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EXPLANATORY NOTES

MOUNT EVELYN, N.T.

Sheet D.53/5
Australian National Grid

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT.
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

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Compiled by B. P. Walpole

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DEPARTMENT OF NATIONAL DEVELOPMENT.

Minister: SENATOR THE HON. W. H. SPOONER, M.M.
Secretary: H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

Director: J. M. RAYNER.

These notes were prepared in the Geological Branch.
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Explanatory Notes on the Mount Evelyn Geological Sheet

Compiled by
B. P. Walpole

The Mount Evelyn Sheet area forms part of the Katherine-Darwin region of the Northern Territory. It includes part of the main divide which separates this region from the central or Bulman basin of the Arnhem Land Aboriginal Reservation. Archaean, Agicondian, Upper Proterozoic, and Lower Cretaceous rocks crop out.

The area is covered by Royal Australian Air Force air photographs at a scale of 1:50,000. From these the Division of National Mapping, Department of National Development, has prepared an uncontrolled photomosaic at a scale of 1 inch to 4 miles; planimetric base maps at 1 inch to 1 mile of the eight eastern 1-mile areas; and a 1 inch to 4 miles base map of the whole sheet. Base-map control is by Shoran, theodolite traverses, and astrofixes. Shoran control was provided by the Bureau of Mineral Resources.

Geological Investigations

Tate (1882) shows part of the Mount Evelyn Sheet on the maps accompanying his report; Tenison Woods (1886), Brown (1906, 1908), Woolnough (1912), and Jensen (1919) also describe parts of the area. These reports deal mostly with reconnaissance trips or with mineral occurrences in the western part of the Sheet and are supplemented by a number of later reports on mineral occurrences prepared by the Aerial, Geological, and Geophysical Survey of Northern Australia (A.G.G.S.N.A) (see references). Noakes (1949) reviews these reports and summarizes the then known geology of the area. A reconnaissance map of the central part of the area was produced by the Bureau of Mineral Resources in 1953 (Walpole, 1953). In 1954 and 1955 the eight western 1-mile areas were mapped at photo-scale by geological parties from the Bureau. A strip 5 miles wide and about 30 miles long around the South Alligator River was mapped at a scale of 1 inch : 1,000 feet. The four eastern 1-mile areas were covered in 1957 by aerial reconnaissance and photo-interpretation.*

PHYSIOGRAPHY

The area lies within the monsoonal climatic zone and has an average annual rainfall of about 60 inches, most of which falls during the summer wet season of three to five months duration.

*Five 1-mile Geological Sheets—Mundogie Hill, Goodparla North, Goodparla South, Ranford Hill, and Mt Stow—are published.

The relief ranges from about 100 feet to a maximum of about 1,000 feet. Although the area is dominated by the rugged Arnhem Land Plateau, most of the area is mature. Three main physiographic units are recognized: the Arnhem Land Plateau; Uplands; and Northern Plains (Fig. 1). These were described by Noakes (1949). The drainage is off a sinuous divide which runs across the Sheet to the south-west (Fig. 1). The main river systems are the Katherine and Fergusson Rivers, which flow south-west to join with the Daly River and enter the Timor Sea; the Mary and South Alligator Rivers, which flow north-west and north to Van Diemen Gulf; and the East Alligator River, which flows north-east before swinging north-west into Van Diemen Gulf. The Mann River flows north-east then north into the Arafura Sea. The Waterhouse River flows south-east and Flying Fox Creek south into the east-flowing Roper River, which empties into the Gulf of Carpentaria.

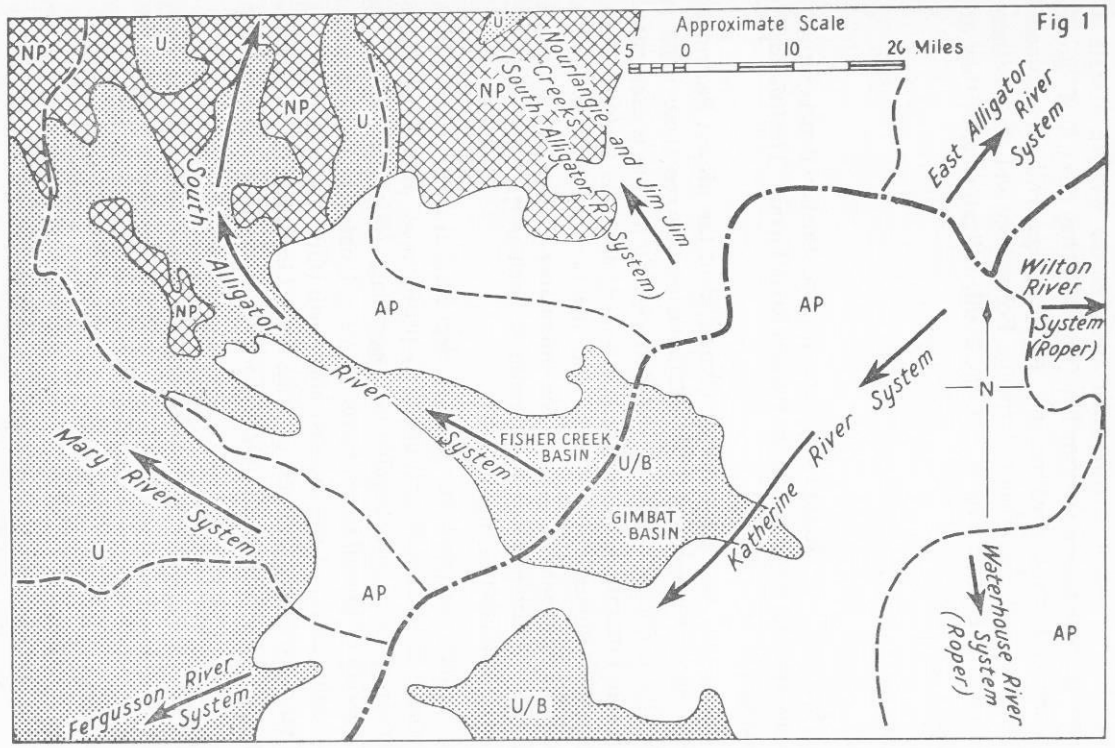
The Mary, South Alligator, and East Alligator Rivers are spring-fed and their upper courses are permanent streams; but their lower reaches, like other streams, are dry or consist of a number of billabongs during the winter months.

In most of the area the stream courses are controlled by features such as the well-developed joint system of the Upper Proterozoic rocks, the South Alligator Fault zone, or the regional north-westerly trend of the Agicondian rocks.

The *Arnhem Land Plateau* is a broad arch with its apex in the north-eastern quadrant of the Sheet and a north-west axis. The plateau is formed of arenaceous and rudaceous sediments with intercalated volcanics, which are cut by a spectacular conjugate system of vertical tension joints with major components striking north-east, north-west, north, and slightly north of east. The margins of the plateau are bold escarpments ranging up to 800 feet in height and formed by differential erosion of the softer underlying Agicondian rocks. The plateau is deeply dissected by hundreds of minor watercourses eroded along joints. Uplands basins such as the Gimbat and Fisher Creek basins (Fig. 1) are reflections of basement highs; the original cover of Upper Proterozoic rocks was thin and consequently more readily removed by erosion. Parts of the plateau are covered by Mesozoic rocks, in places eroded to only a few feet thick and mostly weathered to residual sand. Local variation in thickness up to 100 feet are due mainly to irregularities in the pre-Mesozoic depositional surface. In surrounding areas the Mesozoic is up to 200 feet thick; so the plateau was probably arched during the Cainozoic era.

The *Uplands* are in the south-western corner of the Sheet. They have a mature rolling topography and are formed by the Cullen Granite and the hornfelsed country rock along its margins. A hornfelsed zone in Agicondian rocks forms the divide between the Mary and Fergusson River systems. North of this divide the Uplands merge into the Northern Plains.

The *Northern Plains* consist of wide soil-covered flats separated by low strike-ridges and rounded knolls, commonly rising less than 50 feet above plain level. The flats are cut by numerous shallow meandering watercourses. The streams in this area have been degraded by an uplift which succeeded the arching of the Plateau and which is evidenced by raised beaches along the shore of Van Diemen Gulf.



Bureau of Mineral Resources, Geology and Geophysics. December, 1961.

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STRATIGRAPHY

The stratigraphy of the area is summarized in Table 1.

ARCHAEAN

The Archaean rocks are basement ridges which define the western margin of the Eastern Trough of the Pine Greek Geosyncline (Fig. 4). They consist of "greenstones" — altered basalt and basalt agglomerate. At Mundogie Hill they coincide with a marked thinning out of the Mount Partridge Formation and the northern limit of the main part of the Eastern Trough. In the South Alligator valley they are overlain by the Masson Formation.

LOWER PROTEROZOIC

Agicondian System

The Agicondian System in the Mount Evelyn area includes the Goodparla Group, South Alligator Group, and one formation of the Finniss River Group. The lithologies of these units are summarized in Table 1.

The *Goodparla Group* is a facies assemblage composed of the Mount Partridge, Masson, and Golden Dyke Formations. The relationships between these units is shown diagrammatically in Figure 2. The Mount Partridge Formation is dominated by arkose, the Masson Formation by quartz greywacke, and the Golden Dyke Formation by dolomitic sediments and chert; and the boundaries between the formations have been mapped on the basis of the dominance of these typical rock types. Siltstone of variable composition is common to each unit. The formation boundaries are either gradational or interfingered.

The Goodparla Group occupied the primary depositional basin of the Pine Creek Geosyncline and had an easterly and northerly provenance. It was succeeded by the *Finniss River Group*, a greywacke-siltstone assemblage which has a westerly provenance. Interfingering of Burrell Creek Formation and Golden Dyke Formation indicates that some sedimentation from the east and north (Goodparla Group) was admixed with material derived from the west (Finniss River Group). This apparently ceased with the formation of the Eastern Trough, in which the South Alligator Group was deposited.

The *South Alligator Group* in places is interfingered with Masson Formation, in places overlies with regional disconformity or with local unconformity, or is faulted against, Masson and Mount Partridge Formations. These variations in relationship are due to several factors—chiefly the provenance at a particular stage in the development of the secondary Eastern Trough, and its geographical position in regard to the trough; and the stability or instability of the basement at any particular locality during sedimentation. The South Alligator Group has been subdivided into three formations—Koolpin Formation, Gerowie Chert, and Fisher Creek Siltstone. The *Koolpin Formation* lies on the western and northern margins of the trough. On the western margin it is marked by discontinuous algal bioherms interfingered with a carbonaceous pyritic member which forms the main bulk of the formation. The reefs are localized on the basement ridge which runs from Turnoff Creek in the south to the north-western corner of the Sheet. The carbonaceous member contains

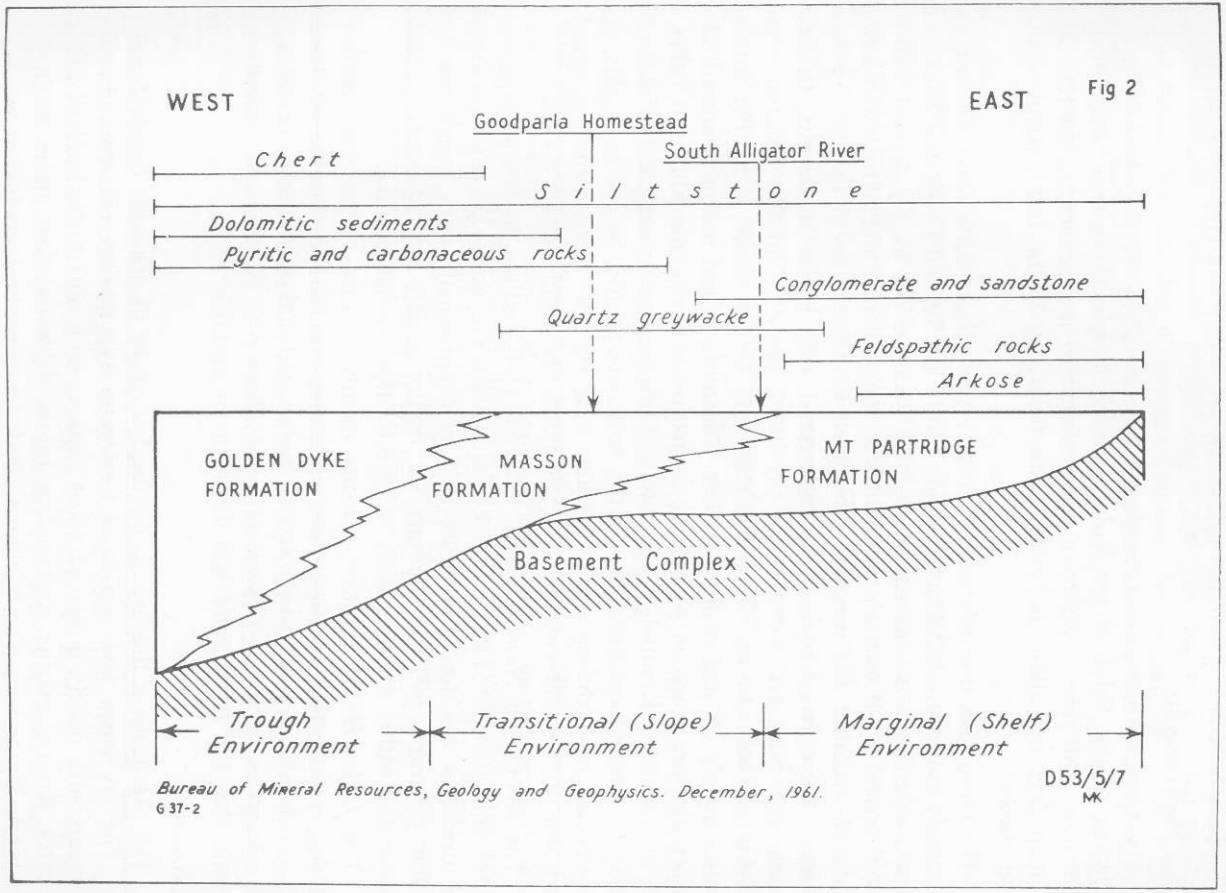
WEST
EAST
Fig 2
Goodparla Homestead
South Alligator River
Chert
Siltstone
Dolomitic sediments
Pyritic and carbonaceous rocks
Conglomerate and sandstone
Quartz greywacke
Feldspathic rocks
Arkose
GOLDEN DYKE FORMATION
MASSON FORMATION
MT PARTRIDGE FORMATION
Basement Complex
Trough Environment
Transitional (Slope) Environment
Marginal (Shelf) Environment
Bureau of Mineral Resources, Geology and Geophysics. December, 1961.
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TABLE I.

SUMMARY OF STRATIGRAPHY : MT EVELYN SHEET

Age	Rock Unit and Symbol	Thickness (feet)	Lithology	Remarks
Quaternary	Alluvium, etc. (Qa)		Soil, alluvium	
	Superficial Deposits (Qal)		Ferruginous zone of laterite profile.	
Lower Cretaceous	Mullaman Beds (Klm)	Variable up to 200	Freshwater and marine deposits—sandstone conglomerate. Contains unidentified plant remains and marine organisms.	Unconformably overlies Precambrian rocks. Boundaries between marine and freshwater rocks not yet established.
Upper Proterozoic	*Katherine River Group*	Up to 9,000	Contains three formations listed below.	Consists essentially of medium to coarse shelf deposits with intercalated lenses of volcanics. Deposited in small basin structures interconnected by platforms.
	Diljin Hill Formation (Pudj)	Variable up to 5,300	Mixed volcanics, pyroclastics and sediments. Basalt, amygdaloidal and vesicular basalt with quartz greywacke, conglomerate and sandstone lenses. Reference sections on Diljin Hill 1 mile area, Katherine Sheet.	Top Formation Katherine River group. Undifferentiated sequence in Mt. Evelyn Sheet area consists mainly of arenites.
	Gundi Greywacke Member (Pugu)	Variable up to 460	Purple to red brown quartz greywacke, tuffaceous in places. Reference section Gundi Creek tributary of Waterhouse west Branch, Katherine Sheet.	Member of Diljin Hill Formation best exposed on Katherine Sheet.
	Diamond Creek Member (Pudi)	Variable up to 700	Basalt, limestone, siltstone conglomerate. Reference Section, Diamond Creek 4 miles east of Waterhouse Waterfall, Katherine Sheet.	Member of Diljin Hill Formation best exposed on Katherine Sheet.
	Kombolgie Formation (Puk)	Variable up to 5,200	Alternating sediments and volcanics. Volcanics occur as lenses and are identified separately in different areas. Sediments include coarse to medium quartz greywacke, conglomerate, feldspathic sandstone, quartz sandstone, quartz siltstone, cobble conglomerate, tuffaceous conglomerate. Reference sections at Kombolgie Creek or east flowing creek which joins South Alligator River 3 miles west of El Sharana Mine.	Overlies Edith River Volcanics, in places with local unconformity or disconformity. Relationships are explained as being due to instability of basin margins during sedimentation and associated vulcanism.
	Kurrundie Member (Pur).	Variable up to 420	Purple or buff quartz greywacke with conglomerate bands in places. Type Section Kurrundie Creek.	Basal member of Kombolgie Formation. Not developed on north-eastern side of South Alligator Valley.
	Plum Tree Volcanic Member (Pud)	1,200 (appx.)	Andesite, rhyolite and dacite, commonly porphyritic in feldspar, amygdaloidal in places, pyroclastic. Reference sections at Plum Tree, Kombolgie, and Dinner Creeks.	Shown on some earlier maps as Dinner Creek Volcanics.
	Birdie Creek Volcanic Member (Pud).	700 (appx.)	Mainly andesite, amygdaloidal in places, pyroclastic. Reference section at Birdie Creek.	Equivalent of Plum Tree Volcanics in Sleisbeck area.
	Edith River Volcanics (Pue)	Variable up to 4,000	Mainly acid to intermediate volcanics—rhyolite and dacite, intercalated with lenses of 'valley fill' sediments—silicified calcarenite breccia, conglomerate, polymictic conglomerate, sandstone and pyroclastics in South Alligator valley.	Basal unit of Katherine River Group. Has been subdivided into different members in South Alligator area. Members not shown here due to small scale of map. Unconformably overlies Agicondian.
Lower Proterozoic (Agicondian System)	*South Alligator Group* (Pla)		Contains three formations listed below.	Youngest Group in Agicondian on eastern side of Pine Creek Geosyncline. Deposited in secondary Eastern Trough. Overlies Goodparla Group with regional disconformity or local unconformity. Folded with Goodparla Group.
	Fisher Creek Siltstone (Plf)	Up to 17,000 (estimate) (only)	Mainly siltstone, minor micaceous greywacke, greywacke siltstone. Reference section—upper reaches of Fisher Creek.	Overlies and interfingers with Koolpin Formation and Gerowie Chert.
	Gerowie Chert (Plg)	Variable up to 3,000 (estimate only)	Chert and impure chert. Reference section—4 miles due south of Showell Billabong.	Facies change with underlying Koolpin Formation. Possibly diagenetic alteration product of dolomitic sediments.
	Koolpin Formation (Plk)	Variable up to 3,000 (estimate only)	Algal dolomite as discontinuous bioherms in places at base. Pyritic carbonaceous siltstone with chert (after dolomite) lenses nodules and bands, carbonaceous siltstone. Pyritic siltstone, in places capped by gossanous hematite. Reference sections—biohermal structures on west bank South Alligator River between Pul Pul Hill and Coronation Hill, other rocks—Koolpin Creek.	Basal formation of South Alligator Group. Essentially a reef facies developed on old basement ridge along western margin of Eastern Trough.
	Finniss River Group			Burrell Creek Formation only unit represented on Mt Evelyn Sheet.
	Burrell Creek Formation (Plb)	Up to 8,000	Greywacke, siltstone, greywacke-siltstone. Overlies and interfingers with Golden Dyke Formation. Reference sections—Pine Creek— Goodparla track for 8 miles east of Mary River crossing. Burrell Creek or hills immediately east of 101 mile peg, Stuart Highway, Pine Creek Sheet.	
	Goodparla Group		Contains three formations listed below.	Basal unit of Agicondian System, Pine Creek Geosyncline.
	Golden Dyke Formation (Pld)	Up to 9,000	Chert, carbonaceous siltstone, thin bedded dolomite, pyritic carbonaceous siltstone with chert lenses, bands and nodules. Pyritic siltstone, in places, capped by gossanous hematite. Reference section Golden Dyke area, Pine Creek Sheet, Evelyn mine and Northern Hercules mine areas.	Top formation of Goodparla Group, Deposited in Central Trough where interfingered with overlying Burrell Creek Formation.
	Masson Formation (Plm)	Variable up to 10,000	Quartz greywacke, siltstone, carbonaceous siltstone, in places pyritic and in places with silicified dolomite bands, nodules and lenses. Minor conglomerate, quartz sandstone, banded siltstone, calcareous siltstone. Reference section—Mt Masson mine area, Pine Creek Sheet.	Formation is composed mainly of lenses of quartz greywacke intertonguing with siltstone of different types.
	Coirwong Greywacke Member (Plc)	Variable up to 1,000	Medium to coarse quartz greywacke, minor conglomerate. Reference sections — Coirwong Gorge or South Alligator Valley.	Prominent marker in Masson Formation in South Alligator Valley.
	Mt Partridge Formation (Plp)	Variable. Estimated up to 10,000	Arkose, arkose conglomerate, siltstone, medium quartz sandstone, in places ripple marked and cross bedded, conglomerate. Minor quartz greywacke, silicified dolomite lenses and ferruginous siltstone. Locally metamorphosed. Reference sections—Mt Partridge or Yemelba ridge.	Basal unit of Goodparla Group.
	Mundogie Sandstone Member (Plu)	Variable up to 5,000 (estimate only)	Coarse to medium quartz sandstone, ripple marked and cross bedded in places, conglomerate, sandy siltstone, minor quartz siltstone and quartz greywacke. Reference section at Mundogie Hill.	Local facies of Mt Partridge Formation developed around and on basement high in Mundogie Hill agea. Thickens radially from core of Mundogie dome and grades out into Mt Partridge rocks to east, Masson Formation to west.
Archaean	Stag Creek Volcanics (As)	Not known	Altered basalt and basalt agglomerate. Reference Section—core of Mundogie Dome. North bank of Stag Creek opposite El Sharana mining camp	Basement to Agicondian in South Alligator River valley and at Mundogie Hill.

prominent chert bands, nodules, and lenses. The chert is altered dolomite. The *Gerowie Chert* is a facies change of the Koolpin Formation, which it interfingers and overlies. The chert may be diagenetically altered dolomite. The *Fisher Creek Siltstone* is locally interfingered with the Koolpin Formation and Gerowie Chert. The main rock type is siltstone, with minor micaceous greywacke and greywacke-siltstone.

Upper Proterozoic

The Upper Proterozoic succession is represented by the *Katherine River Group*, consisting of the Edith River Volcanics, Kombolgie Formation, and Diljin Hill Formation. All three units have been subdivided into members, but the scale of the map does not allow the subdivisions belonging to the Edith River Volcanics to be shown.

The Group lies unconformably on the Agicondian. *Edith River Volcanics* crop out mainly in the South Alligator Valley and in the Turnoff Creek and Snake Creek areas. In the South Alligator area, the basal member is a locally derived 'valley fill' deposit consisting of quartz and polymictic conglomerate and pyroclastics admixed with acid volcanics and commonly confined to depressions in the old Agicondian surface. These basal rocks are interfingered with lenses of silicified calcarenite breccia and both are overlain by rhyolite. There is an old volcanic vent at Coronation Hill. In the Turnoff Creek and Snake Creek areas the formation consists mainly of acid or intermediate volcanics. Local unconformities and disconformities are common within the formation in the South Alligator Valley and with the overlying Kombolgie Formation. They are due to irregular sedimentation, caused by sharp local variations in the basement profile; by the instability of the depositional zone during sedimentation; and by the fundamental geographical restriction of the acid vulcanism which marks the Edith River Volcanics.

The *Kombolgie Formation* is a succession of medium to coarse arenites and rudites with intercalated lenses of volcanics. Quartz greywacke is a common sediment. The formation was deposited in a system of depositional basins, interconnected by shallow platforms which commonly are occupied only by sediments. Local unconformities within the formation are due to depositional features.

The *Diljin Hill Formation* consists mainly of medium to fine arenites. It includes a distinctive purple tuffaceous greywacke (*Gundi Greywacke Member*) and a volcanic member composed of basalt and tuff with lenses of ferruginous and calcareous sediments (*Diamond Creek Member*). Sharp local disconformities indicate that the rocks were laid down in an unstable area.

Mesozoic

The Mesozoic in this area is confined to rocks of probable Lower Cretaceous age. The *Mullaman Beds* consist of freshwater and marine sediments. Freshwater sediments with poorly preserved plant remains crop out at the head of the South Alligator River ; marine rocks occur in the tableland four miles south-west of Goodparla Homestead. The Mullaman Beds have not been studied in detail and the boundaries of the freshwater and marine rocks are not known. The beds form cappings, commonly less than 100 feet thick, on the Precambrian rocks and in most places are covered by a layer of residual sand.

Cainozoic

Soil and alluvium covers most of the north-western part of the area. Lateritization expressed as a fully developed profile is not common, although some of the Cretaceous cappings and the Koolpin Formation on the northern part of the Sheet have been affected. Cainozoic weathering of the Agicondian rocks has produced, in some places, considerable differences between the appearance of the rocks in outcrop and that at depth. A common example of this is provided by siltstones of the Masson and Koolpin Formations, which are commonly pyritic and carbonaceous in the unweathered zones, but crop out as reddish siltstone.

Igneous Rocks

Granites

The granitic intrusions are discordant bodies commonly composed of massive, unstressed rock. The largest mass is the Cullen Granite, essentially hornblende-biotite granite with minor syenite differentiates. It is porphyritic in feldspar and is surrounded by a hornfels contact aureole. The Wolfram Hill Granite is probably an apophysis of the Cullen Granite. The Grace Creek Granite is granite porphyry, the Malone Creek Granite microgranite, and the Jim Jim Creek mass contaminated biotite granite. The intrusions are comagmatic. A potassium-argon age of 1695 million years has been determined for the Cullen Granite.

Small quartz-feldspar porphyry dykes are associated with the Cullen Granite in the Ranford Hill and Goodparla South 1-mile areas.

Zamu Complex

The Zamu Complex consists of a swarm of dykes and sills concentrated in the general South Alligator area and extending south-east to the Katherine River and north-west of Jim Jim Creek. Preliminary studies of these rocks show them to be dolerite or granophyric differentiates of dolerite, including syenite, diorite, microdiorite, and adamellite. Some sills were folded with the sediments; but most of the dykes were intruded after folding but before the intrusion of the granite.

Other Basic Intrusives

A folded dolerite sill is intruded along the boundary between Masson and Golden Dyke rocks near McCarthy's mine in the Goodparla South 1-mile area. A small dolerite dyke intrudes Edith River Volcanics near the head of the South Alligator River.

Volcanic Rocks

The Archaean Stag Creek Volcanics are altered basalt and basalt agglomerate. There are no volcanic rocks in the Agicondian succession in the Mount Evelyn area. The volcanic rocks of the Upper Proterozoic Katherine River Group show increasing basicity with each succeeding unit: the Edith River Volcanics are acid to intermediate, with rhyolite as the main component, ignimbrite, subordinate dacite, and minor andesite and basalt; Plum Tree Creek and Birdie Creek Volcanics are mainly andesite, with subordinate rhyolite, dacite, and basalt; and Diamond Creek Volcanics are mainly basaltic.

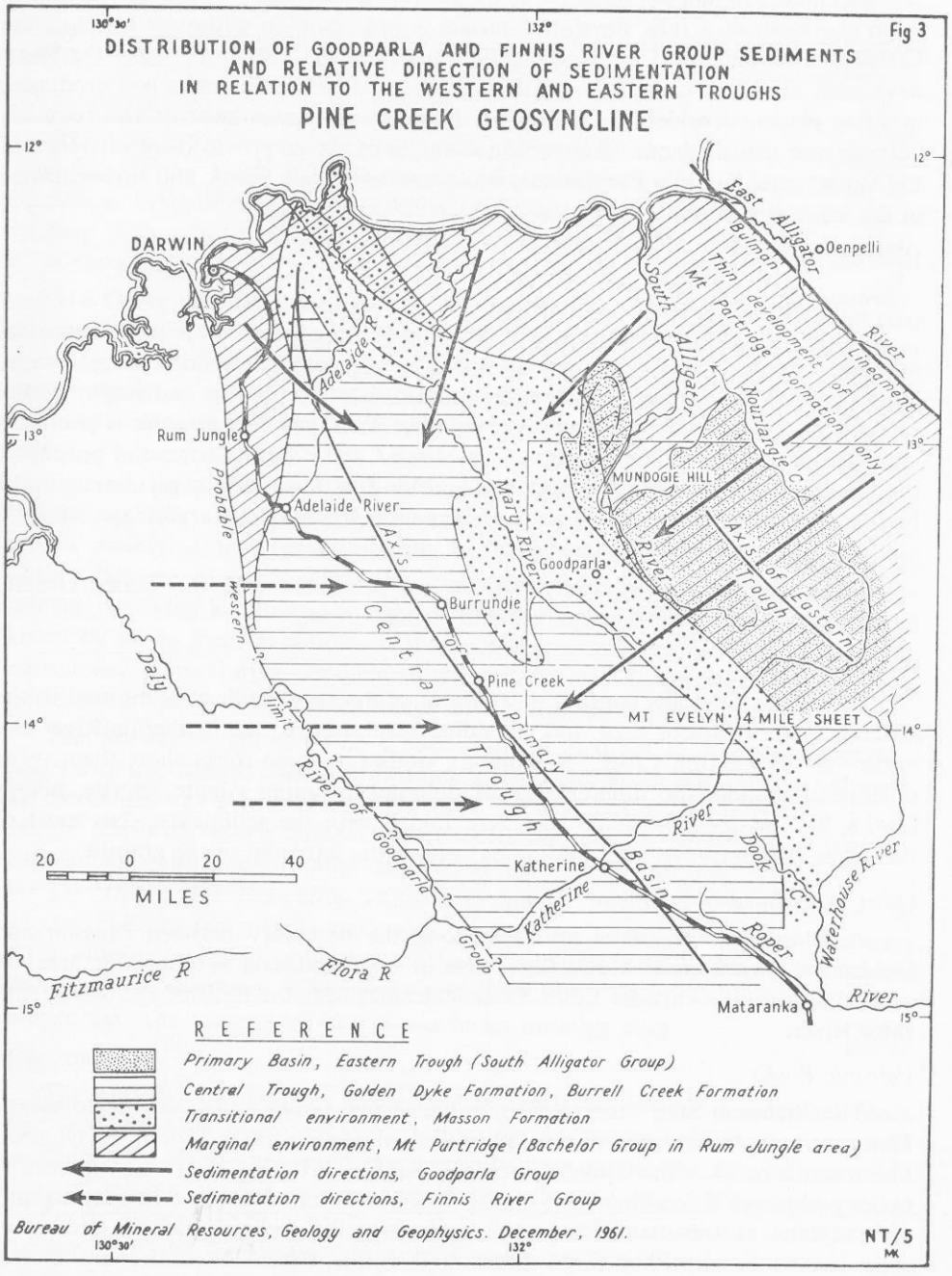
Fig 3
DISTRIBUTION OF GOODPARLA AND FINNIS RIVER GROUP SEDIMENTS
AND RELATIVE DIRECTION OF SEDIMENTATION
IN RELATION TO THE WESTERN AND EASTERN TROUGHS
PINE CREEK GEOSYNCLINE
130°30'
132°
12°
13°
14°
15°
DARWIN
Oenpelli
East Alligator River
Lineament
Rum Jungle
Adelaide River
Adelaide R
Mary River
Goodparla
Burrundie
Pine Creek
MUNDOGIE HILL
Mourlangie C.
Probable Western Daly Limit
Axis of Central Trough
Axis of Eastern Trough
Thin development of Mt Partridge Formation only
South Alligator River
Bulman
MT EVELYN 4 MILE SHEET
River of Goodparla
Katherine
Katherine Group
Basin
Dook C.
Roper River
Waterhouse River
Fitzmaurice R
Flora R
Mataranka
20 0 20 40
MILES
REFERENCE
Primary Basin, Eastern Trough (South Alligator Group)
Central Trough, Golden Dyke Formation, Burrell Creek Formation
Transitional environment, Masson Formation
Marginal environment, Mt Partridge (Bachelor Group in Rum Jungle area)
Sedimentation directions, Goodparla Group
Sedimentation directions, Finnis River Group
Bureau of Mineral Resources, Geology and Geophysics. December, 1961.
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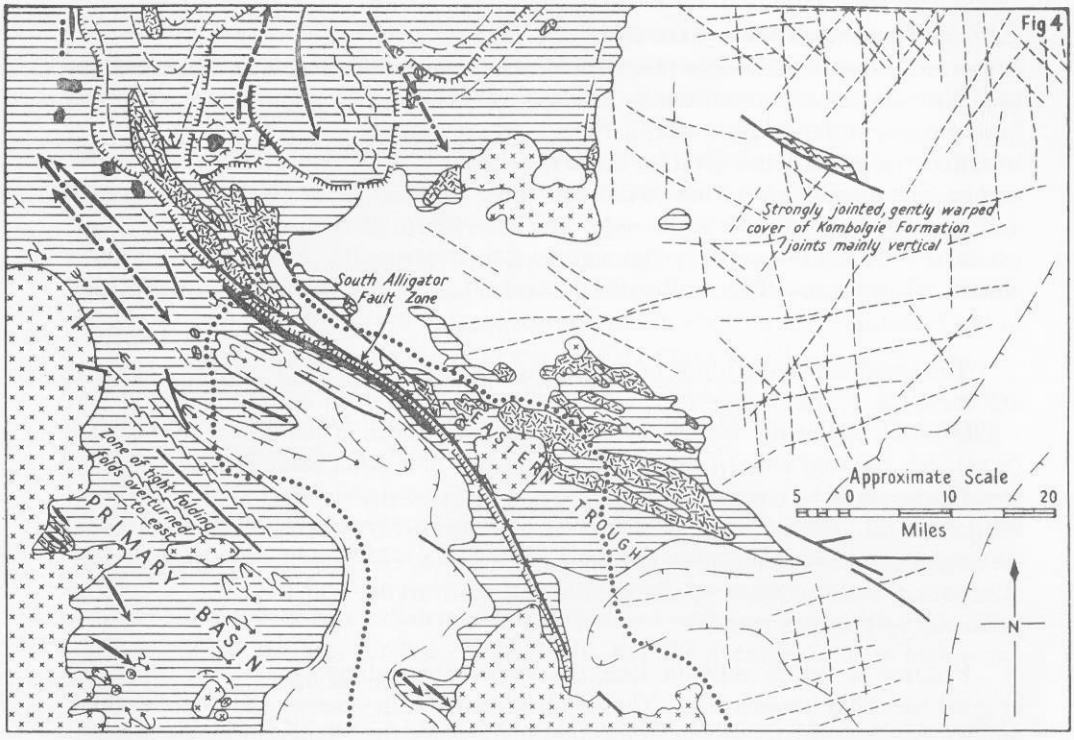

UPPER PROTEROZOIC

Basin and platform deposits of Kombolgie Formation

LOWER PROTEROZOIC (Agicondian System)

Granitic intrusions

Basic sills and dykes - Zamu Creek Complex

Folded geosynclinal sediments

ARCHAEAN

Basement highs - Stag Creek Volcanics

Geological boundary

Strike & direction of prevailing dip

Trend of fold axes in tightly folded area

Anticlinal axis showing direction of plunge

Synclinal axis showing direction of plunge

Plunge of minor anticline

Plunge of minor syncline

Schistosity

Fault or fault zone

South Alligator Fault Zone

Overthrust fault

Vertical tension joints

Distribution of Edith River Volcanics

Margin of Eastern Trough

Bureau of Mineral Resources, Geology and Geophysics. January, 1962.
G 37-4
D 53/5/8
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STRUCTURE

The internal structure of the Archaean rocks is not known.

The Agicondian rocks were folded and faulted by a single orogeny. This was not severe; the formations retain their original spatial relationships and there has been little apparent foreshortening of the geosynclinal tract. The folds and faults have a regional trend north-west, parallel to the alignment of the axes of the central trough of the primary basin and of the eastern trough (see Figs. 3 and 4). The central and eastern troughs are asymmetrical structures bounded to the west by steep faults and shelving up gradually to the east. The central trough is the primary structure; the eastern trough is secondary and was developed during the later stages of geosynclinal sedimentation. The results of reconnaissance gravity work across the trough in the Mundogie Hill area are discussed in Appendix 2.

The amplitude and attitude of the folding vary from place to place. Pitch changes are common. A local zone of overturned folding occurs on the Goodparla South 1-mile Sheet, where the fold axial planes are overturned to the east (Section EF). In general, the fold pattern suggests a dominance of torsion produced by tensional stress rather than by compression and the geosynclinal structure is that of a modified composite intracratonic basin. There is no distinctive orogenic belt. Dynamic metamorphism is very low grade over most of the area, except in the Mount Partridge area, where mica schists and schistose arkose and arkose conglomerate have been produced by shearing stress.

Faulting is severe only in localities where the sedimentary record indicates original basement irregularities. The South Alligator valley marks a fault-zone which follows and accentuates an old hinge-line marked by the change in facies between Mount Partridge and Masson sediments and later by the eastern margin of the South Alligator Trough. In common with most other zones of faulting in the Agicondian rocks of the area, the trend is north-west. The South Alligator fault-zone consists mainly of high-angle reverse faults; but as these have suffered repeated movements at least into the Upper Proterozoic, the original attitude cannot be determined. A small overthrust fault occurs on the east side of the Mundogie Hill dome and is probably controlled to some extent by the basement high which forms the core of the dome.

The Upper Proterozoic rocks are gently folded—most structures can be attributed to modified depositional features. The faulting in the South Alligator/Turnoff Creek zone affects the Upper Proterozoic rocks, but the overall dislocation is small and has not greatly affected the pattern of ridges and valleys on the underlying Agicondian surface, many of which can still be clearly identified in the South Alligator Valley. Vertical tension jointing is very well developed, the main directions being north-east, north-west, north, and about 80° magnetic.

The Cretaceous rocks are neither folded nor faulted in this area, but are known to be faulted in places on the adjoining Pine Creek and Katherine Sheets.

ECONOMIC GEOLOGY

Mineral deposits include gold, copper, lead, tin, wolfram, silver, arsenic, and uranium. Apart from uranium, which was not discovered in the area until 1953, most of the large number of mineral showings were located, worked, and abandoned early in the century. Spasmodic attention has been paid to some deposits, particularly those of wolfram and tin, in recent years, when high prices for those particular metals prevailed. The deposits are all small, commonly hydrothermal vein type. The majority are concentrated on the Goodparla South and Ranford Hill 1-mile areas and are clearly associated with the Cullen Granite or its apophyses. Small amounts of alluvial gold were won, mainly by Chinese miners, at Wandie diggings. The better known deposits are those at Wolfram Hill and Mountain View (wolfram), Hidden Valley and Crest of the Wave (tin), Coronet Hill (copper, lead, silver, arsenic), Evelyn (lead), and Northern Hercules (gold). Production records are incomplete. Available figures are shown as Appendix 1.

Uranium deposits are confined to the South Alligator Valley and a few occurrences of minor importance in the Sleisbeck and Turnoff Creek areas. In the South Alligator area, 7 deposits with reserves totalling about 100,000 tons of 0.5 percent U_3O_8 have so far been discovered.

The orebodies are localized in shears; most lie close to or across the Upper Proterozoic/Agicondian unconformity. The main ore-shoots are in the Agicondian rocks. Pitchblende is the chief economic mineral, but the surface ore is commonly in the form of spectacular showing of secondary uranium minerals. Gold is a by-product of the Palette ore and is also known at Coronation Hill. The deposits are all small, of limited known depth, but the average grade is high compared with most uranium deposits.

In recent years the search for iron in the Northern Territory has been intensified. Drilling beneath ironstone material in the Koolpin formation, north of Mundogie Hill, showed that it was only a gossanous capping formed above pyritic sediments. Similar gossans appear elsewhere on the pyritic carbonaceous siltstone of the Koolpin and Golden Dyke Formations. A hematite vein transgressing South Alligator Group sediments near the headwaters of Nourlangie Creek was also drilled and found to die out at a shallow depth.

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APPENDIX 1

MINERAL PRODUCTION RECORDS

Production records are incomplete and do not necessarily show total metal content of ore produced or value of production.

(i) Figures for tin and wolfram probably refer to tons of concentrate, which may have averaged somewhere between 60 and 70 percent.

(ii) Gold fineness is not known but is probably less than 850. Production was from alluvial and lode sources.

(iii) Lead production quoted as 'ore' is probably mainly in the form of concentrates, possibly averaging about 70 percent Pb. Only a few figures for silver are known, and are not quoted here.

(iv) Percentage copper is quoted where known. Most parcels probably averaged over 20 percent Cu.

Totals (all sources): Gold 31,141 oz. (includes 2,041.77 fine oz.)
Tin 272.32 tons (concentrates.)
Wolfram 408.043 tons (concentrates), 2715 tons ore of unknown grade.
Lead 1308.42 tons (ore).
Copper 2,950.4 tons (ore—includes 1.6 tons Cu).

Year	Producer	Amount
	GOLD	
1891	Eureka (Northern Hercules)	2,003 oz.
1892	Eureka (Northern Hercules)	2,003 oz.
1893	Eureka (Northern Hercules)	1,356 oz.
1894	Evelyn (Probably Eureka)	2,138 oz.
1895	Eureka	1,465 oz.
	Wandi	200 oz.
1898	Eureka	9,029 oz.
	Wandi	863 oz.
1899	Eureka	1,490 oz.
	Wandi	282 oz.
1900	Eureka	576 oz.
	Wandi (2,500 oz. alluvial)	3,400 oz.
1901	Wandi	362 oz.
1902	Wandi	740 oz.
1903	Wandi	1,955 oz.
1904	Wandi	1,237.25 oz.
1905	Wandi	419 oz.
1934–35	Yemelba	44 oz.
1935–36	Yemelba	38.25 oz.
1936–37	Yemelba	128.00 oz.
1937–38	Yemelba	32 oz.
1938–39	Yemelba	8.74 fine oz.
	Eureka	2.57 fine oz.
1955–56	Northern Hercules	2,042.6 fine oz.

TIN

Year	Producer	Amount
1906	Hidden Valley	2.25 tons
1907	Crest of the Wave	6.00 tons
1908	Fergusson River (Upper)	9.00 tons
	Wolfram Hill	25.00 tons
1909	Fergusson River (Upper)	3.00 tons
	Wolfram Hill	3.60 tons
1910	Wolfram Hill (includes 9.62 tons Crest of the Wave)	16.65 tons
	Mary River	12.60 tons
	Hidden Valley	3.85 tons
	Fergusson River (Upper)	1.85 tons
1911	Wolfram Hill (probably includes Crest of the Wave)	20.00 tons
	Mary River	7.75 tons
	Hidden Valley	3.75 tons
	Fergusson River (Upper)	2.00 tons
1912	Wolfram Hill (includes 5.45 tons Crest of the Wave)	14.00 tons
	Mary River	12.00 tons
	Hidden Valley	4.00 tons
	Fergusson River (Upper)	3.00 tons
1913	Crest of the Wave	8.30 tons
	Hidden Valley	1.10 tons
1914–15	Crest of the Wave	29.50 tons
1916–17	Crest of the Wave	21.00 tons
1917–18	Crest of the Wave	29.60 tons
1919–20	Crest of the Wave	22.30 tons
	Mary River	6.05 tons
	Wolfram Hill—Hidden Valley	1.54 tons
1920–21	Crest of the Wave	25.00 tons
	Mary River	N/A.
1921–22	Crest of the Wave	1.90 tons
1922–23	Crest of the Wave	11.00 tons
1923–24	Hidden Valley	0.59 tons
1924–25	Hidden Valley	6.47 tons
1925–26	Hidden Valley	4.94 tons
1926–27	Hidden Valley	3.05 tons
1930–31	Hidden Valley	1.15 tons
1931–32	Hidden Valley	2.00 tons
1933–34	Crest of the Wave	9.10 tons
1938–39	Mary River	0.14 tons
	Crest of the Wave	0.23 tons
1952–53	Hidden Valley	1.06 tons
1953–54	Hidden Valley	8.19 tons
1954–55	Hidden Valley	10.90 tons

WOLFRAM

Year	Production	Amount
1900	Wolfram Hill	10.00 tons
1901	Wolfram Hill	5.15 tons
1904	Wolfram Hill	28.00 tons
1905	Wolfram Hill	61.00 tons
1906	Wolfram Hill	103.00 tons
	Hidden Valley	2.25 tons
1907	Wolfram Hill	75.50 tons
	Ferguson River (Upper)	1.25 tons
	Hidden Valley	12.50 tons

Year	Production	Amount
1908	Wolfram Hill (held for sale)	30.00 tons
1909	Wolfram Hill (held for sale)	11.95 tons
	Fergusson River (Upper)	0.11 tons
1910	Wolfram Hill	63.20 tons
	Hidden Valley	1.80 tons
	Fergusson River (Upper)	1.95 tons
1911	Wolfram Hill	42.00 tons
1912	Wolfram Hill	27.10 tons
1913	Wolfram Hill	11.35 tons
1914–15	Wolfram Hill	6.25 tons
1915–16 }	Wolfram Hill	40.50 tons
1916–17 }		
1917–18	Wolfram Hill	62.70 tons
1918–19	Wolfram Hill	N/A.
1919–20	Wolfram Hill	47.40 tons
1936–37	Wolfram Hill	N/A
1937–38	Wolfram Hill	6.75 tons
1938–39	Wolfram Hill	4.61 tons
1939–40	Wolfram Hill	8.61 tons
1940–41	Wolfram Hill	3.83 tons
1941–42	Wolfram Hill	0.10 tons
1944–45	Wolfram Hill	2.18 tons
1946–47	Wolfram Hill	0.332 tons
1947–48	Wolfram Hill	5.27 tons
1949–50	Wolfram Hill	1.60 tons
1950–51	Wolfram Hill	1.95 tons
1951–52	Wolfram Hill	0.76 tons
1952–53	Wolfram Hill	23.28 tons
1953–54	Wolfram Hill	20.83 tons

SILVER-LEAD

Year	Production	Amount
1886–87	Evelyn	
	2,224 tons of ore smelted to produce bullion containing 601 tons of lead and 89,391 ozs. of silver	
1902	Evelyn	200.00 tons
1904	Evelyn	40.00 tons
1905	Evelyn	42.00 tons
1906	Evelyn	67.25 tons
	Silver Spray	67.50 tons
1907	Silver Spray	18.85 tons
	Evelyn	8.75 tons
1913	McCarthy's	300.00 tons
	Bower Bird	8.00 tons
1915–16	McCarthy's	178.00 tons
1924–25	Evelyn	191.25 tons
1925–26	Evelyn	42.00 tons
	Hidden Valley	9.65 tons
1926–27	Hidden Valley	23.50 tons
	(70% Pb, 34 oz. silver per ton)	
1928–29	McCarthy's	10.50 tons
1929–30	Mount Gardiner	7.00 tons
1937–38	Hidden Valley	2.00 tons
1947–48	Evelyn	6.85 tons
1948–49	Zamu Creek	8.00 tons
1949–50	Zamu Creek	12.78 tons

COPPER

Year	Production	Amount
1898	3 miles north-east Wandi	40.00 tons
1899	Mount Gardiner	13.00 tons
1901	Mount Diamond	23.00 tons ore
	IXL	100.00 tons ore
1905	Mount Diamond	72.25 tons ore
	Walden's	166.75 tons ore
	Wolfram Hill	38.00 tons ore
	Mount Gardiner	21.50 tons ore
1906	Mount Diamond	16.00 tons ore
	Walden's	233.50 tons ore
	Wolfram Hill	66.75 tons ore
	Mount Gardiner	26.75 tons ore
1907	Mount Davis	173.50 tons ore
	Mount Diamond	120.85 tons ore
	Walden's	218.10 tons ore
	Wolfram Hill	61.00 tons ore
	Mount Gardiner	14.00 tons ore
	Fergusson River (Upper)	8.00 tons ore
1908	Mount Davis	269.00 tons ore
	Fergusson River (Upper)	41.00 tons ore
	Wolfram Hill	3.00 tons ore
1909	Mount Diamond	20.35 tons ore
	Fergusson River (Upper)	13.00 tons ore
1910	Fergusson River (Upper)	0.15 tons ore
1912	Wolfram Hill	57.20 tons ore
	Mount Davis	56.00 tons ore
	Mount Diamond	20.00 tons ore
1913	Mary River	31.50 tons ore
1915–16	Coronet Hill	62.00 tons ore
	Wolfram Hill	35.00 tons ore
1916–17	Mount Diamond	148.00 tons (26% Cu.)
1917–18	Coronet Hill	158.00 tons (22% Cu.)
	Coronet Hill Extended (18% Cu.)	27.50 tons
	Mary River	37.50 tons
1918–19	Coronet Hill	158.00 tons ore
	Walden's	600.86 tons ore
	Mount Davis	332.00 tons ore
	Mount Diamond	220.00 tons ore
1919–20	Mount Diamond	63.15 tons ore
1929–30	Coronet Hill	13.90 tons ore
	Mount Diamond	6.10 tons ore
1955–56	North Hercules	1.60 tons (Cu.)

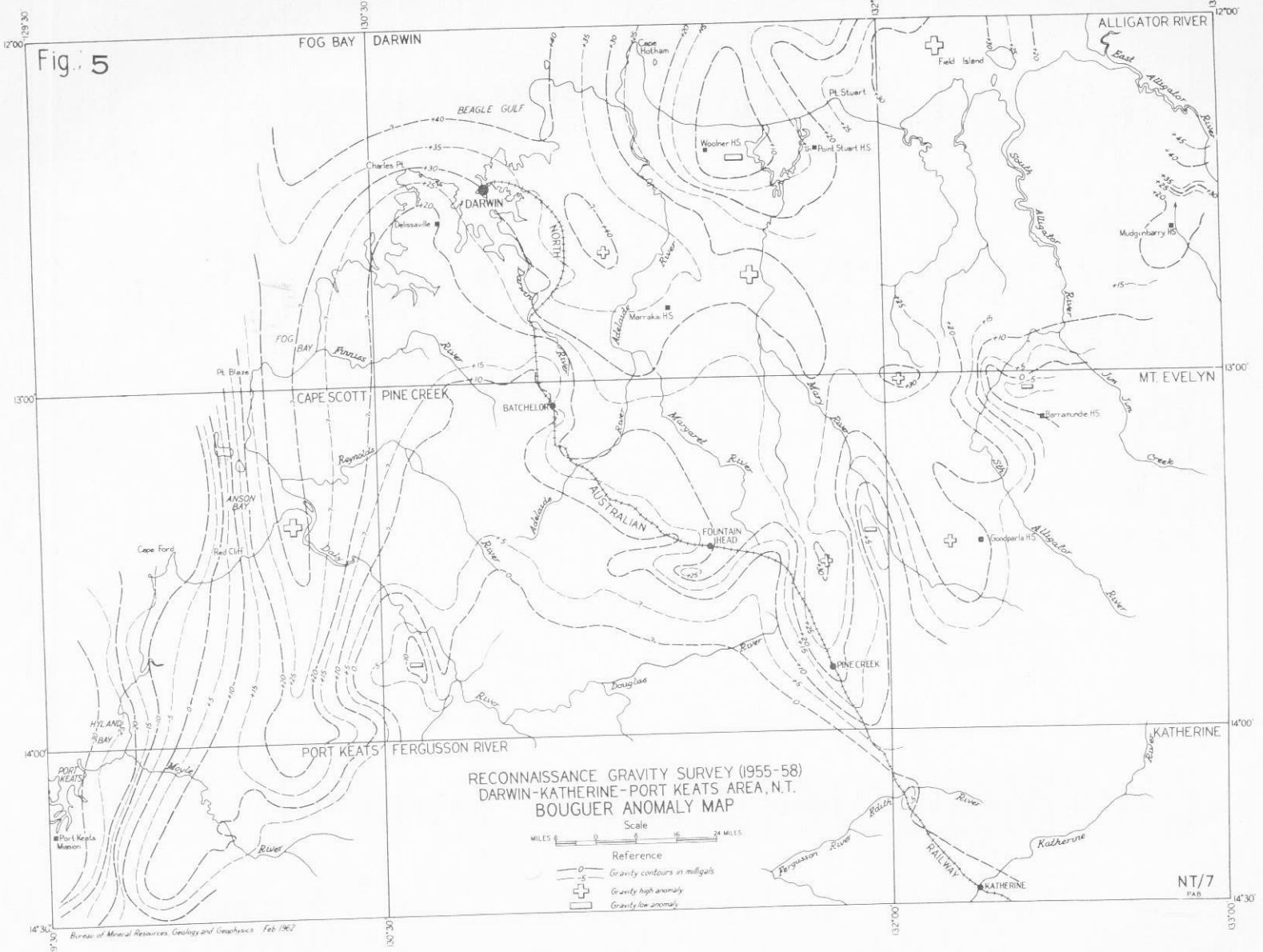
Fig. 5
FOG BAY
DARWIN
ALLIGATOR RIVER
CAPE SCOTT
PINE CREEK
MT. EVELYN
PORT KEATS
FERGUSSON RIVER
KATHERINE
BEAGLE GULF
ANSON BAY
HYLAND BAY
AUSTRALIAN
RAILWAY
Cape Hotham
Field Island
Pt Stuart
Woolner HS
Point Stuart HS
Charles Pt
DARWIN
Delissaville
Marrakai HS
Mudginberry HS
Pt Blaze
BATCHELOR
Barramundie HS
Goodparla HS
FOUNTAIN HEAD
Cape Ford
Red Cliff
PINE CREEK
Port Keats Mission
KATHERINE
RECONNAISSANCE GRAVITY SURVEY (1955-58)
DARWIN-KATHERINE-PORT KEATS AREA, N.T.
BOUGUER ANOMALY MAP
Scale
MILES 0 8 16 24 MILES
Reference
Gravity contours in milligals
Gravity high anomaly
Gravity low anomaly
NT/7
PAB
Bureau of Mineral Resources, Geology and Geophysics Feb 1962

APPENDIX 2.

NOTES ON A GRAVITY SURVEY OF THE DARWIN-KATHERINE REGION

by

W. J. LANGRON.

The results of a reconnaissance gravity survey carried out over the Pine Creek Geosyncline in the Darwin-Katherine area are shown on Figure 5. The plan shows the traverses surveyed and contours of the Bouguer anomalies. The observed values of gravity have been reduced to Bouguer anomalies, using an elevation correction factor of 0.0601 milligals per foot. Datum for the observed gravity values is a pendulum station at Darwin.

Observations were mostly confined to stations along existing tracks, but were supplemented by underwater observations along the northern and north-western coasts. At best, the data constitute a reconnaissance survey of the area, but are adequate to show the broad outline of the gravity pattern.

The results reveal a considerable gravity relief, especially in the central and eastern portions of the area, with a range of over 50 milligals. Another feature is the extensive distribution of positive Bouguer anomalies over the area, possibly because of its association with the Indonesian tectonic zone.

The gravity results cannot be interpreted in detail because of the paucity of essential evidence, mainly with regard to rock densities. The rock densities, so far as they are known, are summarized in the following table, which shows the range of density values for the various rock types:

Age	Rock Type	Density
Proterozoic :	Granites	2.64 — 2.66
	Siltstone, greywacke, etc. (Burrell Creek Formation)	2.68 — 2.72
	Basic rocks and carbonaceous dolomitic siltstone (Golden Dyke Formation)	2.85 — 2.95
Archaean :	Stag Creek Volcanics	3.0 — 3.1

It is noticeable that only between the granites and sediments on the one hand and the basic rocks on the other is there sufficient contrast in density to account for the large variations in Bouguer anomalies. It does not appear, either from the field mapping or gravity results, that the Stag Creek Volcanics are extensively distributed as a 'basement rock', and although the basement is probably complex there is little evidence to suggest a marked change in its density throughout the area. It is possible, therefore, that the density contrast responsible for the major variation in gravity is that between the materials of the granitic and basaltic layers of the earth's crust.

It is reasonable to suppose that variations in the depth to the basaltic layer will reflect the major tectonic structure of the Pine Creek Geosyncline. The sediments occupy depressions in the crust beneath which the basaltic layer is also depressed to an

equal or lesser extent. Troughs and ridges in the Archaean basement are most probably underlain by troughs and ridges in the upper surface of the basaltic layer, although it seems likely that their amplitudes will be somewhat smaller.

The gravity results indicate three distinct zones, an eastern and a western trough separated by a ridge of high Bouguer values extending from near Pine Creek towards Mount Bundey and thence to Darwin.

On present evidence it seems that the greatest depth to the basaltic layer, and by inference the greatest thickness of Proterozoic sediments, is in the eastern trough, under Yemelba Ridge. In the western trough the Bouguer values, although lower than in the eastern trough, are in part due to the presence of the Proterozoic granite near Hermit Hill. The western traverses also include a thin cover of Cambrian rocks of approximately the same density of the Proterozoic sediments. The central plateau of high Bouguer values, which in the main is located on rocks of the Golden Dyke over Masson Formation, probably indicates a zone of comparatively shallow basement.

Gravity features, in general, have a north-westerly strike and thus follow the dominant structural grain of the geosyncline.

Over Archaean areas around Cannon Hill and south-west of Hermit Hill gravity rises to high positive Bouguer values. However, the highest readings are not reached until well beyond the mapped boundaries of the Archaean basement.

The steep gravity gradient south of Cannon Hill is due to a major fault at right angles to the traverse.

The association of gravity 'lows' with outcropping granite (e.g., Rum Jungle, Cullen, Hermit Hill Granites, etc.) is general throughout the area. Simple calculations show that the Cullen Granite east of Pine Creek has a 'root' which may extend down to about 15 kilometres.

Minor gravity 'highs' can be correlated with some basic intrusives, particularly those within the Golden Dyke Formation.

The principal value of the gravity survey is that the results form a useful guide to the broad structural interpretation of the area.