually lose height, although their relief does not diminish. They end rather abruptly near Betts Creek.

Dissected Hilly Terrain occurs in a broad zone among the headwaters of the Flinders River and its tributaries, and in discontinuous zones bordering the Ranges. The drainage pattern is close in this unit, and hills are numerous. Although the hills are steep, local relief amounts to only 200-300 feet, and is commonly much less. A few prominent monadnocks, e.g., Mount Davenport, rise to 600 feet above the surrounding country.

To the north of the Lolworth Range, the Plains form a flat or gently undulating surface which slopes gradually from 2500 feet above sea-level in the north-west to 1500 feet in the north-east. The western edge of the Plains in this area forms a plateau with respect to the adjoining country (Dissected Hilly Terrain); for this reason we have distinguished the western part of the Plains as a separate sub-unit, the Cargoon High Plain. The western margin of the Cargoon High Plain is defined by the Great Dividing Range, which coincides approximately with the 2250 foot contour. West of here the country consists of hills whose summits coincide approximately with the level of the High Plain itself. They have been formed by dissection of the Cargoon High Plain, which formerly extended farther to the west. An eastern margin to the Cargoon High Plain has been set arbitrarily at the 2250 feet contour. In the west the predominantly flat surface of the Cargoon High Plain is interrupted by the two Cainozoic basalt vents of Mount Courtney and Mount Hackett, which rise to 200 to 300 feet above the surrounding plain. Along its southern margin the Cargoon High Plain merges with the low hills bordering the Lolworth Range.

Farther to the east, owing to their gradual decrease in elevation, the Plains contrast more strongly with the hills bordering the Lolworth Range. Near Lolworth Homestead a few small but steep hills, consisting of inliers of basement rocks, rise from the plain. Near Leonidas Mill, two low, shield-like rises are probably old volcanic vents.

The Recent Toomba Basalt occurs in the north-east. The basalt is bordered by a broken low scarp 10 to 15 feet high, probably corresponding closely with the original edge of the flow. The surface of the flow is extremely rough, and forms an impassable barrier to all vehicular and most other forms of transport. The southern edge of the basalt is loosely referred to locally as the "Great Basalt Wall". However, in the regional sense, it is an insignificant physiographic feature.

South of the Lolworth Range the plain is further subdivided as Dissected Plain. In places streams are incised 30 to 40 feet below plain level.

The Lolworth Range Plateau Residual forms part of the summit of the Lolworth Range. It is the only remnant of a formerly more extensive gently undulating plateau. It is bordered by a low, indented scarp. Drainage on the Plateau Residual is weak and poorly defined.

DRAINAGE AND GEOMORPHOLOGY

(a) Present Day Drainage

The headwaters of the Flinders River (Range Creek and Sandy Creek) drain the Dumbano Granite. Streams here are fairly closely spaced; they have no obvious structural control. Farther south, where the Flinders River and its tributaries drain country underlain by the Cape River Beds, the pattern is even closer and still largely uncontrolled by structure, except near the narrow quartzite belt. Here superimposed drainage has been obstructed by quartzite ridges which have caused incised meanders to develop in Morepork and Oxley Creeks north-east of the belt.

Where Lolworth Creek rises (as Duck Creek), it forms part of the poorly developed consequent drainage on the Nulla Basalt. Lake Cargoon probably developed in a depression in the surface of the basalt flow. In the north-eastern corner of the area some of the southern tributaries of Lolworth Creek have been impounded by the basalt, and a group of small lagoons has been formed. The middle reaches of Lolworth Creek are deeply incised into the basalt.

The Campaspe-Cape River system is broadly structurally controlled. The Cape River has eroded a wide, tapering valley in the less resistant biotite-rich rocks of the Cape River Beds and Ravenswood Granodiorite. Here the regional orientation of the Cape River is controlled by the trend of the underlying basement rocks. In detail the drainage pattern is open, and not strongly oriented.

(b) History of the Drainage Pattern

Part of the drainage pattern has been inherited from Tertiary erosion cycles. The earliest recognisable cycle developed on the gently undulating Miocene(?) laterite surface, of which a remnant can be recognised in the axial zone of the Lolworth Range. A study of the drainage pattern in

Photo Plate 1

Vertical stereo-pair (nominal scale 1:80,000) of part of the Lolworth Range, showing capture of the headwaters of Brandy Creek by the Campaspe River. Part of the "Lolworth Range Plateau Residual" (drained by Brandy Creek, a stream which has survived from an earlier erosion cycle), occupies the south-western part of the picture. Note the rather low relief of the summit of the range, with gorges to the north and south. For location, see Figure 2, Physiographic Sketch Map.

Photos by Adastra Ltd.

G.S.Q. Neg.

TABLE 1

STRATIGRAPHIC TABLE OF ROCK UNITS

		AGE	ROCK UNIT	LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	STRUCTURAL/ DEPOSITIONAL ENVIRONMENT	RELATIONSHIPS	CORRELATION	THICKNESS	ECONOMIC GEOLOGY
CAINOZOIC	QUATERNARY		Qa	Sand, silt, and gravel	Bordering stream channels in south-east part of area	Alluvial flats	Fluviatile	Superficial		Possibly up to 50 feet in places	Gold, water
			Q	Black soil, sandy soil, sand, rare gravel	Lake Cargoon/Duck Creek district	Plains	Residual and colluvial	Superficial		Small, but unknown	
		Recent?	Toomba Basalt Qrt	Vesicular, ropy, olivine basalt	North-east part of area	Regionally flat; in detail very rough. The "Great Basalt Wall"	Probably one flow. Terrestrial	Overlies Nulla Basalt	Kinrara Basalt (EINASLEIGH, White, 1962)	Generally 15 to 20 feet. Possibly 50 feet near vent.	
		Pliocene-Pleistocene	Nulla Basalt Czn	Olivine basalt (some inter-bedded sand lenses)	Northern part of area, east of Great Dividing Range	Plains, dissected in the east	Several flows. Terrestrial	Disconformably overlies Campaspe Beds	Sturgeon Basalt (Vine, et al., 1964)	Generally 20 to 30 feet. Possibly 100 feet near vents	Water
			Czb	Olivine basalt	Isolated occurrences	Conical hills (Mounts Courtney and Hackett, and Black Mount). Small mesa in south-east (not named)	Mounts Courtney and Hackett are ancient terrestrial vents; Black Mount may be an ancient vent.	In part equivalent to, in part younger than, the Nulla Basalt		May be 200 to 300 feet at vents. Elsewhere 20-30 feet	
	TERTIARY	Pliocene?	Tl	Nodular to pisolitic ferricrete; ferruginous buck shot gravel	South of Cape River	Plains and low mesas	Lateritic weathering profile	Recognised only on Campaspe Beds		Maximum 3 to 4 feet.	
		Pliocene?	Campaspe Beds Tc	Unsorted argillaceous sandstone, conglomerate, rare siltstone; commonly micaceous; locally ferruginous	Around foot of Lolworth Range, and in low country around Pentland	Plains and low mesas	Terrestrial, sheet-like; torrential piedmont deposit	Unconformable on Miocene(?) ferricrete (Betts Creek)		Up to 50 feet	Gold, water
PALAEOZOIC	UPPER PERMIAN		Pum	Pink, porphyritic leucocratic microgranite; granitic intrusion-breccia	Eastern extremity of Lolworth Range	Microgranite forms rugged hills up to 3300 feet a.s.l. (Mount Stewart); breccia forms a small, dissected depression 5 miles west-north-west of Mount Stewart	Microgranite occurs as an oval stock, up to 5 miles across; breccia occurs in a small plug, up to ½ mile across. Epizonal	Intrudes Lolworth Igneous Complex	Other Upper Palaeozoic epizonal igneous complexes in the Cairns-Townsville Hinterland (White, 1961, Branch, 1962)		Gold, copper, wolfram, lead, bismuth, pyrite, minor molybdenite and torbernite

AGE		ROCK UNIT		LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	STRUCTURAL/ DEPOSITIONAL ENVIRONMENT	RELATIONSHIPS	CORRELATION	THICKNESS	ECONOMIC GEOLOGY
PALAEOZOIC	UPPER PERMIAN	Mundic Igneous Complex	Pud	Porphyritic micro-adamellite (photo-interpretation only)	One small body 5 miles south-south-east of Mount Stewart	Rugged crater-like depression	Small boss 2/3 mile across	As for Pum	As for Pum		As for Pum
		Puv		Conglomerate with granitic and volcanic boulders; rhyolite, tuff, tuffaceous siltstone and sandstone	Range Creek area; Betts Creek area	Rugged to undulating country of moderate relief near Range Creek. Hills, cappings, and low rises near Betts Creek	Terrestrial, near shoreline of inland sea. Intermittent vulcanicity	Unconformably overlies Dumbano Granite and older rocks. Unconformably overlain by Sturgeon Basalt	Probably equivalent to Betts Creek Beds (Vine et al., 1963)	Up to 200 feet	Gold
		Pzg		Pink coarse leucogranite; light-grey hornblende-biotite adamellite; medium grey quartz diorite	Leucogranite occurs three miles south-south-east of Pentland; adamellite and quartz diorite at Gypsy Pocket	Low undulating rises	Stocks (epizonal?)	Leucogranite intrudes Ravenswood Granodiorite; other rocks intrude Cape River Beds			
	LOWER DEVONIAN	Lolworth Igneous Complex Dli		Porphyritic biotite adamellite and granodiorite; garnet-muscovite granite and adamellite; quartz diorite; muscovite pegmatite dykes and sheets	Lolworth Range and environs. Mount Remarkable and Mount Specimen	Rugged, broken country of the Lolworth Range, with bordering hills and rises	Part of a post-orogenic batholith	Intrudes Cape River Beds and Ravenswood Granodiorite			Gold and minor sulphides, associated with pegmatite dykes
		Dumbano Granite Dlg		Porphyritic biotite adamellite, foliated in places; garnet-muscovite granite; muscovite pegmatite dykes and sheets	Between Gargoon Homestead and Range Creek	Unevenly dissected rises and low hills	Late syn-orogenic and post-orogenic	Intrudes Cape River Beds			Silver and gold; minor copper, lead, and antimony
	SILURIAN	Ravenswood Granodiorite	Sa	Foliated, red and pink, leucocratic biotite granite and microgranite; biotite pegmatite dykes and sheets	Chiefly in a restricted belt north-east of Pentland. Lesser outcrops near Cornelia Homestead	Pentland outcrop forms low rises; Cornelia outcrop forms a hill 300 feet above the plain	Late synorogenic batholith	Intrudes the remainder of the Ravenswood Granodiorite			
			Sg	Foliated white biotite adamellite	Between Cornelia Homestead and Granite Creek	Low undulating rises		Intrudes the Cape River Beds			
			Sn	Foliated and gneissic adamellite and granodiorite; gneiss; rare migmatite	Broad belt extending north-west and west of Pentland. Small area west of Davey Creek	High strike-ridges near Gorge Creek with up to 1,000 feet of relief. Undulating low rises elsewhere					

AGE	ROCK UNIT		LITHOLOGY	DISTRIBUTION	TOPOGRAPHY	STRUCTURAL/ DEPOSITIONAL ENVIRONMENT	RELATIONSHIPS	CORRELATION	THICKNESS	ECONOMIC GEOLOGY
EARLY PALAEOZOIC	Cape River Beds	Pzq	Chiefly quartzite, with interbedded quartz-mica schist and amphibolite	Narrow axial belt within main outcrop area, widening south-eastwards	High rugged strike-ridges formed by quartzite bands. Relief up to 1,000 feet	Possibly geosynclinal, although the quartzites are rather pure. Grade of metamorphism corresponds to high greenschist, and locally to almandine amphibolite facies of regional metamorphism	Oldest rocks in the Sheet area		Unknown, but probably many thousands of feet	Gold-bearing, but gold believed to be related to the Lolworth Igneous Complex
		Pzc	Mica schist, phyllite, quartz-mica schist, biotite gneiss,* amphibolite; rare calc-silicate rocks, metamorphosed greywacke and tuff *garnet-biotite gneiss,	Broad belt extending for 65 miles north-west from Pentland towards Oaky Creek	Steep hills with close drainage pattern in the north-west. Low rises with rare steep hills in the south-east					

the Lolworth Range shows that two streams (Brandy Creek and the Campaspe River) which now join the eastward-flowing drainage, have successively beheaded a major westward-flowing stream, the ancestral Glen Creek, which rose near Mount Stewart (see photo plate 1). Accordingly it is thought that in Miocene(?) times the major divide lay much farther to the east than at present. Furthermore, a hypothetical ancient peneplain can be reconstructed sloping gently to the south-west, and coincident with the summits of the Lolworth Range, the Great Dividing Range, and the White Mountains. It is believed that river capture by easterly flowing streams caused the old divide to migrate fifty or more miles to the west during the dissection of this peneplain. During this migration, which possibly occupied late Miocene and early Pliocene times, the Cape River eroded a wide valley, and, together with Lolworth Creek, the Campaspe River, and Betts Creek, captured streams which formerly flowed west and joined the Flinders River. During this period the Lolworth Range and the quartzite strike ridges emerged as features.

By the time the Campaspe Beds were being deposited (Pliocene?) the present-day regional drainage pattern had emerged. Outpourings of basalt in Pliocene-Pleistocene times (Nulla Basalt) engulfed small streams which had developed on the plains to the north of the Lolworth Range, and in places modified the course of Lolworth Creek. Later, small consequent streams developed on the Nulla Basalt.

REGIONAL GEOLOGY

(The stratigraphy of the area is summarised in Table 1)

(a) EARLY PALAEOZOIC

Cape River Beds

The oldest rocks on HUGHENDEN are early Palaeozoic(?) schist, gneiss, and quartzite which crop out in a belt extending for 65 miles north-west of Pentland. They are regarded at present as early Palaeozoic.

These rocks were first described by Daintree (1868) who later (1870) named them "Cape River Series". Other workers, in particular Rands (1891 and 1894) and Marks (1910), noted and briefly described the occurrence and lithology of some of these rocks.

After the regional geological mapping of this area in 1963 the name "Cape River Metamorphics" was proposed and accepted for these rocks. However, further mapping on CHARTERS TOWERS in 1964 (Wyatt et al., in prep.) has indicated that there are quite large areas of sediments (chiefly labile arenites and siliceous siltstones) which are probably the non-metamorphosed equivalents of the metamorphics on HUGHENDEN. The name "Cape River Metamorphics" has therefore been withdrawn, and "Cape River Beds" has been proposed for the entire sequence of metamorphics and sediments.

Daintree described all metamorphic rocks in the Pentland area as his "Cape River Series". However, the recent regional mapping has indicated that orthogneiss occurs in the country between Gorge Creek and Pentland, and therefore we have preferred to map such rocks as part of the Ravenswood Granodiorite, rather than include them in the Cape River Beds. To this extent the proposed name "Cape River Beds" has a more restricted meaning than Daintree's "Cape River Series". Small pods and sheets of granitic rocks, together with metamorphosed dykes and sills, have, in places been mapped with the Cape River Beds, because they are too small to map individually at 1:250,000 scale.

Daintree recognised a threefold division in his Cape River Series: basal schist and gneiss in the north-east, followed by mica schist and subordinate hornblende schist, with an upper subdivision of quartzite and subordinate schist forming the country to the west (the Great Dividing Range). Planar structures in the metamorphics commonly dip to the south-west; however, they represent metamorphic foliation and schistosity rather than sedimentary layering, and we therefore hesitate (with Rands, 1894) to infer any particular sedimentary succession from our limited field observations.

Distribution and Topography

The unit occupies 400 square miles, extending in a 65-mile belt from Pentland north-west to Oaky Creek. Around Pentland, where the Cape River Beds are intruded by the Ravenswood Granodiorite, the unit occurs as separate roof pendants. Minor outcrops occur at the head of Inkerman Creek, south-east of the Lolworth Range, and again north-west of Lolworth Homestead, where they occur as small inliers emerging above the basalt plain.

In the north-west the undifferentiated part of the unit (Pzc) forms low but steeply dissected hills with broadly coincident summits. This coincidence is due to their having been relatively recently exhumed from beneath Cainozoic basalt which had been extruded on a flat land-surface. In the south-east, where base-level of the creeks is controlled by the level of the Cape River, exhumation from beneath the Campaspe Beds (Pliocene ?) is less advanced, and dissection not so well developed. Here, and in the intervening country occupied by the valley of the Cape River, the surface is rather uneven; steep hills, e.g., Mount Richardson and Mount Davenport, rise above an undulating surface of low hills and plains. The quartzite sub-unit (Pzq) forms high, rugged strike ridges, whose relief is about 1000 feet in the south-east. Along much of the eastern boundary between this sub-unit and the remainder of the unit there is a strong escarpment, which forms one of the most striking physical features in the area.

Lithology

(a) Undifferentiated (Pzc)

In the north-western part of the belt the rocks range from phyllite and quartzite in the greenschist facies to amphibolite and garnet-biotite gneiss. In general the higher grade rocks are found along the north-eastern margin of the belt, i.e., closer to granite of the Lolworth Igneous Complex.

South and east of Lake Cargoon, scattered outcrops of biotite-quartz-feldspar gneiss are surrounded by alluvium; in some places a dark red garnet is present in zones parallel to the north-west foliation, whereas elsewhere the gneiss has been shattered, and the fragments have been rotated and then cemented by quartz and tourmaline. Quartz and biotite are associated in lenticular segregations in the gneiss, which here has a granodioritic composition. Veins and sheets of aplitic and pegmatitic garnet-biotite-muscovite granite cut the gneiss in varying attitudes; the garnets in this granite are a much lighter red than those in the gneiss.

Amphibolites occur in Range Creek, south-west of the Mount Emu diggings; they are similar to amphibolites of the Ewan Metamorphics at Ewan (on TOWNSVILLE) — hornblende-plagioclase rocks, with some sphene and epidote — and are cut by coarse, hornblende-plagioclase pegmatites, quartz-alkali feldspar veins, and by quartz-epidote veins. Although their foliation is broadly parallel to the regional trend, the amphibolites may slightly transgress the mica-schists which surround them.

In the Morepork Creek area the dissected country consists of mica schists and metamorphosed arenites (some calcareous), which are folded, foliated, and extensively veined by quartz. Quartzose bands in the sequence illustrate the microfolding; they are dark grey-green, fine-grained rocks, with biotite and a little muscovite developed parallel to each other and (usually) parallel to the foliation defined by the more mica-rich schists. The mica content ranges from about 5 percent in the quartzose rocks to about 70 percent in the most pelitic bands; muscovite and biotite are generally of equal abundance.

Near the Dumbano Granite the mica schists are interbanded in lenticular masses with white muscovite granite and biotite adamellite; gradations exist between the three rock types. The schists here are composed mainly of mica and quartz; feldspar is less abundant.

In the central part of the belt the following types of rock have been recorded: quartzofeldspathic gneiss and schist; garnet-mica-quartz gneiss; tremolite-epidote-quartz-feldspar gneiss; augen gneiss; metamorphosed feldspathic greywacke. The last-named rock (which

Photo Plate 2:

Northern bank of Cape River, 1.5 miles north - west of Oakvale Homestead. Intricately folded biotite gneiss of the Cape River Beds, intruded by a narrow dyke of biotite adamellite. This dyke is probably associated with the post-orogenic Lolworth Igneous Complex; it is essentially rectilinear.

B.M.R. Neg. No.G/6827.

Photo Plate 3:

In creek bed near road crossing, 2 miles west-north-west of Oakvale Homestead. Finely banded biotite gneiss of the Cape River Beds, with concordant lenses of quartz-epidote pegmatite. In places these lenses contain hornblende and tourmaline.

B.M.R. Neg. No.G/6818

occurs beside the road two miles south-east of Mount Richardson) appears to be of lower metamorphic grade than the biotote schist with which it is interlayered. It contains clastic fragments of mica schist.

Muscovite in this area is usually subordinate to biotite. Augen of quartz up to nine inches long, locally containing large epidote and hornblende crystals, occur throughout the gneisses; irregular sheets of quartz commonly occur parallel to the foliation, but locally transgress it. The augen gneiss consists of quartz, feldspar, tremolite-actinolite, sphene, and altered hornblende. This rock occurs as a narrow band within biotite schists one mile south of where Oxley Creek crosses the western boundary of the belt of quartzites. It is similar in composition to the tremolite-epidote-quartzo-feldspathic gneisses, which are massive, fine-grained, green and white laminated rocks. These gneisses generally form bands, about one foot thick, apparently interbedded with fine biotite gneisses. Although the bands are in general parallel to the foliation of the enclosing gneiss, they locally transgress it, and in places lens out rather suddenly. Near Black Gin Creek a band of tremolite gneiss cuts across the foliation of the host gneiss, and has been shear-folded by movements in the foliation plane of the host gneiss. It is possible that the tremolite gneisses represent small bodies of intrusive rocks. If, on the other hand, they were originally interbedded siliceous-calcareous sediments, the metamorphic foliation makes a high angle with bedding. This would be at variance with observations elsewhere within the central part of the belt, where metamorphic foliation is parallel to bedding, for example, in a creek section two miles west-north-west of Oakvale Homestead.

In the <u>south-eastern</u> part of the belt the Cape River Beds occur in discontinuous areas separated by the Ravenswood Granodiorite. These occurrences are interpreted as roof-pendants. Biotite-muscovite schist predominates, grading in places to foliated granodiorite. Small, localised areas of migmatite have been found in these transition zones, which abound with xenoliths of schist in all stages of assimilation.

The rocks forming Mount Davenport and its foothills occur as a large roof pendant on the Ravenswood Granodiorite. They are chiefly rather pure muscovite schist (no biotite), but at the southern foot of the mountain amphibolite, muscovite quartzite, and hornfelsed feldspathic sediments occur. The muscovite schists, which are commonly iron-stained to a lustrous, brownish-red, are intruded by thin sills of metamorphosed biotite microgranite and microgranodiorite, which may possibly be related to the Ravenswood Granodiorite. The muscovite schists contain microcline and other alkali feldspar.

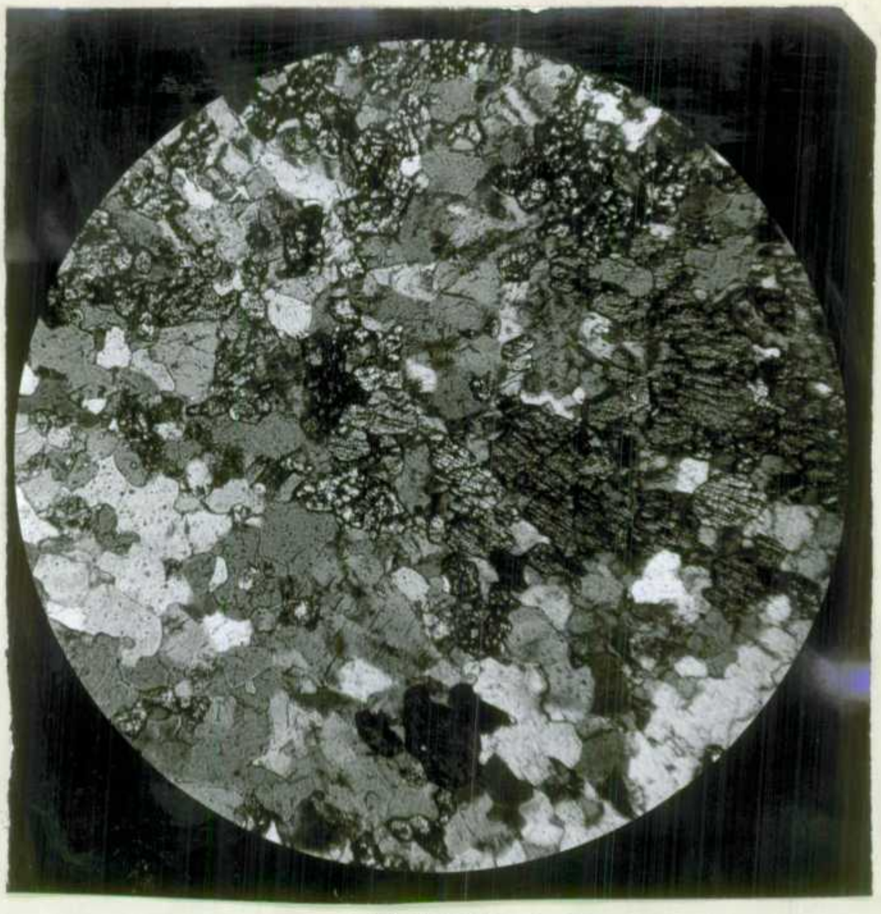


Photo Plate 4:

Diopside granofels, Cape River Beds, one mile north-west of Kiora H.S. The rock consists of diopside, quartz, actinolite, albite-oligoclase, and epidote. Diopside, quartz, and felds-par appear in the photograph. Albite-oligoclase occurs in the bottom centre of the picture.
Crossed nicols. X45. Microslide No. G.S.Q. 15019. B.M.R. Neg. No. G/6740.

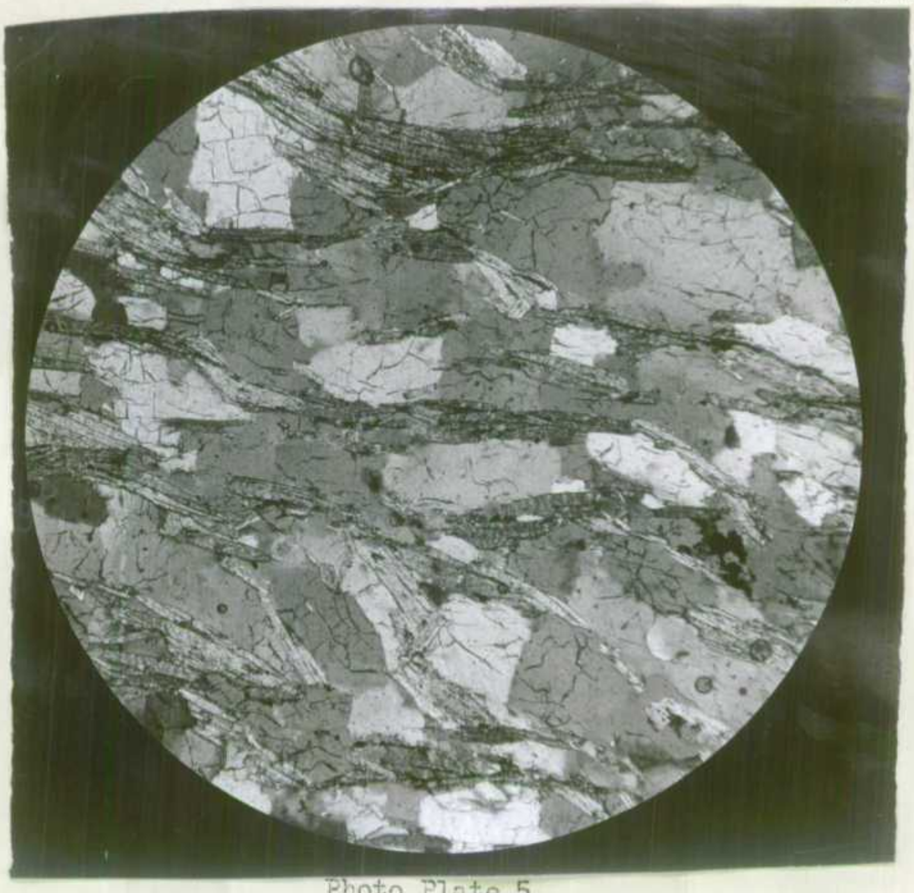


Photo Plate 5

Hematitic muscovite schist, Cape River Beds, 1.2 miles north-west of Kiora H.S. Muscovite, quartz, and minor hematite (e.g., in the south-~~west~~ east quadrant). Crossed nicols, X45. Microslide No. G.S.Q. 15003. B.M.R. Neg. No. G/6749.

Hematitic muscovite schists (photo plate 5) and hematitic muscovite-cordierite schist form low ridges about one mile north-west of Kiora Homestead, but a hundred yards or so to the south-west diopside granofels (photo plate 4) crops out. Marble and calcareous hornfels form a small roof pendant on the Ravenswood Granodiorite beside the road one mile north of Mount Remarkable.

A small outcrop beside the Campaspe River, four miles north of Mount Davenport, consists of finely banded, pink, granitic gneiss; it is intruded by folded and boudinaged biotite pegmatite, and by later rectilinear veins of muscovite pegmatite. Much of this biotite pegmatite (locally garnetiferous) is believed to be related to the granitic phase (Sa) of the Ravenswood Granodiorite; the muscovite pegmatite (usually garnetiferous) is related to the Lolworth Igneous Complex.

Garnet-biotite-muscovite schist and gneiss, with some amphibolite, crop out in one of the eastern tributaries of Fat Hen Creek, three miles north-west of Cornelia Homestead. Low, linear outcrops of dark green, altered, coarse tremolite-chlorite rock occur one and a half miles east-south-east of Cornelia Homestead.

Half a mile south-east of Capeville Homestead an interesting rock crops out where a creek meets the southern margin of the Cape River alluvial flat. The rock consists of scattered, elliptical fragments of altered feldspar and microcline-quartz-biotite rock up to half an inch long, in a greenish-purple, very fine-grained matrix of chlorite and sericite. Cleavage is strongly developed in the groundmass, and flakes of chlorite and sericite are bent around the fragments. The rock is probably a metamorphosed pyroclastic containing phenoclasts of granite (microcline-quartz-biotite). If so, its presence in this sequence is strange. It is apparently of much lower metamorphic grade than the schists and gneisses of the area; no contacts were seen in the field. If the fragments are indeed phenoclasts of granite in a pyroclastic rock, and if the rock belongs with the Cape River Beds, then the phenoclasts were presumably derived from the basement (granite) on which the Cape River Beds were laid down. Similar rock was found forming a steep ridge beside Cornelia Creek, one and a half miles south-east of Cornelia Homestead. It is possible that these rocks are mylonitised granite. However, weakly foliated, but otherwise unaltered pink leucocratic granite of the Ravenswood Granodiorite (Sa) crops out a few hundred yards to the north-east. However, it may be that this rock, together with the metamorphosed feldspathic greywacke mentioned above, is evidence for the existence of remnants of a younger, scarcely metamorphosed, sequence infolded within the Cape River Beds. However much more field-work would be required to prove or disprove the reality of such a sequence.

(b) Belt of Quartzites (Pz_q)

The central belt of the Cape River Beds consists of prominent strike ridges formed by the resistance to erosion of thin bands of rather pure quartzite, interbedded with easily eroded grey quartz-mica schist. The following rock-types have been recorded: quartzite; quartz-mica schist; quartz-muscovite schist; quartzo-feldspathic amphibolite; rare andalusite(?) - mica schist. Rather pure quartzite and grey quartz-mica schist are the chief rock-types. The quartzofeldspathic amphibolites are interbedded with quartzite in Black Gin Creek; they consist largely of colourless or pale green tremolite. Epidote-quartz hornfels is developed in quartzite close to the Gypsy Pocket granitic intrusion (Pzg). Concordant sheets of rhyolite (possibly late Palaeozoic) intrude quartzite near Gypsy Pocket. Small lenses of quartz, up to nine inches long, occur parallel to the foliation within the quartz-mica schists.

Bedding in the quartzite belt is apparently parallel to the foliation. In the north-west, individual beds of quartzite average three to five feet in thickness between beds of mica schist of similar width. The quartzite beds appear to thicken towards the south-east at the expense of the schists. Individual beds of quartzite may be up to 100 feet thick.

Structure

The overall structural trend of the Cape River Beds is remarkably constant; the foliation strikes north-west and dips vertically, or at steep to moderate angles to the south-west. Steep, north-easterly foliation dips occur in the quartzite belt, chiefly in the south. Near Lake Cargoon shallow dips to the north-east were recorded in relatively competent bands of a quartzite-schist sequence. Schist, phyllite, and fine-grained quartzose rocks near Mount Cracknell show large-scale structures; On the air photographs folds have not been positively identified, except in the belt of quartzites (Pz_q) which displays the tectonic style better than the remainder of the unit. Two possible folds have been photo-interpreted in the schists in the north-west, but the easterly one (immediately west of Lake Cargoon) is not entirely in accordance with field observations. Synclinal closures occur at both ends of the quartzite belt, which may comprise the youngest part of the sequence. Sudden changes in width of the quartzite belt (e.g., south of Gypsy Pocket) are tentatively attributed to fold closures which are otherwise not apparent. It is evident that the sequence has been isoclinally folded. Shallowly dipping foliation probably indicates near-recumbent folding in restricted areas. Lineation, expressed by the axes of small drag-folds, plunges to the south-east at angles ranging from 10 to 30 degrees. In the north-west the plunge of lineations is believed to parallel the axes of the major structures which here are largely synclinal. A measured synclinal closure at the south-eastern end of the quartzite belt indicates a reversal of plunge in this area.

The structure of the schists at Mount Davenport is regionally anomalous: at the summit the dip of the schistosity is 10 degrees to the north, and at the base of the hill moderate south-westerly dips were recorded in the south-west, and moderate easterly dips in the east. This structure may have been caused by an irregularity in the basement. Just north of Pentland the foliation strikes north-north-west.

In the north-west, numerous north-west trending lineaments are apparent on air photographs; many of these may be faults. Faults of similar strike occur north of Mount Remarkable. Numerous faults trending just north of east cut the quartzite belt and cause up to half a mile of apparent horizontal displacement. Farther south transcurrent faults trend north-east. Movement is mainly sinistral, but dextral movement can be detected in places.

The deformation is believed to have been the result of north-east-south-west compression. The east-north-east trending faults are probably wrench-faults. The north-west trending strike faults are possibly dip-slip faults with high-angle reverse movement.

Thickness (Pz_q)

The belt of quartzites is apparently the only part of the Cape River Beds in which contrasting rock-types can be easily identified and, if necessary, mapped. Here the alternations in lithology may represent the original sedimentary succession. However, transpositions of beds, resembling sedimentary layering, have been reported in metamorphic sequences elsewhere (Turner and Weiss, 1963, pp. 92-94, 111). The folding is apparently isoclinal; and the scarcity of recognisable closures, combined with the uncertainty in tracing one quartzite bed around any particular closure, frustrates any estimate of thickness. Elsewhere the structure of the deeply eroded schists and gneisses is not well known. Therefore it is not possible to give an estimate of the original thickness of the unit in anything but very general terms. It almost certainly amounts to many thousands of feet.

Metamorphism

No systematic petrological study has been made of the Cape River Beds. But it can be stated in general terms that most of the rocks probably fall into the quartz-albite-epidote-biotite subfacies of the greenschist facies of regional metamorphism (Turner and Verhoogen, 1960). Some of the rocks are of lower grade than this (e.g., in the extreme north-west), whereas others probably belong to the almandine-amphibolite facies. Neither staurolite, kyanite, nor sillimanite have so far been recorded. Possible andalusite was noticed in some rocks (R.R. Vine, pers. comm.), but has not been positively identified. No section was cut from the rare migmatites (mapped, at this scale, with the Ravenswood Granodiorite), but they may possibly contain high-grade minerals. Insufficient field work has been carried out to be sure whether or not the metamorphism is related to granitic intrusions. However, on present evidence we strongly suspect that the Lolworth Igneous Complex and the Ravenswood Granodiorite have controlled the degree of recrystallisation.

Original Lithology

The Cape River Beds were laid down as a thick sequence of shale, siltstone, and sandstone, which gave rise to schist, gneiss, and quartzite. Locally calcareous and dolomitic sediments gave rise to amphibolite, tremolite schist and gneiss, marble, and pyroxene hornfels. Volcanic rocks cannot be ruled out as possible progenitors of some of the strongly recrystallised schists and gneisses.

Age and relationships

The Cape River Beds are intruded by the Ravenswood Granodiorite (Silurian) and Lolworth Igneous Complex and Dumbano Granite (Lower Devonian). The Cape River Beds are overlain unconformably by the Upper Permian Betts Creek Beds.

The unit bears a certain resemblance to the Paddy's Creek and Lucky Creek Formations of CLARKE RIVER, which have been mapped as Proterozoic. Mapping on CHARTERS TOWERS in 1964 has shown that the Cape River Beds are more likely to be early Palaeozoic rather than Precambrian.

Mineralisation

Much of the gold mineralisation is associated with dykes which intrude the Cape River Beds. Many of these dykes are believed to be related to the Lolworth Igneous Complex.

Grains of pyrite, aligned in thin bands parallel to the foliation, were noticed in mica schist in a hornfels zone north of Gypsy Pocket.

(b) SILURIAN

Ravenswood Granodiorite

Extensive outcrops of granodioritic rocks in the Pentland district are considered to be an extension of the Ravenswood Granodiorite batholith. Much of the outcrop area, especially immediately north and west of Pentland, was mapped by Daintree, (1870) in his "Cape River Series". He described (1868) the lowest subdivision of this Series as "laminated granite, mica, and hornblende slates", stating that, "near the junction of the schistose and granite rocks, so great has been the alteration, that it is difficult to say where the schists end and the granite commences". In the area mapped by

Daintree as underlain by his "Cape River Series" we have differentiated rocks which we consider to be predominantly metasediments (Cape River Beds) ~~from~~ From intrusive, granitoid rocks of granodioritic to adamellitic composition, which we have included in the Ravenswood Granodiorite. These rocks intrude the Cape River Beds.

On HUGHENDEN much of the Ravenswood Granodiorite is foliated on a strike similar to that of the metamorphics. In this area it is essentially synorogenic with respect to the metamorphics which it intrudes. Both the Cape River Beds and the Ravenswood Granodiorite have been intruded by a post-orogenic batholith (Lolworth Igneous Complex).

Two sub-units have been differentiated, one characterised by strongly foliated "granodiorite" and orthogneiss (Sn), and a later, pink granite phase (Sa). Foliation is widespread and characteristic of the unit. A preliminary age determination on hornblende from the Ravenswood Granodiorite from the TOWNSVILLE Sheet area has given a Silurian age (420 million years) (determination by A.W. Webb at the Department of Geophysics, Australian National University).

Distribution and Topography

The unit extends from north-west of Gorge Creek south-east in a broad belt which widens to include most of the basement rocks between the Campaspe River and the Great Dividing Range. A minor outcrop area occurs among the headwaters of Davey Creek, five miles south-west of Lolworth Homestead. In all, the unit covers about 120 square miles within the Sheet area. Around Gorge Creek the gneisses (Sn) give rise to high, resistant, strike-ridges which rise 1000 feet above the Cape River, and form the south-western part of the Lolworth Range. Along strike to the south-east these ridges pass rather suddenly into the gently undulating, low-lying country which is typical of the unit as a whole. Outcrop here is poor, and must be sought in small creeks and gullies. A short, steep ridge, one and a half miles east of Cornelia Homestead, and rising about 300 feet above the plain, consists of the late granite phase (Sa).

Lithology

(a) Gneisses (Sn)

This sub-unit consists chiefly of plutonic rocks which have undergone various degrees of shearing and recrystallisation. They are coarsely (rarely finely) banded, dark and pale grey rocks, consisting of crudely alternating bands of dark (chiefly biotite) and light minerals (quartz and feldspar). In places the feldspar is tinged slightly pink. It may be noticeably porphyritic. In general the rocks are regarded as orthogneisses, but in the hilly country around Gorge Creek, some paragneisses almost certainly occur, broadly interfoliated with the orthogneisses. The rocks are igneous in

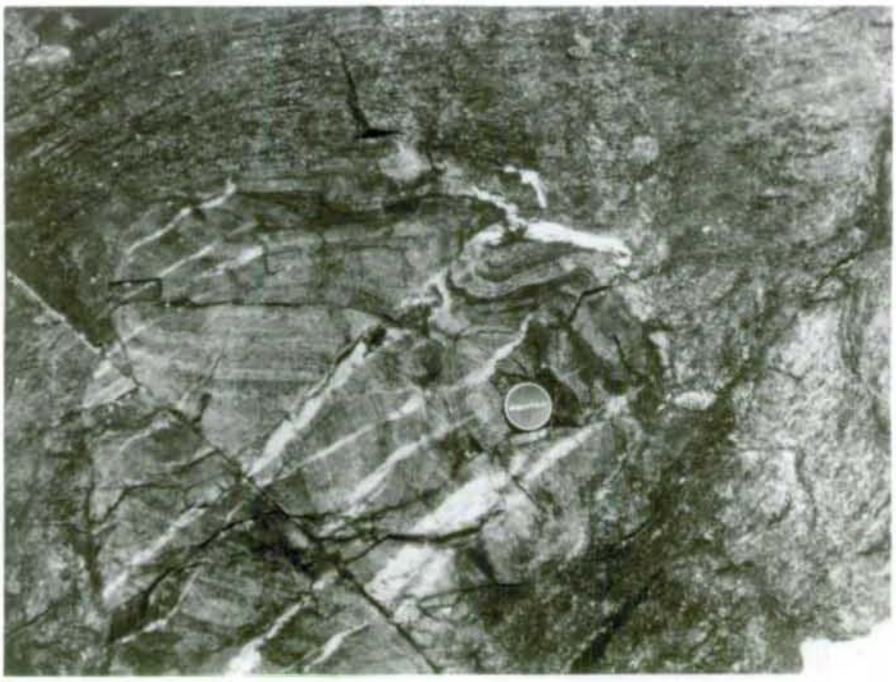


Photo Plate 6

In creek bed east of Gorge Creek, 3.6 miles north-north-west of Oakvale Homestead. A rounded xenolith of contorted mica-schist with quartz veins, in gneissic adamellite of the Ravenswood Granodiorite. Camera lens hood gives scale.

B.M.R. Neg. No. G/6816.

aspects, and some outcrops contain abundant xenoliths of schist and gneiss (Photo Plate 6). Flow-folding is locally well developed.

Rocks of the sub-unit are rich in biotite. The following types have been recorded (mainly from the Gorge Creek area where outcrops are fresh and plentiful): grey, fine to medium, foliated adamellite; dark-grey, uneven-grained gneissic adamellite; dark-grey, fine-grained, crudely foliated, blastoporphyritic gneiss; dark-grey, uneven-grained, schistose, garnetiferous augen gneiss; dark-grey, uneven-grained, mica-quartzofeldspathic gneiss (this rock may be a paragneiss); and rare black, lustrous, fine-grained, foliated meladiorite. Biotite commonly amounts to 20 percent; in one rock biotite and muscovite together total 35 percent, and alkali feldspar (25 percent) is completely pseudomorphed by sericite. The plagioclase (15 to 30 percent) is mainly oligoclase, and quartz ranges from 25 to 40 percent (50 percent in the probable paragneiss). Meladiorite was found only at the head of Gorge Creek; it contains 10 percent quartz, and 45 percent each of andesine and hornblende. The augen gneiss contains augen of alkali feldspar (partly replaced by quartz), micropegmatite and blastopoikilitic garnet (partly replaced by biotite); flow-lines of biotite about the garnet crystals indicate that crystallisation of garnet was succeeded by at least one stress episode. In most rocks, however, the effects of stress have been largely obliterated by recrystallisation, perhaps owing to the intrusion of the nearby Lolworth Igneous Complex.

In the low-lying country to the south and east specimens suitable for thin-sectioning are not easy to obtain, because the rocks are usually weathered and friable. The sub-unit here consists chiefly of foliated dark to pale grey granodiorite, locally very rich in biotite, and crowded with xenoliths of biotite schist. In places foliated granodiorite seems to grade into schist. "Pockets" of biotite-rich, almost black, rock occur in places among outcrops of more normal granodiorite. Rare zones of migmatite are developed.

The area occupied by this sub-unit south-west of Lolworth Homestead consists chiefly of gneissic adamellite.

(b) Pink Biotite Granite (Sa)

Several apparently well-defined outcrops of foliated granite are mapped as part of the unit. The largest outcrop, north-east of Pentland, consists of strongly foliated and crudely banded, pink and red biotite granite: quartz (40 percent) is sheared and partly recrystallised; microperthite (35 percent) is bent and slightly altered; plagioclase (15 percent) is highly fractured; biotite (10 percent) is in general associated with recrystallised quartz. The outcrops east and north-west of Cornelia Homestead consist of weakly foliated, pink biotite leucogranite. Xenoliths of pink to buff,

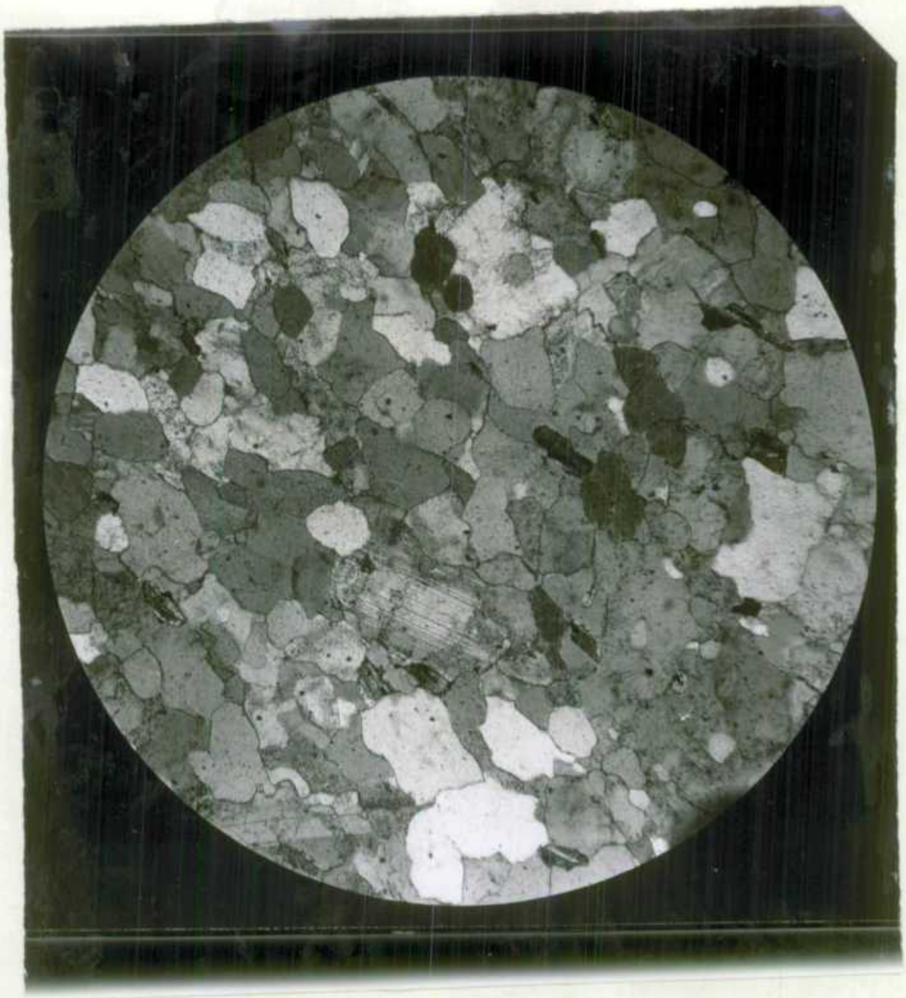


Photo Plate 7

Microadamellite; xenolith, probably late granite phase (Sa) of Ravenswood Granodiorite, in Lolworth Igneous Complex, 4 miles north of Cornelia Homestead. The long axes of plagioclase, quartz, and biotite are sub-parallel in west-north-west direction. Two grains of biotite are visible just below the twinned plagioclase (oligoclase) in the lower central part of the photograph.
Crossed nicols, X45. Microslide No.G.S.Q. 15018.
B.M.R. Neg. No. G/6746.

leucocratic, foliated, biotite microgranite and granite (s.l.) occur in the Lolworth Igneous Complex just north of Cornelia Homestead (photo plate 7). Biotite pegmatite dykes in the area are considered to be associated with this phase of the unit; they are commonly folded and boudinaged. Some of the pegmatites are garnetiferous.

(c) Undifferentiated Ravenswood Granodiorite (Sg)

An area underlain by poorly outcropping, foliated, biotite granodiorite or adamellite occurs between the Cape River and Granite Creek, near Mount Davenport. The rock here is only moderately foliated, and is apparently more homogeneous than the remainder of the unit. In fact it resembles the main part of the Ravenswood Granodiorite on CHARTERS TOWERS. Outcrops occur in the left (north-east) bank of the Cape River, at the Flinders Highway crossing. Here the rock is a pinkish-white, rather weathered, coarse, slightly porphyritic, a moderately foliated, biotite granodiorite or adamellite. It is intruded by frequent veins of coarse biotite pegmatite. Location of the boundary between this undifferentiated part of the unit and the gneissic sub-unit (Sn) is arbitrary.

Structure and Tectonic Environment

Foliation in the unit dips regionally to the south-west at moderate to steep angles. Parts of the later granite sub-unit (Sa) near Pentland have an almost horizontal foliation. The degree of foliation varies widely, and is greatest in the north-west. The contact of the unit with the Cape River Beds is regionally discordant, but approaches concordance in the north-west. In the country south of Ballabay Homestead and south-east towards Pentland the contact is sub-horizontal and close to the surface; its ~~position~~ trend in plan is modified by very small changes in topography; it is also gradational. Its mapped position therefore is very approximate.

The Ravenswood Granodiorite is considered to have been affected by the closing stages of the orogeny which folded and metamorphosed the sediments of the Cape River Beds.

Age and Relationships

As stated above a specimen from the Ravenswood Granodiorite on TOWNSVILLE is Silurian. Samples have been collected from the HUGHENDEN area for radioactive age-determination, but results are not yet available.

The Ravenswood Granodiorite intrudes the Cape River Beds, and is intruded by the Lolworth Igneous Complex.

Order of Emplacement

The biotite granite phase of the unit intrudes the granodiorite/gneiss phase. However, because parts of the granite phase are more strongly foliated than parts of the granodiorite, degree of foliation is clearly more indicative of local tectonic environment than of order of emplacement. For this reason it is not possible to say whether the more strongly foliated gneisses at Gorge Creek, are older or younger than the less foliated granodiorite.

Origin

Rare occurrences of migmatite suggest that parts of the Ravenswood Granodiorite may have originated by metasomatism of sedimentary material. At all events, abundant xenoliths of schist in all stages of assimilation indicate that the magma suffered considerable contamination. Parts of the unit may have been emplaced by a process of invasion and transformation of the schists and gneisses by "migma", as envisaged by Read (1957).

Mineralisation

None of the widespread mineralisation in the area was positively identified as being related to the Ravenswood Granodiorite. However, the rock unit as a whole should be regarded as a potential source. The gold mineralisation at Charters Towers is controlled by dykes which intrude the Ravenswood Granodiorite, and which may be genetically related to it.

C. LOWER DEVONIAN

Lolworth Igneous Complex

The Lolworth Igneous Complex is a body of granitic rocks, of batholithic dimensions, which crops out on HUGHENDEN and CHARTERS TOWERS, and to a very minor extent on TOWNSVILLE.

The Complex consists of coarse massive granitic rocks, ranging from biotite granodiorite and biotite adamellite to muscovite granite. A small area of quartz diorite north of Mount Richardson is mapped as part of the Complex. All rock types can be conveniently considered as part of a post-orogenic batholith which discordantly intrudes the Cape River Beds and the Ravenswood Granodiorite. A thermal metamorphic aureole is developed, but its extent was not delineated during the reconnaissance mapping. Pegmatite and granite dykes associated with the Complex intrude it and the country rocks.

A sample from the Lolworth Igneous Complex on Charters Towers has been dated radiometrically by the potassium-argon method (muscovite) at 400 million years ($\pm$ 1%), which is Lower Devonian. This agrees well with the 390 million years age obtained so far from two samples of the Dumbano Granite on CLARKE RIVER.

Distribution and Topography

The Lolworth Igneous Complex crops out over about 400 square miles in the north-eastern part of HUGHENDEN. Its southern boundary is well-established, where it intrudes older rocks; its northern boundary is concealed beneath Cainozoic basalts and sediments. The rocks forming Mounts Specimen and Remarkable, six miles south of the main batholith, may be outlying cupolas of the Complex.

Rocks of the Complex form the Lolworth Range, the predominant physical feature of the area. The summits of the Range emerge indistinctly from a broad, unevenly dissected surface of moderate relief; they reach an elevation of 2600 to 2700 feet above sea-level. In the south-east, a broken escarpment of rugged spurs and steep valleys and gorges, which forms the southern edge of the Range, does not coincide with the margin of the Complex, which extends farther to the south-east where it forms low, undulating country and dissected hills. In the south-west, the boundary of the Complex lies considerably to the north of the Lolworth Range escarpment, but north-west of Mount Richardson the escarpment coincides generally with the southern boundary of the Complex until it merges, still farther to the west, with hills developed in the Cape River Beds. To the north of the Lolworth Range the Complex forms hills which slope northwards, and merge with the basalt plain. Topographic distinction between the plains and hilly country occupied by the Complex is more pronounced towards the north-east.

Mount Specimen is a steep conical hill rising 600 feet above the surrounding plain. Mount Remarkable is a north-east trending ridge rising 300 feet above the plain.

Lithology

(a) Main Body

Large areas towards the centre of the Complex remain unexamined; nevertheless a broad picture of the lithological variation has emerged.

The major part consists of massive, pale-grey to pale-pink, medium to coarse, biotite adamellite and granodiorite, in which minor amounts of muscovite are characteristic. Large poikiloblasts of microperthite, enclosing quartz and biotite, are commonly developed. Biotite tends to occur in well-defined clot-like aggregates.

Another major rock-type (best developed on CHARTERS TOWERS) is pegmatitic garnet-muscovite granite or adamellite. This rock is characteristically banded and pale salmon-pink but both red and white varieties occur. The bands appear to be a primary feature. The texture of the bands varies from aplitic to graphic or pegmatitic, and grainsize varies widely. Feldspar crystals range in length up to an observed maximum of one foot. Individual bands of consistent grainsize and texture range from fractions of an inch to several inches (or rarely several feet) in thickness. The banding is also to some extent compositional, reflecting varying content of quartz, feldspar, and particularly muscovite. Pink garnet is a universal accessory, almost amounting to an essential mineral in some of the more aplitic bands. Minor amounts of biotite occur. On HUGHENDEN garnet-muscovite granite (s.l.) forms the undulating, hilly country north of Mount Stewart and east of the Nigger's Bounce, and a belt of country south-east of the Lolworth Range escarpment. A specimen collected from near the escarpment contains microcline, muscovite, plagioclase, quartz, and a little pink garnet.

Where the Lolworth Range escarpment trends north-east from near Cornelia Homestead to Mount Stewart it coincides approximately with a transition zone between biotite adamellite to the north-west and muscovite granite (s.l.) to the south-east. This zone, which is several miles wide, consists of adamellite and granite in which biotite may predominate over muscovite. Large, pink, zoned plagioclase crystals (possibly porphyroblasts) are common in the rocks of this zone.

Massive, fine to medium, light-grey quartz diorite forms a narrow extension of the Complex among gneisses of the Ravenswood Granodiorite, four miles north-west of Gorge Creek. The quartz diorite may have resulted from contamination by the country rock of mafic-rich gneiss. It forms a belt of low-lying country among rugged ridges of gneiss.

The rocks at Mounts Specimen and Remarkable have been strongly altered, probably by lateritisation, but possibly also by metasomatism; many small mineral shows have been worked in the immediate area. The abundant muscovite in these rocks inclines us to correlate them with the Lolworth Igneous Complex. Mount Remarkable appears to consist of a very thick dyke of altered muscovite granite, which bifurcates and narrows towards the south-west.

(b) Dykes

Pink and white garnetiferous muscovite pegmatite, aplite, and granite dykes are extremely abundant within the Complex. Most outcrops of the Complex, and of the country rocks near its margin, are cut by such dykes. The dykes are of similar texture and composition to the eastern (muscovite granite) part of the Complex, where they sharply transgress the primary banding. The dykes range in thickness from a few inches up to many feet, the most common thickness being two to three feet. They dip at steep to moderate angles. North-east of Cornelia Homestead, where banded muscovite granite of the Complex intrudes the Ravenswood Granodiorite, frequent ridges of pegmatitic muscovite granite occur among sparse outcrops of weathered biotite granite (s.l.) (Ravenswood Granodiorite). Nearer the contact it is hard to be sure whether these ridges are dykes extending into the country rock or are merely resistant primary bands in the main body of the Complex. Here the mapped position of the contact is very approximate. The difficulty of distinguishing between dykes and primary bands exists also in areas of poor outcrop within the eastern part of the Complex. The muscovite pegmatite, aplite, and granite dykes are equally abundant in the central and western parts of the Complex, which consist of biotite-bearing rocks. Here there seems to be a tendency for coarser-grained and thicker dykes to occur in the country rock close to the Complex, whereas within the Complex itself the dykes are thinner and aplitic. One of these aplitic dykes consists of quartz, equal parts of oligoclase and potash feldspar (orthoclase and microperthite), muscovite, and accessory garnet. ~~It has the composition of an adamellite.~~

In the country around Gorge Creek, north of Oakvale Station, numerous greyish-white, fine-to-medium-grained <u>muscovite-biotite adamellite</u> dykes intrude coarse gneiss of the Ravenswood Granodiorite. These dykes are similar in composition and aspect to rocks of the Lolworth Igneous Complex nearby, to which they are believed to be genetically related.

<u>Structure and Tectonic Environment</u>

Rocks of the Lolworth Igneous Complex do not appear to have undergone any major tectonic deformation. However, in some thin sections the quartz is seen to be slightly strained.

In the east, the southern contact of the Complex regionally transgresses the foliation of the country rocks, and probably dips quite steeply. Roof-pendants of country rock are unknown in this area. Mounts Specimen and Remarkable may be formed from an outlying cupola of the Complex.

In the west the contact of the Complex is not so obviously transgressive; its outcrop follows a sinuous course, suggesting that the contact may dip at a shallow angle.

Primary banding in the eastern part of the Complex dips at moderate-to-low (rarely steep) angles, and open, sinuous folds appear in some outcrops. An attempt was made to record attitudes in the field, but was abandoned as soon as it became apparent that amplitudes and wavelengths could be measured in feet or yards, rather than miles. Furthermore, rock surfaces coincident with the plane of banding were seldom found.

Since emplacement, the Complex has yielded along predominantly north-east-grending fractures. In the east these have been filled by dykes of the Mundic Igneous Complex (probably Upper Permian); in the west they are expressed as lineaments prominent on air photographs. Geomorphological features associated with these lineaments suggest that they are faults, but little is known of their relative movements. They may be related to probable transcurrent faults of similar trend in the Cape River Beds to the south-west.

The Complex is regarded as post-orogenic. It has a discordant contact with the country rock, and is not foliated.

Age and Relationships

The Lolworth Igneous Complex intrudes the Cape River Beds and the Ravenswood Granodiorite, and is intruded by the Mundic Igneous Complex. The radiometric age-determination of 400 million years (Lower Devonian) is consistent with field relationships.

Origin

The banded nature of the eastern part of the Complex, and the occurrence in it of garnet rather than biotite, raise interesting problems. Origin by granitization of sediments is a tempting hypothesis. A sequence deficient in MgO might possibly have given rise to garnet rather than biotite. Weighing against the argument in favour of granitization are the apparently transgressive contact of the granite, and (except in the belt of quartz diorite near Gorge Creek) the extreme scarcity of xenoliths in the granite farther than a few feet from the contact.

From geochemical, mineralogical, textural, and structural view-points the Complex (especially the garnet-muscovite granite) is worthy of detailed study.

Order of Emplacement

The relative ages of the different rocks of the Complex were not established. The pegmatitic garnet-muscovite granite appears to form an envelope enclosing the eastern half of the main biotite adamellite/granodiorite body. This could lead to the conclusion that the pegmatitic garnet-muscovite granite was emplaced first. However, the numerous garnet-muscovite pegmatite dykes, which are apparently identical in composition and texture to the pegmatitic granite, also intrude the main part of the Complex. This could imply conversely that the pegmatitic garnet-muscovite granite was emplaced later than the biotite-bearing portions. Examination of a few thin sections from rocks of the transition zone was inconclusive. Perhaps all parts of the Complex are essentially co-eval, and they may reflect differential contamination by country rocks rather than magmatic differentiation.

Mineralisation

Quartz-reefs in the Lolworth Range are being worked intermittently for gold (the Brilliant Brumby Mine). The reefs intrude muscovite-biotite adamellite of the Lolworth Igneous Complex. There is a possibility that they are related genetically to the Mundic Igneous Complex.

Early workers in the Cape River Goldfield (Daintree, 1868; Rands, 1891, 1894) referred to the common association of gold reefs with the numerous "elvan" dykes of the area. It is likely that most of these dykes are the pegmatite, aplite, and granite dykes related to the Lolworth Igneous Complex.

A local resident reported that books of white mica up to a foot across occur near Pentland. They probably occur in the pegmatite dykes referred to above.

Dumbano Granite

The Lower Devonian Dumbano Granite of CLARKE RIVER (White, 1962) extends south onto HUGHENDEN, where it intrudes the Cape River Beds.

It was discussed by Vine, Bastian and Casey (1963), who examined it briefly while mapping the sedimentary formations on HUGHENDEN.

Distribution and Topography

The Dumbano Granite occupies a single outcrop area of eighty square miles in the north-western portion of that part of HUGHENDEN which was mapped during the current survey. Other outcrops occur farther west, and for information on these the reader is referred to Vine, Bastian, and Casey (1963).

The Dumbano Granite forms unevenly dissected, undulating rises and low hills drained by the headwaters of the Flinders River.

Lithology

Three main types of "granite" occur in the area: grey even-grained adamellite, grey adamellite with relatively large pink feldspar phenocrysts, and pink muscovite granite (s.l.). The adamellites are quite strongly foliated over wide areas. In the west of the area, south of Reedy Springs Homestead,(two miles north of the boundary of the sheet area), pink feldspar-porphyritic adamellite is the most abundant variety, but patches of even-grained adamellite and red garnetferous-muscovite granite occur in lenticular masses elongated in a north-westerly direction. Gradations from even-grained adamellite to porphyritic adamellite occur from outcrop to outcrop, and no relative ages were determined; both rock types are cut by sheets of aplitic or pegmatitic pink muscovite granite (s.l.). Feldspar phenocrysts (or porphyroblasts) occur, up to 2.5 cm. across, in a medium-grained groundmass of quartz, alkali feldspar, plagioclase, biotite and a little muscovite; they show no preferred orientation, and may be zoned (differences in composition or in content of inclusions). Grey adamellite occurs at Cargoon Homestead where it underlies a thin sheet of basalt. East of Range Creek and near the Flinders River inclusions of schist are elongated parallel to the foliation of the enclosing even-grained adamellite. Also in this area, and intimately associated with the schists, is a white muscovite-quartz-feldspar granite in which lenses of muscovite lie parallel to the foliation: this granite is quite distinct from the pink muscovite granite, and may possibly belong to an earlier intrusive (syn-orogenic?) episode.

Pink muscovite granite, with or without small, light red garnets, is well developed in the north-eastern part of the outcrop area; it is cut by sheets of aplite and pegmatite similar in composition to the granite, and identical to the sheets which intrude adamellite and schist to the south-west. Quartz, alkali feldspar, and muscovite are the main constituents of the pink granite; garnet and biotite occur sporadically.

Structure and Tectonic Environment

Both types of adamellite are foliated to varying degrees in a west-north-west direction. The pink muscovite granite is not foliated. A few easterly and north-easterly lineaments have been photo-interpreted; these are probably small faults. In the west the granite is faulted against and underlies undifferentiated Upper Permian sediments and volcanics. In the south-west and east it is overlain by Cainozoic basalt. In the south the Dumbano Granite intrudes the Cape River Beds. Here the contact consists of inter-layered white muscovite granite, biotite adamellite, and mica schist. Gradations exist between these three rock types, which interfinger and occur as lenticular outcrops. The mapped boundary of the granite here is very approximate. The adamellites were probably emplaced just before the end of the orogeny which folded the Cape River Beds. The pink muscovite granite was emplaced shortly afterwards.

Age and Relationships

The Dumbano Granite was regarded provisionally as Proterozoic by White (1962), by analogy with dated granites of similar relationship and aspect on CLARKE RIVER and EINASLEIGH. A sample taken from the Dumbano Granite near Reedy Springs Homestead (CLARKE RIVER) gave an absolute age of 390 million years (Lower Devonian) on biotite, but White later rejected this age on the grounds that it is not consistent with field relationships, and that it probably indicates a later deformation of the granite (Vine, Bastian, and Casey, 1963). However, more recently (Richards et al., in prep) analysis of muscovite from the same sample has given an identical age (390 million years), and this is now accepted as the true age (Lower Devonian). Another sample from the Dumbano Granite on CLARKE RIVER has also given an age of 390 million years.

Except for the muscovite granite, the lithology of the Dumbano

Granite on HUGHENDEN corresponds broadly with that described from the type area on CLARKE RIVER. The pegmatitic garnet-muscovite granite, which is evidently the youngest component of the Dumbano Granite, is identical with part of the Lolworth Igneous Complex; it seems reasonable to regard them as chronologically and probably magmatically related. The remainder of the Dumbano Granite cannot easily be correlated with either the Lolworth Igneous Complex or the Ravenswood Granodiorite; in fact it shows affinities with both of these units.

Mineralisation

The abandoned Mount Emu Plains Diggings are situated in the Dumbano Granite adjacent to its contact with the Cape River Beds. Silver and gold, with minor amounts of copper, lead, and antimony, were mined from sulphide-bearing greisen and auriferous quartz lenses in grey biotite granite. The greisen and veins are probably genetically related to the Dumbano Granite.

(d) UPPER PERMIAN

Unnamed Sediments and Volcanics (Puv)

Volcanic sediments, pyroclastics, and acid lavas crop out in two widely separated localities. These rocks are believed to be Upper Permian. Their maximum thickness is possibly 200 feet.

Distribution and Topography

The major outcrop area covers twelve square miles near Range Creek, a tributary of the Flinders River. Other outcrops occur fifty-five miles to the south-east, near Betts Creek.

In the north-west the rocks form rugged to undulating country of moderate relief rising to 3000 feet above sea level; this contrasts strongly with the flat plateau developed on the neighbouring Sturgeon Basalt to the west. The rocks are drained by the headwaters of Range Creek. To the east the Dumbano Granite forms more gentle slopes into which the creeks are less deeply incised.

In the Betts Creek area the rocks are poorly preserved; near the railway line they form low rises. About one mile south-west of Golden Mount a few small hills and cappings occur among strike ridges of the Cape River Beds.

Lithology

In the Range Creek area north of Camden Homestead the rocks rest on the Dumbano Granite. Acid volcanics from here were described by Vine, Bastian, and Casey (1963).

West of a prominent north-east-trending fault, the basal part of the sequence consists of conglomerate containing rounded and subangular pebbles of granite, porphyry, and flow-banded rhyolite. This passes upwards to conglomerate with angular fragments, then to finer sediments - sandstones and tuffaceous beds. Next to the fault the rocks are highly sheared and weathered. The sequence is probably not very thick; it dips gently to the west. East of the fault a conglomerate (possibly 100 feet thick) composed of granite debris and boulders lies directly on granite and schist. This conglomerate is overlain by 50 feet of other conglomerate containing sub-angular pebbles of rhyolite (some of it flow-banded)in a sandy matrix; chert and epidote fragments occur sporadically. The volcanic conglomerates are overlain by acid tuffs and interbedded sandstones (30 to 50 feet) and finally by 20 to 30 feet of acid porphyry: the basal units dip off the granite at about 30° to the south, but the dip quickly flattens out. The acid porphyries may be flows or high-level intrusions; they are composed of irregular quartz and feldspar phenocrysts set in a blue-grey, fine-grained matrix.

In the Betts Creek area acid volcanics crop out over an area of one and a half square miles south-west of Golden Mount. The chief rock type is a highly weathered, reddish-yellow, rhyolitic, quartz-feldspar porphyry, containing rare angular fragments of quartz up to three inches in diameter. Felsite dykes intrude the Cape River Beds nearby. Rands (1891) considered the rhyolitic porphyries to be ashstones. He reported that they contain numerous schist and quartzite fragments. He also reported that the rocks grade into coarse agglomerate, and suggested that they represent the neck of an old volcano. In a rail cutting to the south-east, thinly bedded, pink-to-buff tuffaceous siltstone dips gently to the south-west off a basement of migmatite of the Ravenswood Granodiorite. A thin basal conglomerate underlies the siltstone. A sill-cum-dyke of porphyritic rhyolite intrudes the tuffaceous siltstone. The country immediately to the north and west of the railway cutting is covered in places by quartzite pebbles which are believed to have weathered out of conglomerates of similar age to the tuffaceous siltstone.

Structure

In the Range Creek area the rocks dip gently to the west and south. At the north-east-trending fault the rocks are probably downthrown to the north-west. No folding was observed in the sequence, and the gentle dips may be original.

At Betts Creek the sequence dips gently to the south-west. No structure was decipherable in volcanics at Golden Mount.

Thickness

At Range Creek the sequence probably totals 200 feet, or less. At Betts Creek about 30 to 40 feet of tuffaceous siltstone are exposed.

Age and Relationships

In the Range Creek area the sediments rest unconformably on the Dumbano Granite, and are overlain unconformably by the Sturgeon Basalt (Cainozoic). At Betts Creek the tuffaceous siltstone rests unconformably on basement of the Cape River Beds and Ravenswood Granodiorite. Seven miles west of here the Betts Creek Beds, dated as Upper Permian (Vine, Bastian, and Casey, 1963), lie unconformably upon the Cape River Beds, and have a similar strike and dip to the tuffaceous siltstone in the railway cutting. Lithologically, however, the two sequences are not particularly alike, although the Betts Creek Beds contain fine-grained sediments which are possibly tuffaceous. Nevertheless, it is thought likely that the tuffaceous siltstone sequence is a contemporaneous facies equivalent of the Betts Creek Beds, deposited nearer to a centre of volcanic activity. The beds at Range Creek are also tentatively correlated with the Betts Creek Beds.

These sediments and volcanics are therefore regarded provisionally as Upper Permian in age.

Mineralisation

Rands (1891, p.6) seems to imply that gold occurred in agglomerate near Golden Mount. He describes the agglomerate as forming an old volcanic neck. It is likely that this agglomerate is the same age as the volcanics (Puv) just described.

Mundic Igneous Complex

The Mundic Igneous Complex is a group of mainly intrusive igneous rocks which occur as small stocks, bosses, and other bodies aligned in a north-westerly direction in the country drained by the headwaters and tributaries of Mundic and Homestead Creeks. The main bodies of the Complex form the Pentland Hills (CHARTERS TOWERS) and Mount Stewart (HUGHENDEN area); smaller, isolated bodies occur between these two main bodies. Dykes associated with the Complex extend out from the main centres for more than 20 miles into the country rocks. Constituent rock units, although differing in composition, are similar in aspect and mode of occurrence. The boundary between HUGHENDEN and CHARTERS TOWERS passes through the Complex, most of which lies within CHARTERS TOWERS.

The Complex is of the high-level, epizonal type (Buddington, 1959), closely associated with volcanics; but the volcanics here have been all but removed by erosion. The Complex was emplaced into the early Palaeozoic craton of granite and metamorphics.

The Mundic Igneous Complex appears to be similar in mode of occurrence, size, and age to the epizonal complexes described by Branch (1962) from CLARKE RIVER, GILBERTON, EINASLEIGH, and ATHERTON.

The Complex is believed to be late Palaeozoic, probably Upper Permian.

Distribution and Topography

The Complex occurs as five discrete bodies (excluding associated dykes), covering twenty-five square miles. Three of the bodies, covering twelve square miles, occur on HUGHENDEN. An oval granitic stock, with well defined borders, covering about eleven square miles, forms Mount Stewart and the surrounding peaks. These consist of rugged, broken country, protruding 600 to 700 feet above the general level of the Lolworth Range in the south-west, and rising abruptly 1500 feet above the plain in the north-east. The summit of Mount Stewart is 3300 feet above sea-level.

Two smaller plug-like bodies have been mapped; they lie to the north-west and south-east of Mount Stewart. Both occur as dissected depressions, a few hundred acres in extent.

The acid dykes of the Complex (flow-banded felsites) in places form distinct ridges, which can be readily photo-interpreted; they are less prone to erosion than the rocks of the Lolworth Igneous Complex which they intrude. On the accompanying map, brackets around the symbol "f" indicate that a felsite dyke has been photo-interpreted. These are the only dykes in the Sheet area which have a strongly positive geomorphological expression.

Lithology

(a) Stocks and bosses

The rock forming Mount Stewart is a red, leucocratic, porphyritic microgranite (Pum). Medium-grained phenocrysts of kaolinised red feldspar and quartz occur in a fine mosaic of similar composition. The rock includes scattered, small patches of mottled dark and pale green material, which could possibly be altered dolerite xenoliths. Otherwise mafics are not apparent. A thin section was cut, but was too altered to reveal anything more than is apparent in hand-specimen. This specimen was taken from the summit, which is half a mile south-west of the boundary of the stock. No variation was apparent between the boundary and the summit. Intruding rocks of the Lolworth Igneous Complex, which form the north-eastern foothills, a cone-sheet of brown granophyre several hundred feet thick dips at a moderate angle towards the microgranite stock.

Photo Plate 8

In the bed of Mundic Creek, 4 miles south of Mount Stewart. Fault cutting a felsite dyke of the Mundic Igneous Complex. The dyke is 10 feet thick - somewhat narrower than the average for felsite dykes of the Complex. It intrudes massive, coarse, muscovite-biotite adamellite or granite of the Lolworth Igneous Complex.

B.M.R. Neg. No. G/6825.

One mile north-west of the Mount Stewart Stock, a small, oval, dissected depression was found to be composed of granitic intrusion-breccia, emplaced as a small boss in the Lolworth Igneous Complex. The breccia consists of blocks of coarse muscovite granite (Lolworth Igneous Complex) and flow-banded felsite (probably from dykes of the Mundic Igneous Complex) embedded in a granitic groundmass.

Two miles south-east of the Mount Stewart stock another small, ruggedly dissected depression has been photo-interpreted. It is thought to be a small boss consisting of one of the less acidic rock types of the Complex, but analogy with a similar body nearby on CHARTERS TOWERS, which consists of porphyritic hornblende microadamellite (hand-specimen description). Such rocks (Pud), which contain a more normal percentage of mafics than the rocks forming the main bodies of the Complex, are well developed around the northern flanks of the Pentland Hills, a short distance to the south-east on CHARTERS TOWERS. They show extreme variation, ranging from possible dolerite through to microgranite, and are thought to have been emplaced early in the history of the Complex. The photo-interpreted body described above is the only representative on HUGHENDEN of this sub-unit of the Complex.

(b) Dykes

Dykes associated with the Mundic Igneous Complex fall into two groups - dolerite/microdiorite and felsite. The felsites are invariably the younger, in contrast with the Perm-Carboniferous dykes of the Townsville district. Excellent exposures of both groups of dykes occur in the headwaters of Mundic Creek (photo plate 8.). The dolerite/microdiorite dykes are much less abundant, and are thinner than the felsite dykes.

The dolerite/microdiorite dykes were seen to intrude the Lolworth Igneous Complex only. They average two foot in thickness, and their observed maximum thickness is five foot. Dolerites and microdiorites appear to be of equal abundance. Calcite is a common alteration product. In the field they have the typical dark blue-grey colour of basic dykes, but are locally mauve to dark brown, possibly owing to contamination by wall rocks. They tend to develop a bright orange weathering crust. Some are markedly porphyritic.

The felsite dykes intrude the Lolworth Igneous Complex and the dolerite/microdiorite dykes. The term "felsite" is used here as on TOWNSVILLE as a field term to describe pale acid dykes. They are commonly flow-banded, either parallel to their margins, or in sinuous plications. They range between five and fifty feet in thickness, and average twenty feet. In many respects they strongly resemble felsite dykes of similar age in the Townsville district, but show more textural variation. In hand-specimen the felsites are pale buff to pinkish buff, and commonly contain only rare quartz phenocrysts. Other dykes contain crowded phenocrysts of red feldspar and quartz, and yet

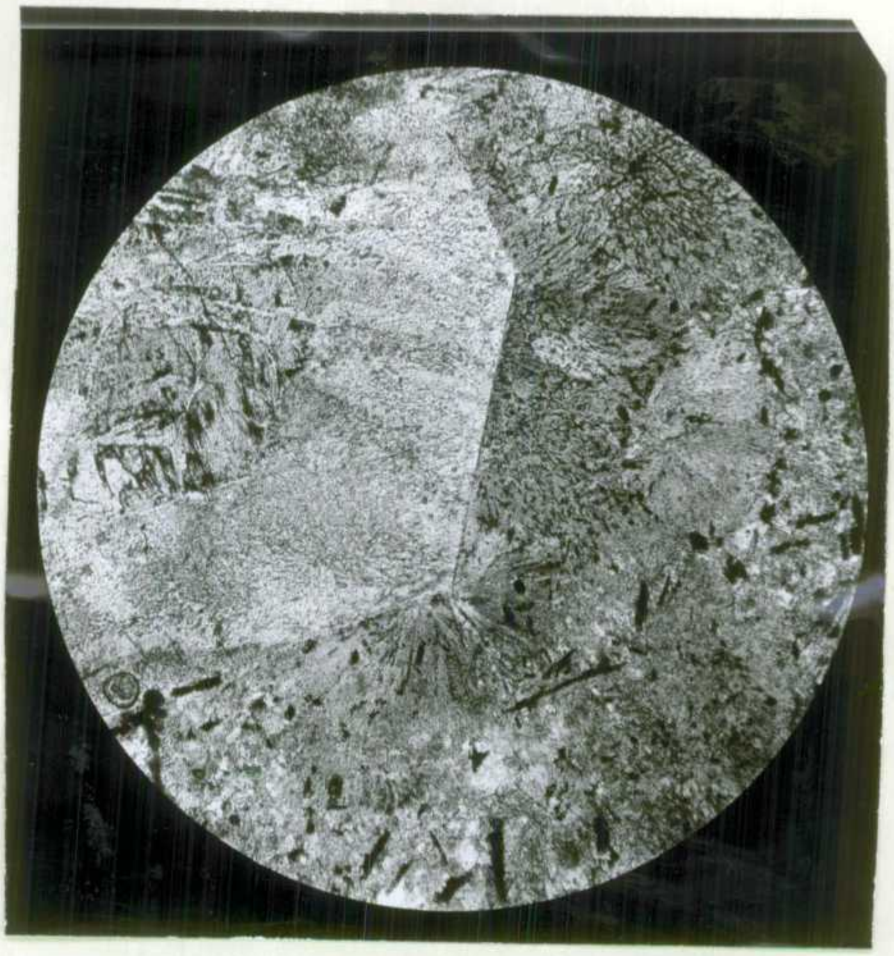


Photo Plate 9

Spherulitic, porphyritic rhyolite dykes, of the Mundic Igneous Complex, intruding granite or adamellite of the Lolworth Igneous Complex, 3 miles south-south-east of Mount Stewart.

Some centres of spherulitic growth occur on the border of the feldspar phenocryst. The phenocryst is pseudomorphed by quartz and feldspar in micrographic intergrowth; they have grown inwards from the margin. In the north-west quadrant (core of the pseudomorph), brown, semi-opaque material has replaced the feldspar. Acicular crystals of ore-minerals are abundant.

Crossed nicols, X45. Microslide No. G.S.Q. 15030.

B.M.R. Neg. No. G/6744.

others have only feldspar phenocrysts. Some felsite dykes weather bright red in patches. Three specimens were sectioned; in one the feldspar was too altered to be determined; the other two are rhyolites, one porphyritic, the other spherulitic and porphyritic (Photo plate 9).

At two localities both felsite and dolerite/microdiorite were seen in intimate association as composite and multiple dykes. At one of these localities a flow-banded, quartz-porphyritic felsite dyke, six feet thick, is flanked on either side by a two-foot thick band of dolerite with calcite-filled amygdales. This rock was identified as a dolerite in thin section; in the field a perfect colour transition between the two rock types extends over a width of six inches. There may not be much difference in age at this locality, although the felsite is apparently younger. At the other locality a band of pink felsite thirty feet thick forms the core of a multiple dyke whose margins consist of dolerite/microdiorite, each one to two feet thick. Blocks of dolerite are included in the felsite, and the contacts are sharp, although the colour of one of the dolerite dykes grows paler towards the felsite contact. Here it appears that a dolerite/microdiorite dyke has been fractured in the centre parallel to its contacts, and intruded by acidic magma which expanded it to ten times its former width. At yet another locality a thick felsite dyke was seen to have abruptly truncated a dolerite/microdiorite dyke.

The intrusion of the felsite dykes is then well established as the later episode.

Structure and order of emplacement

The probable order of emplacement of rocks belonging to the Complex is summarised in Table 2 (also see Diagrammatic Sketch, fig.3):

Table 2

ORDER OF EMPLACEMENT OF ROCKS OF THE MUNDIC IGNEOUS COMPLEX

Order of emplacement	Symbol	Rock Types	Mode of occurrence	Sheet Area: Hughenden	Sheet Area: Charters Towers
1	Puo	Volcanic breccia (and possibly other extrusive rocks)	Extrusive Crudely bedded		X
2	Pud	Minor intrusives, including microgranite, microadamellite, micromonzonite, microdiorite, diorite, and dolerite.	Small bosses and bodies of unknown shape. Roof pendants.	X	X
	d	Dolerite/microdiorite	Dykes	X	X
3	Pug	Pink and red, drusy leucogranite (Pentland Hills)	Stock		X
4	f	Felsite (including rhyolite, rhyodacite, and other acidic rocks)	Dykes (some cone-sheets ?)	X	X
5	Pum	Red, porphyritic, leucocratic micro-granite (Mount Stewart)	Stock	X	
		Granitic intrusion-breccia	Boss	X	

FIG. 3

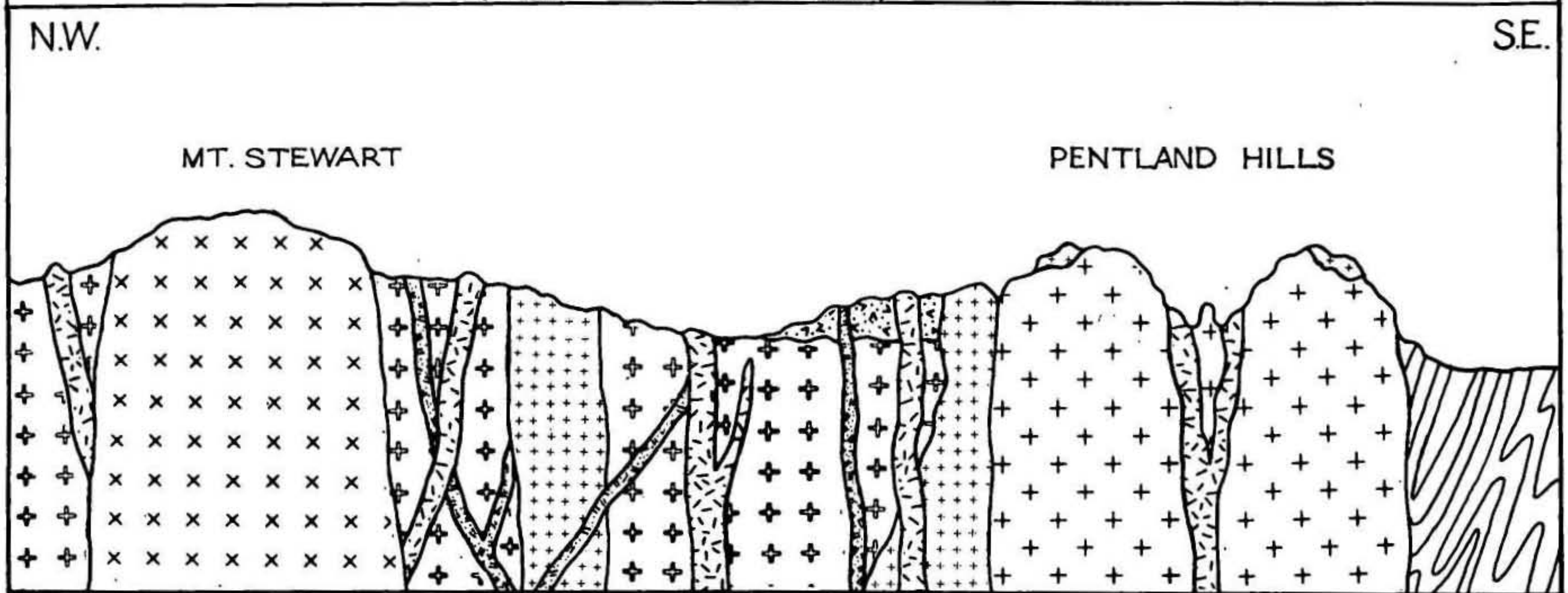
MUNDIC IGNEOUS COMPLEX

(UPPER PERMIAN)

CHARTERS TOWERS & HUGHENDEN 1:250,000 SHEET AREAS

Diagrammatic sketch section illustrating probable order of emplacement of the rocks of the Complex.

(NOT TO SCALE)



REFERENCE

1 *Volcanic breccia (Pue)*

2 *Microadamellite, hornblende microdiorite, dolerite, granite and other ~~differentiates (Pud)~~. Minor Intrusives (Pud)*

Dolerite/microdiorite dykes.

3 *Drusy leucogranite (Pug)*

4 *Felsite dykes.*

5 *Porphyritic microgranite (Pum).*

Lolworth Igneous Complex } *Country rocks*

Cape River Metamorphics } *Country rocks*

Volcanic breccia (Pue, CHARTERS TOWERS only) rests upon, and includes numerous phenoclasts of the coarse granitic rocks of the Lolworth Igneous Complex.

The minor intrusives (Pud), apart from their emplacement as isolated bodies into the Lolworth Igneous Complex, occur as roof pendants in the Pentland Hills leucogranite, and as irregular bodies flanking its northern margin: because of their petrological similarity it is believed that the dolerite/microdiorite dykes are broadly co-eval with the minor intrusives (Pud). They were seen to intrude only the Lolworth Igneous Complex. The minor intrusives in the north-western foothills of the Pentland Hills contain frequent xenoliths of doleritic rock; these may be remnants of dyke rocks, or alternatively of the earliest differentiated members of the series which formed the minor intrusives themselves.

The Pentland Hills leucogranite (CHARTERS TOWERS only) intrudes both the volcanic breccia (Pue) and some of the minor intrusives (Pud).

The felsite dykes intrude the volcanic breccia (Pue), the Pentland Hills leucogranite (Pug), and the minor intrusives. Neither the microgranite of Mount Stewart nor the boss of granitic intrusion-breccia to the north-west (both Pum) are cut by felsite dykes; the boss contains numerous fragments of flow-banded felsite, and in the field it appears to truncate felsite dykes. These two bodies are considered to comprise the final magmatic episode of the Complex.

Some of the photo-interpreted felsite dykes which intrude the Lolworth Igneous Complex immediately west of the Mount Stewart stock appear to dip towards this stock. They may be cone-sheets. A thicker cone-sheet, composed of granophyre, occurs outside and close to the north-eastern margin of the stock.

The felsite dykes of the Complex extend out from the main centres in two major swarms, one extending north-west towards the Niggers Bounce, the other south-west along the south-eastern escarpment of the Lolworth Range. The magma which formed these acid dykes was probably rather viscous, and acidic magma chambers (or one large chamber) may possibly have existed fairly close to the surface over a larger area than indicated by the main bodies of the Complex.

Rocks of the Complex are cut by strong north-west trending faults, and by some which trend south-west.

Age and Relationships

All rocks of the Mundic Igneous Complex intrude the Lolworth Igneous Complex. The Complex is overlain by the Campaspe Beds (Pliocene (?)).

Acid volcanics, largely pyroclastics (Puv) occur near Betts Creek, five and a half miles south-west of Pentland. The age of these deposits is not known, but on structural, stratigraphic and perhaps lithological grounds it is tempting to equate them with the Upper Permian Betts Creek Beds, which crop out a short distance to the west. They are intruded by rhyolite dykes similar to the felsite dykes of the Mundic Igneous Complex. For this reason the Mundic Igneous Complex is regarded provisionally as Upper Permian.

Mineralisation

Gold, copper, wolfram, lead, bismuth, and pyrite mineralisation occurs at the Midas Mine and other small mines nearby. These workings (known collectively as "Lolworth Diggings") are situated a few miles north west of the Complex, on a granite spur known as the "Niggers Bounce". Uranium (torbernite) and molybdenite mineralisation have also been reported.

Morton (1932) stated that the mineralisation is associated with quartz and siliceous pegmatite veins, which invariably post-date dykes of "pegmatite, aplite, porphyry, and dark-coloured, intermediate to basic rocks". It is apparent from air photographs and field observations that a dyke swarm associated with the Mundic Igneous Complex is strongly developed as far north-west as the Niggers Bounce. Therefore it is very likely that the "porphyry and dark-coloured, intermediate to basic dyke rocks" described by Morton are felsite and dolerite/microdiorite dykes of the Mundic Igneous Complex. If this is so, the mineralisation, being later than those dykes, was probably emplaced at a late stage in the development of the Complex.

(e) UNNAMED PALAEOZOIC GRANITIC BODIES (Pzg)

Within the area there occur two bodies of granitic rocks which cannot readily be related to any of the named plutonic units. They are possibly late Palaeozoic, but present evidence is inconclusive.

Distribution and Topography

One body forms an irregular depression known as Gypsy Pocket, which is broadly aligned in a north-easterly direction among hills of quartzite and schist of the Cape River Beds. The pocket is about three square miles in area, and is situated near the head of the Cape River, about 35 miles north-west of Pentland. The surface of the pocket undulates gently, and contrasts strongly with the surrounding hills of metamorphic rocks.

The other body has a sub-circular outcrop, two miles in diameter, centred three miles south-east of Pentland. It is topographically indistinct, and forms low spur-like rises which to the north emerge from alluvium, and to the south merge into the low-lying and gently undulating or flat surface developed on the Ravenswood Granodiorite and Campaspe Beds.

Lithology

The Gypsy Pocket body consists chiefly of massive, fine-to-medium grained, light grey adamellite. A microslide (G.S.Q. 15264) reveals that the rock has a granitic texture, and contains oligoclase, microperthite, quartz, biotite, and hornblende in decreasing order of abundance. This rock forms the main part of the body; it is intruded by aplite dykes. A very narrow zone of quartz diorite trends south-west part of the mass. This is a massive, fine-grained, medium grey rock, with an uneven granitic texture (G.S.Q. 15265); it contains andesine, quartz, hornblende, biotite, epidote, and sphene. A dyke of porphyritic hornblende microdiorite intrudes the schists and gneisses three miles south of the quartz diorite, to which it may be genetically related.

The body south-east of Pentland consists of massive, pink, coarse-grained biotite leucogranite. It is intruded by aplite dykes which are pegmatitic towards their centres.

Structure

The Gypsy Pocket body is probably a partly unroofed stock having greater lateral dimensions at depth. The body near Pentland is sub-circular and stock-like in cross-section.

Age and Relationships

The Gypsy Pocket body apparently truncates a rhyodacite dyke which intrudes the Cape River Beds nearby. This dyke may be related to the other felsite dykes of the area (see sections on Mundic Igneous Complex and Upper Permian Volcanics), which are provisionally regarded as Upper Permian. On the other hand, the Gypsy Pocket body may be a cupola of the Lolworth Igneous Complex. Lithologically it is not unlike rocks from the south-western part of the Complex. However, muscovite pegmatite dykes are not associated with this body.

The body near Pentland intrudes strongly foliated Ravenswood Granodiorite. Its size and circular outline are typical of the small late Palaeozoic granitic bodies of North Queensland.

Mineralisation

No mineralisation was positively indentified as being related to these igneous bodies. However, it is possible that pyrite in hornfelsed schist

Photo Plate 10

Metamorphosed microgranodiorite dyke, intruding garnetiferous gneiss of the Cape River Beds, 2.5 miles north of Ballabay Homestead. Biotite at extinction (top left), embayed quartz (centre left), and plagioclase (bottom centre) occur as phenocrysts in a granular groundmass of quartz, feldspar, biotite, and muscovite. 2 cm. to the right of the quartz grain is a light-coloured cluster of muscovite. Crossed nicols, X45. Microslide No. G.S.Q. 15022.
B.M.R. Neg. No. G/6739.

forming the northern margin of Gypsy Pocket is related to the nearby granitic stock.

(f) PALAEOZOIC DYKES OF UNKNOWN AFFINITIES

Many dykes in the area are considered to be genetically related to named plutonic bodies, and have already been described. Such are felsite and dolerite/microdiorite dykes (Mundic Igneous Complex), muscovite pegmatite and muscovite-biotite adamellite dykes (Lolworth Igneous Complex), and biotite pegmatite dykes (late granite phase (Sa) of the Ravenswood Granodiorite).

Dykes of unknown affinities occur in the area. Such are: white tourmaline pegmatite; quartz; white, alkali-feldspar-tourmaline pegmatite; white adamellite, with tourmaline-muscovite pegmatite phase; all of ~~which~~ these intrude gneiss of the Ravenswood Granodiorite in the Gorge Creek area. The white adamellite, with tourmaline pegmatite phase, is similar to the adamellite dykes of the Lolworth Igneous Complex.

Intrusive into foliated granodiorite and gneiss of the Ravenswood Granodiorite south of the Cape River are dykes of: metamorphosed andesite or microdiorite; microdiorite; pink, muscovite-tourmaline pegmatite; cream, siliceous, plagioclase porphyry (dacite?); green andesite or microdiorite, containing rare plagioclase and biotite phenocrysts; and andesite or microdiorite, characterised by long, acicular amphibole phenocrysts. The metamorphosed and altered andesites intrude the Cape River Beds near Black Gin Creek, and the Ravenswood Granodiorite in a number of localities. Some of these altered andesite dykes intrude dykes which are believed to be related to the Lolworth Igneous Complex.

At Mount Davenport sills of metamorphosed microgranite and microgranodiorite intrude the Cape River Beds. Dykes of similar aspect and composition (photo plate 10) intrude the Cape River Beds and Ravenswood Granodiorite near, and north of, Ballabay Homestead. Some of these are intruded by garnet-biotite pegmatite, which is believed to be associated with the late granite phase (Sa) of the Ravenswood Granodiorite.

Mica schist of the Cape River Beds is commonly intruded by concordant pod-like veins of pegmatitic quartz-feldspar-biotite rock. These are especially common in the Cape River Beds/Ravenswood Granodiorite contact zone.

Quartz veins are locally abundant in the Cape River Beds.

(g) CAINOZOIC

Campaspe Beds

Tertiary sediments cropping out between the Cape and Campaspe Rivers were mapped variously as the "Cape-Campaspe Series" and the "Campaspe-Cape Series" by Dunstan (1913). The current survey has revealed that those sediments extend over a wide area (chiefly on CHARTERS TOWERS), and can be mapped conveniently as a unit. The name "Campaspe Beds" has been accepted for those sediments. They include most of the auriferous drifts of the Lower Cape, referred to as "older alluvium" by Rands (1891), and cover much of the area mapped as "Pliocene Tertiary Boulder Drift" by Daintree (1868).

Distribution and Topography

The unit forms much of the plains country in the south-east of the mapped area; erosional remnants are preserved among the foothills of the Lolworth Range. The Campaspe Beds have been extensively dissected, and crop out characteristically in small scarps bordering the flood plains of streams in the plains country; they underlie flat interfluves. Around the foot of the Lolworth Range hills of granite emerge from those interfluvial areas, which slope gently away from the granite and level out to form extensive plains. Innumerable small outcrops of Campaspe Beds occur at various levels in the Lolworth Range, but it has been possible to map only a few of them at 1:250,000 scale.

Lithology

Argillaceous gritty sandstone and pebble (locally cobble) conglomerate are the main lithologies. Conglomerate predominates wherever the unit abuts against a source area. Fine-to-medium-grained sandstone, with local siltstone, is present in the unit away from source areas. Quartz and feldspar are the chief constituents. White mica is commonly abundant, and is usually disoriented. Grains of garnet occur locally. The unit is typically poorly sorted and poorly bedded, although stratification is just detectable in most outcrops. On interfluves the unit is usually marked by a veneer of residual sand and soil; in general, outcrops occur only along the banks of creeks.

The unit is overlain in some areas (chiefly south of the Cape River, see geological map) by a horizon of pisolitic-to-nodular, dark brownish-red ferricrete, usually two to three feet thick. A zone of mottling underlies this, commonly with a rather abrupt transition. In these areas the Campaspe Beds are rather red. By contrast north of the Cape River most outcrops are pale buff to white, and are probably remnants of the pallid zone of a lateritic profile. At no single locality was a full lateritic profile seen. On the geological map areas where the ferricrete capping is commonly preserved have been distinguished from areas where it has been largely removed.

Structure

The unit is essentially horizontal, but original dips of up to 10 degrees occur where the Campaspe Beds abut against the ranges and hills.

Cross-bedding and other sedimentary structures are rare, and are usually associated with lenses and scours. Graded bedding was not detected.

Thickness

No more than twenty feet of sediment was seen in any one section. The greatest amount of dissection has occurred near the source areas, but here estimates of thickness are frustrated by the original dip and absence of bedding. Over two hundred feet of sediments have been reported from bores sunk in the unit near the bed of the Cape River on CHARTERS TOWERS. It is possible that all of these sediments belong to the Campaspe Beds, although older Tertiary (Miocene?) sediments do occur in the area. Although Daintree (1868) records a thickness of sixty feet a few miles west of Pentland, average maximum thickness on HUGHENDEN probably does not exceed fifty feet.

Depositional Environment

The source of the Campaspe Beds has been the coarse granitic rocks of the Lolworth Range. The unit has the form of a broad, sheet-like piedmont extending out around the foot of the Lolworth Range. The marked lack of sorting, the consistently poorly developed bedding, the random orientation of mica flakes and the persistence of coarse sand and pebbles for long distances from the source area all indicate that the Campaspe Beds were laid down under torrential conditions. An arid climate with heavy seasonal rainfall, in combination with a sparse cover of vegetation, would provide such conditions.

Age and Relationships

The unit unconformably overlies the Cape River Beds, the Ravenswood Granodiorite, and the Lolworth and Mundic Igneous Complexes.

One locality is known on HUGHENDEN (in Betts Creek, six miles west-south-west of Pentland) where the Campaspe Beds disconformably overlie an older ferricrete surface. This surface is regarded as equivalent to the older ferricrete (Miocene?) of CHARTERS TOWERS.

The Campaspe Beds are overlain by the Nulla Basalt, which in this area is regarded as Pliocene-Pleistocene. The unit is provisionally regarded as Pliocene.

Mineralisation

It was in gravels now mapped as Campaspe Beds that alluvial gold was first discovered in the Cape River Goldfield in 1867. The Pentland "Deep Lead", which ran from near Capeville Homestead south towards Rush Creek, consisted of an old river channel which is believed to have become choked with detritus during deposition of the Campaspe Beds. At least 15,000 ounces of gold were won from this channel during the second half of the last century. Alluvial gold has been won from numerous small workings in the area, and it is likely that many of them were located in sediments of the Campaspe Beds.

Although no alluvial prospects are known at present, the Campaspe Beds should be regarded as a potential alluvial host rock for heavy minerals. Daintree (1868) commented, "Whilst the recent alluvial deposits seem only to reward the miner in the immediate vicinity of some rich quartz reef, or other gold matrix, this [the "Pliocene Tertiary Boulder Drift", now mapped as Campaspe Beds], so far as yet tested, yields gold of a rounded, waterworn character, independent of any local source of supply". Daintree's remarks, when considered in the light of the probable torrential depositional environment of the Campaspe Beds, should be borne in mind in the course of any further search for heavy minerals in the area.

Ferricrete (including laterite) (Tl)

South of the Cape River the Campaspe Beds are overlain by a layer of nodular to pisolitic ferricrete, which in places reaches a maximum thickness of three or four feet. Possibly the ferricrete represents a remnant of the ferruginous zone of a lateritic profile. It appears to be restricted to the Campaspe Beds at present; its absence from other host rocks is attributed to erosion. The profile is thin, and downward transition to the weakly developed mottled zone occurs within one or two feet.

In the right (south) bank of Betts Creek, nine miles west of Pentland, cross-bedded, pale-brown, conglomeratic grits of the Campaspe Beds disconformably overlie a ferricrete developed in argillaceous grit; this older ferricrete is believed to represent the main period of lateritisation in Australia, which is generally considered to be of Miocene age.

A remnant of the Miocene(?) weathering surface can be recognised on the Lolworth Range. Ferricrete does not occur here, but the ancient surface can be recognised on air photographs (see Photo Plate 1). It may represent the pallid zone of a former laterite profile. The host rock (granite of the Lolworth Igneous Complex) is easily recognisable.

Nulla Basalt

Distribution and Topography

Twidale (1956) applied the name "Nulla Basalt" to the older of the two basalts forming the Nulla Province, which extends over 2,000 square miles, chiefly on CLARKE RIVER. On HUGHENDEN the province includes all basalt occurring within the Lolworth Creek drainage basin (i.e., north and east of the Lolworth Range and Great Dividing Range).

The Nulla Basalt itself crops out over four hundred square miles, from Duck Creek in the west to the eastern border of the Sheet area. Topographically it constitutes a broad and rather featureless plain which slopes gradually from an elevation of 2500 feet above sea-level in the west to below 1500 feet fifty miles away to the east. In the east it has been dissected by Lolworth Creek and its tributaries.

Lithology

No specimen from HUGHENDEN was sectioned. Specimens collected from TOWNSVILLE and CHARTERS TOWERS are olivine basalt, with abundant altered olivine among titanaugite and plagioclase. Fresh basalt on HUGHENDEN is blue-grey, with common phenocrysts of yellow-green olivine up to 2 mm. across; the basalt weathers dark brown and smooth, except where vesicles cause a pitted surface.

Local residents have reported that water bores drilled in the basalt have encountered interbedded lenses of running sand. Morton (1932) reported blocks of diatomite, "probably derived from an interbedded seam". He indicated that this seam occurs between the Nulla and Toomba Basalts.

Structure

The Nulla Basalt occurs in flat sheets, representing different flows. One and a half miles east of Leonidas Mill a low irregular rise with a central crater-like depression is interpreted as an old vent. It has very low relief. No other large-scale structures are known. Vesicles near the tops of flows were the only small-scale structures seen.

Thickness

In places the existence of more than one flow can be deduced from a vague "stepped" aspect on air photographs. Such "steps" indicate that flows may be up to twenty feet thick at their edges. The aggregate thickness of the Nulla Basalt within the Sheet area could possibly amount to one hundred feet or more.

Age and Relationships

The Nulla Basalt unconformably overlies early Palaeozoic granite and metamorphics. Its correlative to the west of the Great Dividing Range, the Sturgeon Basalt, unconformably overlies Cretaceous sediments.

A sample from CHARTERS TOWERS has been dated radiometrically by the total rock method (potassium-argon); its age is 1.32 million years, ± 5 percent (Pliocene-Pleistocene)*.

Twidale regarded the Nulla Basalt as equivalent to the Older McBride and Older Chudleigh basalts to the north, i.e., late Pliocene to early Pleistocene. Mapping on TOWNSVILLE indicates that some of the basalt in the Nulla Province could be older than this. There the lower flows of Nulla Basalt have been lateritised. There is no sign of a laterite profile on the Nulla Basalt on HUGHENDEN - in fact it is believed to be disconformable on the Campaspe Beds, which, although capped by a well-developed ferricrete, themselves lie unconformably upon the main laterite (Miocene?). The evidence for a disconformity is the absence of a ferricrete capping on the Campaspe Beds where they are overlain by the Nulla Basalt in Hann Creek (CHARTERS TOWERS). It is thought that the ferricrete was removed by erosion in this district. However, thin lenses of sediment similar to the Campaspe Beds appear to be interbedded with, and in places may actually overlie, the Nulla Basalt. The relationship is complicated by the varying ages of the Nulla Basalt at different places, and by contemporaneous erosion, which gave rise to abutment unconformities along creek beds. However, in general, a late Pliocene to early Pleistocene age for the Nulla Basalt is considered reasonable for HUGHENDEN. In places it has a well developed soil cover. It is overlain by the Toomba Basalt (probably Recent). On HUGHENDEN the Nulla Basalt is probably broadly equivalent in age to the upper levels of the Sturgeon Basalt, which crops out west of the Great Dividing Range (Vine, Bastian, and Casey, 1963).

Toomba Basalt

The very young Toomba Basalt (Twidale, 1956) overlies the Nulla Basalt in the north-eastern corner of the Sheet area. Twidale regarded the Toomba Basalt, together with the Kinrara Basalt, which occurs on EINASLEIGH, as the youngest basalts in North Queensland. That part of the Toomba Basalt which occurs on HUGHENDEN was not visited during this survey.

Distribution and Topography

The Toomba Basalt covers about ninety square miles of the Sheet area. Its borders can be readily photo-interpreted, owing to its dense, black

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*Determination by A.W. Webb at the Department of Geophysics, Australian National University.

photo-pattern. Its surface is regionally flat. However, a shield-like dome, with a paler photo-pattern, occurs near the western end of the basalt. This was probably the eruption centre. Frequent "pockets", the largest ("Long Pocket") 10 square miles in area, occur in the eastern half of the outcrop. These consist of low rises of Nulla Basalt which the Toomba Basalt failed to engulf. The scarp formed by the edge of the Toomba Basalt is very irregular both in plan and in section. It averages only 10 to 15 feet in height, but is quite impassable to vehicles; this has earned it the title "Great Basalt Wall". In detail the surface of the Toomba Basalt is highly irregular.

Lithology

A sample of the Toomba Basalt was collected from near Myola Homestead, which lies just east of the Sheet area; it is a porphyritic olivine basalt with fairly fresh olivine. In hand specimen the basalt is clinker-like, fine-grained, and highly vesicular. Crystals of olivine are visible to the naked eye.

Structure

The Toomba Basalt is regarded as a single flow which was erupted from a vent close to the western edge of the outcrop area. The flow can be traced north-east for fifty-five miles to Reedy Lake (TOWNSVILLE). There is no sign of terracing, which could be expected, had there been more than one flow.

The surface of this basalt consists of a chaotic maze of fissures and collapse pits. A lava tunnel (shown on the geological map) can be traced on air photographs trending in a south-easterly direction for five miles near Glencoe Homestead. The photo-interpreted vent-site was not visited on the ground; it appears, from the photographs, to be a large, rather rough, shield-like structure.

Thickness

The maximum thickness seen in the walls of fissures and pits was estimated at fifteen feet. However, this was near the edge of the flow. Around and slightly downstream from the vent the basalt may be as much as one hundred feet thick (estimated from the relief of the vent area, as seen on air photographs).

Age and Relationships

The Toomba Basalt directly overlies the Nulla Basalt (Pliocene-Pleistocene). It appears to be preserved essentially in the state in which it was extruded. Twidale (1956) regarded it as late Pleistocene to Recent in age. White (1962) mapped it as Recent. We have no reason to differ from White's opinion.

Photo Plate 11
Aerial view of Black Mount, 24 miles west-northwest of Pentland. A prominent hill, probably a volcanic plug, mantled by blocks of slightly vesicular olivine basalt (Cainozoic). Photo by R.R. Vine.

B.M.R. Neg.No. M325/22

Unnamed Basalt (Czb)

Three small areas are mapped in which the age-relations of the basalt are not known.

Mounts Hackett and Courtney are formed from a basalt which weathers to a rusty brown crumbly material; the slopes of these hills are strewn with fragments of ropy lava and with bombs up to 15 inches long which are chilled at their margins and highly vesicular in their cores. Fresh samples of this basalt were not found; small pieces indicate that olivine phenocrysts are absent - at least from the ropy lava and bombs. The degree of weathering of this basalt suggests that it is significantly older than the Toomba Basalt. The two mountains were probably scoria cones built up after the massive olivine-porphyritic basalt (Nulla) had solidified. Alternatively, perhaps this basalt represents an eruption episode intermediate in age between the Nulla and Toomba Basalts.

Black Mount (photo plate 11) is an isolated flat-topped cone, strewn with boulders of slightly vesicular basalt. Black Mount is such a prominent physical feature, and so isolated, that it must be regarded as an old eruption centre or volcanic plug. Its location close to a fault, and on a boundary between competent and incompetent rocks of the basement, supports this view. Neither bombs nor scoriaceous lava were found on its slopes.

The third area is an isolated mesa of basalt, half a square mile in area, resting on the Cape River Beds thirteen miles west of Pentland. The basalt here resembles the Nulla and Sturgeon Basalts.

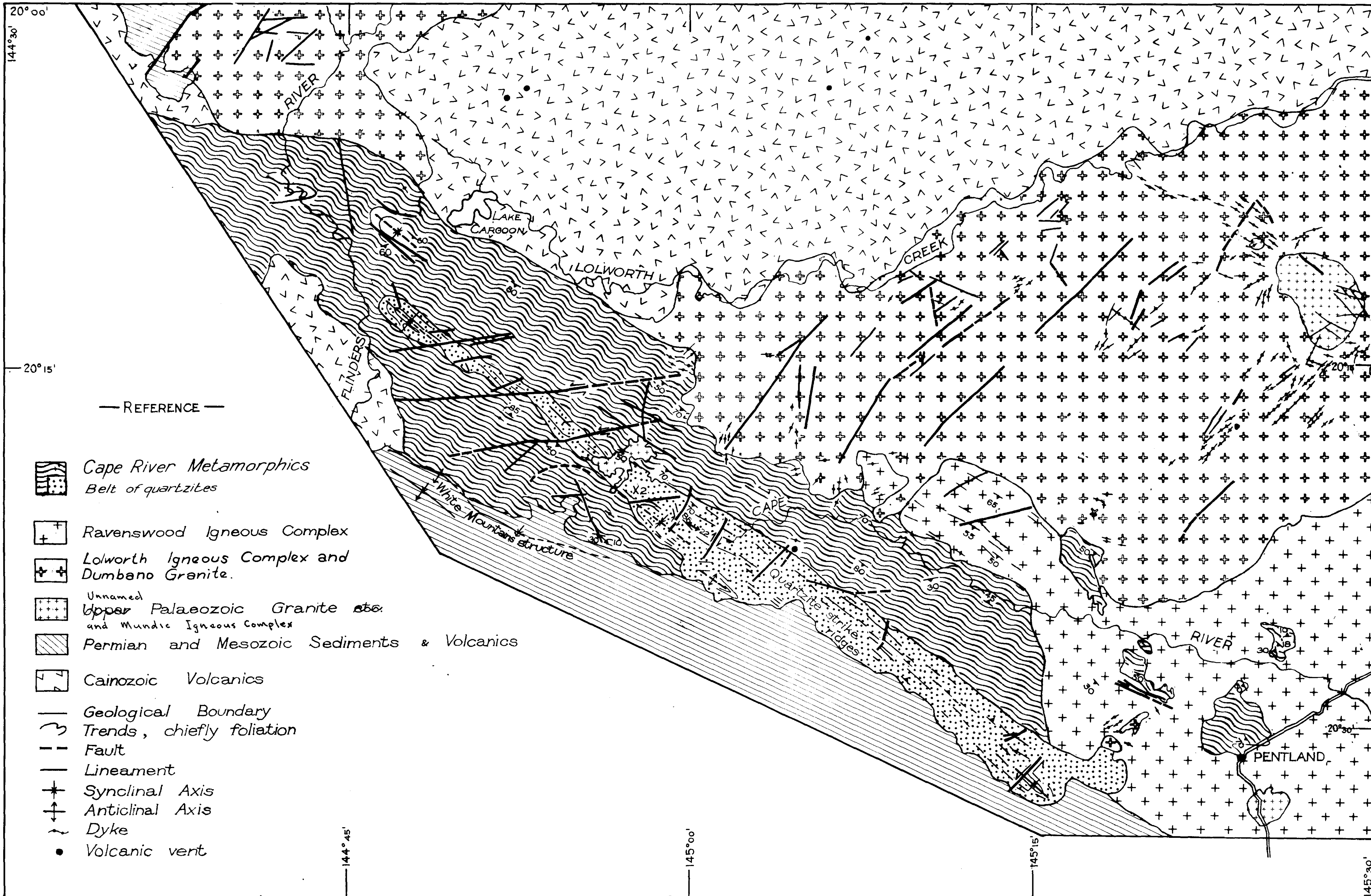
Quarternary Sediments (Q, Qa)

Much of the area is covered by thin and discontinuous residual sand, which is merely the weathering product of the underlying rock. On the Lolworth Range this sand is locally quite coarse, and contains a high proportion of feldspar and white mica. These deposits have not been mapped.

Areas of residual and colluvial black soil, sandy soil, sand, and rare gravel (Q) occur on the Nulla Basalt around, and to the north of, Lake Cargoon. The black soil has been derived from weathering of the underlying basalt, and the remaining sediments originate from the Dumbano Granite.

Alluvium (Qa) crops out extensively in the beds and banks of creeks where they have established a base level, chiefly in the low-lying country to the south. It is being deposited and reworked at the present day. Much of the alluvial gold obtained from the Cape River Goldfield was won from Quaternary alluvium.

FIG. 4



STRUCTURAL SKETCH MAP OF THE NORTH EASTERN PORTION OF THE HUGHENDEN SHEET (S.F.55-1)

STRUCTURAL GEOLOGY

The Hughenden Sheet area consists of three major structural and stratigraphic units: (1) superficial, but widespread, Cainozoic basalts and sediments, (2) the Eromanga Basin sequence of Upper Permian to Lower Cretaceous sediments, and (3) the basement of Palaeozoic metamorphic and igneous rocks. This report deals only with (1) and (3). The major rock-groups mapped during the course of this survey are outlined, together with their regional structure, on Figure 4, Structural Sketch Map.

The Cape River Beds and much of the Ravenswood Granodiorite have a strong north-westerly regional trend. Ranges of metamorphic rocks aligned in accordance with this trend formed the north-eastern margin of the Eromanga Basin in this area.

There are three principal fault directions: just north of east, north-east, and north-west. The faults which trend just north of east (more or less confined to the Oxley and Scrubby Creeks district) are mainly sinistral transcurrent faults with displacements of up to half a mile. These faults are confined to the Cape River Beds. The north-east-trending faults cut the Lolworth Igneous Complex also. It will be noticed from the geological map that these faults appear to die out near the margin of the Complex, and reappear in the quartzite belt of the Cape River Beds (Pzq). The faults are probably continuous, but have no geomorphological expression in the intervening mica schists. Such faults (also largely transcurrent) were possibly induced in response to weak and senile north-east - south-west compression, shortly after the Lolworth Igneous Complex had cooled. The north-west faults occur principally in the Cape River Beds.

In Upper Permian times further north-westerly and south-westerly fractures were opened up in the Lolworth Igneous Complex, probably in response to the rise of the magma which formed the Mundic Igneous Complex.

GEOLOGICAL HISTORY

In Precambrian to early Palaeozoic times pelitic, arenaceous and calcareous sediments and possible volcanics (Cape River Beds) were laid down, probably in a trough aligned north-west. These sediments were later folded and metamorphosed to the high greenschist and low almandine-amphibolite facies of regional metamorphism. While compressive stress was still active the metasediments were intruded by granodiorite batholith (Ravenswood Granodiorite).

After the major stresses had ceased, both the Cape River Beds and Ravenswood Granodiorite were intruded by a post-orogenic batholith (Lolworth Igneous Complex). The Dumbano Granite probably includes correlatives of both batholiths. During and after the intrusion of the Lolworth Igneous Complex the country was uplifted, and a long period of erosion followed, exposing the roots of the resulting mountain chain.

In Upper Permian times, acid (and to a lesser extent basic) magma invaded the upper levels of the crust. Some acid magma reached the surface and was extruded and interbedded with contemporaneous sediments (Upper Permian (?) Volcanics). Much of the magma failed to reach the surface, but instead cooled beneath a shallow cover, giving rise to the various bodies (stocks, bosses, and dykes) of the Mundic Igneous Complex. Early in the history of this Complex dolerite/microdiorite dykes and minor intrusions of predominantly intermediate composition, were emplaced.
The Unnamed Palaeozoic Granitic Bodies were possibly emplaced during this period, which also witnessed the start of epicontinental sedimentation in the Eromanga Basin. This sedimentation continued intermittently until the Cretaceous.

A further period of erosion followed. In the Miocene (?) a thick lateritic weathering profile was developed on a surface which was undulating but of low relief. This lateritic surface was extensively dissected by further erosion, and the ensuing detritus was deposited as the Campaspe Beds, (Pliocene?). A suitable climate for the development of a lateritic profile again ensued. The ferricrete thus produced was locally eroded before further igneous activity, this time entirely basic, occurred in Pliocene-Pleistocene times, when floods of olivine basalt (Nulla and Unnamed Basalts) were erupted, and covered many hundreds of square miles. Basalt extrusion probably continued locally and intermittently during the Pleistocene (Unnamed Basalts).

The youngest basalt in the area (Toomba Basalt) was probably erupted in Recent times.

ECONOMIC GEOLOGY

Only two metals, gold and to a lesser extent silver, have been produced in commercial quantities from the Sheet area. The discovery of gold along the Cape River near Pentland in 1867 heralded a long but spasmodic history of prospecting which led to a total recorded production of 55,000 ounces of gold from the Sheet area. An attempt is now being made to resume mining on a small scale in the Mount Stewart district. Silver was discovered in 1915 at Mount Emu Plains; the total recorded production of this metal is 4500 ounces.

Minor quantities of base metals occur in the gold and silver ores, but no commercial production has been recorded.

Underground water is obtained for stock from shallow bores in the Nulla Basalt, in alluvium, and in the Campaspe Beds. Water has been drawn from the alluvium of the Cape River for irrigation of small citrus orchards and vineyards in the Capeville district; it is being used at present to irrigate lucerne at Ballabay Homestead.

GOLD AND SILVER

The chief producing area has been the Cape River Gold and Mineral Field, which had a recorded production of 45,000 ounces of gold. However, the actual production was considerably greater; for not only is there no record of the quantity won by the Chinese miners, who were almost as numerous as the European miners during the most productive years of the field, but in later years the production (admittedly only small) was included with that of Charters Towers, and cannot now be separated.

A total production of 8363 ounces of gold has been recorded from the group of mines known as the "Lolworth Diggings" (Midas, Mons Meg, etc.).

4500 ounces of silver and 400 ounces of gold have been produced from the Mount Emu Plains field.

1650 ounces of gold have been produced from the Mount Stewart area.

Cape River Gold and Mineral Field

Gold was discovered in 1867 (Upper Cape and Pentland (Lower Cape)), and production continued intermittently until 1938 (Clearview). There were several centres of mining; both alluvial and reef mining were carried out.

Pentland (Lower Cape)

Gold occurred here as surface alluvial, deep-lead, and reef deposits.

The surface alluvial deposits were quickly exhausted, and the output is not recorded, but it is known (Rands, 1891) that many of the gullies were extremely rich.

Several deep leads were worked, but by far the most important was that at Lower Cape, usually known simply as "The Cape River Deep Lead". It consists of 12"-18" of auriferous conglomerate lying on schist, and overlain by virtually barren alluvium. The lead begins at Capeville, where it was shallow, narrow and rich, and extends south becoming progressively deeper, wider, and poorer. About 2½ miles from Capeville mining was approaching an economic limit, and this came abruptly when a large aplite dykes was encountered, forming a high "bar" in bedrock. South of this "bar" only small disconnected areas were rich enough to be mined, and the cost of sinking up to 100 feet from the surface made further exploration prohibitive. Morton (1937) traced the lead at the surface for a further 2½ miles, and concluded that, although rich patches must still be present, such as that worked near Rush Creek, they are too small and scattered to repay exploration.

A gold lead was also worked along Sandy Creek, near Cornelia Homestead.

Some lode mining was also carried out in the Pentland district. The Sarah Howson, Mystery, and Hayward reefs were located about 2 miles east of the "Cape River Deep Lead". The reefs, which were reported to occur in "granitoid schist", are roughly parallel to one another, and strike 030° to 040°, parallel to a major regional fault direction. The Golden Hill reef, 5 miles south-west of Pentland, was another small producer. The production from all these reefs was small; picked crushings yielded up to 2 ounces per ton. The deepest shaft reached 90 feet. [redacted] Minor lead and copper mineralisation was reported.

Daintree (1868), Rands (1891, 1894), Marks (1910a), and Morton (1937) have published reports on the mines in this district. Shepherd (1937) discussed the question of drilling in the Cape River Gold and Mineral Field.

Upper Cape

Workings were centred on the lower reaches of Gorge Creek where it enters the Cape River.

Lode mining was restricted to narrow but very rich quartz leaders near the contact between schist and gneiss (Cape River Beds) and intrusive biotite-rich gneissic adamellite (Ravenswood Granodiorite). The reefs worked were Green's, Harp of Erin, Wheel of Fortune, and Occidental. All were small producers, with an average grade of 10 dwt. of gold per ton.

Most of the reefs in the Upper Cape district occur in the Cape River Beds; they appear to have been closely associated with dykes which are probably part of the Lolworth Igneous Complex.

Alluvial gold occurred in small, rich leads (the Canton, Pothole, and Bluff Leads) along Gorge Creek and in the Cape River north of Oakvale Homestead. These leads carried gold to a depth of 40 feet, where they died out in contact with hornblende schist bedrock. At one time (Morton, 1933) consideration was given to dredging these prospects, but nothing eventuated. Rands (1891) reported that gold had been found in gullies several miles west of Black Mount; this locality is within the quartzite belt (Pzq) of the Cape River Beds.

Reports referring to this district have been written by Daintree (1868), Rands (1891, 1894), Marks (1910a), and Morton (1933, 1937a).

Mount Clearview

This mine was situated near the head of the Cape River, west of the old road which connected Lolworth and Goldsborough Homesteads. Mineralisation was discovered in 1915, but although considerable development took place, little gold was won. Work recommenced in 1933, and continued until 1938, when 1700 ounces of gold had been produced; the average grade was about 14 dwt per ton. The geology was described by Cameron (1920) and Morton (1940); numerous unpublished reports are also available. The ore occurred in four reefs in fine-grained mica-quartz gneiss and schist of the Cape River Beds, which here trend north-west. The reefs occupy meridional fissures which are cut by numerous dykes of biotite granodiorite and pegmatite (offshoots of the Lolworth Igneous Complex).

Mount Davenport

Mount Davenport was the centre of some lode and alluvial production. Two reefs, the Union and the General Grant, were worked in mica schist. The main shaft in the Union Reef was sunk to 180 feet, and that in the General Grant to 110 feet.

Mount Remarkable

Both alluvial and lode deposits were worked. Specimen Creek and its tributary gullies were rich in alluvial gold. The main producers were the Balgay and the Barcoo; others were the Morning Star, Governor Blackall, Lone Star, Martin's, Albion's and Mariner's, and Commissioner's Reefs. Attempts were made in the late 1930's and early 1940's to recommence mining of the Balgay Reef, but the venture failed (Morton, 1940).

The major lodes lie south of Mount Remarkable; the rather erratic gold mineralisation occurred in quartz reefs which occupied near-meridional fissures in quartzite and mica-schist (roof-pendants in the Ravenswood Granodiorite). The rocks are intruded by muscovite granite dykes.

The maximum shaft depth is 162.5 feet, but most are about 30 feet deep. The average grade of ore was 2 ounces per ton, though some lodes carried up to 20 ounces per ton, but crushings were small and were generally composed of picked stone.

Mount Emu Plains Area

The Mount Emu Plains mining area was worked from 1910 to 1915 and from 1939 to 1942. It is in the Dumbano Granite adjacent to its contact with the Cape River Beds. The granite here often carries muscovite instead of the more usual biotite. The orebodies are veins of quartz, or greisen with quartz lenses, carrying sufficient galena, pyrite, arsenopyrite, and sphalerite to seriously interfere with gold extraction.

The most important lode is the Granite Castle, which has been explored for about a third of a mile at the surface. It consists of greisen with lenses of quartz occupying a well-marked fissure striking east and dipping steeply to the north. It ranges in width from a few inches to 5 feet. The quartz sections, whose average width is about ten inches, appear to carry most of the gold. The lode has been worked to a maximum depth of 100 feet in the "Granite Castle", and 90 feet in the "Granite Castle West". Recoveries from hand-picked shipments were over 1oz. gold/ton, 20oz. silver/ton, 8 percent lead, and nearly 1 percent (Ball, 1941) copper. The high silver:gold ratio is presumably due to the galena content.

A small but interesting producer was the Diccan (Diccan), a 2 to 3 inch quartz leader showing free gold. One recorded example of its richness was £240 value of gold and silver from 68lb. of ore. It was followed to a depth of 60 feet (Russell, 1912).

Some of the lodes were sufficiently rich in lead at the surface for an attempt to be made to work them for silver and lead, but this was not successful, and mining appears to have depended on gold values.

Lolworth Area

Several mines situated between Brandy and Toby Creeks (tributaries of Lolworth Creek) were collectively known as the "Lolworth Diggings". Gold was discovered in 1926, and mining ceased in 1953; little was produced after 1938.

There was very little alluvial production on this field. The deposits occur in biotite adamellite of the Lolworth Igneous Complex. The adamellite has been intruded by various dykes which are probably related to the Mundic Igneous Complex. The ore-bodies are later than the dykes. They are aberrant, high-temperature types, comprising small veins of sulphide (pyrite, arsenopyrite, chalcopyrite, sphalerite) with a greisenized aureole, greisen pipes carrying small amounts of the same sulphides, and pegmatitic quartz veins. Typical high-temperature minerals recorded as present in small amounts are wolfram, scheelite, molybdenite, bismuth, and tourmaline.

Crystal Oak Mine

The Crystal Oak was the site of the original discovery. The deposit occurs in granite intruded by pegmatite dykes, and consists of a stockwork of gold - and copper-bearing quartz veins. A small amount of copper and about 350oz. of gold were produced between 1928 and 1939. The grade averaged about 1oz. of gold per ton from picked ore. The workings are less than 100 feet deep.

Sunrise Group

The only sizeable mines in this group were the Sunrise and the Big Shine. The ore occurs in small pegmatitic quartz veins occupying fissures in the granite. The Sunrise produced about 800oz. and the Big Shine 250oz.. The ore was high grade - about 5 ounces per ton at the Sunrise, and 2oz. at the Big Shine, but the ore-bodies were small.

Mons Meg

The Mons Meg lode was discovered in 1934, and worked until 1953. The ore-body is a greisen pipe, which also carries small quantities of galena, sphalerite, and chalcopyrite. The ore averaged 17 dwt. per ton, and was enriched where the ore-body intersected a dioritic dyke which may have acted as a barrier. The main shaft is 194 feet deep; the total production was 2700 oz..

Midas

The Midas mine was the biggest producer on the Lolworth field; 3550oz. of gold were taken from it between 1934 and 1950. The ore occurs in a pipe of greisenised granite. Besides gold minor sphalerite and chalcopyrite are present. The main shaft is 130 feet deep, and the average grade was 28dwt. per ton.

Mount Stewart Area

No geological work has been done on most of the mines near Mount Stewart; over 60 of them are mentioned in Warden's and other reports. The main group on and around Mount Stewart itself seem to have mostly north to north-east strikes and easterly dips, and the average thickness of the lodes is about 1 foot. The maximum recorded depth of workings is 112 feet (The Surprise). Distribution of values appears to have been erratic. The total recorded production from the area is 1650 fine oz. of gold from 2300 tons of ore.

The Brilliant Brumby, which lies to the west of the main group, has been described in some detail (Cribb, 1939). The main line of reef strikes 350°, and is almost vertical, and offshoots from it form a number of smaller, almost parallel reefs. The average thickness of the reefs is about 1 foot, and the maximum about 3 feet. This outcrop can be traced for 1000 feet, and surface workings extend for 700 feet; but the main workings, at the northern end, are about 400 feet long and up to 78 feet deep. Total recorded production is 790 fine oz. from 950 tons of ore.

The Brilliant Brumby is being re-opened by a local resident, Mr. L. Powell.

General Note on Mineralisation

Noteworthy features of the mineralisation on HUGHENDEN are pegmatitic quartz veins (Lolworth), greisen (Lolworth and Mt. Emu Plains), veins associated with dykes, and virtually merging into them (Upper Cape (Daintree, 1868, and Rands, 1891)), highly auriferous quartz leaders (Mt. Emu Plains and Upper Cape), and the generally erratic distribution of rich gold values through otherwise almost barren rock (Pentland).

The primary structural control appears to be fractures lying in the North to North-East octant.

Some of the mineralisation of the area can be fairly confidently related to the numerous granitic dykes which emanate from the Lolworth Igneous Complex. The early workers (notably Daintree) referred to the favourable influence of "elvan" dykes on the mineralisation, especially near Gorge Creek (Upper Cape district) where the quartz reefs seemed to him almost to be "a continuation to the surface of the elvan veins themselves". The only dykes found in this district during the 1963 reconnaissance survey were white adamellite dykes related to the Lolworth Igneous Complex. Again, at Mount Remarkable, the only dykes noted by us were of altered muscovite granite (again believed to be related to the Lolworth Igneous Complex). Daintree claimed that the "elvan" dykes of the Mount Remarkable district had influenced the occurrence of gold.

Other mineralisation, for example at Mount Davenport and east of Capeville, is perhaps just as likely to have been genetically related to the Ravenswood Granodiorite as to the Lolworth Igneous Complex.

The mineralisation at Mount Emu Plains is fairly obviously related to the Dumbano Granite.

At the Lolworth Diggings the mineralisation appears to have followed the intrusion of various dykes. Our inference is that these dykes and the mineralisation are part of the Upper Permian(?) Mundic Igneous Complex. Gold at Golden Mount may also be Upper Permian. Of the Mount Stewart group of mines, any situated on Mount Stewart itself must neccessarily be related to the Mundic Igneous Complex because Mount Stewart consists of microgranite belonging to that Complex.

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AUSTRALIA 1:250,000

HUGHENDEN

QUEENSLAND

1:250,000 GEOLOGICAL SERIES SHEET SF 55-1

PRELIMINARY EDITION, 1964

SUBJECT TO AMENDMENT

Reference

- Geological boundary
- Anticline
- Syncline
- Monocline
- Fault (U D indicate relative vertical movement down, up)
- Fault (arrows indicate relative horizontal movement)
- Where location of boundaries, faults, and folds is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes
- Strike and dip of strata
- Trend lines showing plunge
- Dip > 45°
- Joint pattern
- Lineament
- Strike and dip of foliation showing plunge of lineation
- Vertical foliation
- Foliation dip indeterminate
- Strike and dip of primary pegmatite banding
- Macrofossil locality
- Microfossil locality
- Plant fossil locality
- Spore locality
- Dyke
- Extinct basalt volcanic vent
- Type section
- Measured section
- Section reference number
- Mine
- Abandoned mine
- Flowing bore
- Non-flowing bore or well
- Abandoned bore or well
- Spring
- Waterhole
- Earth tank
- Dam
- Windmill
- Road
- Vehicle track
- Railway with siding
- Fence
- Homestead
- Airport
- Landing ground
- Yard
- Astronomical station
- Trigonometrical station
- Height in feet, datum mean sea-level
- Position doubtful

Reference

Era	Period	Unit	Symbol	Description
CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qc	Basalt scree
			Q	Undifferentiated residual and colluvial black soil, sand, and rare gravel
			Qb	Clay, silt, clay soil
			Qs	Sand, gravel, rubble, sandy soil
		Toomba Basalt	Qt	Vesicular olivine basalt
	UNDIFFERENTIATED	Sturgeon Basalt	Czm	Olivine basalt
		Nulla Basalt	Czn	Olivine basalt
			Czb	Olivine basalt
			Czw	Argillaceous sandstone, conglomerate
			Czd	Duricrust (silcrete, laterite)
	TERTIARY		Tl	Ferricrete (including laterite)
		Campaspe Beds	Tc	Argillaceous sandstone, conglomerate, siltstone, sand
		Glendower Formation	Tg	Argillaceous sandstone, conglomerate, sandy mudstone
MESOZOIC	LOWER CRETACEOUS	Wilgunya Formation		
		Allaru Member	Kla	Mudstone, calcareous siltstone, silty limestone
		Toolebuc Member	Klo	Platy and concretionary limestone, calcareous shale
		Ranmoor Member	Klq	Mudstone, carbonaceous mudstone, calcareous siltstone
		Jones Valley Member	Klj	Siltstone, calcareous siltstone, limestone
		Doncaster Member	Kld	Mudstone, glauconitic mudstone, concretionary limestone, quartz sandstone, glauconitic sandstone
		Gilbert River Formation	Klg	Conglomerate, sandstone.
	JURASSIC	Blantyre Sandstone	Jb	Quartz sandstone, carbonaceous shale, coal, conglomerate.
	LOWER TRIASSIC	Warang Sandstone	Rlw	Kaolinitic sandstone, conglomerate, variegated mudstone
PALAEOZOIC	UPPER PERMIAN	Mundic Igneous Complex	Pum	Pink porphyritic microgranite; granitic intrusion breccia
			Pud	Porphyritic microadamellite
		Betts Creek Beds	Pub	Lithic sandstone, kaolinitic lithic sandstone, micaceous siltstone, conglomerate mudstone, carbonaceous shale, coal, pebbly mudstone, tuff, breccia
			Puv	Conglomerate, rhyolite, tuff, tuffaceous siltstone and sandstone
	LOWER PERMIAN OR UPPER CARBONIFEROUS	Boonderoo Beds	Plb	Mudstone, varves, sandy mudstone lithic sandstone, rare tillite
UPPER PALAEOZOIC (?)			Pzg	Leucogranite, adamellite, quartz diorite
PRECAMBRIAN TO LOWER PALAEOZOIC		Lolworth Igneous Complex	Pzl	Porphyritic biotite adamellite and granodiorite, garnet-muscovite granite and adamellite, quartz diorite; muscovite pegmatite.
		Dumbano Granite	Pzd	Porphyritic biotite adamellite, garnet-muscovite granite; muscovite pegmatite
			Pzy	Foliated leucocratic biotite granite and microgranite; biotite pegmatite.
			Pzr	Foliated white biotite adamellite
			Pzn	Foliated and gneissic adamellite and granodiorite gneiss; rare migmatite.
		Cape River Metamorphics	p€q	Chiefly quartzite, with quartz-mica schist and amphibolite
			p€m	Mica schist, quartz-mica schist, biotite gneiss, garnet-biotite gneiss, amphibolite; rare tremolite gneiss, calc-silicate rocks, metamorphosed greywacke and tuff.

Geology, 1962-63, by: R.R. Vine, L.V. Bastian, M.A. Reynolds, A.G.L. Paine, R.R. Harding, F. de Keyser, R.Z. de Ferranti (B.M.R.)
D.J. Casey, D.E. Clarke (G.S.Q.)
Compiled, 1963-64, by: R.R. Vine, L.V. Bastian, A.G.L. Paine (B.M.R.)
D.E. Clarke (G.S.Q.)
Drawn by: I. Chertok.

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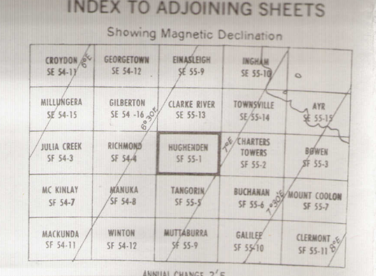

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MILES

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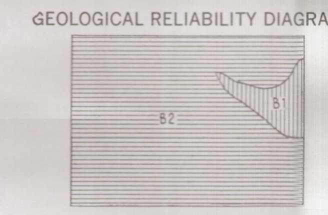

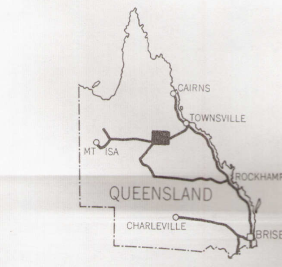

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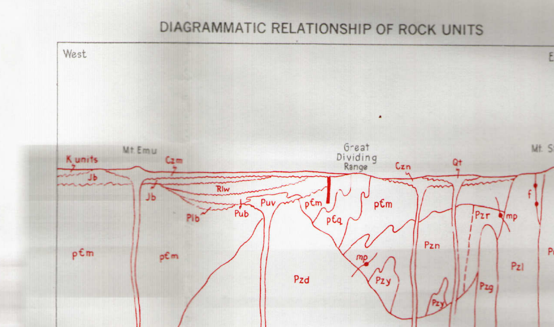
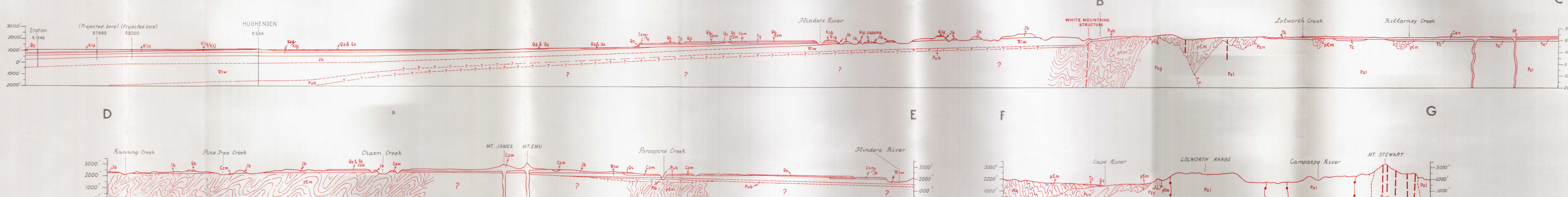


Sections

Folding schematic



HUGHENDEN

Sheet SF 55-1