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EXPLANATORY NOTES ON THE LISSADELL 1:250,000 GEOLOGICAL SHEET SE. 52/2 WESTERN AUSTRALIA

Compiled by

D. Dunnet and K.A. Plumb

EXPLANATORY NOTES ON THE LISSADELL 1:250,000 GEOLOGICAL SHEET, SE.52-2. WESTERN AUSTRALIA.

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EXPLANATORY NOTES ON THE LISSADELL 1:250,000 GEOLOGICAL SHEET SE52-2

INTRODUCTION

The Lissadell 1:250,000 Sheet area is bounded by latitudes 16°S and 17°S and longitudes 127°30'E and 129°E, and covers portion of the East Kimberley Division of north Western Australia.

Access includes the Great Northern Highway from Perth to Wyndham which runs north through the middle of the Sheet area; and the Duncan Highway from Wyndham to Nicholson and then Darwin which follows the eastern edge of the Sheet area. Both are formed gravel roads, cut by flood waters during the "wet". Work was in progress in 1963 to make the Great Northern Highway an all-weather road. Station tracks give fair access to the eastern half of the Sheet, but vehicle tracks in the west are suitable only for 4-wheel drive vehicles. They are the Bedford Stock Route, and tracks linking it to Bow River Station. The Speewah Valley can be reached by 4-wheel drive vehicle, and it is reported that Plants Homestead has been reached from Karunjie Homestead to the west of the Sheet area.

The port of Wyndham is 50 miles to the north of the Sheet area, and is serviced by ships from Perth and Darwin. A tri-weekly air service also operates from Perth.

The only settlements on the Lissadell Sheet area are the pastoral properties of Argyle Downs, Bow River, Dunham River, Glenhill, Lissadell and Rosewood Stations. These employ both white and aboriginal labour. The total population is about 200.

The climate is monsoonal with a short wet summer season and a long dry winter. The area lies between the 20" and 30" isohyet; up to 90% of the rain falls during the months of January and February.

Maps and air photographs available in 1963 were: air photographs at a scale of 1:50,000 flown by the Royal Australian Air Force in 1948; photo-mosaics at a scale of one inch to one mile, compiled by the Department of Lands and Surveys, Perth; a topographic map at 1:250,000 scale with 250 feet contours, produced by the Royal Australian Survey Corps; and a planimetric map at 1:250,000 scale compiled by the Department of Lands and Surveys Perth.

The geological map accompanying these Notes was compiled on Survey Corps photoscale compilations and subsequently reduced to 1:250,000 scale.

Previous Investigations:

In 1879 surveyor, Alexander Forrest, led the first expedition to cross the Kimberley Division. He was accompanied by a geologist, Fenton, who made brief geological observations. (Johnston, 1962).

Hardman (1885) traversed the East Kimberleys in 1884 and outlined the geology of the region. His gold report inspired the eventual rush to Halls Creek, resulting in the development of the port of Wyndham. Other contributions to the regional geology were made in the subsequent years by Wade (1924), who reported on the oil prospects of the region, and Blatchford (1927) who made notes on the rocks of the Sheet area between the Speewah Valley and Argyle Homestead. Edwards and Clarke (1940) investigated the petrology of the basic rocks of the region.

Little was added to Hardman's knowledge of the regional geology however, and his work formed the basis for all post-war investigations, especially in the Palaeozoic basins. Matheson & Tiechert (1946) were the first to broadly subdivide the Proterozoic stratigraphy, followed by Traves (1955) who reconnoitred the regional geology of the east Kimberleys and the adjoining Victorian River Basin in the Northern Territory. Guppy, Lindner, Rattigan and Casey (1958) working in the West Kimberleys, subdivided the Kimberley Basin sediments for the first time, and Harms (1959), extended their work, by mapping the major Precambrian rock units throughout the Kimberley Region. Harm's work provided the framework for the current mapping of the Precambrian.

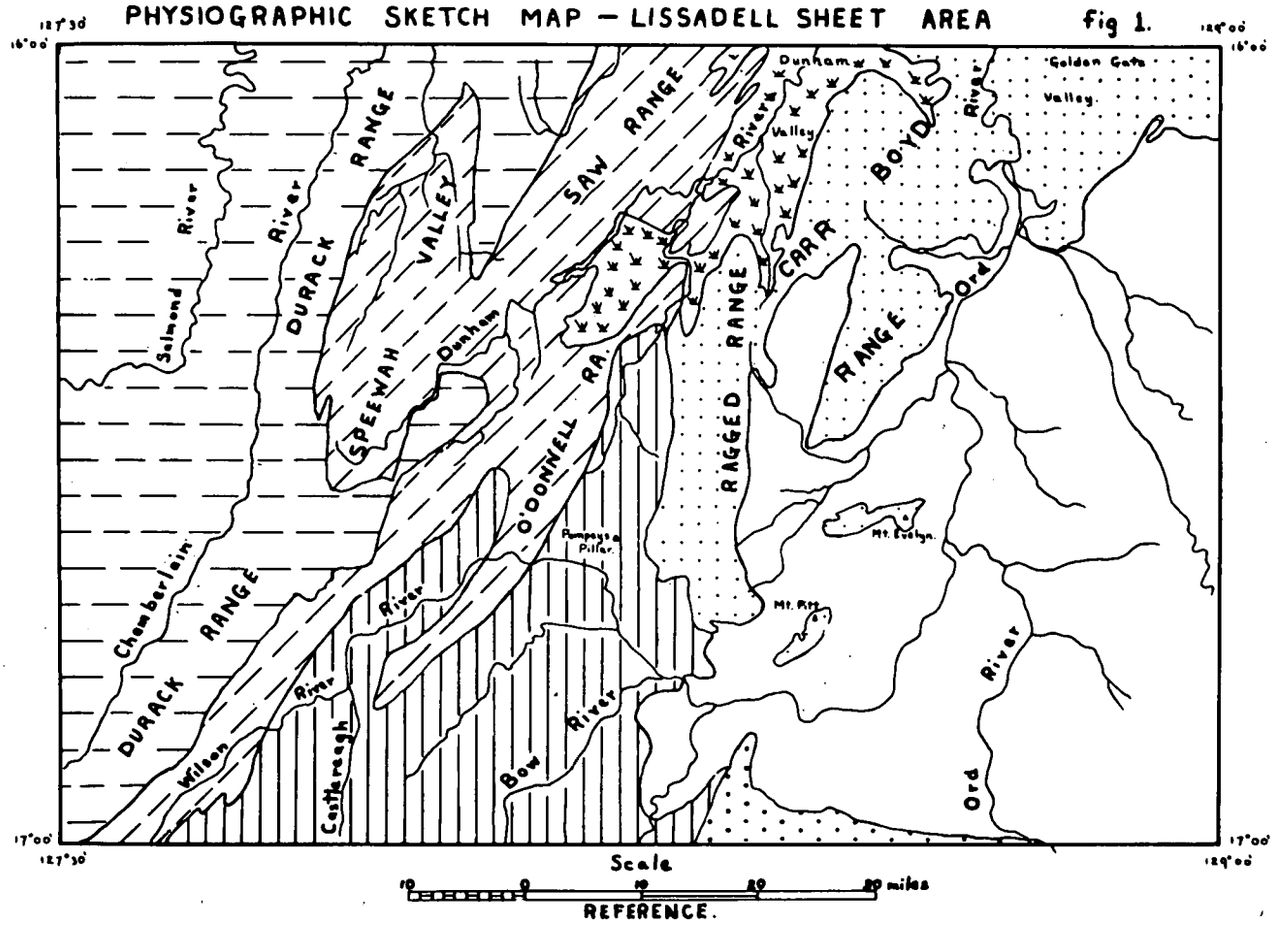
These notes and the accompanying geological map are based on a joint survey carried out in 1963 by the Bureau of Mineral Resources and the Geological Survey of Western Australia, as part of a programme, commenced in 1962, to map the whole of the Kimberley Division at 1:250,000 scale.

PHYSIOGRAPHY

Drainage:

The Lissadell Sheet area is drained by two major groups of streams, both of which rise in the southwest of the Sheet area. One group flows north or north-east as the Chamberlain, Salmond, and Pentecost Rivers, the second group flows north-east then east as tributaries of the Ord River. These are the Bow, Wilson, Castlereagh, O'Donnell, and Dunham Rivers. The Ord River rises to the south of the Sheet area where it flows east then north to cross the eastern side of the Sheet area in a

PHYSIOGRAPHIC SKETCH MAP — LISSADELL SHEET AREA Fig 1.



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broad valley. All of these streams, with the exception of the Chamberlain River (see below) have a superimposed consequent pattern, subsequently modified along part of their length by the structure of the rocks they traverse. Tributaries are markedly subsequent.

The superimposed nature of the major streams suggests an ancient land surface extending across the Sheet area. Subsequent uplift has produced dissection and super-position of the present landform. This is supported by the general uniform elevation of the tops of major ranges throughout the area. To the south in the Gordon Downs Sheet area (Smith, 1963a) remnants of a Tertiary land surface are preserved as laterite capped mesas, and laterite remnants occur on the Kimberley Plateau to the north-west (Harms, 1959). The highest part of the surface in this Sheet area was probably the southwest corner, where the major streams now rise.

Physiographic Divisions:

The most striking feature of the physiography of the Sheet area is the relationship between topography and rock-types. This greatly facilitates the use of air photographs in geological mapping.

The Sheet area contains seven of the nine physiographic subdivisions of the East Kimberleys (Dow, Gemuts, Plumb & Dunnet, in prep.) which are based on Traves (1955). These subdivisions are the Kimberley Plateau, Kimberley Foothills, Carr Boyd Ranges, Bow River Hills, Osmond Ranges, Ord Plains, and Cambridge Gulf Lowlands (Figure 1).

Kimberley Plateau: The Kimberley Plateau covers a large region to the west and extends onto the western part of this Sheet area. The bedrock of the Plateau is gently dipping Kimberley Group and Bastion Group sediments, and the eastern margin of the Plateau is a prominent scarp along the edge of the Durack Ranges, controlled by the contact of the Kimberley Group with the underlying Speewah Group rocks.

The Plateau consists of structural benches and gently dipping cuestas bounded by scarps up to 250 feet high. These benches are controlled by the resistant sandstone beds from which the overlying soft beds are being stripped by scarp retreat. The elevation of the Plateau is generally between 1500 and 1800 feet, with a maximum of 2,250 feet in the southern Durack Ranges. The sandstone bedrock crops out boldly throughout the Plateau, and there is limited soil cover and sparse vegetation.

The major streams such as the Salmond and Pentecost Rivers are superimposed meandering streams transgressing the structure of the bedrock. They are incised into gorges up to 750 feet deep. The Chamberlain River, however, follows the contact between the Elgee Siltstone and Warton Sandstone for eighty miles, in an assymetrical valley bounded by the Elgee Cliffs in the west and a large cuesta of resistant Warton Sandstone in the east.

Minor streams are subsequent with a dendritic drainage pattern, controlled by joints in the areas of flat-lying rocks, or a rectangular pattern in areas of dipping rocks, controlled by bedding and jointing. Perennial, spring-fed streams are common and flow in narrow gorges with numerous small waterfalls.

In the Durack Ranges the dipping bedrock produces broad cuestas, 500 feet high, formed by erosion of Elgee Siltstone and Carson Volcanics.

Kimberley Foothills: These border the Kimberley Plateau in the east where Younger Proterozoic rocks are folded and faulted adjacent to the strongly deformed central zone of the Sheet area. The foothills are erosional remnants of a previously more extensive Kimberley Plateau surface. Differential erosion of interbedded resistant and non-resistant rocks has produced rugged topography; a complex system of high hogsbacks and cuestas. Small plateaux occur locally where the bedrock is flat-lying. The ridges rise to 1,750 feet elevation, and have a maximum relief of 1,000 feet.

Most of the drainage is subsequent and controlled by either bedding, joint or fault directions in the bedrock; a rectangular drainage pattern results. Major streams, the Dunham and Wilson Rivers, are superimposed consequent streams subsequently modified by the underlying bedrock.

Perennial spring-fed streams are common in the foothills, especially adjacent to the margins of the Kimberley Plateau. They rise along joint and fault planes.

The Saw Ranges are a striking example of the Foothills, being a simple set of parallel hogsbacks, with dip-slopes up to 70°, rising 1000 feet above the Cambridge Gulf Lowlands. There is less relief in the O'Donnell Range and the topography more complex. The pattern of strike ridges is complicated by folding and faulting in the bed-rock.

Large valleys occur in the Foothills on outcrops of dolerite. The largest of these, the Speewah Valley, has formed

on a large dolerite sheet which occupies the core of an elongate dome 20 miles long and 8 miles wide. Erosion of the dolerite has produced a valley of subdued rounded hills completely surrounded by prominent cuestas of the overlying rocks.

Carr Boyd Ranges: Some of the most rugged country in the Sheet area is the Carr Boyd Ranges east of the Dunham River. Elevations range from 2,000 feet in the south to 1,000 feet in the north; relief is up to 1500 feet. The bedrock is mainly interbedded sandstone and siltstone deeply dissected by narrow, valleys and gorges.

Most of the drainage in the Ranges is superimposed, but modified by the structure of bedrock to an irregular dendritic pattern. Superimposed drainage is well illustrated where the Ord River cuts through the Carlton Gorge. Springs are common within the Ranges and along the large "bounding" faults. The smaller streams frequently terminate in hanging stream junctions.

The Ranges are commonly bounded by high steep fault scarps. The Ivanhoe and Carr Boyd Faults are examples. In the Revolver Creek valley and Golden Gate Country* erosion has removed the sandstone cover and exposed the less-resistant Older Proterozoic rocks in large valleys.

The southern edge of the Ranges near Pompey's Pillar is a high scarp, which rises to over 2,000 feet elevation, and slopes eastwards in a series of sandstone cuestas to a base-level of about 750 feet elevation, in the valley around Glenhill Station.

A prominent shallow dipping dissected cuesta, about 20 miles long and 3 miles wide, is situated between this range and the Ivanhoe Fault. It is called the Ragged Range from the ragged skyline along its prominent western scarp. The elevation of the scarp is about 1,500 feet, and the Range slopes gradually eastwards. It has a dendritic insequent drainage pattern deeply incised into the gently dipping, soft Palaeozoic conglomerate and sandstone.

Mt. Pitt and Mt. Evelyn are erosional remnants of the Carr Boyd Ranges within the Ord Plains and have a relief of over 750 feet.

Bow River Hills: These are an area of relatively low relief between the Kimberley Foothills and Carr Boyd Ranges, formed on the north-north-east trending belt of crystalline rocks of the Lamboo Complex. The Foothills have an open textured dendritic drainage pattern between rounded, low, rocky hills,

* name submitted for approval.

TABLE I

STRATIGRAPHIC RELATIONSHIPS
LISSADELL SHEET AREA
SHOWING ROCK UNITS AND DISTRIBUTION

~~~~ UNCONFORMITY

	GREENVALE DUNHAM FAULT		IVANHOE FAULT		HALLS CREEK FAULT
CAINOZOIC	Qa	Czs	Czb	Undifferentiated	
PALAEOZOIC	Cockatoo Sandstone	Ragged Range		Conglomerate	Pz Palaeozoic Undifferentiated
					Panton Formation, Linnekar Limestone, Hedleys Limestone — Negri Group
	Lower Cambrian Undifferentiated €1(?)				
	Antrim Plateau				Volcanics
					Mt Forster Sandstone — Albert Edward Group
					Ord Group: Ranford Formation (Jarrad Sandstone Member); Moonlight Valley Tillite
YOUNGER PROTERZOIC					? ? Mt Parker Sandstone ? ?
	Bastion Group: Cockburn Sandstone, Wyndham Shale, Mendena Formation				
	Kimberley Group: Pentecost Sandstone, Elgee Siltstone, Warton Sandstone, Carson Volcanics, King Leopold Sandstone				
	? ?				
	Speewah Group: Luman Siltstone, Looningnin Arkose, Valentine Siltstone				
	Liamma Beds				
	O'Donnell Formation				
					Stonewall Sandstone — Carr Boyd Succession
					Glenhill Formation — Carr Boyd Succession
					Lissadell Formation — Carr Boyd Succession
					Golden Gate Siltstone — Carr Boyd Succession
					Hensman Sandstone — Carr Boyd Succession
					? ? Red Rock Beds
OLDER PROTERZOIC	Mt Remarkable Cgl Mbr / Whitewater Volcanics				Revolver Creek Formation; Whitewater Volcanics
	Lamboo Complex				Undifferentiated
	Halls Creek Group				Undifferentiated

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subdued strike ridges and dissected mesas.

The porphyritic crystalline rocks produce high terraced plateau and mesas, dissected by a joint controlled rectangular drainage. Areas of shearing, and basic rocks are exposed as low fertile pockets within the poorly vegetated granitic rocks.

Relief is commonly about 500 feet, but is up to 1,000 feet in the Bow River area. The elevation ranges from less than 500 feet to 1950 feet on Castlereagh Hill.

Osmond Ranges: The northern margin of the Osmond Ranges occurs near the southern boundary of the Sheet area. Here the high cuestas and hogsbacks of the Dixon Range Sheet area (Dow & Gemuts, 1964) slope northwards to the Ord Plains. The ridges dip gently north and are dissected by a feathered dendritic drainage. Relief is up to 700 feet.

Ord Plains: The Ord River has formed widespread, low-lying plains east of the Carr Boyd Ranges. The bedrock of the Plains is poor outcrop of Cambrian basalt and carbonate rocks, and large areas are covered by residual and alluvial soils. Extensive black soils form excellent cattle grazing country in the Sheet area.

The Plains are about 250 feet above sea-level in the north, and rise gradually south and east to about 1000 feet to merge with the Osmond Ranges, Victoria River and Sturt Plateaux (Traves, 1955). Away from the river, low structural benches and rounded hills of basalt have a relief of up to 300 feet.

Cambridge Gulf Lowlands: These Lowlands occur mostly on the adjoining (north) Cambridge Gulf Sheet area, and are only represented on the Lissadell Sheet area by the black soil flats bordering the Dunham River Valley. This valley has formed on the poorly-resistant Palaeozoic rocks and is bordered by the Kimberley Foothills and Carr Boyd Ranges.

STRATIGRAPHY

Most of the rocks exposed in the Sheet area are of Proterozoic age. Extensive areas of Palaeozoic rocks are exposed in the eastern part of the Sheet area. The Stratigraphy of the Sheet area is summarised in Table II and the stratigraphic relationships of the rock units are illustrated in the Correlation Chart, Table I.

PRECAMBRIAN

PROTEROZOIC

The oldest rocks exposed in the Sheet area are of Proterozoic age. They have been tentatively divided into two informal subdivisions, Older Proterozoic and Younger Proterozoic pending the results of geochronological studies currently in progress. The Younger Proterozoic referred to here includes those rocks which unconformably overly the igneous and metamorphic rocks of the Lamboo Complex. They include most of the undeformed Precambrian sedimentary rocks of the region. The Older Proterozoic rocks include the strongly folded regionally metamorphosed Halls Creek Metamorphics, metamorphic and intrusive rocks of the Lamboo Complex and the unconformably overlying and unmetamorphosed Whitewater Volcanics and Revolver Creek Formation. All the Older Proterozoic rocks have been intruded by igneous rocks of the Lamboo Complex.

A programme of radiometric dating of rocks from the area is at present in progress at the Australian National University.

OLDER PROTEROZOIC

The Older Proterozoic rocks have been divided into four major units:

Revolver Creek Formation
Whitewater Volcanics
Lamboo Complex
Halls Creek Metamorphics.
(bottom)

Halls Creek Metamorphics

The Halls Creek Metamorphics are exposed mainly in the Gordon Downs (Smith, 1963a) and Dixon Range (Dow & Gemuts, 1964) Sheet areas, to the south, where they have been subdivided into several formations. In the Lissadell Sheet area the unit consists mainly of quartz greywacke and slate which have been regionally metamorphosed to low greenschist facies and show a later, contact metamorphism adjacent to granite. The regional folding has produced a slaty cleavage and transposed bedding in the pelitic rocks.

The Metamorphics are intruded by hornblende granodiorite, porphyritic granite, and dolerite dykes. The Metamorphics are overlain with very strong angular unconformity by the Whitewater Volcanics and Revolver Creek Formation, or where these are absent by the Younger Proterozoic rocks of the Carr Boyd succession.

Lamboo Complex

The Lamboo Complex forms a belt nearly 200 miles long and 30 miles wide between Halls Creek (to the south of the Sheet area) and Dunham Hill. Isolated outcrops occur throughout the Carr Boyd Ranges. Major faults delineate the eastern and western margins of the belt.

The Complex can be divided broadly into two units. (1) Metamorphic rocks including granites believed to have formed by fusion and melting of country rocks ('gneissic granite') and, (2) Intrusive Rocks comprising basic intrusives and later granites and dyke rocks.

(1) Metamorphic Rocks

The Tickalara Metamorphics crop out between Mount Nyalasy and the southern margin of the Sheet area. The rocks are mostly migmatite gneisses and fall within the granulite facies of regional metamorphism.

They consist of light-coloured bands of granitic composition alternating with dark bands defined concentration of ferromagnesian minerals. The bands are discontinuous, and are mainly schlierin strung out parallel to the foliation. The rocks contain garnet, sillimanite, cordierite, and in rare cases, graphite.

Brown, weathered micaceous metasediments and banded amphibolite crop out west of Bow River and just north of Mount Nyalasy. Most outcrops of these rocks are close to large shear zones or later granite intrusions. They are possibly migmatite gneiss which has undergone retrograde metamorphism.

The migmatite contains dark lenses and bands of basic granulite, which range in length from a few inches to several miles. In hand specimen the granulite is dark-green to black, granular in texture, and, commonly has a rudimentary foliation. It consists mainly of plagioclase, clinopyroxene, quartz, and hornblende, and in some places also contains orthopyroxene, garnet, biotite, and cummingtonite. It was probably mostly derived from basic intrusions.

The 'Gneissic Granite' includes a wide variety of acid rocks, which may have originated by anatexis of the Tickalara Metamorphics.

The most common type in the Sheet area is orthopyroxene-rich-granite - called "charnockite" in the field. It is brown to dark blue, rarely foliated, and has a distinctive vitreous

lustre. It is composed of andesine, microcline, orthopyroxene, minor biotite and amphibole, and accessory apatite and zircon. It has a gradational contact with the gneiss. The transition zone consists of plastically deformed and partly mobilised gneiss and is up to half a mile wide.

The northern end of a large body of medium to coarse-grained, foliated gneissic granite crops out near the Halls Creek Fault on the southern margin of the Sheet area. It is concordant with the surrounding metasediments and the boundary is gradational. The exact transition from paragneiss to gneissic granite could not be determined.

(2) Intrusive Rocks

The Basic Rocks constitute about one third of the Lamboo Complex in the Dixon Range Sheet area, (Dow & Gemuts, 1964) but are less extensive in the Lissadell Sheet area. They occur as irregular bodies rarely greater than four miles long, either intruded into gneiss, or as remnants within the later granites. The rocks are gabbro or dolerite commonly uralitized. Alteration generally takes the form of saussuritization of the feldspar; and of the pyroxene to hornblende or actinolite.

Most of the larger bodies have a foliated, marginal zone, which in some cases is metamorphosed to granulite facies, while the central parts of the body are only uralitized.

The Porphyry crops out in the south western part of the Sheet area, around McPhees Creek, and in the Golden Gate area to the north-east. The most common rock is dark grey and very fine-grained, and contains phenocrysts of oligoclase and subordinate quartz. The groundmass consists of quartz and potash feldspar (commonly as granophyric intergrowths) biotite, chlorite, and accessory apatite, zircon and sphene. Small rounded xenoliths are common. The porphyry is intrusive and almost identical in composition to the intrusive phases of the Whitewater Volcanics; the two are regarded as comagmatic.

The 'Porphyritic Granite' is the most common rock type in the Lamboo Complex in the Lissadell Sheet area. It crops out as large intrusions in the west and north of the Complex and as small intrusions around Mount Pitt. It intrudes Tickalara Metamorphics, 'Basic Rocks', 'Porphyry' and Whitewater Volcanics.

The rocks are all coarse-grained, and range in texture from even-grained to porphyritic. The even-grained granite consists of anhedral microcline surrounded by granular or fractured quartz. Biotite forms small clusters and common

accessories are muscovite and magnetite. The porphyritic granite consists of large phenocrysts (up to 3 cm. across) of microcline and subsidiary quartz, in a quartzitic groundmass containing some andesine and albite. Zircon, apatite, tourmaline, and biotite are accessory minerals. The two rock types grade into one another.

'Biotite Granite' crops out around the Bow River on the southern margin of the Sheet area, and in Castlereagh Creek near Mount Lookout. In the south it is massive and appears to intrude the 'Porphyritic Granite' but no good contacts were seen and it could be a finer-grained, biotite-rich phase of the 'Porphyritic Granite'. No thin-sections of the rock have been examined; it could be a granodiorite.

Massive hornblende granite which crops out in Castlereagh Creek has been referred to this unit. It is grey to white and appears to be less acid than most of the granite intrusions of the area: in places it may be diorite composition.

The Mixed Rock is an intimate mixture of sheared granite, porphyry and, metamorphic and basic rocks, which occur as scattered outcrops along the Halls Creek Fault near Mount Pitt. They are generally highly sheared and crop out poorly. It was found impossible to map the individual rock types.

White 'Muscovite Granite' crops out as dykes up to 300 feet wide in much of the eastern part of the Lamboo Complex; in some places it is extensive enough to be shown on the 1:250,000 geological map. The rock is fine-grained and consists of muscovite, kaolinized feldspar, and quartz: ferromagnesian minerals appear to be absent. Associated small pegmatite dykes contain quartz, potassic feldspar and subordinate muscovite, magnetite, tourmaline, ilmenite and epidote.

Near Mount Nyulasy a pale green, epidotized variety of 'Muscovite Granite' intrudes the base of the Revolver Creek Formation, with little disruption of bedding and no visible thermal effect.

The 'Hybrid Diorite' intrudes metasediments four miles north-east of Mount Nyulasy. The intrusion contains a bewildering variety of rock types ranging from gabbro to hornblende (?) granodiorite, all of which may crop out within a radius of 100 feet. It may be a highly contaminated magma, or it may be a mixture of basic and acid magmas.

Whitewater Volcanics: The Whitewater Volcanics crop out in a discontinuous belt for over 200 miles. In the Lissadell Sheet area they crop out from the O'Donnell Range to the southern margin of the Sheet, and in the Revolver Creek and Golden Gate Country. The discontinuous outcrop may be a result of erosion (they are in places unconformably overlain by Younger Proterozoic) or initial scattered extrusions.

The Volcanics consist of welded ash-flow tuff and rhyolitic flows. In the O'Donnell Range area the lower part of the sequence contains a considerable amount of intrusive porphyry. The fabric of the extrusive and high level intrusive rocks is similar even in thin section, and where other criteria cannot be established, the mode of occurrence is difficult to determine. The intrusive rocks are similar to the 'Porphyry' of the Lamboo Complex, which is considered to be comagmatic with the Volcanics. In the Golden Gate Country this 'Porphyry' intrudes the Whitewater Volcanics, with the 'Porphyritic Granite' intruding the 'Porphyry' and Volcanics. Here also the Whitewater Volcanics overlie the Halls Creek Metamorphics with strong angular unconformity.

The Mount Remarkable Conglomerate Member of the Whitewater Volcanics is mapped only in the O'Donnell Range in this Sheet area. It thins laterally and only a minor volcanic conglomerate occurs in the Wilson River area.

A volcanic conglomerate at the base of the Member is considered to indicate an erosional disconformity within the Whitewater Volcanics.

Revolver Creek Formation: This Formation crops out in isolated areas within the Car Boyd Ranges: four miles north-east of Mount Nyalasy, immediately east of the Ragged Range and around Revolver Creek. It overlies, in different places, the Whitewater Volcanics, 'Porphyritic Granite', and the Halls Creek Metamorphics with marked angular unconformity. The base is intruded by a highly epidotized 'Muscovite Granite'.

It is overlain with angular unconformity by the Hensman Sandstone; erosion has removed the whole of the unit in most areas.

The Formation contains three distinct 'members': a thin basal quartz sandstone overlain by amygdaloidal basalt with arkose interbeds, which in turn are overlain by alternating blocky quartz sandstone and siltstone.

The basalt shows marked variation in thickness; a difference of from 1,000 feet to 2,500 feet was observed over a strike length of one mile.

In the Revolver Creek area the basal sandstone is absent and the Volcanics are much thinner. The silt and shale beds have a prominent slaty cleavage.

YOUNGER PROTEROZOIC

The stratigraphic relationships of the Younger Proterozoic rocks of the Sheet area is shown in Table I. They unconformably overlie the Older Proterozoic and consist mainly of unmetamorphosed arenites and lutites. Most of the rocks were deposited in shallow water. They are exposed in three distinct successions (Dow et al. in prep.), and there is little overlap between them. For the sake of convenience of description these three sequences have been termed the Carr Boyd succession, Kimberley Basin succession and Eastern succession.

The Carr Boyd succession is the oldest; it crops out between the Dunham Fault and Halls Creek Fault and forms most of the Carr Boyd Ranges. It consists of a rhythmically deposited sequence of arenites and lutites with an unconformity at the top of each rhythmic unit (Dow et al. in prep). The Kimberley Basin succession includes all Younger Proterozoic rocks exposed west of the Dunham-Ivanhoe Fault system. The lower part of the succession is equivalent to the Carr Boyd succession, but it includes much younger rocks in the upper part. The Kimberley Basin succession consists of arenites with subordinate lutites and minor volcanics. The Eastern succession is exposed only east of the Halls Creek Fault, and is younger than the two western successions. It is best exposed in the Dixon Range Sheet area (Dow & Gemuts, 1964) to the south. In the Lissadell Sheet area it crops out as discontinuous exposures of arenites, lutites and minor glacials along the line of the Halls Creek Fault.

A more complete discussion of these successions and their relationships is given by Dow et al. (in prep.).

The base of the Younger Proterozoic has been defined (Dow et al. in prep.) as the base of the Hensman Sandstone in the east; and the base of the stratigraphically equivalent O'Donnell Formation in the west.

Carr Boyd Succession

Up to 30,000 feet of Younger Proterozoic arenites and lutites were deposited in the Carr Boyd Range area. These rocks have been divided into seven formations, five of which crop out in the Lissadell Sheet area - the Hensman Sandstone, Golden Gate Siltstone, Lissadell Formation, Glenhill Formation and Stonewall Sandstone. The other two units, the Pincombe Formation and Bandicoot Range Beds, crop out to the north in the Cambridge Gulf Sheet area (Plumb & Veevers, in prep.). The Red Rock Beds in the south-east around Turkey Creek and Mount Pitt are equivalent to an unknown part of the Carr Boyd succession.

Unconformities are present at the base of all formations in the succession except the Golden Gate Siltstone. These unconformities are consistent throughout the area.

The 30,000 feet thick Carr Boyd succession, is considered to be stratigraphically equivalent to the O'Donnell Formation and Liamma Beds, of about 3,200 feet plus total thickness, in the base of Kimberley Basin succession (Dow et al, in prep.).

The Hensman Sandstone is very uniform in lithology. It sits unconformably on a number of Older Proterozoic rock units throughout the area and grades upwards into the Golden Gate Siltstone. This latter unit thickens gradually from 800 feet in the west to about 7,000 feet in the east, adjacent to the Halls Creek Fault; the increase in thickness being marked by a change in sediment types; from shallow to deeper water deposition.

In the southwest lithic-quartz greywacke and green shales, of shallow water origin, are associated with massive sandy hematite at Pompeys Pillar Iron Deposit, suggesting an oxidising environment during sedimentation. These rocks grade eastwards through interbedded black siltstones and laminated fine-grained sandstones to a uniform succession of black shale and pyritic shale in the eastern Golden Gate Country. The pyrite and dark coloured sediments suggest a reducing environment. In thin section the fine-grained sandstones of the Revolver Creek area show a very open framework of detrital quartz in a chloritic clay matrix. Sediments in the Golden Gate Country appear to indicate more unstable deeper water conditions of sedimentation. Shales and siltstones in the area between the Halls Creek and Revolver Creek Faults have a prominent, subvertical cleavage.

The Lissadell Formation overlies the Golden Gate Siltstone with angular unconformity in places; in the southwest of the Carr Boyd Ranges it sits directly on Hensman Sandstone indicating

800 feet of erosion. The Formation thickens from 2,000 feet in the western Carr Boyd Ranges to about 5,000 feet in the north Carr Boyd Ranges. Adjacent to the Carr Boyd Fault it thins rapidly to about 500 feet. This appears to be primarily a depositional thinning although post depositional erosion may have contributed. The lower half of the Formation is mainly sandstone; siltstones are dominant in the upper half. This change is gradational and a facies change occurs within the gradational zone in the south-west Carr Boyd Ranges from siltstone in the north to sandstone in the south. No outcrops of the Formation occur east of the Carr Boyd Fault.

The Glenhill Formation rest on the Lissadell Formation with angular unconformity; up to 1,000 feet of the Lissadell Formation has been eroded prior to deposition of the Glenhill Formation. A consistent white quartz sandstone ranging between 200 and 700 feet thick comprises the base of the Formation. This is overlain, in most areas, by interbedded fine-grained sandstones and siltstone grading up into micaceous siltstone and shale. Eight miles west of Carlton Gorge a facies change occurs in this part of the section. The micaceous siltstones grade eastwards into medium to coarse-grained quartz sandstone with minor siltstone interbeds.

No outcrop of the Formation occurs east of the Carr Boyd Fault.

Only the lower part of the Stonewall Sandstone crops out along the northern margin of the Sheet area; the Sandstone is more extensive on the Cambridge Gulf Sheet area to the north (Plumb & Veevers, in prep.). It overlies the Glenhill Formation with angular unconformity.

Red Rock Beds: Vertical beds of quartzite occur as a fault wedge east of the Halls Creek Fault, on the southern margin of the Sheet area. They belong to the Red Rock Beds, a more complete section of which occurs in the Dixon Range Sheet area (Dow & Gemuts, 1964). The Red Rock Beds are the oldest rocks of the Eastern succession, and are equated with all, or part of, the Carr Boyd succession.

The quartzite is white, fine-grained and thin to medium-bedded: fine laminae can be distinguished in good exposures. Minor greenish-grey siliceous siltstone is interbedded with chert and less siliceous green shale.

Kimberley Basin Succession

Over 16,000 feet of arenites, lutites and minor volcanics are exposed in the Kimberley Basin (Dow et al. in prep.) in the west of the Sheet area: the Basin extends westwards from the Sheet area to cover the greater part of the Kimberley Division.

The rocks in the Kimberley Basin succession were first subdivided by Guppy et al. (1958) in the West Kimberleys. Harms (1959) extended this sub-division, with minor modification, throughout the Kimberley Division. The succession has been redefined in the East Kimberleys by Dow et al. (in prep.) as shown below.

Redefined Kimberley Basin Units

Guppy et al (1958)	Harms (1959)	Dow et al. 1963	
			Cockburn Sandstone
	Mount House Beds	Bastion Group	Wyndham Shale
			Mendena Formation
	Pentecost Sandstone		Pentecost Sandstone
Warton Beds	Elgee Shale		Elgee Siltstone
	Warton Sandstone	Kimberley Group	Warton Sandstone
Mornington Volcancis	Mornington Volcanics		Carson Volcanics
King Leopold Beds			King Leopold Sandstone
			Luman Siltstone
	King Leopold Sandstone	Speewah Group	Looningnin Arkose
			Valentine Siltstone
			Liamma Beds
			O'Donnell Beds

There are major unconformities at the base of the Liamma Beds, the base of the Speewah Group; and a probable unconformity at the base of the Kimberley Group. The Mount House Beds in the type area (Guppy et al., 1958) are now considered much younger than the Bastion Group.

Outcrops of the Kimberley Basin rocks are bounded in the east by the Greenvale-Dunham-Ivanhoe Fault system. The rocks are only gently folded and faulted, except adjacent to the Greenvale Fault, where the O'Donnell Formation and Liamma Beds are sheared and tightly folded.

The two basal units, the O'Donnell Formation and Liamma Beds, are stratigraphically equivalent to the Carr Boyd succession; a change in sedimentation occurs across the Dunham-

Ivanhoe Fault system. The rest of the Succession is younger (Dow et al. in prep.).

O'Donnell Formation: The O'Donnell Formation rests on the Whitewater Volcanics with erosional unconformity: a ferruginous volcanic greywacke, derived by weathering and erosion of the Volcanics, occurs at the base. This is overlain by an arenite sequence which is stratigraphically equivalent to the Hensman Sandstone; the higher part of the Formation could not be correlated directly. A hematite-rich sandstone, 20 feet thick and similar to the Pompey's Pillar ironstone occurs locally in the Wilson River area. The lowermost siltstones of the O'Donnell Formation are similar to the most western outcrops of the Golden Gate Siltstone. The change from O'Donnell Formation to Carr Boyd succession is gradational and taken arbitrarily at the Dunham Fault.

Three sandstone members and two siltstone members can be recognised in the O'Donnell Range. Farther south in the Wilson River area at least 2,000 feet of section has been removed by erosion and only the lower sandstone member is preserved. In the Dixon Range Sheet area (Dow & Gemuts, 1964) the O'Donnell Formation is up to 4,500 feet thick, in contrast to the maximum section preserved on the Lissadell Sheet area of 2,400 feet.

Adjacent to the Greenvale Fault low grade metamorphism, strong cleavage folds and transposed bedding have formed in lutites of the O'Donnell Formation.

Dolerite: Dolerite dykes and sills crop out in the O'Donnell Range intruding the Whitewater Volcanics and O'Donnell Formation. Similar dykes occur in the Golden Gate Country and in the Lamboo Complex around Pompey's Pillar.

The O'Donnell Formation is the youngest unit known to be intruded by the dolerite. In the valley around Moonlight Valley Yard a sill, estimated about 5,000 feet, intrudes the upper part of the Formation.

This dolerite differs from the Hart Dolerite, and is probably older. It is uralitized, commonly sheared, and is not as rich in magnetite. Traces of copper have been found in joints. In thin section sheaths of amphibole replace pyroxene, and feldspar is saussuritized.

Liamma Beds: The Liamma Beds are preserved as remnants along the Greenvale Fault. They overlie the O'Donnell Beds with strong angular unconformity and are in turn unconformably

overlain by the Speewah Group. In places the Speewah Group lies directly on the O'Donnell Formation.

The lithologies of the O'Donnell Formation and Liamma Beds are very similar but the fine-grained sediments of the Liamma Beds can be distinguished by their more chloritic nature, green colour, poor sorting, open framework of quartz grains in thin section, and slumping. Bedding is very thin and regular or micro-crossbedded. Coarse sandstones contain tourmaline and cross-bedding, ripple-marks and clay pellets are common. Fine-grained sediments weather to blade shaped fragments in outcrop due to bedding and cleavage parting. The Liamma Beds represent intermittent stable shallow-water and unstable deeper water sedimentation which produces an alternating succession of quartz sandstone and interbedded green chloritic siltstone and quartz greywacke.

The Beds are cleaved and folded adjacent to the Greenvale Fault. A complete section is not exposed in the Sheet area due to the unconformity at the top; and to dislocation by the Greenvale Fault.

Speewah Group

The Speewah Group is characterized by the association of highly feldspathic arenites with chloritic lutites and minor acid volcanics. It overlies the Liamma Beds with a strong angular unconformity and is less effected by the Greenvale Fault than the Liamma Beds and O'Donnell Formation. It is overlain by the Kimberley Group with probable erosional disconformity. No definite relationship could be established in this Sheet area due either to structural complications, poor outcrop, or the presence of dolerite sills in key areas. The upper siltstone member of the Luman Siltstone is markedly thinner in the southern Durack Ranges, due apparently to erosion. Preliminary reconnaissance indicates an angular unconformity in the Lansdowne Sheet area to the south-west.

The Speewah Group is intruded over wide areas by prominent sills of Hart Dolerite, some of which enclose large blocks of sedimentary rocks 'rafted' along joints and fault planes. The sills commonly follow definite beds for long distances. A particularly persistent sill follows near, or along the unconformity surface between the Liamma Beds and Valentine Siltstone throughout the western Sheet area. Another sill follows the contact between the Luman Siltstone and the overlying Kimberley Group.

The Group crops out west of the Greenvale-Dunham Fault system in this Sheet area. The basal Valentine Siltstone, contains two thin rhyolitic ashstone and tuff beds within green chloritic siltstone and minor feldspathic quartz sandstone. A thick sill of dolerite intruding the base of the Formation has frequently incorporated large amounts of sedimentary material so that the complete section is rarely present.

The conformably overlying Looningnin Arkose is characterised by arkose, and by arenites with abundant pink feldspar, or clay after feldspar. Thick beds, crossbeds and ripple-marks are characteristic. A consistent band of siltstone about 100 feet thick is found in the lower third of the formation. A second siltstone band is present in the upper third in the Wilson River area. The Formation has a distinctive banded photo-pattern of low strike ridges controlled by differential erosion of the various arenite beds. The unit thickens to the southwest.

The Luman Siltstone, at the top of the Group, consists of three members: purple chloritic micaceous siltstone at the base, friable clayey or feldspathic quartz sandstone in the middle, and, at the top, brown to grey finely micaceous shale and siltstone, with 'satin sheen' bedding surfaces. The lower siltstones have abundant flow-casts, slump structures, ripple marks and mud cracks. The formation is consistently intruded by dolerite, especially at its contact with the overlying Kimberley Group.

Kimberley Group

The Kimberley Group consists mainly of quartz sandstone with minor siltstone and basic volcanics. It crops out extensively to the west of the Sheet area forming the bedrock of the Kimberley Plateau (Harms, 1959). In the Sheet area it crops out only to the west of the Dunham-Greenvale Fault system. Most of the units in the Group thin out noticeably to the east.

The Kimberley Group overlies the Speewah Group with probably erosional disconformity, (see Speewah Group), and is conformably overlain by the Bastion Group.

The King Leopold Sandstone, at the base of the Group consists of quartz sandstone and minor grit and conglomerate. Scattered feldspar is present. The formation is very resistant to erosion and has a distinctive massive, white, jointed photo-pattern, a result of the sparse vegetation and strong jointing. The sandstone is estimated from air-photographs to be 3000 feet

thick in the Saw Ranges, but may be as much as 4000 feet in the Durack Ranges where it is difficult to obtain a reliable estimate.

The overlying Carson Volcanics crop out poorly and consist of altered basic volcanics interbedded with highly feldspathic sandstone, minor micaceous and chloritic siltstone, and sandstone. The feldspathic sandstone is strongly cross-bedded. Marked lateral variation in percentage of sediment and basalt occurs. The formation commonly contains a consistent basal basalt flow; and micaceous sediments at the top. In the southwest Durack Ranges the unit thickens and contains up to five recognisable flows, with thin sandstone interbeds. It is here intruded by a small sill of Hart Dolerite. In the King River area there is no basalt.

The overlying Warton Sandstone is a blocky quartz sandstone which grades up into feldspathic sandstone and minor siltstone interbeds. It crops out prominently and is capped by a characteristic, white, silicified quartz sandstone along the Durack Ranges. The formation thins eastwards.

The Elgee Siltstone crops out poorly in a scarp beneath the Pentecost Sandstone, and overlies the Warton Sandstone. It is a distinctive cherry-red siltstone interbedded with minor flaggy fine-grained sandstone. Green and grey dolomite, and algal dolomite, are present in the base of the formation in the southern Chamberlain River area. Lenses of quartz sandstone 200 feet long and 30 feet thick occur in places. The contact with the Pentecost Sandstone is gradational.

The Pentecost Sandstone is mainly composed of medium-grained quartz sandstone with minor feldspar and very distinctive purple siltstone members about 100 to 200 feet thick. These latter control erosional benches and scarps on the Kimberley Plateau. The lower member contains glauconitic sandstone. The formation thins from 3600 feet in the west to only 2200 feet east of the Saw Ranges.

Hart Dolerite: The Hart Dolerite intrudes the O'Donnell Formation, Liamma Beds, Speewah Group, the King Leopold Sandstone and Carson Volcanics in the Lissadell Sheet area. Harms (1959) reports dolerite intruding rocks as young as the Mount House Beds in the West Kimberleys: it is most extensive within the Speewah Group, and a sill up to 6000 feet thick has been noted in the Speewah Valley. Large blocks of sedimentary rocks over a mile square and at least several hundred feet thick have been 'rafted' along fault and joint planes and are completely

enclosed in dolerite. Minor feeder dykes intrude Kimberley Group rocks. The dolerite crops out as rounded, boulder-strewn hills, with thick grass cover, and has a characteristic 'flat', dark-grey pattern on air photographs.

The rocks range from dolerite and quartz dolerite to coarse grained gabbro and diorite; Edwards (1942) shows that they are saturated with respect to quartz. Dolerites occurring in the thinner sills are generally finer grained and have a sub-ophitic fabric. They contain andesine or labradorite and pigeonite or diopsidic augite. Magnetite is a ubiquitous accessory. Minor (altered) olivine and hypersthene is present in some specimens.

An extensive dolerite sill intrudes at or near the base of the Speewah Group. In the Speewah area it appears to be a composite sheet. It is coarser grained than other and thinner sills, and consists of a coarse gabbro or quartz gabbro. Hypersthene is common in some specimens but less than half the total pyroxene in others. Magnetite may make up to 15% of the rocks; the feldspar is calcic andesine or labradorite. Biotite, quartz, epidote and olivine occur as accessories.

A granophyre up to 800 feet thick forms the upper contact of this sheet throughout the Sheet area. It is red in colour, due to iron stained feldspar, quartz rich and poor in mafic minerals. Potash feldspar and quartz commonly form a myrmekitic inter-growth. The granophyre contains numerous sedimentary inclusions; and in the field it is difficult in many cases to recognise the contact between it and altered sediment. In some places sandstone is epidotised up to 200 feet from the contact. The contact effects of the smaller sills are not pronounced. Chilled margins up to 2 feet wide are found in the dolerite and the adjacent sandstones are enriched in iron; and siltstone is recrystallised to fine white mica and chlorite for several feet from the contact.

Bastion Group

The section of the Bastion Group exposed in the Sheet area is incomplete. The Group conformably overlies the Kimberley Group and consists mainly of green shales and siltstones alternating with quartz sandstones and minor carbonate rocks. Traves (1955) and Harms (1959) mapped the rocks as Mount House Beds (Guppy et al, 1958) but it is now considered that this correlation is incorrect. (Dow et al. in prep.).

The Mendena Formation contains green and purple siltstone with subordinate green shale, fine grained sandstone, and

dolomite. These alternate with three beds of blocky quartz sandstone. The Formation crops out poorly, mainly as sandstone rubble covered rises. The lithology represents a gradation between the underlying Pentecost Sandstone, which contains little siltstone and the overlying Wyndham Shale, which lacks sandstone interbeds. Flakes of secondary copper minerals occur on bedding and joint planes near Plants Homestead.

The Wyndham Shale crops out very poorly in the scarp below the overlying Cockburn Sandstone. It contains grey-green shale with irregular interbeds of flaggy fine-grained sandstone or siltstone. Mud cracks, flow-casts and wavy bedding are characteristic. Minor thin beds of sideritic sandstone or siderite and nodules of siderite up to 2 feet across are present within the shales.

The Cockburn Sandstone has only the basal few hundred feet preserved in this Sheet area. A more complete section occurs in the Cambridge Gulf Sheet area (Plumb & Veevers, in prep.).

Eastern Succession

The Younger Proterozoic rocks of the Eastern succession are discontinuous exposures along the eastern side of the Halls Creek Fault. Farther east they are unconformably overlain by Palaeozoic rocks. A complete section is present in the Osmond Ranges in the Dixon Range Sheet (Dow & Gemuts, 1964) but their relationship to the Kimberley Basin Succession is uncertain. The inferred relationships are shown in Table I.

The rock units exposed are:

Mount Forster Sandstone
Ord Group
Mount Parker Sandstone

Mount Parker Sandstone: In the Lissadell Sheet area small remnants of Mount Parker Sandstone up to 400 feet thick have been preserved beneath the unconformably overlying Ord Group. The formation unconformably overlies Red Rock Beds or Golden Gate Siltstone. It consists of reddish pink, or purple, micaceous quartz grit, minor lenses of quartz pebble conglomerate and thin red and khaki-green shale interbeds. It is flaggy to blocky, crossbedded, and in places there are abundant ripple marks.

Ord Group:

An incomplete section of the Ord Group (Dow et al. in prep.) unconformably overlies the Mount Parker Sandstone, Carr

Boyd succession, or Halls Creek Metamorphics in the Lissadell Sheet area. Units between the Mount Parker Sandstone and Ord Group in the Dixon Range Sheet area (Dow et al. 1964) are absent. In most outcrops the Ord Group is unconformably overlain by the Antrim Plateau Volcanics. The units mapped in the Lissadell Sheet area are, in order of superposition:

Ranford Formation
  Jarrad Sandstone Member
Moonlight Valley Tillite

The Moonlight Valley Tillite contains 160 feet of unsorted boulders of older rocks in a fine-grained green silty matrix. The boulders range from less than one inch to tens of feet in diameter, and include quartzite, granite, metamorphic rocks, dolomite, jasper and chert. Many boulders are highly polished and striated. The Tillite is of undoubted glacial origin, and was described in more detail by Dow et al. (op.cit).

On the Lissadell Sheet area outcrop is poor, but scattered boulders are common on the scarp below the Ranford Formation. The top of the Tillite is marked by a very persistant, thin bed of laminated pink dolomite.

The Ranford Formation unconformably overlies the Moonlight Valley Tillite and is unconformably overlain by the Albert Edward Group. It is only about 800 feet thick in this Sheet area; compared to 1900 feet in the Dixon Range Sheet area (Dow & Gemuts, 1964). North of Argyle Downs 350 feet of the Jarrad Sandstone Member occurs at the base of the Formation. This is a massive red-brown ferruginous quartz greywacke. The Member cannot be traced south of Argyle Downs Station, but occurs again in the Osmond Range on the Dixon Range Sheet. (Dow & Gemuts, 1964).

The upper part of the Ranford Formation, at Mount Brooking, consists of claystone, siltstone and shale overlain by a thin quartz greywacke, and capped by thinly-bedded to laminated siltstone and fine-grained ferruginous sandstone. In this part of the section is the well known 'zebra-stone' or 'ribbon-stone' (Larcombe, 1926; Blatchford, 1927; Hobson, 1930) of Argyle Downs. Well preserved fossil jelly-fish are found in the fine-grained rocks at the top of the Mount Brooking section (Dunnet, in prep.). Some of the forms are similar to the Ediacara fauna of South Australia (Sprigg, 1949), but some new forms are also present (Opik, pers.comm.).

Preliminary radiometric dating (Bofinger, pers.comm.) indicates a late Upper Proterozoic age for the Formation.

Albert Edward Group

Only the basal 30 feet of the Group is preserved, that of the basal formation, the Mount Forster Sandstone and it is the youngest Proterozoic unit exposed in the Lissadell Sheet area. It occurs only on the southern margin of the Sheet where it unconformably overlies the Ranford Formation and is itself unconformably overlain by the Antrim Plateau Volcanics. The formation consists of purple to pink, thin-bedded to massive fine-grained quartz sandstone, with well-rounded and well-sorted grains.

PALAEOZOIC

CAMBRIAN

Cambrian rocks crop out over most of the Sheet area east of the Halls Creek Fault and extend westwards into the Ragged Range and Dunham Valley. Matheson and Teichart (1945) and Traves (1955) subdivided these rocks, and little was added to their mapping during the present survey.

LOWER CAMBRIAN

Antrim Plateau Volcanics: The Antrim Plateau Volcanics crop out over most of the Ord Plains, and extend as small outliers as far west as the Speewah area. Edwards and Clarke (1940) described the Volcanics of the region as a homogenous petrographic province of tholeiitic basalts.

The Volcanics consist of a series of basalt lava flows less than 100 feet thick many of which can be traced for several miles. Massive fine grained basalt is the main rock type, but vesicular basalt is common. Agglomerate and about 30 feet of a red-brown cherty quartz sandstone occurs at the base of the Volcanics. The thickness ranges from 2800 feet near Mount Pitt, to only about 100 feet in the Speewah area. Vesicles are filled with agate, chalcedony, calcite and green to brown fibrous zeolite. Geodes of amethyst quartz are found west of Dunham River Homestead. Traces of copper are quite common (see Economic Geology).

The Volcanics are regarded as Lower Cambrian in age (Traves, 1955; Dow, et al. op.cit.).

Lower Cambrian(?): 400 feet of brown inter-bedded medium-grained cross-bedded quartz sandstone, brown-green calcareous siltstone and glauconitic Biconulites limestone unconformably overlie the Antrim Plateau Volcanics at the foot of the western escarpment of the Ragged Range. They are in turn unconformably overlain by the Ragged Range Conglomerate of

probable Upper Devonian age. Öpik (pers. comm.) has determined a metadoxidid trilobite and Biconulites from these beds and regards the age as probably late Lower Cambrian.

MIDDLE CAMBRIAN

Negri Group:

The Cambrian sediments which overlie the Antrim Plateau Volcanics on the Ord Plains belong to the Negri Group. They are folded into assymetrical structural basins termed the Rosewood and Argyle Basins by Matheson and Teichert, (1946). A third, small, unnamed basin occurs east of Mount Pitt. Most of these rocks erode easily and form open rolling plains of fertile black-soils from which resistant limestones crop out as subdued cuestas and hogsbacks. Rocks of the Negri Group in the Lissadell Sheet area form a conformable sequence and include the formations, listed in order of superposition below:

Panton Formation
Linnekar Limestone
Nelson Shale
Headleys Limestone

The Headleys Limestone crops out in all three basins. It consists of 20 to 30 feet of massive fine-grained grey limestone, containing chert nodules, overlain by 100 to 130 feet of laminated and thin-bedded, fine-grained, grey limestone. No fossils have been found in the Limestone but its stratigraphical position places it in the Lower or early Middle Cambrian.

The Nelson Shale in the Dixon Range Sheet area (Dow & Gemuts, 1964) is 600 feet thick but only small exposures of grey and blue shale and calcareous shale are known in the Lissadell Sheet area. In plaoes it is gypsiferous and pyritic.

The Linnekar Limestone crops out in the Rosewood and Argyle Basins. In the Dixon Range Sheet area (Dow & Gemuts, 1964) it consists of 10 to 20 feet of medium-bedded grey limestone overlain by 50 to 60 feet of thin-bedded grey or brown, fine-grained limestone containing thin marl interbeds. Only the more resistant basal unit crops out in the Lissadell Sheet area.

The formation is richly fossiliferous in the Dixon Range Sheet area, but only fragmentary trilobite remains were found on Lissadell. The age of the formation is lower Middle Cambrian.

** DEVONIAN

Rocks of Devonian age crop out in the Ragged Range, Southern Carr Boyd Range, Dunham Valley and King River Valley.

** The Panton Formation in the Dixon Range Sheet area (Dow & Gemuts, 1964) is made up of about 600 feet of inter-bedded shale and flaggy limestone. Massive grey limestone about ten feet thick crops out in the Rosewood and Argyle Basins and only a few small outcrops of massive grey shale and siltstone and thin flaggy limestone are known. The age of the Formation is lower Middle Cambrian.

UPPER DEVONIAN

Ragged Range Conglomerate: 800 feet of red-brown and yellow cross-bedded quartz sandstone and conglomerate with pebbles, cobbles and boulders of quartzite unconformably overlie the Lower Cambrian (?) rocks in the Ragged Range. The top is eroded. Massive conglomerate is the dominant lithology in the southern part of the Ragged Range, and this passes laterally into sandstone in the northern part of the Range. The conglomerate extends east into the valley bordering the southern Carr Boyd Ranges, where it crops out poorly as rises of quartzite boulders, weathered out of the conglomerate.

Pelecypods and Gastropods collected near the base and 600 feet above the base, in 1963, indicate a probable Upper Devonian age; hence the Ragged Range Conglomerate is probably equivalent to part of the Cockatoo Sandstone of the Cambridge Gulf Sheet area.

Cockatoo Sandstone: Isolated outcrops of friable red-brown medium-grained clayey quartz sandstone crop out along a fault line in the western King River Valley. They are a continuation of extensive outcrops farther north in the Cambridge Gulf Sheet area.

Palaeozoic Undifferentiated: Conglomerate and friable quartz sandstone outliers crop out south of Mount Hensman and appear to overlie the Cockatoo Sandstone to the north in the Cambridge Gulf Sheet area (Plumb & Veevers, in prep.). No fossils have been found, but Matheson & Teichert (1946) considered these rocks to be of Permian (?) age and equated them on lithological grounds, with the Precambrian Ord Group. They consist, in part, of reworked Moonlight Valley Tillite, but most pebbles are silicified sandstone derived from the Carr Boyd Succession. The thickness is less than 500 feet.

CAINOZOIC

Black Soil: Extensive residual black soils have formed on Cambrian rocks on the Ord Plains. Residual black soils also occur on the Hart Dolerite in the Dunham River Valley.

Superficial Soils: Superficial sand, residual soils, elluvium and travertine occur throughout the Sheet area. Sand occurs on the tops of sandstone plateaux and as valley deposits adjacent to sandstone ranges, associated with scree and gravels. Many scarps shown on the map as outcrop, such as the Elgee Siltstone, are, in fact, covered by thin scree deposits. Residual arkosic soils are common on the Lamboo Complex.

Alluvium: Deposits of Quaternary and Recent sediments, including alluvial black soils, have been deposited along all major streams of the Sheet area. The Dunham and Ord Rivers have very extensive flood plains with alluvial deposits in places deeper than 50 feet: these deposits show marked vertical variation in sediment type.

STRUCTURE

The Sheet area includes three major tectonic divisions (after Traves 1955). The Halls Creek Mobile Zone is a fault bounded belt of Older Proterozoic metamorphic and igneous rocks overlain in the north by faulted Younger Proterozoic rocks. It is bounded on the west by the Kimberley Block, a relatively stable area of gently warped and flat-lying Younger Proterozoic rocks. The Sturt Block in the east contains Younger Proterozoic and Cambrian rocks which also are only gently folded. The distribution is shown in figure II.

Halls Creek Mobile Zone:

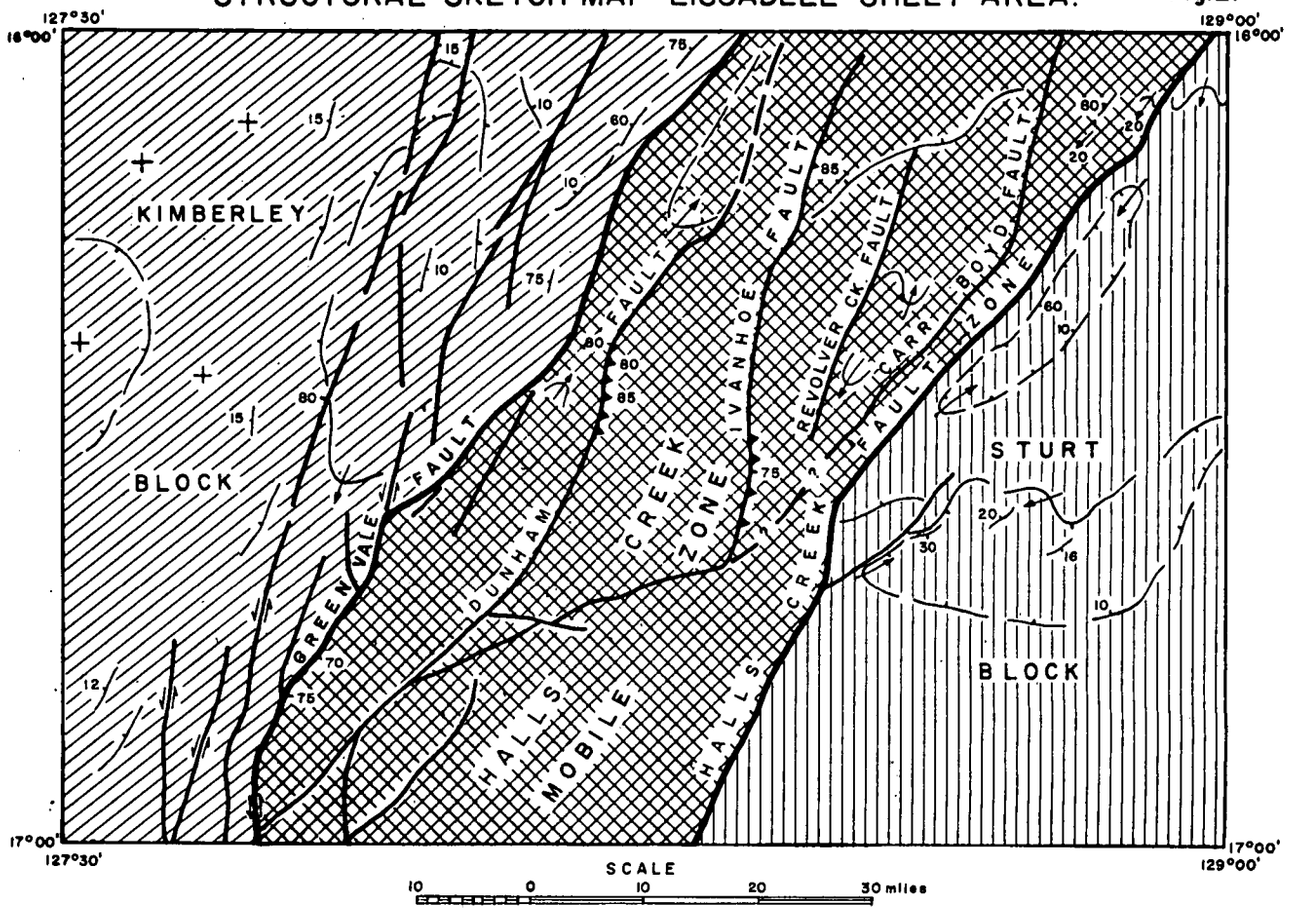
This Zone contains intensely deformed metamorphic rocks and igneous rocks of the Lamboo Complex, overlain by the faulted and unmetamorphosed Younger Proterozoic rocks of the Carr Boyd succession. Its boundaries are two major faults, the Halls Creek Fault in the east and the Greenvale Fault in the west. Both trend about 200° magnetic. The Zone is cut by other major faults of similar magnitude to the bounding faults.

Folding: The Tickalara and Halls Creek Metamorphics have been folded and deformed by regional stresses. In the Tickalara Metamorphics the axes of isoclinal flow folds trend north-north-east their plunge varies from shallow north to vertical. Adjacent to the "gneissic granite" the structure is very complex, with plastic flow and transposition of folded layers, coupled with anatexis to produce an irregular structural pattern of minor folds. The axial planes of these folds dip steeply, amphibolites, produce 'stengel gneiss'. The 'stengels' plunge steeply north or south. Marble bands exhibit extreme flowage.

The Halls Creek Metamorphics crop out as inliers within the Younger Proterozoic rocks of the Carr Boyd Range. The rocks dip steeply and have a sub-vertical axial plane slaty cleavage which trends between 180° and 220°. The rocks are mainly metamorphosed to greenschist grade. Folding is related to the competency of rocks; small scale folds are common in slates and phyllites. Transposition of bedding is common in thinly

STRUCTURAL SKETCH MAP - LISSADELL SHEET AREA.

Fig.2.



REFERENCE

- Kimberley Block
- Sturt Block
- Halls Ck. Mobile Zone
- 10 Bedding trend with dip
- \+ Horizontal bedding
- Plunge of syncline
- Plunge of anticline
- Fault with horizontal movement sense
- 80 Fault with dip of fault plane
- 75 Thrust fault with dip of thrust plane

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bedded quartz greywackes. The folds plunge from 35°north to vertical. Quite large vertical folds are present, and may be indicative of a second phase of folding.

Younger Proterozoic rocks within the Zone are only folded as a result of compression within fault blocks. (See Faulting).

Faulting: The Halls Creek Mobile Zone is bounded by faults with large displacements and is broken by a series of anastomosing faults, many of which have movements comparable with the bounding faults. The major faults are the Halls Creek, Carr Boyd, Revolver Creek, Ivanhoe, Dunham and Greenvale faults. (See fig. II).

The faults have long complex histories of periodic movement, and intensity of movement and associated shearing tends to decrease with the age of the rocks affected.

The Halls Creek Fault forms the eastern margin of the Halls Creek Mobile Zone. It has a shear zone up to one quarter of a mile wide and dips steeply to the east and the west. In the Argyle Downs area the movement is distributed over several faults in a zone up to four miles wide. Strongly cleaved phyllites, phyllonites and mylonites are developed.

Large vertical displacements are invariably east-block down. Near the Carr Boyd Range, Antrim Plateau Volcanics are faulted against Lamboo Complex, suggesting a minimum throw of 9000 feet. Horizontal displacements are probably large, but difficult to estimate. In the Dixon Range Sheet area (Dow & Gemuts, 1964) a horizontal displacement of 16 miles, west-block south, is postulated.

The Carr Boyd Fault is adjacent to the Carr Boyd Ranges, and forms the western margin of a shear zone four miles wide between it and the Halls Creek Fault. Near Carlton Gorge it branches from the Halls Creek Fault into a north-striking fault zone up to half a mile wide, and defined by a prominent scarp on the west.

The fault wedge between the Carr Boyd and Halls Creek Faults has rotated about an east-west axis, the northern end of the wedge being upthrown several thousand feet. The rocks are strongly folded and sheared in the southern apex of the wedge.

The Revolver Creek Fault is a western splay of the Carr Boyd Fault and has smaller splay faults diverging from it. The block between the two major faults has been subjected to rotational strain similar to the Golden Gate block. This strain was released on a curved cross fault to the north and the whole

block has subsided about 6000 feet. Compression on this block produced broad anticlines and synclines, whose axial planes lie at about 15° to the bounding faults. These major anticlines culminate , plunging 20°south and 25° north. An axial plane cleavage is developed in the less competent rocks of the Golden Gate Siltstone.

Folded cleavages in the Halls Creek Metamorphics adjacent to the Revolver Creek Fault indicate a considerable horizontal component of movement west-block north. North of Revolver Creek the Fault illustrates the varying nature of fault movement in this area. The Older Proterozoic rocks are strongly faulted, the overlying Hensman Sandstone is displaced very little, and the Glenhill Formation is unaffected. Movement ceased during deposition of the Lissadell Formation.

The Greenvale Fault Zone forms the western margin of the Halls Creek Mobile Zone. The Zone is a composite system of intersecting faults striking about 210° and 180°. These combine to produce a "dog-leg" trend to the Fault. The 210° striking legs dip 70° to 75° east and drag folds indicate a high-angle reverse-fault movement, with vertical displacement up to 8000 feet. This leg is represented by a zone of strong shearing up to 2 miles wide; the more intense folding and shearing occurs in the older rocks of the Whitewater Volcanics and O'Donnell Formation.

The 180° - 190° striking legs diverge westwards, and in part appear to displace the 210° legs. These splay faults show little vertical displacement, but horizontal movements up to 20,000 feet, west block south, are indicated.

The Dunham Fault is a prominent easterly splay of the Greenvale Fault. It is a shear zone up to one mile wide which commonly contains reef quartz. The Fault dips steeply east and has a high-angle reverse movement along the O'Donnell Range. Vertical displacement of the order of 8,000 feet is indicated, but a horizontal displacement of 20,000 feet west-block south could also give the observed stratigraphic displacement.

The fault has affected Devonian rocks.

The Ivanhoe Fault diverges from the Dunham Fault and strikes about 240° across the Lamboo complex as a wide shear zone. In the south-west corner of the Carr Boyd Range its trend changes sharply to 195°. On this southern corner the Fault has an apparent horizontal displacement of 10,000 feet, west-block south. To the north adjacent to the Ragged Range, up

to 7,000 feet vertical displacement is indicated. Six miles to the south only 3,000 feet of movement is apparent. Devonian rocks have also been strongly dislocated.

The horizontal movement sense in the faults of the area in almost all cases is west-block-south. This is suggestive of compressive stress from the northwest and strain expressed by anastamosing wrench faults.

Kimberley Block

The Kimberley Block is located west of the Mobile Belt and consists of only slightly deformed or flat lying Younger Proterozoic rocks. Dips increase towards the Mobile Zone and are steeply upturned along the Greenvale Fault.

The structure of the margin of the Block is controlled by splay faults of the Greenvale Fault which trend between 180° and 195°, and dip steeply east or west. Vertical displacements appear to be minor, but horizontal displacements are as much as 20,000 feet, west block south. Fault wedges of steeply dipping rocks are found adjacent to the margins of the Block. The rocks have yielded by fracture along narrow zones and shearing is subordinate.

Folding consists only of broad domes of which the main example is the Speewah Dome. Some tight folds are developed along the western edge of the Greenvale Fault.

Sturt Block :

The Sturt Block is a stable area which is adjacent to the Halls Creek Mobile Zone on its eastern side. Only part of the Sturt Block is located on the Lissadell Sheet and here fault wedges of Younger Proterozoic rocks occur along the eastern edge of the Halls Creek Fault. These wedges are bounded by the Fault and north-easterly splays of the Halls Creek Fault. These two fault trends (020° and 045°) are the main structural features of the Block. Negligible faulting affects the Cambrian sediments.

The Rosewood and Argyle Basins are markedly asymmetrical structural basins. The long axes of the basins trend north-east, parallel to the splay faults. The western edges of the Basins are sharply terminated against the Halls Creek Fault producing steep dips. The Argyle Basin is the best example, where the eastern edge dips 20° north-west and the western edge dips 70° southeast.

The present distribution of rock units in the Sheet area

is markedly controlled by major faulting. It is not known to what degree this is a result of primary sedimentation. Faults are known to have affected the distribution and thickness of sedimentation in some units, the most striking example being the Carr Boyd succession. Here sedimentation, in part, is restricted to a basin bounded by the Dunham and Halls Creek Faults. Movements within the central Halls Creek Mobile Zone during sedimentation have influenced the nature of the sediments. This has made it impossible to correlate, by lithological means, stratigraphically equivalent units across the bounding faults.

ECONOMIC GEOLOGY

Copper:

Small showings of copper have been found throughout the Sheet area in rocks of many ages; no economic deposits are known and the chances of finding any are considered to be remote.

Whitewater Volcanics: Small amounts of copper mineralization were noted in two localities in the Whitewater Volcanics: a carbonate staining on the surface of a waterfall in a creek five miles south of Dunham River ~~Jumpup~~ Jump Up; and a thin isolated vein of quartz, arsenopyrite and minor chalcopyrite crops out six miles north-east of Moonlight Valley Yard. The vein could only be traced for several inches in acid volcanics adjacent to a basic dyke.

Older Dolerites intruding the O'Donnell Formation: Malachite and azurite coat joints in a uralitized dolerite sill intruding the O'Donnell Formation in Moonlight Valley (Lissadell Sheet area).

Elgee Siltstone: Small flakes of azurite coat bedding planes of the Elgee Siltstone west of the Chamberlain River, in the south-~~eastern~~ western part of the Lissadell Sheet area.

Mendena Formation: Harms (1959) reports copper minerals at Plants Homestead as "minor veinlets of copper carbonate, oxides and chalcocite in a siltstone a few chains south of the homestead. Individual veins do not exceed four feet in length and three inches in width: their origin is not apparent". Only flakes of carbonate on joint surfaces were found during the 1963 survey.

Hart Dolerite: Traces of copper carbonate are recorded from two localities within the Speewah Dolerite Sheet. At Martin's Silver-lead Prospect azurite and malachite are as scattered patches within quartz (Harms, 1959). Azurite was noted in a shear zone associated with epidote and quartz about five miles

north of the Speewah Homestead.

Traces of copper are common throughout the Hart Dolerite in the area but the possibility of economic occurrences is considered to be remote.

Antrim Plateau Volcanics: Small occurrences of copper minerals have been reported from widespread localities in the Antrim Plateau Volcanics. Most consist of carbonate, chalcocite and cuprite: native copper is also found either as vesicle fillings or as sparse disseminations. The basalt immediately underlying the Headleys Limestone in the Rosewood Wall area contains no visible copper minerals, but channel samples six feet long cut across it assayed about 0.6 percent copper (Harms 1959). Other samples from the same horizon further afield showed no significant copper content.

Headleys Limestone: Minor copper stains occur in the Headleys Limestone in widespread localities. The largest are found in the Rosewood Wall and near Old Lissadell Homestead, but they are of small extent and of no economic interest.

The mineralization in the Rosewood Wall consists of disseminated and nodular chalcocite, and associated secondary carbonates, which are generally concentrated near the base of the Limestone. It occurs as discontinuous patches over a distance of three miles.

Matheson and Teichert suggest that the copper has been leached from the volcanics by surface waters and fixed by the limestone. Alternatively, the copper may be of sedimentary origin, having been deposited from water richer in copper because of volcanic action.

Minor copper carbonates occur in joints in undifferentiated Cambrian limestone underlying the Ragged Range Conglomerate in the western scarp of the Ragged Range. The occurrences are of academic interest only.

Lead

Small deposits of lead are known in Halls Creek Metamorphics, in granite of the Lamboo Complex, and in the Younger Proterozoic rocks of the Kimberley Basin, but none appears to offer economic prospects.

Two deposits occur in the Hart Dolerite of the Speewah area. Martin's Silver-lead Prospect (Blatchford, 1927) is situated on the north-eastern side of a domed sheet forming the valley floor at its contact with the Speewah Group. The mineralization is a flat narrow vein on top of the granophyre

of the Hart Dolerite exposed where almost all of the overlying Speewah Group has been eroded. The second occurrence is galena (and fluorite) in a shear zone about five miles north-north-west of the old Speewah Homestead. The shear zone can be traced for almost ten miles, but the mineralization occurs in lenticular veins of quartz over a strike length of about 400 feet only.

Traces of galena were noted in the Valentine Siltstone above a dolerite sill, near a small fault, two miles north of the Dunham River. Galena has also been reported from near Mount Lookout. A hand specimen from this locality showed minor galena associated with quartz.

Uranium:

Uranium was discovered south of Dunham River Homestead by United Uranium N.L. in 1954. It is situated close to the Dunham Fault near the Dunham Jumpup (de la Hunty, 1955).

The northern mineral leases M.C. 39 and 42 covered a basic dyke intruding sheared granite. Autunite lining joints in the dyke has been prospected by shallow costeans and a shaft: the shaft is now inaccessible. The radioactivity of the dyke was tested for 4000 feet, but only the shaft area gave high readings.

A second prospect straddles the Great Northern Highway (M.C. 40 and 41). North of the Highway several costeans cut the contact between sheared granite and quartz sandstone of the Hensman Sandstone Torbernite occurs as a narrow vein up to four inches wide in sheared granite close to the sandstone. During 1963 the Department of Main Roads constructed a new road which passed immediately south of the prospect, but no further mineralization is visible in the road cutting.

Other claims along the Dunham Fault to the south, held by United Uranium N.L., were reported by de la Hunty. These were not located during the 1963 survey, but are apparently of less significance than the northern ones.

Iron:

Beds of low grade siliceous hematite crop out over a total strike length of about 10 miles, near the base of the Golden Gate Siltstone, in the south-western Carr Boyd Ranges near Pompeys Pillar. They have been studied and assayed by Harms (1959) and Macleod (1963), and only two deposits approach ore grade: the 'Western Deposit' originally the 'Pompeys Pillar Deposit' about 7 miles north of Mount Nyalasy, and the 'Eastern Deposit' (originally the 'Matsu Deposit') lying about

six miles north east of Mount Nyalasy. The two deposits are separated by the Ivanhoe Fault, which displaces the 'Eastern Deposit' 10,000 feet east. The 'Western Deposit' was drilled in 1962 and more exhaustively in 1963-64. Results are not available for publication.

The deposits crop out on the dip slope of a large cuesta of the Carr Boyd Range, and are bedded sedimentary deposits associated with shallow water quartz sandstones and ferruginous shales. The massive hematite and sandy hematite is up to 35 feet thick in both deposits. Six million tons of 60% Fe_2O_3 grade ore is estimated to be available by selected mining in the 'Western Deposit', and up to twenty million tons of much lower grade ore in the 'Eastern Deposit' (Macleod, 1963).

The overall low grade and limited extend makes it unlikely that either deposit could be mixed economically under present market conditions to provide a direct shipping ore, however, as much of the hematite-rich zone is coarsely granular, the deposits could conceivably provide a substantial tonnage of beneficiable ore.

Scattered beds of hematitic sandstone and metasomatised ferruginous sandstone occur in the Wilson River and O'Donnell Range areas; none are of economic significance.

Water:

Surface water is restricted to springs and waterholes in the more rugged and inaccessible parts of the Sheet area. With a few exceptions they are situated unsuitably for stock utilisation. All, or nearly all, the annual rainfall of 20-30 inches falls during the Summer monsoon. The run off is rapid and streams as a result are not permanent. The surface water must be supplemented by groundwater for stock purposes.

Supplies of up to 30,000 gallons per hour are obtained in some places from crystalline rocks, soft sandstone, basalt and alluvium (Passmore, 1964). Water is very scarce in some areas, as the low grade metamorphics, some of the crystalline rocks, and shales yield very little groundwater. Most of the groundwater is suitable for domestic use, and only in rare cases it is too saline for cattle.

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TABLE II

STRATIGRAPHIC TABLE - LISSADELL SHEET AREA

ERA	AGE	ROCK UNIT AND SYMBOL	THICKNESS IN FT	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	REMARKS
CAINOZOIC	QUATERNARY	Alluvium Qa		Alluvium	River flats	Universal	Includes alluvial black soils in places.
	UNDIFFERENTIATED	Sand Czs		Sand, soil cover, alluvium, travertine	Plateaux surfaces and valleys adjacent to ranges	Throughout Sheet area	
		Black soil Czb		Black soil	River valleys and plains	Mainly in Ord valley	Primarily residual on Cambrian rocks.
	UNDIFFERENTIATED	Pz	500-	Pebble and boulder conglomerate, coarse quartz sandstone	Flat, rounded, boulder strewn hills.	West of Mount Hensman	Age unknown; overlies Cockatoo Sandstone (?) unconformably in Gulf Sheet area.
				UNCONFORMITY			
	UPPER DEVONIAN	Cockatoo Sandstone Duc	200 exposed in this Sheet area.	Medium to coarse, friable, brown, pink and white clayey quartz sandstone.	Low isolated hills adjacent to fault.	West of King River.	Southern extremity of extensive outcrops in Cambridge Gulf Sheet area.
		Ragged Range Conglomerate Dr	900+	Friable red conglomerate, quartz sandstone, silty quartz sandstone.	Highly dissected cuesta with steep sided rounded hills.	The Ragged Range; Dunham Valley; and valley south of Carr Boyd Ranges.	Preliminary fossil study indicates Devonian age. Equivalent to Cockatoo Sandstone, and probably also Buckanan Sandstone in Dixon Range Sheet area.
PALAEOZOIC	MIDDLE CAMBRIAN NEGRI GROUP ★	Panton Formation €mp	560	Predominantly grey shale, siltstone and marl. Contains thin limestone	Poor outcrop, mainly black soil and alluvium cover with outcrop of limestone beds.	In the Rosewood and Argyle Basins, eastern part of Sheet area	No fossils recorded. Stratigraphic position indicates lower Middle Cambrian age.
		Linnekar Limestone €ml.	120	Medium-bedded grey limestone overlain by thin-bedded grey limestone and marl.	Very low strike ridges		Fossils include Redlichia forresti, Xystidura sp., Biconulites hardmani, Girvanella.
		Headley's Limestone €my	150	Massive grey limestone containing chert nodules, overlain by laminated and thin-bedded grey limestone.	Rubble on black soil plains, very low strike ridges.		Probable hiatus at base. Rests on weathered ferruginous basalt with structural conformity.
	LOWER CAMBRIAN	Undifferentiated €l(?)		Brown friable medium-grained quartz sandstone; interbedded flaggy calcarenite, calcareous sandstone and siltstone. Green-brown crystalline limestone and pelleted limestone.	Base of scarp under Ragged Range Conglomerate	Western flank of Ragged Range only.	Preliminary work on fossils indicates Lower Cambrian age.
		Antrim Plateau Basalt €la	3000	Tholeiitic basalt lavas, vesicular and amygduloidal in part. Rare andesite lavas and agglomerate. Chert capping.	Dissected plateaux and low cuestas; often covered by soil.	Extensive in eastern part of Sheet area, and around Dunham River.	Amygdules of quartz, amethyst and chalcedony. Marked unconformity at base. Copper present in places.
				UNCONFORMITY			
		Porphyry P		Fine-grained quartz feldspar porphyry		Small intrusives along Ivanhoe Fault in eastern Dunham Valley	Age unknown. Not sheared by fault.

ERA	AGE	ROCK UNIT AND SYMBOL	THICKNESS IN FT	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	REMARKS
PRECAMBRIAN	PROTEROZOIC	ALBERT EDWARD GROUP: Mt Forster Sandstone Pae	Less than 300 ft	Fine-grained purple and white quartz sandstone.		Southern margin of Sheet area adjacent to Halls Creek Fault.	Extensive outcrop in Dixon Range Sheet area. Rests with probable angular unconformity on Ord Group.
		ORD GROUP: Ranford Formation Pos	730	Laminated ferruginous and micaceous quartz sandstone and siltstone; red-brown fine-grained quartz greywacke; white to mauve claystone, siltstone, shale and fine-grained sandstone. "Zebra-stone"	Poor outcrop as strike ridges; plateau capping in vicinity Mt. Brooking.		Contains jelly-fish similar to Ediacara fauna of South Australia. Includes well-known 'zebra-stone' or 'ribbon-stone' at Argyle Downs.
		Jarrad Sandstone Member Poj	350	Massive red-brown ferruginous quartz greywacke and clayey quartz sandstone. Mud pellets common.	Prominent strike ridges with distinctive dark air photo pattern.	Along the line of the Halls Creek Fault, north of Argyle Downs and around Mount Brooking.	Commonly occurs at base of Ranford Formation.
		Moonlight Valley Tillite Bom.	160 (2-10 ft) (dolomite)	Tillite overlain by marker bed of laminated and thinly bedded pink and cream dolomite.	Poor outcrop in scarp below resistant Jarrad Sandstone Member and as low rounded hills.		Tillite generally preserved as residual boulders. Dolomite good marker bed. Strong unconformity at base.
		U N C O N F O R M I T Y					
		Mount Parker Sandstone Bsp.		Pink to purple micaceous quartz grit. Minor quartz pebble conglomerate. Thin red and Khaki-green shale interbeds.	Low rocky ridges and mesas.	Between Lincoln Yard and Bow River, east of Halls Creek Fault.	Unconformably overlies Red Rock Beds. Unconformably overlain by Ord Group.
		BASTION GROUP: Cockburn Sandstone Btc	Less than 200 preserved in Sheet area.	Fine to medium-grained massive quartz sandstone. Minor interbeds purple-brown and grey (micaceous) fine-grained sandstone and thin-bedded green-grey micaceous siltstone shale; silty and clayey sandstone.	Plateau cappings.		Top of the Proterozoic succession in west of Sheet area. Ripple marks and cross-bedding common.
		Wyndham Shale Btw.	2,300* (Measured in Cambridge Gulf Sheet area)	Fissile green, grey and black siltstone and shale with regular interbeds (2"-1') laminated green and grey fine sandstone. Minor black to grey sandstone with siderite nodules.	Crops out poorly beneath scarp of Cockburn Sandstone	Around the Salmond River in the west, the King River and western flanks of the Dunham valley in the north.	Mud cracks, load casts and wavy bedding common. Oval siderite nodules up to two feet diameter common.
		Mendena Formation Btm	360* (Measured in Cambridge Gulf Sheet area)	Blocky white medium-grained quartz sandstone alternates with interbedded flaggy green, grey and purple siltstone; laminated fine-grained micaceous sandstone and dolomitic sandstone, flaggy white fine-to medium-grained sandstone and blue-grey green, buff and pink dolomite and oolitic dolomite.	Low strike ridges of sandstone with areas of poor outcrop between.		Contains three consistent sandstone beds. Ripple marks, clay pellets and cross bedding. Copper traces in vicinity of Plants Homestead. Transitional between Wyndham Shale and underlying Pentecost Sandstone.
		Hart Dolerite Bdh		Dolerite, gabbro, diorite and granophyre	Prominent, rounded, rocky ridges and hills.	Western part of Sheet	Intrudes rocks as young as Carson Volcanics. Especially common in Speewah Group. Granophyre formed at base of Speewah Group.

ERA	AGE		ROCK UNIT AND SYMBOL	THICKNESS IN FT	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	REMARKS
PRECAMBRIAN	PROTEROZOIC	KIMBERLEY GROUP	Pentecost Sandstone Bkp	3,650*	Medium-grained, blocky to massive pink to pale purple brown quartz sandstone and flaggy fine-grained white quartz sandstone. Minor (micaceous) fine-grained sandstone, siltstone and shale. Glauconitic sandstone.	Resistant unit. Plateaux and cuestas with structural benches due to soft beds.	West of the Chamberlain River, around the King River and Dunham River Valleys.	Minor feldspar, ripple marks, cross-bedding, clay pellets common. Yellow and purple ferruginous spots characteristic. Three consistent siltstone members.
			Elgee Siltstone Bke	610*	Massive, reddish-purple to cherry-red siltstone with scattered interbeds of flaggy laminated fine purple brown sandstone. Minor grey-green shale. Dolomite and algal dolomite beds near base insouth.	Extremely poorly exposed in scarp beneath Pentecost Sandstone.	Along the Elgee Cliffs and in the Saw Ranges. Upper King River area.	Good stratigraphic marker. Outcrops scattered; generally covered by Pentecost Sandstone talus.
			Warton Sandstone Bkw	700*	Blocky to massive, medium to coarse-grained quartz sandstone and feldspathic sandstone. Minor grit and purple shale.	Resistant, prominent hogsbacks and cuestas.	Throughout the Durack	Ripple marks, slumping cross-bedding and clay pellets noted. Thins to 430 feet east of Saw Ranges.
			Carson Volcanics Bkc	750*	Massive, fine to medium grained altered basalt, vesicular basalt, blocky cross-bedded purple, brown and grey feldspathic quartz sandstone. Minor flaggy, white micaceous sandstone, green chert and chloritic siltstone.	Crops out in scarp beneath Warton Sandstone. Scattered outcrop.	and Saw Ranges area, in the western part of the Sheet area.	Excellent stratigraphic marker. Basalt generally altered, especially the feldspar. Unit measured as 870 feet thick east of Saw Ranges. Rapid lateral changes in proportions of basalt and sandstone.
			King Leopold Sandstone Bkl.	3,000+	Blocky to massive, white to purple quartz sandstone and feldspathic sandstone. Grit, pebble and cobble conglomerate.	Resistant unit. Rugged dissected plateaux, cuestas.		Possible unconformity at base.
		SPEEWAH GROUP	Luman Siltstone Bpl.	670*	Interbedded green and brown siltstone and brown and grey shale. Flaggy to fissile purple and green chloritic micaceous shale, siltstone and fine-grained sandstone. Fine-grained clayey and feldspathic quartz sandstone, micaceous and glauconitic in places.	Poor outcrop in scarp and valley, with central strike ridge of sandstone, beneath King Leopold Sandstone.	Along the base of the Durack Ranges and Saw Ranges in the western part of the Sheet area.	Overlain probably unconformably by King Leopold Sandstone. Top of unit obscured by talus. Upper member of unit markedly thinner in south west (erosion?); formation has three well defined members. Extensively intruded by Hart Dolerite. Flow-casts, slumping, ripple marks, mud cracks in basal member.
			Looningnin Arkose Bpo	980*	Blocky to massive, pale purple-brown to pink medium-grained feldspathic sandstone, arkose and clayey sandstone. Minor medium-grained white to pink quartz sandstone, purple, brown and grey micaceous siltstone, fine sandstone, and glauconitic arkose.	Resistant. Well defined cuestas of moderate elevation. Characteristic thin-banded pattern on air photographs defined by bedding.	Bedford Stock Route and Speewah areas in western part of Sheet area.	Excellent stratigraphic marker. Thickness about [illegible] feet in southwest. Cross-bedding, ripple marks common. Clay and shale pellets present. Extensively intruded by Hart Dolerite.
			Valentine Siltstone Bpv	340*	Thinly bedded, green, chloritic siltstone, siliceous siltstone and tuffaceous siltstone. Minor fine-to medium-grained pink quartz sandstone and feldspathic sandstone. Rhyolitic ashstone and tuff.	Soft unit outcrops poorly in scarps below Looningnin Arkose.		Extensively intruded by Hart Dolerite. Base of unit frequently incorporated into dolerite. Strongly unconformable on Liamma Beds and O'Donnell Formation.

U N C O N F O R M I T Y

ERA	AGE	ROCK UNIT AND SYMBOL	THICKNESS IN FT	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	REMARKS
PROTEROZOIC	PRECAMBRIAN	Liamma Beds Bi	780+* (reference area) Probably in excess of 2000 elsewhere.	Massive to blocky, fine to coarse-grained, white to brown quartz sandstone, in part feldspathic with thin interbeds of grit containing rounded tourmaline. Alternates with thinly interbedded green, grey and black chloritic siltstone and fine-grained quartz sandstone and quartz greywacke. Minor rhyolitic tuff and volcanic greywacke.	Sandstones form hog-backs; siltstones form valleys between.	O'Donnell Range and along eastern side of Bedford Stock Route adjacent to Greenvale Fault.	Completely eroded and covered by unconformable Speewah Group in places. Slumping, micro-cross bedding and graded bedding in fine sediments. Very thin bedding of quartz greywacke and highly chloritic green silts is characteristic.
		UNCONFORMITY					
		Dolerite Bdl		Dolerite, uralitized dolerite.	Scattered outcrop in residual black soil covered valleys.	O'Donnell Range area.	Occurs as sills and dykes. Lithologically different to and more deformed than Hart Dolerite. Contains minor copper.
		O'Donnell Formation Bn	2,400+* (Reference Section.)	Blocky, white to brown, fine-to coarse-grained quartz sandstone, feldspathic sandstone and friable silty sandstone with minor grit and pebble conglomerate. Alternates with interbedded (2"-8") red, green, khaki and black shales, siltstones, fine-grained sandstone and quartz greywacke. Minor tuff, ash and greywacke.Volcanic conglomerate and volcanic greywacke locally at base. Pyritic quartz greywacke and ferruginous quartz sandstone in places.	Resistant unit. Prominent cuestas and hogsbacks of sandstone. Soft units give narrow valleys.	From O'Donnell Ranges southwards along eastern side of Bedford Stock Route.	Strong angular unconformity with overlying Liamma Beds. Erosional contact with underlying White-water Volcanics. Base stratigraphically equivalent to Hensman Sandstone. Intruded by thick Dolerite sill (Bdl).
	'CARR BOYD SUCCESSION'	Red Rock Beds Bck		Quartz conglomerate, silicified quartz sandstone, red siltstone.	Fault bounded massive flat topped range.	Remnants along the Hall's Creek Fault, on south of Sheet area.	Stratigraphic equivalent of the Carr Boyd Succession.
		Stonewall Sandstone Bcs	Less than 1,000 ft exposed on this Sheet area.	Blocky to massive, red to white, friable, medium to coarse-grained quartz sandstone; subordinate red shale; purple ferruginous friable sandstone; feldspathic quartz sandstone. Minor quartz greywacke and pebble conglomerate.	Dissected plateau.	Carr Boyd Ranges at northern boundary of Sheet.	Highest unit of 'Carr Boyd Succession' exposed in Sheet area. Unconformably overlies Glenhill Formation.
		UNCONFORMITY					
		Glenhill Formation Bcg.	2,000 west to 5,000 east	Flaggy, red, grey and black, micaceous siltstone and shale; interbedded laminated green and white glauconitic fine-grained sandstone and green to purple siltstone. Massive to blocky white quartz sandstone. Minor inter-laminated red siltstone and white fine-grained sandstone; laminated mudstone.	Massive sandstones form cuestas and mesas. Fine-grained sediments crop out in valleys.	Carr Boyd Ranges, Glenhill Station and Carlton Gorge.	Overlies Lissadell Formation with angular unconformity in places. Consistent sandstone member at base. Unit dominantly silty in south: sudden facies change to dominantly sandy near Carlton Gorge.
		UNCONFORMITY					
		Lissadell Formation Bcl.	Up to 5,000	Blocky to massive,white,well sorted and clean, fine to medium grained, quartz sandstone and minor grits. Alternates with flaggy to fissile, purple, green and grey siliceous siltstone, micaceous quartz, siltstone and shale.	Sandstones in lower part form rugged sandstone ranges. Soft units produce dissected hill country, often with narrow gorges.	Carr Boyd Ranges.	Mainly sandstone in lower half grades to mainly siltstone in upper half of unit. Facies change present. Overlies Golden Gate Siltstone with either erosional disconformity or angular unconformity.
		UNCONFORMITY					

ERA	AGE	ROCK UNIT AND SYMBOL	THICKNESS IN FT	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	REMARKS
CAMBRIAN		Hybrid Diorite Bb		Granodiorite, diorite, gabbro.			
		'Muscovite Granite' Bb1		Muscovite granite, muscovite pegmatite.			Late stage dykes and small stocks.
		'Mixed Rock' Bb2		Intimate mixture of granite, gabbro, dolerite and metamorphic rocks.			Cannot be separated at scale of this map.
		'Biotite Granite' Bb3		Massive biotite-rich granite and hornblende granite. Epidotized hornblende granite.	Rounded rocky hills, tors and plateaux. Poor outcrop in part.	Southern central part of Sheet area; Revolver Creek; Golden Gate Country.	Intrudes Whitewater Volcanics.
		'Porphyritic Granite' Bb4		Porphyritic granite with phenocrysts of microcline; coarse, even-grained granite.			Biotite tends to form knots. Quartz rich groundmass. Intrudes Whitewater Volcanics.
		'Porphyry' Bb5		Quartz-feldspar porphyry.			Comagmatic with Whitewater Volcanics.
		'Basics' Bb6		Gabbro and dolerite; uralitized gabbro and dolerite; amphibolite.			Intrudes gneissic granite.
		'Gneissic Granite' Bbg		Gneissic granite and granodiorite; hypersthene granite.			Syntectonic orthogneiss.
PROTEROZOIC		Tickalara Metamorphics Bbt.		Schist, amphibolite, para-gneiss migmatite, granulite, calc-silicate metamorphic rocks.	Low rocky hills	South central part of Sheet area.	High grade metamorphic rocks, equivalent, at least in part, to Halls Creek Metamorphics.
		HALL'S CREEK METAMORPHICS Undifferentiated Bh.		Undifferentiated Quartz greywacke, slate, mica schist. Minor greenschist, tuff and conglomerate.	Low rubbly hills with recta-linear drainage.	Carr Boyd Ranges and Golden Gate Country.	
?		Nelson Shale Cmo	590 (Dixon Range Sheet area)	Grey, brown and blue shale. Gypsiferous and pyritic in part. Thin sandstone and limestone beds.	Very poor exposure in creeks.	Underlies black soil in Ord Valley. Argyle and Rosewood Basins.	Outcrops not shown on 1:250,000 scale. Lithologies from Dixon Range Sheet area.

* Thickness derived from section measured with Abney level and tape. Other thicknesses estimated from air photographs or maps.

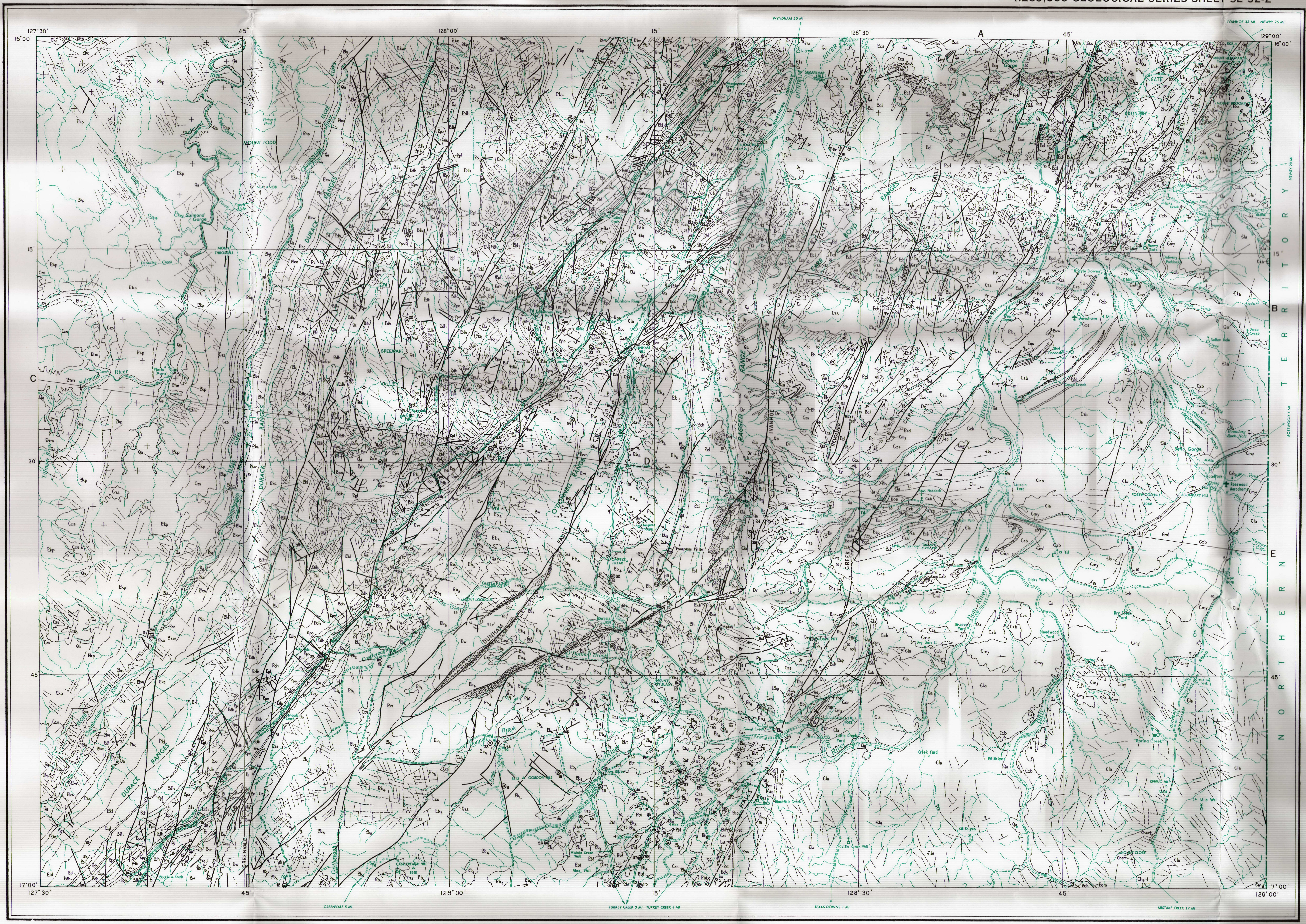
PRELIMINARY EDITION, 1964
SUBJECT TO AMENDMENT

AUSTRALIA 1:250,000

LISSADELL

WESTERN AUSTRALIA

1:250,000 GEOLOGICAL SERIES SHEET SE 52-2



Reference

- Geological boundary
- Anticline
- Syncline
- Plunge of minor anticline
- Plunge of minor syncline
- Plunge of fold axes
- Plunge of fold axes in cleavage
- Fault
- Shear zone

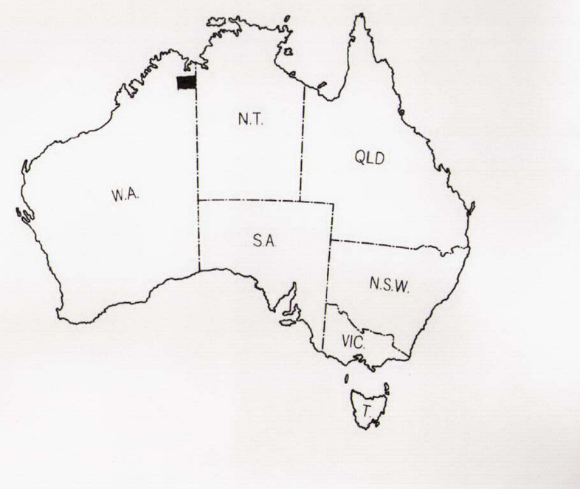
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

- Strike and dip of strata
- Vertical strata
- Horizontal strata
- Overturned strata
- Trend lines } air-photo interpretation
- Joint pattern } air-photo interpretation
- Strike and dip of foliation
- Vertical foliation
- Strike and dip of cleavage
- Vertical cleavage
- Apparent dip of cleavage on bedding plane
- Direction and plunge of lineation
- Inclined platy flow
- Horizontal platy flow
- Macrofossil locality
- Dyke; q-quartz, do-dolerite
- Age determination sample locality with reference number
- Prospect
- Minor mineral occurrence
- Unexploited mineral deposit
- Cu Copper
- Fe Iron
- Pb Lead
- Ag Silver
- U Uranium
- Bore with windpump
- Well with windpump
- Spring
- Tank
- Earth tank
- Road
- Vehicle track
- Telephone line
- "BOW RIVER" Homestead
- Landing ground
- Trigonometrical station
- Yd Yard

Reference

Era	Period	Unit	Symbol	Description
CAINOZOIC	QUATERNARY		Qa	Alluvium
	UNDIFFERENTIATED		Czs	Sand, soil cover, alluvium, travertine
			Czb	Black soil
PALAEOZOIC	UNDIFFERENTIATED		Pz	Conglomerate, sandstone
	UPPER DEVONIAN	Cockatoo Sandstone	Duc	Friable brown clayey quartz sandstone
	DEVONIAN	Ragged Range Conglomerate	Dr	Friable red quartz sandstone, silty quartz sandstone, conglomerate
	MIDDLE CAMBRIAN	Negri Group: Panton Formation	Ꞓmp	Shale, siltstone, limestone
		Negri Group: Linnekar Limestone	Ꞓml	Limestone, marl
		Negri Group: Nelson Shale	Ꞓmo	Grey, brown and blue shale, gypsiferous and pyritic in part. Minor limestone and sandstone. (Sections only)
		Negri Group: Headleys Limestone	Ꞓmy	Limestone
	LOWER(?) CAMBRIAN	Undifferentiated	Ꞓl	Brown friable sandstone; flaggy calcareous sandstone and siltstone, green-brown crystalline limestone, pelletal limestone
		Antrim Plateau Volcanics	Ꞓla	Basalt, vesicular basalt, agglomerate, red-brown sandstone, chert
			P	Fine-grained quartz feldspar porphyry
PRECAMBRIAN	PROTEROZOIC	Albert Edward Group: Mount Forster Sandstone	Ꞓao	Fine-grained purple and white quartz sandstone
		Ord Group: Ranford Formation	Ꞓos	Laminated ferruginous and micaceous quartz sandstone and siltstone; fine-grained quartz greywacke; claystone, shale and fine grained sandstone; "zebra-stone"
		Ord Group: Jarrad Sandstone Member	Ꞓoj	Massive red-brown ferruginous quartz greywacke
		Ord Group: Moonlight Valley Tillite	Ꞓom	Tillite, pink laminated dolomite
		Mount Parker Sandstone	Ꞓsp	Quartz sandstone, quartz conglomerate
		Bastion Group: Cockburn Sandstone	Ꞓtc	Massive quartz sandstone, micaceous siltstone, green shale
		Bastion Group: Wyndham Shale	Ꞓtw	Fissile green and grey shale; laminated fine-grained sandstone interbeds, siderite
		Bastion Group: Mendena Formation	Ꞓtm	Quartz sandstone alternating with green and purple siltstone, fine-grained sandstone, dolomite
		Hart Dolerite	+ +	Granophyre
			Ꞓdh	Massive gabbro, dolerite, diorite, granophyre
		Kimberley Group: Pentecost Sandstone	Ꞓkp	Blocky medium-grained quartz sandstone, purple siltstone, fine-grained, micaceous siltstone, glauconitic sandstone
		Kimberley Group: Elgee Siltstone	Ꞓke	Massive red siltstone, fine-grained sandstone, shale, micaceous shale, dolomite
		Kimberley Group: Warton Sandstone	Ꞓkw	Blocky quartz sandstone and feldspathic sandstone, grit, purple shale
		Kimberley Group: Carson Volcanics	Ꞓkc	Massive altered basalt, blocky feldspathic sandstone, micaceous feldspathic sandstone, chloritic siltstone, green chert
		Kimberley Group: King Leopold Sandstone	Ꞓkl	Massive quartz sandstone, feldspathic sandstone, pebbly sandstone, grit, conglomerate
		Speewah Group: Luman Siltstone	Ꞓpl	Brown siltstone and shale; purple chloritic micaceous shale and fine-grained sandstone; friable feldspathic and clayey sandstone; quartz sandstone
		Speewah Group: Looningnin Arkose	Ꞓpo	Massive pink feldspathic sandstone, arkose, quartz sandstone, purple siltstone, micaceous siltstone, green micaceous feldspathic siltstone
		Speewah Group: Valentine Siltstone	Ꞓpv	Thinly bedded green chloritic siltstone and siliceous siltstone, quartz sandstone, feldspathic sandstone, quartz greywacke, rhyolitic ashstone and tuff
		Liamma Beds	Ꞓi	Buff quartz sandstone, thinly bedded green and grey siltstone, shale, fine-grained quartz greywacke, granular sandstone
			Ꞓdl	Dolerite, uralitized dolerite
		O'Donnell Formation	Ꞓn	Buff quartz sandstone, feldspathic sandstone, granular sandstone, thinly bedded grey shale, siltstone, fine-grained sandstone, quartz greywacke, pyritic sandstone, conglomerate
		Red Rock Beds	Ꞓck	Quartz conglomerate, silicified quartz sandstone, red siltstone
		Stonewall Sandstone	Ꞓcs	Friable quartz sandstone
		Glenhill Formation	Ꞓcg	Black and red-brown shale, laminated fine-grained galuconitic sandstone, green siltstone, massive quartz sandstone, laminated sandstone
			(stippled)	Massive white quartz sandstone
		Lissadell Formation	Ꞓcl	Massive quartz sandstone, purple, green and grey siltstone, fine-grained sandstone, micaceous shale, tuff(?), pyritic sandstone
		Golden Gate Siltstone	Ꞓcd	Black pyritic shale, micaceous siltstone, fine-grained sandstone, quartz greywacke, blue and white sandstone, red mudstone, green shale, tuff(?), sandy hematite
		Hensman Sandstone	Ꞓch	Massive silicified white quartz sandstone
		Revolver Creek Formation	Ꞓr	Amygdaloidal basalt, arkose, quartz sandstone, flaggy purple micaceous siltstone, massive chocolate-brown siltstone, slate
		Whitewater Volcanics	Ꞓw	Acid lavas and pyroclastics, agglomerate, intrusive quartz-feldspar porphyry
		Mount Remarkable Conglomerate Member	Ꞓwr	Volcanic conglomerate and greywacke, feldspathic sandstone and siltstone, green chert, chert fragment sandstone
		Lamboo Complex: "Hybrid Diorite"	Ꞓb	Granodiorite, diorite, gabbro
		Lamboo Complex: "Muscovite Granite"	$Ꞓb_1$	Muscovite granite and pegmatite, epidotized granite
		Lamboo Complex: "Mixed Rock"	$Ꞓb_2$	Intimate mixture of granite, gabbro and metamorphic rocks
		Lamboo Complex: "Biotite Granite"	$Ꞓb_3$	Biotite granite, hornblende granite, granodiorite
		Lamboo Complex: "Porphyritic Granite"	$Ꞓb_4$	Porphyritic granite, coarse-grained granite
		Lamboo Complex: "Porphyry"	$Ꞓb_5$	Quartz-feldspar porphyry, hornblende granodiorite
		Lamboo Complex: "Basics"	$Ꞓb_6$	Gabbro, dolerite, uralitised dolerite and gabbro, amphibolite
		Lamboo Complex: "Gneiss and Gneissic Granite"	$Ꞓb_8$	Gneissic granite and granodiorite, hypersthene granite
		Lamboo Complex: Tickalara Metamorphics	Ꞓbt	Schist, amphibolite, paragneiss, migmatite, granulite, calc-silicate metamorphic rocks
		Halls Creek Group Undifferentiated	Ꞓh	Quartz greywacke, slate, mica schist, greenschist, tuff, conglomerate

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Western Australia. Topographic base compiled by the Royal Australian Survey Corps. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:50,000 scale. Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

MONTAGUE SOUND SD 51-12	DRYSDALE SD 52-9	MEDUSA BANKS SD 52-10	PORT KEATS SD 52-11	FERGUSSON RIVER SD 52-12
PRINCE REGENT SD 51-16	ASHTON SD 52-13	CAMBRIDGE GULF SD 52-14	AUVERGNE SD 52-15	DELAMERE SD 52-16
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NO ANNUAL CHANGE

Scale 1 : 250,000

5 0 5 10 15 MILES

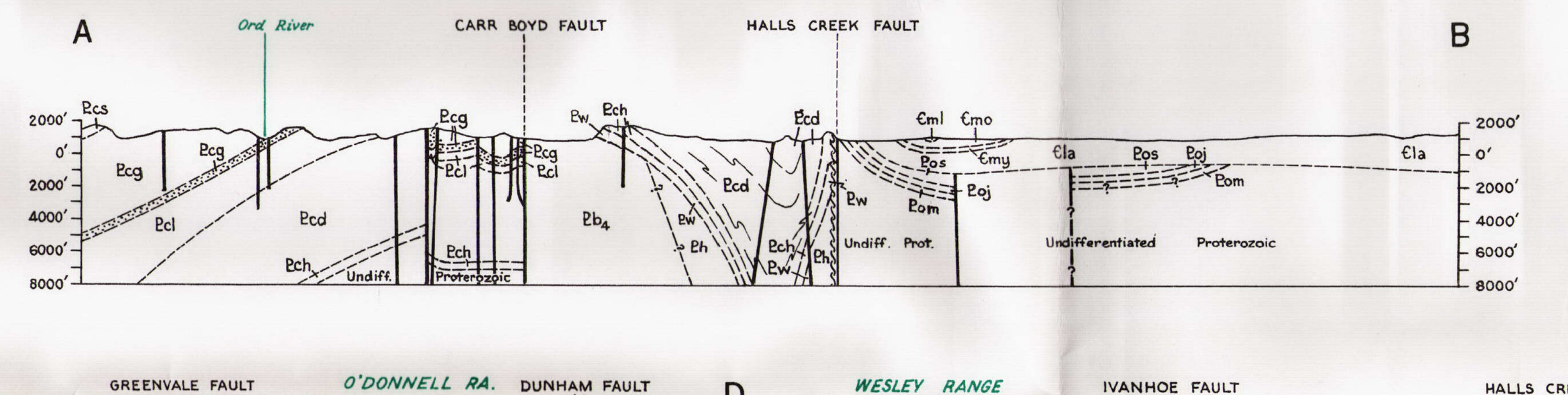
5 0 5 10 15 20 25 KILOMETRES

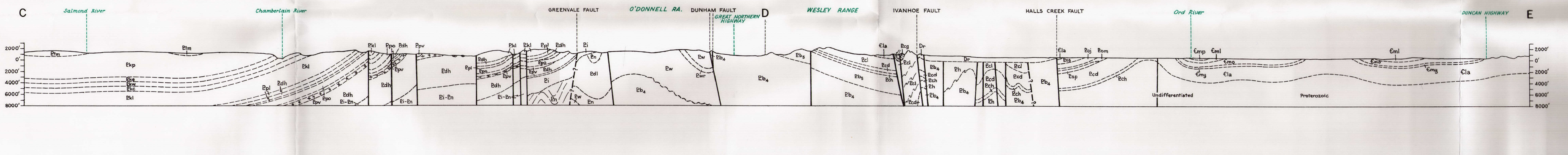
Sections

Folding diagrammatic

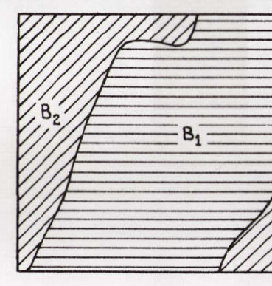
Scale : $\frac{V}{H} = 2$

(Cainozoic units omitted from sections)





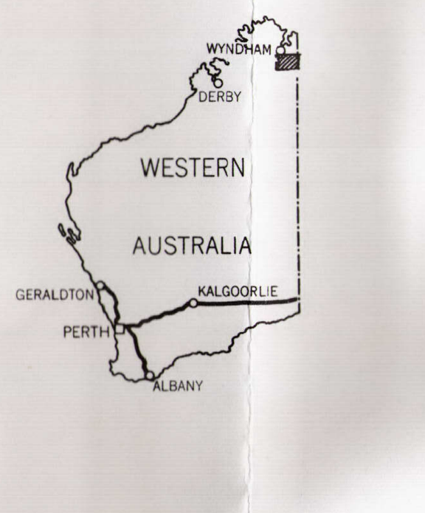
GEOLOGICAL RELIABILITY DIAGRAM



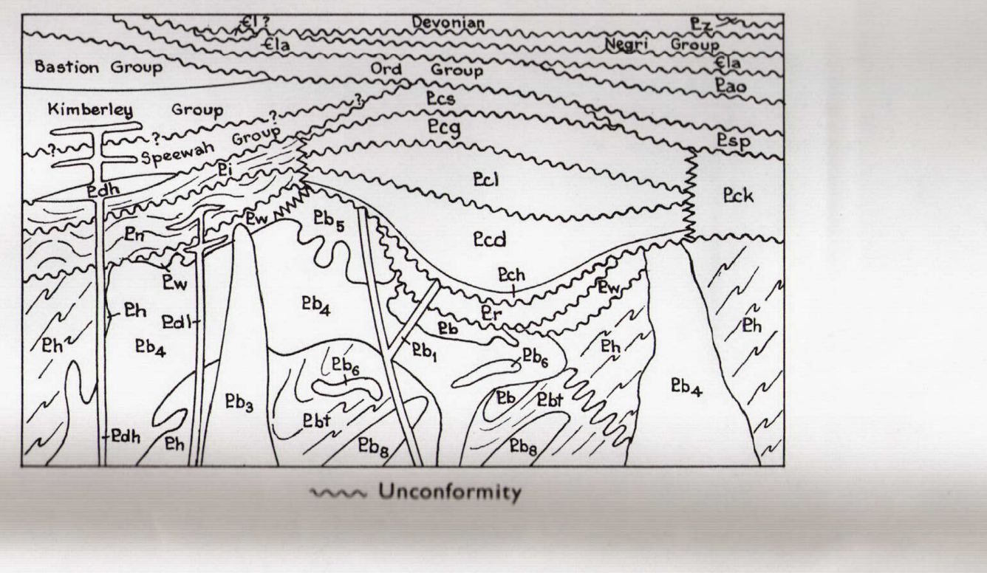
B_1 Detailed reconnaissance—numerous ground traverses and air-photo interpretation

B_2 Reconnaissance—scattered ground and helicopter traverses, and air-photo interpretation

Geology, 1963, by: K.A.Plumb, D.Dunnet, D.B.Dow, V.M.Bofinger, J.H.Latter. (B.M.R.)
J.R.Passmore, I.V.Gemuts. (G.S.W.A.)
Compiled, 1964, by: K.A.Plumb, D.Dunnet, J.L.McGovern
Drawn by: J.L.McGovern, F.J.Roberts



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity

LISSADELL

SHEET SE 52-2