COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1960/126

EXPLANATORY NOTES TO THE FERGUSSON RIVER FOUR-MILE GEOLOGICAL SHEET, NORTHERN TERRITORY.

by

M.A. Randal.

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INTRODUCTION

Base Maps

The Fergusson River 4-mile Sheet area occupies the south-western portion of the Katherine-Darwin region in the Northern Territory of Australia. It lies between longitudes 130°30'E and 132°E and between latitudes 14°S and 15°S.

The area is wholly covered by vertical air photographs at a scale of 1:30,000. In 1952 and 1953 the Division of National Mapping produced, at a scale of 1:63,360, uncontrolled photo mosaics of the twelve one-mile areas within the four-mile area. In 1958 the Division produced topographic base maps of the one-mile areas from the air photographs with astrofixes for control.

Access

The Stuart Highway and the North Australia Railway traverse the north-eastern corner of the area; the eastern portion is served by a network of station tracks and by the Katherine-Wyndham road, which cuts across the south-eastern corner.

Access to the remainder of the Sheet area is governed by the crossings on the Daly River. The north-western corner is served by the Port Keats track, which crosses the river at Daly River Police Post, north of the Sheet area. The Banyan Farm crossing carries the track from Fenton Airfield, in the Pine Creek 4-mile Sheet area, to the Collia Tin Field, and the Clara Farm Crossing the track to Dorisvale. The crossing at Clara Farm is more reliable than that at Banyan Farm. From Dorisvale a disused track gives access to the ruins of Wombungee Homestead and the eastern Fitzmaurice River area.

Vehicular movement is extremely difficult in the hilly and plains country west and south of Collia. Access into this area was gained by means of a helicopter based on Collia Waterhole.

Climate

The climate is monsoonal, with a short wet season from late November to early April and a long dry season for the remainder of the year.

In the dry season, days are warm and nights relatively cool; humidity is low. The coolest period is a few weeks late in July and early in August. Early morning dews are frequent during the first three months of the season. The prevailing winds in the dry season are from the south-east, but occasionally winds from the north-west bring clouds and a few light showers. Towards the end of the dry season temperature and humidity rise, and cloudy days are more frequent; wind directions become variable, with winds from the north-west predominating. Early storms begin in October, and by the end of November, which is the hottest month, rain is frequent and heavy.

The 35" isohyet passes through the southeast of the area and the 45" isohyet through the north-west. Rainfall is the major climatic feature affecting plant growth, and consequently growth is generally restricted to the short wet season.

GEOLOGICAL INVESTIGATIONS.

In 1894 and 1905 H. Y. L. Brown passed through the area in the course of wide traverses to the south and east. He examined and reported on both the Woolngi Goldfield and the Fletcher's Gully Gold Prospect (Brown, 1895 and 1906). In 1914-15 H. I. Jensen passed through the eastern section en route to Tanami (Jensen, 1915). He included the Woolngi Goldfield in a report on the adjoining Agicondi Province in 1919.

In 1936 geologists of the Aerial, Geological and Geophysical Survey of North Australia mapped the Fletcher's Gully Goldfield and the Collia-Buldiva Tinfield (Hossfeld, 1937a, b). This was the first detailed mapping done within this Sheet area.

The Bureau of Mineral Resources in 1949 published a reconnaissance geological map of the Katherine-Darwin region. This map was the result of field work done in 1946 by L. C. Noakes and included about half the Fergusson River Sheet area (Noakes, 1949). During the early 1950's many radioactive anomalies were examined and reported on by geologists of the Bureau. (Carter, 1952; Gardner, 1953a, b; Jones, 1953).

Geologists of the Bureau of Mineral Resources mapped the Lewin Springs one-mile Sheet in the north-east of the four-mile Sheet area, in 1953 (Rattigan & Clarke, 1955) and the Muldiva Creek one mile Sheet in the north-west in 1955. J. E. Harms, in 1956, mapped part of the Fitzmaurice River area while engaged in the regional mapping of the Kimberleys. The regional mapping of the Fergusson River 4-mile area was completed by the Bureau of Mineral Resources in 1957.

PHYSIOGRAPHY

The present cycle of erosion in the area was presumably initiated in late Tertiary or Quaternary time by uplift, tilting, and warping of the whole Katherine-Darwin Region (Noakes, 1949). An extensive laterite profile, developed mainly on the rocks of the Mullaman Group, varies considerably in elevation between the Wingate Plateau and Darwin. On the Wingate Plateau it is about 1000 feet above sea level and drops to about 300 feet in the Daly River Basin, rising to 900 feet near Pine Creek and again dropping to about 100 feet near Darwin. It is not clear to what extent this variation in elevation can be attributed to post-Tertiary movements because it is difficult to trace horizons in the lateritised sediments and because of the lack of accurate levelling in the area.

Evidence of tilting is shown by the drainage pattern of the Daly River Basin. This basin appears to be open to the south-east, but to the north-west it is bounded by the tablelands and uplands country. However, the Daly River, which drains the basin, flows in a northwesterly direction and leaves the basin in a narrow gap worn through the hard rocks of the uplands on the Pine Creek 4-mile area.

Nine physiographic units are recognised in the area (Fig. 1) : (1) the Daly River Basin, (2) the Wingate Plateau, (3) the Tablelands, (4) the Mesas, (5) the Uplands, (6) the Granite Areas, (7) the Wingate Foothills, (8) the Western Plains and (9) the River Plains.

The Daly River Basin is 150 miles long and 60 miles wide, extending beyond the borders of the Sheet to the north and south-east. To the south-east, it gradually merges into the mature country south of Mataranka; to the north, it abuts against the Uplands on the Pine Creek 4-mile Sheet area. The basin is not fully mature and is being eroded by the Daly River and its tributaries. In places horizontal bars across the streams have imposed temporary base levels, thus retarding erosion.

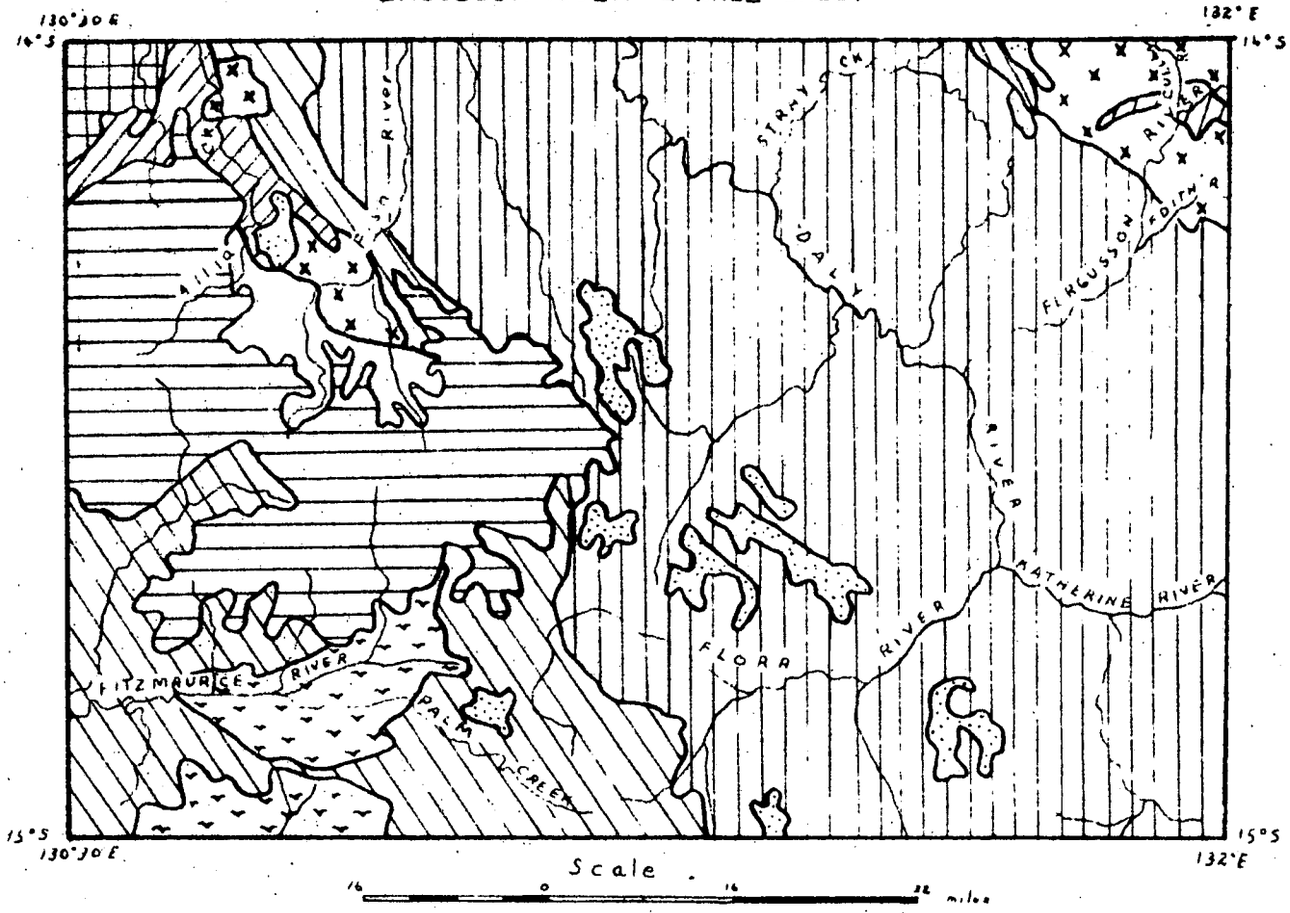
The basin consists mainly of broad plains and low rises, covered by low scrub or open savannah. The streams have cut steep banks and channels deep in alluvium. Red soil is developed over much of the basin and outcrop is scarce.

The Wingate Plateau extends west and north-west from Dorisvale to the headwaters of the Moyle River in the adjoining Port Keats 4-mile Sheet area. It reaches a height of 1000 ft above sea level at a point 10 miles south-west of Collia Waterhole. The plateau forms part of the divide between the Fitzmaurice and the Daly Rivers, the tributaries of which are slowly cutting deep re-entrant valleys into it. On most sides the plateau is bounded by steep cliffs, although in places there is a gradual change from Plateau to Tablelands. In the western half, springs and elongated alluvial flats are common. The plateau is covered by open savannah and tall woodlands.

PHYSIOGRAPHIC SKETCH-MAP

FERGUSSON RIVER 4-MILE SHEET

FIG 1



Daly River Basin

Wingate Plateau

Tablelands

Mesas

Uplands

Granite Areas

Wingate foothills

Western Plains

River plains

The Tablelands form the eastern divide between the Fitzmaurice River and the Daly River, and the south-western foothills to the Wingate Plateau. The topography is youthful: the streams cut steep, rocky gorges along joint planes. The surface of the Tablelands has a local relief up to 300 feet and is rugged and difficult to traverse. The Tablelands in the south of the area have a slight westward slope. In the north-west a narrow strip of Tablelands country forms the western margin of the Daly River Basin; it slopes gently eastward towards the Basin, but its western edge is marked by a prominent escarpment. Vegetation on the Tablelands is typically open forest with tall timber.

The Mesas are best developed in the centre of the area. They were originally continuous with the Wingate Plateau. The highest mesas are 700 feet above sea-level, and their local relief varies from 200 to 250 feet. A hard cap, formed by the ferruginous and pallid zones of a laterite profile, produces cliffs which drop steeply away to the gentle slopes and undulating hills of the underlying rocks. Open forest and savannah are the usual vegetation.

The Uplands is the term applied to the rugged landscape formed by the folded Lower Proterozoic rocks which crop out in the north-west of the area. To the north the Uplands continue on to the Pine Creek 4-mile area; to the south they merge into the Wingate Plateau. The Uplands are characterized by steep-sided strike ridges and narrow valleys. Relief is up to 500 feet. The valleys broaden out to wide alluvial flats which gradually merge into the Western Plains.

The Granite Areas have a characteristic topography which is easy to recognise on air photographs: it consists of rounded rocky hills with a typical drainage pattern of converging alluvial flats. The main drainage is along well-defined watercourses with steep low banks consisting of boulders and unconsolidated gravel. Vegetation is poorly developed and is typically open forest and scrubby open forest; parkland is common on the alluvial flats, particularly near springs.

The Wingate Foothills are rough stony rises, low hills, and elevated alluvial flats lying to the south and west of Collia Waterhole. They were produced by deep erosion of the Wingate Plateau by the headwaters of the Fish River. From 700 feet above sea level near the Wingate Plateau they slope northwards to an elevation of 430 feet near the low country occupied by the Soldiers Ck. Granite. Vegetation is variable and consists of parkland, open scrub, and open savannah.

The Western Plains occupy the north-western corner of the area. They are more widespread in the adjoining Pine Creek, Port Keats, and Cape Scott areas. The Western Plains consist of low, gently undulating plains and swamps. The plains are covered by mainly low open forest and palm scrub, with stands of paperbark trees and pandanus palms in the swamp areas.

The River Plains lie in the south-western part of the Sheet area, around the Fitzmaurice River and the Angalarri River. Their topography is more mature than that of the Daly River Basin; it consists of gently undulating plains with low rubble-covered rises supporting a stunted growth of open scrub and parkland. Anabranches and braided channels are typically developed in the streams.

STRATIGRAPHY

(Table 1)

Archaean (?)

The oldest known rocks in the area are the metamorphosed sediments of the Hermit Creek Metamorphics. These sediments, which consist of migmatite, banded granulite, quartzite and mica schist, have been regionally metamorphosed to a high degree. They are considered to be Archaean because of the structural and metamorphic unconformity between them and the Lower Proterozoic rocks of the Pine Creek Geosyncline.

Lower Proterozoic

Agicondian System:

The Finniss River Group contains the Noltenius Formation, the Burrell Creek Formation and the Berinka Volcanics, and with the Chilling Sandstone forms part of the Lower Proterozoic Pine Creek Geosyncline (Walpole & White, 1955). The relationships of these units can be established only by considering the geology of adjoining areas of the Katherine-Darwin Region.

The Noltenius and Burrell Creek Formations are not in contact in this area, but in other areas they are a facies assemblage. The Noltenius Formation consists of mainly coarse grained clastics deposited in a position close to the margin of the geosyncline. The roof pendant of Burrell Creek Formation mapped near the Fergusson River Railway Siding consists of siltstone and greywacke deposited in the trough zone of the geosyncline. The Berinka Volcanics conformably overlie the Noltenius Formation and consequently are considered to be part of the Lower Proterozoic sequence. No clear contact with the Chilling Sandstone, which also conformably overlies the Noltenius Formation, has been observed.

The Chilling Sandstone was deposited in a shallow water shelf environment on the western side of the geosyncline. It represents the final phase of sedimentation in the Pine Creek Geosyncline.

Upper Proterozoic

Edith River Volcanics

To the southwest of Fergusson River Railway Siding volcanic rocks crop out over an area of sixteen square miles. They are fine-grained rocks, ranging in composition from toscanite to dacite, and porphyritic equivalents intrude the Cullen Granite as sills and dykes.

Edith River Volcanics cont'd.

These rocks unconformably overlie the Cullen Granite and the Burrell Creek Formation, but in this area are not in contact with other Upper Proterozoic rocks. Carter (1952) referred to them as the Fergusson Toscanite and regarded the unit as older than the Buldiva Sandstone. Rattigan & Clarke (1955) called them the Fergusson Volcanics and considered them to be basal Upper Proterozoic. Because of lithological similarities and the wide areal extent of the Edith River Volcanics (Noakes, 1949) fifteen miles south-east of Fergusson Siding the volcanics in the Fergusson River area are regarded as part of the Edith River Volcanics.

Victoria River Group

Four units are recognised in the rocks of the Victoria River Group (Traves, 1955) which crop out in the south-west of the Fergusson River 4-mile area. In the Victoria River Region Laing & Allen (1956) divided the Group into six units; a possible correlation between the units of the Group in the two areas is shown in Table 1.

The Palm Creek Beds, which crop out between the Fitzmaurice River and the Flora River, constitute the base of the Victoria River Group in the area. Their only exposed contact with Lower Proterozoic rocks is at the head of the Angalarri River, where they are faulted against steeply dipping siltstone and greywacke of the Noltenius Formation.

The Palm Creek Beds cropping out south of the Flora River consist of silicified limestone with sandstone interbeds, overlain by massive cliffs of ripple-marked quartz sandstone. The actual contact is hidden by scree and talus, but the dips are conformable and the rocks are considered to be part of the one sequence.

The Palm Creek Beds are conformably overlain by the Angalarri Siltstone. The contact is exposed north and north-east of the Angalarri River, and consists of a gradational change from the arenaceous sediments of the Palm Creek Beds to the chocolate and green siltstones of the Angalarri Siltstone. The siltstone crops out in the plains country along the Fitzmaurice and Angalarri Rivers. South of the Twins, outcrops of dolomite and silty dolomite form prominent rises above the plains level. Harms (1956) reports the occurrence of scattered limestone slabs resting in the alluvium in this area. North of the Wingate Plateau, outcrops of the Angalarri Siltstone are seen dipping gently southwards under the Depot Creek Sandstone. The contact appears conformable, but elsewhere over two thousand feet of arenaceous, silty, and calcareous rocks separate the two units.

West of the Twins fine-grained arenaceous rocks crop out in a large basin, the major portion of which occurs in the Port Keats 4-mile area. The rocks are referred to as the Yambarra Beds. The sequence consists of at least two thousand feet of quartz sandstone, feldspathic sandstone, siltstone, and dolomite. Along the Yambarra Range escarpment to the south, these rocks conformably overlie the Angalarri Siltstone (Harms, 1956). At the head of Alligator Creek on the Port Keats 4-mile area, rocks of the Tolmer Group unconformably overlie the sequence.

The Laurie Creek Beds crop out south-west of Collia Tinfield, and apparently overlie the Yambarra Beds; but the contact was not observed. Near Coolamon Homestead the Laurie Creek Beds consist of silicified medium-grained quartz sandstone interbedded with silicified limestone containing stromatoliths.

Tolmer Group

North-east of Collia Waterhole the Buldiva Sandstone, which consists of massive, quartz sandstone overlain by flaggy sandstone, is conformably in contact with shallow dip slopes of the overlying Hinde Dolomite and the Waterbag Creek Formation. The contacts are clear and show no signs of intervening erosional breaks. Maximum thicknesses are not, however, developed at this point. All three units are unconformably overlain by vesicular basalt, which has filled erosion valleys in the old land surface.

The Buldiva Sandstone is the basal unit of the Tolmer Group. It unconformably overlies the Laurie Creek Beds, and west of the Sheet overlies the Yambarra Beds with a marked angular unconformity. Its sharp contact with the Palm Creek Beds -- shown on the map as an inferred fault -- may be the expression of an unconformity. North-west of Collia, it unconformably overlies the rocks of the Pine Creek Geosyncline.

The formation has been divided into two members. The lower member, the Depot Creek Sandstone Member, is widely distributed through the western half of the Sheet; the overlying Stray Creek Sandstone Member is restricted to the margins of the Daly River Basin. The two members represent the continuous sedimentation of quartz sand in a shallow epeiric sea, and in places the boundary between the two is transitional. The Depot Creek Sandstone Member crops out as massive ridges and tablelands with well developed vertical and horizontal joints. The Stray Creek Sandstone Member is a flaggy fissile rock with little vertical jointing.

The Stray Creek Sandstone Member is conformably overlain by the algal reefs of the Hinde Dolomite, which crops out discontinuously along the western margin of the Daly River Basin, extending to the north on to the Pine Creek 4-mile area, where, near Hayward Creek, it attains its maximum thickness of 200'. The formation consists of massive silicified limestone and dolomite overlain by flaggy, jointed pink dolomite with siltstone interbeds. It is conformably overlain by the Waterbag Creek Formation.

The Waterbag Creek Formation is the uppermost unit of the Tolmer Group and marks the final phase of Upper Proterozoic sedimentation before uplift and the subsequent Lower Cambrian vulcanism. It consists of interbedded ferruginous sandstone, siltstone, and silicified limestone. In the Waterbag Creek area it appears to overlie directly the Depot Creek Sandstone Member, but the contact is obscured by scree and faulting. To the east of Collia both the Stray Creek Sandstone and the Hinde Dolomite are thinning rapidly southwards. They appear to lens out under the Lower Cretaceous cover and probably were never deposited in the Waterbag Creek area.

Lower Cambrian

Volcanic rocks crop out over the southern and central portions of the Sheet area and appear to be the remnants of a single period of vulcanism. The rocks are of the plateau basalt type, with minor tuffaceous material, and vary little from place to place. They are continuous with the basalt outcrops at Willeroo to the south and are therefore regarded as part of the Antrim Plateau Volcanics (Traves, 1955). They unconformably overlie both the Victoria River Group and the Tolmer Group. Near Collia they rest directly on the Soldiers Creek Granite.

Middle Cambrian

The Daly River Group occupies the Daly River Basin and rests unconformably on the Antrim Plateau Volcanics and the Tolmer Group. In the north-east of the area it immediately overlies the Cullen Granite. The Group consists of limestone, sandstone, and siltstone, deposited in shallow water in a slowly sinking basin.

Fossils from the basal unit, the Tindall Limestone, indicate a correlation with the lower Middle Cambrian Gum Ridge Formation at Tennant Creek (Opik, 1959). The Tindall Limestone is conformably overlain by the Jinduckin Formation, which consists of sandstone, siltstone, marl, and limestone lenses. Halite pseudomorphs are common in the sandstone and siltstone beds. The limestone lenses, which reach a maximum thickness of 200 feet, have been formally named the Manbulloo Limestone Member; it is well developed in the Sheet area north-west of Dorisvale Homestead and south-west of the Katherine River, and in the Katherine 4-mile area near Manbulloo Homestead.

The Oolloo Limestone conformably overlies the Jinduckin Formation and is the last record of sedimentation in the area until the Lower Cretaceous transgression.

Lower Cretaceous

The Mullaman Beds unconformably overlie the rocks of all older units; they consist of marine sediments overlying freshwater sediments. The freshwater sediments are more restricted in extent and are not present in all sections. At Buldiva, radiolarian shales overlie beds containing plant remains, with no apparent break in sedimentation. The plant remains have been identified as Otozamites bengalensis by Walkom (in Hossfeld, 1937), who assigned a Jurassic or possible Lower Cretaceous age to them.

Plant remains from near Willeroo have been identified as Jurassic (Brunnschweiler, 1953). Noakes & Crespin (1949 and 1952) regard the radiolarian shales as uppermost Lower Cretaceous. As there is no apparent break between the lacustrine and marine sediments the Mullaman Beds are shown on the map as Lower Cretaceous in age.

TABLE I

STRATIGRAPHY OF FERGUSSON RIVER FOUR-MILE SHEET

AGE	ROCK UNIT	LITHOLOGY	THICKNESS	GEOGRAPHICAL DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS	STRUCTURE	TOPOGRAPHY	PALAE. & CORRELATION	ECONOMIC GEOLOGY
QUATERNARY	Alluvium (Qa)	Alluvial deposits. Soil, silt and sand cover.	20-100'	Widespread in Daly River Basin and Fitzmaurice River area. Developed along watercourses on all units.					Alluvial gold and tin.
	UNCONFORMITY								
LOWER CRETACEOUS	Mullaman Beds (Klm)	Undifferentiated freshwater and marine sandstone, siltstone and conglomerate. Tertiary? laterite developed on old land surface.	200'	Widespread over whole area.	Unconformable on all units.	Horizontal sheet deposits.	Mesas, portion of Wingate Plateau. Rocky, sand covered rises.	Marine organisms and plant remains.	
	UNCONFORMITY								
CAMBRIAN MIDDLE Daly River Group	Colloo Limestone (Cmo)	Silicified limestone; cherty in places.	200'	Scattered outcrops in centre of Daly River Basin.	Conformably overlies Jinduckin Formation.	Depositional basin.	Hills with karst topography. Low mounds and slabs in alluvium.	Algae.	
	Jinduckin Formation (Cmj)	Ferruginous, fine to medium grained quartz sandstone and siltstone, with halite pseudomorphs. Some marl; dolomitic and silicified limestone.	200'	Crops out in Daly River Basin.	Conformably overlies Tindall Limestone.	Depositional basin.	Low, rubble covered rises and small hills.		
	Manbulloo Limestone Member (Cmu)	Silicified, flaggy limestone.	200'	Crops out in western and southwestern portions of the Daly River Basin.	Local development of limestone lenses within Jinduckin Formation.	Shallow, depositional dips.	Low, rocky hills.		
	Tindall Limestone (Cmt)	Lutitic and crystalline limestone with chert nodules and bands; some sandstone.	500'	Discontinuous outcrops around Daly River Basin.	Unconformably overlies Antrim Plateau Volcanics, Tolmer Group and Cullen Granite.	Low, depositional dips.	Low, rubble covered rises and massive hills with karst topography.	Girvanella, Helcionella Hyolithes Biconulites Lingulella Acrotetra Redlichia ptychopariids — Equivalent to Gum Ridge Formation.	
	UNCONFORMITY								

LOWER CAMBRIAN	Antrim Plateau Volcanics (Cla)	Vesicular and fine grained basalt. Some tuffaceous sandstone.	200'	Western margin of Daly River Basin, Collia and headwaters of Fitzmaurice River.	Unconformably overlie sediments of Tolmer Group and Victoria River Group.	Flat-lying or gently dipping flows. In places faulted.	Low, rocky, rounded hills; some black soil areas with large shrinkage cracks.		Native copper, barytes & gypsum. (Traces only).
	UNCONFORMITY								
PROTEROZOIC Tolmer Group	Waterbag Creek Formation (Pwg)	Ferruginous sandstone and siltstone with halite pseudomorphs, some limestone, silicified in places.	500'	Crops out on western margin of the Daly River Basin.	Conformably overlies Hinde Dolomite, but overlaps onto Buldiva Sandstone.	Depositional dips and rolls. In places faulted.	Low, undulating hills, in places well developed dip slopes.		
	Hinde Dolomite (Pwh)	Silicified dolomite and dolomitic limestone with algal reefs.	200'	Northwestern margin of Daly River Basin.	Conformably overlies Buldiva Sandstone.	Low, initial dips.	Well developed dip slopes and low, massive outcrops.	Collenia(?).	
	Buldiva Sandstone: Stray Creek Sandstone Member (Pwy)	Flaggy quartz sandstone and colour-banded siltstone.	1000'	Crops out on north-western and north-eastern margins of the Daly River Basin.	Conformably succeeds Depot Creek Sandstone Member.	Shallow dips. Moderately faulted.	Tablelands, with stony watercourses.	Jellyfish cf. Beltanella.	
	Buldiva Sandstone: Depot Creek Sandstone Member (Pwc)	Pink, ripple-marked, crossbedded, quartz sandstone.	1000'	Crops out on western and north-eastern margins of Daly River Basin; also on western and southern portions of the Wingate Plateau.	Unconformably overlies the Victoria River Group and Lower Proterozoic sediments and granite.	Shallow dips, flat-lying in plateau area; well jointed. Numerous faults.	Tablelands with steep rocky gorges.	Worm-tracks.	
	UNCONFORMITY								
PROTEROZOIC Victoria River Group	Laurie Creek Beds (Pwq)	Silicified, medium-grained, quartz sandstone; silicified limestone.	500'	Crops out southwest of Wingate Plateau.	Probably slight unconformity with Yambarra Beds.	Small, contained basin.	Portion of Tablelands.	Stromatoliths.	
	Yambarra Beds (Pwt)	Feldspathic sandstone, quartz sandstone, siltstone and dolomite.	2000'	Crops out in south-western corner of the area.	Conformably overlies Angalarri Siltstone on the Delamere Sheet.	Forms eastern margin of large basin structure. Well developed joints.	Tablelands with steep, rocky gorges.	Equivalent to Pinkerton Beds. (Laing and Allen).	
	Angalarri Siltstone (Pwj)	Mainly colour-banded siltstone, red sandstone and dolomitic limestone.	1000'	Crops out in Fitzmaurice River-Angalarri River area. Small belt north of Wingate Plateau.	Conformably overlies Palm Creek Beds.	Shallow, depositional (?) dips.	Plains country along Fitzmaurice and Angalarri Rivers.	Equivalent to Auvergne Shale. (Laing and Allen).	
	Palm Creek Beds (Pwx)	Ripple-marked, cross-bedded quartz sandstone; silicified limestone at base.	1000'	Tablelands between Fitzmaurice River and Daly River Basin.	Basal unit in the area of the Victoria River Group. Unconformably overlies the Lower Proterozoic.	Moderate westward dips.	Tablelands with broken surface and steep rocky gorges.	Equivalent to Jasper Gorge Sandstone. (Laing and Allen).	

		UNCONFORMITY						
UPPER PROTEROZOIC	Edith River Volcanics (Pue)	Rhyolitic flows and porphyries.	350'	Isolated outcrops on the Cullen Granite.	Unconformably overlie the Cullen Granite and the Burrell Creek Formation.	Flows, sills and dykes.	Broken and stony hills and rises.	Previously known in this area as Fergusson Volcanics. (see text).
		UNCONFORMITY						
	Chilling Sandstone (Plc)	White, cross-bedded, ripple-marked, medium to coarse grained quartz sandstone and greywacke.	1500'	Crops out in the north-west of the sheet area.	Conformably overlies the Noltenius Formation.	Moderately tight folds. A broad open fold pitches under the Wingate Plateau.	Steep, rocky hills and ridges.	
LOWER PROTEROZOIC AGICONDIAN SYSTEM Finnis River Group	Berinka Volcanics (Pli)	Rhyolite, tuff, ashstone and agglomerate.	1000'	North-western corner of the area.	Conformably overlie the Noltenius Formation.	Folds, extensive faulting.	Steep, rocky hills and ridges.	
	Burrell Creek Formation (Plb)	Siltstone, greywacke and greywacke-siltstone.	8000'	Small roof pendant near Cullen River.	Known to be a lateral facies of the Noltenius Formation on the Pine Creek 4-mile area.	Broad folds.	"	Woolgni Goldfield. Some wolfram and copper shows.
	Noltenius Formation (Pln)	Quartz greywacke, greywacke-conglomerate, siltstone; locally metamorphosed to mica and andalusite schist.	5000'	North-western section of area. Small inlier at head of Angalarri River.	See above.	Tight folds, heavily sheared and faulted.	"	Fletchers Gully Goldfield. Buldiva Tinfield.
		UNCONFORMITY						
ARCHAEAN ?	Hermit Creek Metamorphics (Ah)	Migmatite, banded granulite, quartzite, mica schists.	?	Crops out in the north-western section of the area.	Oldest known rocks in the area. No contacts with other units observed.	Trends E-W.	Mature plains.	

The Mullaman Beds have been extensively lateritised (Noakes, 1949). In places the pallid zone of the laterite profile has been silicified and forms a tough cap rock on the mesas and plateaux. In some areas heavily eroded remnants of the ferruginous zone are preserved.

IGNEOUS AND METAMORPHIC ROCKS

Four granite masses crop out in the Fergusson River 4-mile area. They are the Cullen Granite, the Litchfield Complex, and the Soldiers Creek and Allia Granites. All are similar petrologically and probably belong to the same major period of intrusion. Radioactive age determinations by the potassium/argon method on mica concentrates from the granites give ages ranging from 1695 m. years for the Cullen Granite to 1560 m. years for the Litchfield Complex.

The largest intrusive mass in the Fergusson River 4-mile area is the Cullen Granite. Only a portion of the batholith crops out in the area; beyond the sheet boundaries it extends five miles to the east and over forty miles to the north. Part of the Cullen Granite is concealed beneath the Middle Cambrian Daly River Group. The rocks of the mass range from sodaclase granite through granite to adamellite; textural variations are common. Essential minerals are quartz, potash feldspars (microcline to perthite), plagioclase (albite to oligoclase), and biotite. Hornblende is absent in the sodaclase granite, but is an important constituent of the adamellite.

The granite is a transgressive intrusion, cutting across the fold pattern of the Lower Proterozoic sediments; granitic veins are common in fracture and cleavage planes within the hornfelsed sediments. The contact is well defined, with little granitization or hybridization. Angular stoped blocks and hornfelsic xenoliths occur near the contact.

The Litchfield Complex crops out as tors protruding from deep soil cover in the north-western part of the Sheet area. It consists of mainly xenolithic garnetiferous granodiorite, granite, and adamellite. The minerals in these rocks are quartz, potash feldspars, andesine, biotite and muscovite.

The rocks of the Litchfield Complex have been moderately deformed and altered, but have contributed little to the metamorphism of the sediments of the Hermit Creek Metamorphics which they intrude.

The Soldiers Creek Granite, in the Collia Tinfield area, is a medium-grained adamellite, with quartz, orthoclase, andesine, and biotite; accessory minerals are tourmaline and cassiterite. The granite shows some foliation and the feldspars are heavily altered. The Soldiers Creek Granite intrudes the Noltenius Formation, locally metamorphosing it to andalusite and mica schist. In the Collia area, roof pendants of metamorphosed sediments are common.

The Allia Granite crops out north of Fletchers Gully. The rock is essentially a biotite-muscovite granodiorite which, unlike the other granites, is poor in potash feldspars. It intrudes the Noltenius Formation producing local metamorphism. The Soldiers Creek and the Allia Granites are probably related to the Litchfield Complex.

Dolerite, in places uralitized and albitized to epidiorite, crops out in the north-west of the Sheet area. The relationship between these basic rocks and the Lower Proterozoic sediments is obscure in this Sheet area; but in the Pine Creek 4-mile area, similar basic rocks occur as sills within the Lower Proterozoic sequence.

STRUCTURE

Fig. 2 shows the general structural framework of the Fergusson River 4-mile area. The flat-lying Lower Cretaceous cover has been omitted.

Archaean

The rocks of the Hermit Creek Complex show a marked east-west lineation. They form the basement for the Pine Creek Geosyncline.

Lower Proterozoic

The Lower Proterozoic sediments cropping out in the north-west of the Sheet are folded into a broad syncline pitching south under the Upper Proterozoic sequence. Tight folds are locally developed and are more common in the Noltenius Formation. The rocks have been sheared, faulted, and intruded by granite. The rocks form part of the Pine Creek Geosyncline.

Upper Proterozoic

The rocks of the Victoria River Group have been gently folded into basins; dips rarely exceed 15°. The Tolmer Group forms the margins of the Daly River Basin and has shallow depositional dips into the basin. Faulting is common along joint planes and, north of Collia, strike faults occur. Small monoclinal folds are locally developed.

Cambrian

A few minor faults cut the Antrim Plateau Volcanics. In places pre-existing faults have controlled the distribution of the volcanics, the fault scarps presenting a barrier to the lava flows.

The Daly River Group was deposited in the Daly River Basin, with shallow depositional dips and numerous slump structures. Faulting is rare and on a small scale.

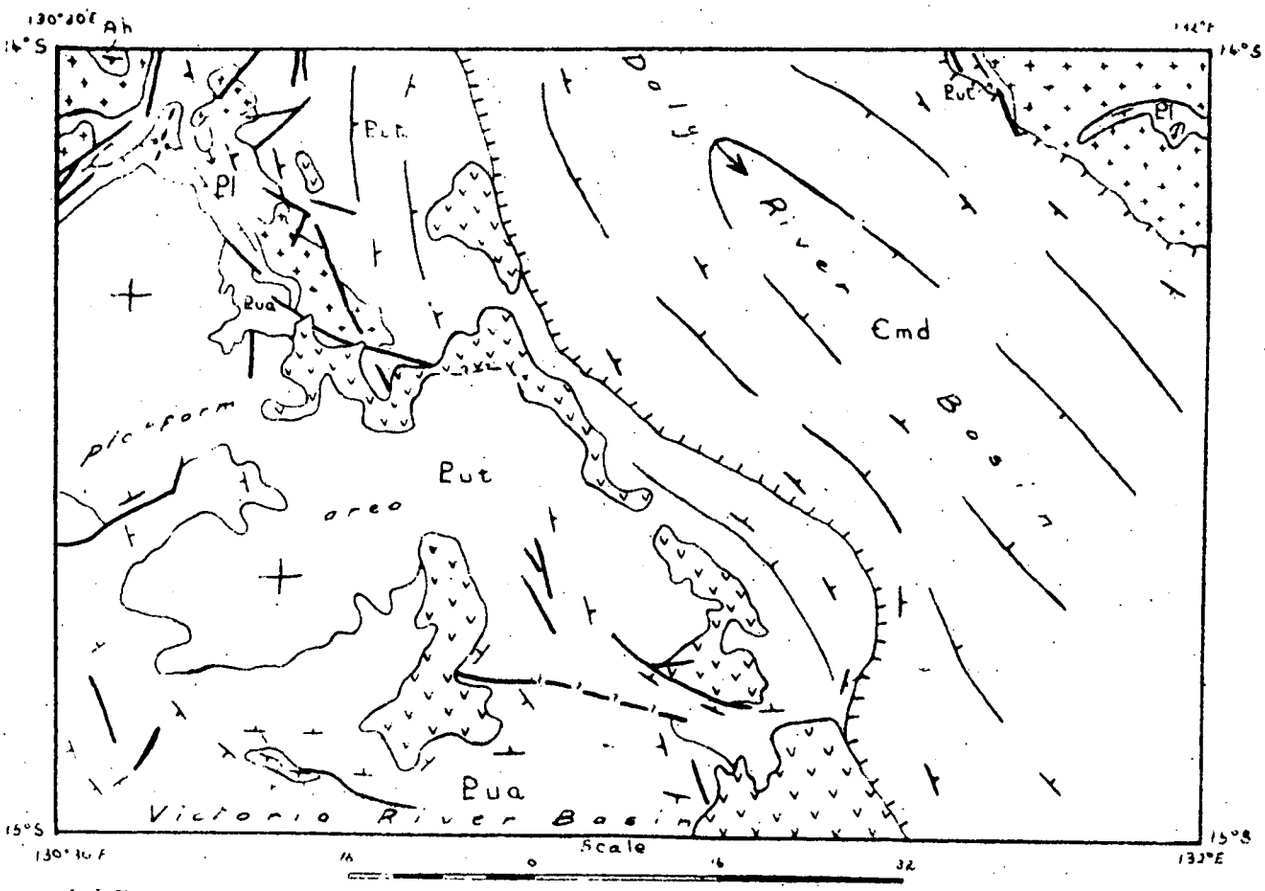
Lower Cretaceous

The Mullaman Beds occur as widespread horizontal sheets with little folding. Small, locally developed hydration folds occur in the shaly beds. In places faulting has affected the beds - probably in post-Tertiary times, because the lateritic capping is also disturbed.

STRUCTURAL SKETCH-MAP

FERGUSSON RIVER 4-MILE SHEET

FIG. 2



Cmd — MIDDLE CAMBRIAN - Daly River Group

— LOWER CAMBRIAN - Antrim Plateau Volcanics

Put — UPPER PROTEROZOIC - Tolmer Group

Pua — " " " - Victoria River Group

— LOWER PROTEROZOIC Granites

Pl — " " " - Folded Sediments

Ah — ARCHAEOZOIC - Hermit Creek Complex

— Fault established

— " inferred

— Axis of synclinal trough upper

— Trend line of previous map

— Regional dip

GEOLOGICAL HISTORY

Owing to paucity of outcrop little is known of the geological history of the Archaean basement.

The Lower Proterozoic sediments were deposited in the Pine Creek Geosyncline, which is better exposed to the north and north-east. Both the Chilling Sandstone and the Noltenius Formation were deposited from the west and north-west. Deposition of the Lower Proterozoic sediments was followed by the only major orogeny recorded in the area. The sediments were folded, intruded by granite, and faulted.

A lengthy period of uplift and erosion followed the Lower Proterozoic orogeny. Towards the end of this period the Edith River Volcanics were extruded on the eroded surface of the Cullen Granite; then the area was submerged and arenaceous sediments were deposited to the east.

Later, the sediments of the Victoria River Group were laid down in the epeiric sea which extended over much of the north-western portion of the Northern Territory and into Western Australia. A period of emergence or non-deposition was followed by a change in the direction of sedimentation, producing the break between the Victoria River Group and the overlying Tolmer Group.

The Tolmer Group was laid down in a more restricted area than the Victoria River Group. Gradual emergence caused the retreat of the epeiric seas and the eventual restriction of sedimentation to the Daly River Basin, which developed as a downwarp on the Lower Proterozoic surface during deposition of the Buldiva Sandstone.

In Lower Cambrian time there was a short period of uplift and erosion during which the Antrim Plateau Volcanics were extruded. Transgression of epeiric seas into the Daly River Basin followed this vulcanism and the lower Middle Cambrian sediments of the Daly River Group were deposited.

The subsequent uplift ushered in a period of high stability as shown by the absence of folding in the Cambrian rocks. Because of this stability the area never had any high relief, thus preserving the Cambrian sediments despite their lack of protective cover during the remainder of the Palaeozoic.

Towards the end of the Jurassic, or early in the Cretaceous, terrigenous material was deposited in isolated lakes which developed in the area. This was followed by the gradual flooding of the area by yet another epeiric sea transgressing from the north and in which fine grained sediments were conformably laid down on the lacustrine deposits.

During Tertiary (?) times climatic conditions were favourable for the formation of a laterite profile, which developed mainly over the soft, sandy shales of the Mullaman Beds. Post-Tertiary warping produced much of the present elevation of the region and initiated the present cycle of erosion.

ECONOMIC GEOLOGY

The area includes the Woolngi Goldfield, the Collia-Buldiva Tinfield, and the Fletchers Gully Goldfield. Gold and tin are the only minerals of economic importance, and mining has been sporadic and generally unrewarding. There is no mining activity at present, although some leases are still held on portions of the Collia-Buldiva Tinfield. Small, uneconomic showings of uranium, copper, barytes and wolfram occur in the area.

Gold

The Woolngi Goldfield was first mentioned in mining reports in 1897, but apparently had been discovered some time previously. The gold occurs in quartz reefs intruding an overfolded anticline in the Burrell Creek Formation. Early activity on this field was appreciable; a ten head battery was erected and at one time the population was over 1000. The field was abandoned in 1908.

Gold was reported at Fletchers Gully in 1905; since then the history of the field has been one of continual closing and re-opening. The gold occurs in quartz reefs filling fissures and tension-cracks associated with faulting in the Noltenius Formation.

Production records for both fields are scant. A summary of the known production is given in Table 2.

Table 2
GOLD PRODUCTION

Period	Area	Amount
1897	Woolngi	240 oz.
1898	"	220 oz.
1899	"	1252 oz.
1900	"	356 oz.
1901	"	2018 oz.
1902	"	367 oz.
1903	"	441 oz.
1905	"	178 oz.
1905-10	Fletchers Gully	300 oz.
1922-23	"	563 oz.
1923-24	"	706 oz.
1924-25	"	464.5 oz.
1925-26	"	108 oz.
1926-27	"	75.9 oz.
1927-28	"	64 oz.
1928-29	"	131 oz.
1934-35	"	20 oz.
1936-37	"	140 oz. approx.
1937-38	"	91 oz.
1938-39	"	29.38 fine oz.
1939-40	"	2.90 fine oz.
1940-41	"	2.76 oz.
1942-43	"	5.27 oz.
1945-46	"	7.38 fine oz.
	TOTAL	7783.09 oz.

Tin

Tin was first discovered at Fletchers Gully in 1905, shortly after the end of the first gold rush to that area. The tin occurs as cassiterite in a few pegmatite dykes associated with the Allia Granite.

The tin deposits at Collia, Buldiva, and Muldiva* were first seriously worked in 1922. Primary ore occurs as cassiterite in quartz-tourmaline pegmatite dykes associated with the Soldiers Creek Granite. Cassiterite derived from these dykes occurs in a local conglomerate at the base of the Mullaman Beds, and also in the alluvium in the streams draining the area. In this area, also, production records are incomplete. A summary is given in Table 3.

Table 3

TIN PRODUCTION

Period	Area	Amount Tons
1910	Fletchers Gully	2.000
1922-23	"	4.200
	Collia	1.000
1923-24	Collia and Muldiva	26.285
1924-25	Collia	5.462
	Muldiva	3.700
1925-26	Collia and Buldiva	5.024
1926-27	" " "	0.544
1927-28	Collia	0.136
1928-29	Collia	1.462
1935-36	Buldiva & Fletchers Gully	N/A
1937-38	Fletchers Gully	N/A
1940-41	Fletchers Gully	0.035
1943-44	"	0.220
1948-49	Collia	0.100
1949-50	"	0.200
1950-51	"	0.390
1951-52	"	0.350
1952-53	"	0.480
	TOTAL	51.588 tons

N/A : Not available.

Uranium

Uranium-bearing minerals were found in the area in 1950, immediately to the east of the Stuart Highway crossing on the Fergusson River. At this occurrence torbernite and autunite, with copper and cobalt minerals, occur in a sheared zone of the Cullen Granite, near the contact of the granite with the Burrell Creek Formation. Four other radioactive occurrences were located in the Cullen Granite, where the mineral, probably autunite or meta-autunite, is associated with quartz-hematite reefs. All these shows were examined in detail by Commonwealth geologists, who recommended that no further work be done.

* Muldiva is the name given to a small gully half a mile north-west of Buldiva.

Copper

Copper shows to the west of the Woolngi Goldfield are shown on Jensen's map (1919) and copper was recovered from Woolngi before 1896, but in neither case are production figures available. Copper minerals occur as traces in shafts and costeans near the Fergusson River Siding, and traces of native copper occur in the Antrim Plateau Volcanics near Collia.

Barytes

Small blows and aggregates of barytes associated with quartz and gypsum occur in the Antrim Plateau Volcanics southwest of Dorisvale Homestead and near Collia.

Wolfram

Small crystals of wolfram are sparsely scattered in quartz veins and stringers in the Burrell Creek Formation, in the Woolngi Goldfield area.

Water

The only perennial stream in the area is the Daly River. The Katherine River flows for most of the year but towards the end of the Dry is a chain of long waterholes. Billabongs provide adequate water along the other major streams and in low-lying swamp areas. Away from the major streams water is scarce and confined to catchment into natural rock holes which are usually dry half-way through the dry season. Springs in the Buldiva Sandstone are common and most are perennial. There are no working bores in the area.

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FIRST EDITION 1961
AUSTRALIA 1:253,440
FERGUSSON RIVER
NORTHERN TERRITORY
4 MILE GEOLOGICAL SERIES SHEET D52-12
WINGATE MOUNTAINS
DALY RIVER
FERGUSSON RIVER
KATHERINE RIVER
FLORA RIVER
FITZMAURICE RIVER
Section A-B
Section E-F
Reference
QUATERNARY
Qa
Alluvium, soil and sand. Ferruginous deposits.
Unconformity
LOWER CRETACEOUS
Mullaman Beds
K&m
Undifferentiated sandstone and siltstone. Fresh-water and marine sediments.
Unconformity
MIDDLE CAMBRIAN
Daly River Group
Oolloo Limestone
€mo
Silicified limestone, in places containing algae.
Jinduckin Formation
€mj
Medium and fine-grained sandstone and siltstone with halite casts, some limestone lenses.
Manbulloo Limestone Member
€mu
Silicified flaggy limestone.
Tindall Limestone
€mt
Fossiliferous limestone with chert bands and nodules.
Unconformity
LOWER CAMBRIAN
Antrim Plateau Volcanics
€la
Mainly basalt, some tuffaceous sandstone.
Unconformity
MESOZOIC CAINOZOIC
PALAEOZOIC
UPPER PROTEROZOIC
Tomkinson Group
Waterbag Formation
Pug
Ferruginous sandstone and siltstone with halite casts. Limestone lenses.
Hinde Dolomite
Puh
Dolomite with algal reefs.
Buldiva Sandstone
Stray Creek Sandstone Member
Puy
Flaggy quartz sandstone, colour-banded siltstone.
Depot Creek Sandstone Member
Puo
Pink, ripple-marked, cross-bedded quartz sandstone.
Unconformity
Victoria River Group
Laurie Creek Beds
Puq
Silicified quartz sandstone, silicified stromatolithic limestone.
Yambarra Beds
Put
Feldspathic sandstone, quartz sandstone, siltstone and dolomite.
Angalarri Siltstone
Puj
Mainly colour-banded siltstone, red sandstone, dolomitic limestone.
Palm Creek Beds
Pux
Ripple-marked, cross-bedded quartz sandstone. Silicified limestone at base.
Unconformity
Katherine River Group
Edith River Volcanics
Pue
Rhyolitic flows and porphyries.
Unconformity
PRECAMBRIAN
Allia Granite
Pga
Coarse porphyritic hornblende-biotite granite.
Cullen Granite
Pgc
Biotite-hornblende granite with syenite differentiates.
Soldiers Creek Granite
Pgs
Coarse biotite granite.
Litchfield Complex
Pgl
Mainly garnetiferous granodiorite and diorite.
LOWER PROTEROZOIC
Pdo
Basic sills and dykes.
Unconformity
Chilling Sandstone
Plh
White cross-bedded, ripple-marked medium to coarse grained quartz sandstone, greywacke.
Finniss River Group
Berinka Volcanics
Pli
Rhyolite, tuff, ashstone and agglomerate.
Burrell Creek Formation
Plb
Siltstone, greywacke, greywacke siltstone.
Noltenius Formation
Pln
Quartz greywacke and greywacke conglomerate. Andalusite and mica schist.
Unconformity
(?)ARCHAEAN
Hermit Creek Metamorphics
Ah
Migmatite, banded granulite, quartzite and mica schist.
Geological boundary.
Syncline, showing plunge.
Fault.
Where location of boundaries, folds and faults 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
Prevailing dip
Vertical strata.
Horizontal strata
Dip <15°
Joint pattern
air-photo interpretation.
Trend of bedding, showing prevailing dip
Foliation (platy flow structure), inclined.
Marine macrofossil locality
Mine
Au Gold
Sn Tin
U Uranium
W Tungsten
·945 Height in feet, barometric, datum mean sea level
Stuart Highway
Vehicle track
North Australian Railway and siding
Florina HS Homestead
W.H. Waterhole
YD. Yard
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS
Unconformity
Direction of main sedimentation
FERGUSSON RIVER
SHEET D52-12
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B1 Detailed reconnaissance, numerous traverses.
B2 Air-photo interpretation and traverses.
C Sketchy - air-photo interpretation.
Geology by: M.A. Randal, D.A. White, O.N. Warin, J.H. Rattigan, A.D. Clark, E.K. Carter, J.C. Fewergker, J. Barrie.
Compiled by: M.A. Randal Jan 1959
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