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Notes on the Geology of the Medusa Banks 1 : 250,000 Geological Sheet SD52 - 10

by

K.A. Plumb and W.J. Perry

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SUMMARY

Over half of Medusa Banks Sheet area is occupied by sea; two land areas are separated by Cambridge Gulf. The submergent coastline shows slight recent emergence. The western coastline is tectonically influenced.

The Kimberley Plateau, west of Cambridge Gulf, consists of rugged structural benches, plateaux, and gently dipping cuestas. It is uninhabited and access is difficult. The Cambridge Gulf Lowlands, east of Cambridge Gulf, are sand covered, low-lying plains bordered on the seaward edge by tidal salt flats and sand dunes. Vehicle access is possible from the south.

About 2,500 feet of arenties, lutites, and minor volcanics of the Carpentarian Kimberley Group are exposed in the Kimberley Plateau; they were deposited in the Kimberley Basin. Most of the Phanerozoic Bonaparte Gulf Basin is covered by sea; the landward part of the basin contains a thick sequence of poorly exposed arenites, lutites, and carbonates of Upper Devonian, Lower and Upper Carboniferous, and Lower Permian age. Cambrian and Ordovician probably occur in the subsurface. A thick post-Permian section is expected off-shore.

Deformation is mild. The Kimberley Basin is dominated by a zone of north-northwest trending faults in the east with uniformly south-southwest dipping strata in the west. The Bonaparte Gulf Basin beds dip uniformly shallowly to the north-east and are cut by numerous northwest trending grabens and horsts; some associated small anticlines occur. Much of the faulting may be quite young.

No mineral deposits are known; prospects are poor. Petroleum prospects in the Bonaparte Gulf Basin are considered good; exploration is in progress.

INTRODUCTION

The Medusa Banks 1:250,000 Sheet area is bounded by latitudes 14°S and 15°S and longitudes 127°30'E and 129°E, and lies within the northern part of the East Kimberley Division of north Western Australia.

Much of the area is occupied by the seas of the Joseph Bonaparte and Cambridge Gulfs. The area is uninhabited and access to the area west of Cambridge Gulf is poor, being restricted to the use of helicopters or small boats. Land access by vehicle from the south or west would be extremely difficult due to the many sandstone ranges and high scarps to be traversed. The area east of Cambridge Gulf is accessible by vehicle track, suitable for 4-wheel drive vehicles, from Carlton Hill.

The climate is monsoonal with a short wet summer season and a long dry winter. The area lies between the 30" and 40" isohyets with most of the rain falling in January and February. Mean temperatures range from 85° in summer to 75° in winter. Average maxima and minima are 95° and 80° in January and 85° and 65° in July. Occasional frosts are possible in the extreme inland parts in the south-west corner.

Maps and air photographs available during 1963-65 were: air photographs at a scale of 1:50,000 flown by the Royal Australian Air Force in 1948; a photo-mosaic at a scale of four miles to one inch compiled by the Division of National Mapping, Department of National Development; and a topographic map at 1:250,000 scale with 250 feet contours produced by the Royal Australian Survey Corps.

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

Previous Investigations

Tasman visited the extreme northern coastline in 1644 (Sharp, 1963) but it was not until 1819 that King (1826) discovered Cambridge Gulf and charted the coastline of Medusa Banks Sheet area, naming many of the features en route.

Gibb-Maitland (1902) traversed the Kimberley Plateau to the south of the Sheet area and reported briefly on its nature. Matheson and Teichert (1946) briefly studied the Bonaparte Gulf Basin, followed by Traves (1955) who reconnoitred the regional geology of the East Kimberleys and the adjoining Victoria River area in the Northern Territory. Traves' most valuable contributions were his stratigraphic subdivision and studies in the Bonaparte Gulf Basin, which provided the framework for subsequent work.

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 has provided the framework for the current mapping of the Precambrian.

Drummond (1963) and Bigg-Wither (1963) compiled the geology and geophysics of the Bonaparte Gulf Basin up to the end of 1962.

These notes and the accompanying geological map are based on the work of two survey parties operating concurrently during the period 1963-66. The first was a joint survey by the Bureau of Mineral Resources and the Geological Survey of Western Australia as part of a programme, commenced in 1962, to map all the Precambrian rocks of the Kimberley Division at 1:250,000 scale. The second was part of a survey by the Bureau of Mineral Resources, commenced in 1963, to assess the oil prospects of the Bonaparte Gulf Basin. This party worked in close liaison with Alliance Oil Development and Anacapa Corporation (Brady et al., 1966) and Australian Aquitaine Petroleum (Guillaume, 1966).

PHYSIOGRAPHY

Drainage

The mainland in the western part of the Sheet area shows two distinct sets of drainage. The first is the Berkeley-De Lancourt River System. This is a superimposed system, only slightly modified by the structure of the rocks it traverses. Minor tributaries, and minor streams draining directly into the sea, are subsequent streams largely controlled by joints in the flat-lying bed-rock.

The second set of drainage is found to the east of the De Lancourt River. Here major streams, such as the Lynne River, are subsequent streams controlled by north-west trending fault scarps bounding fault blocks of resistant Warton Sandstone. Minor streams are controlled by jointing producing a rectilinear pattern.

The Berkeley River is tidal for some 14 miles, passing upstream into strings of large pools, linked by permanently running water in the lower reaches and some tributaries. Other major streams contain only disconnected pools in the 'dry' season.

The low-lying country east of Cambridge Gulf has no major streams. Small watercourses drain from the inland sand plain into the tidal flats and small tidal creeks, lined with mangroves, infringe into the seaward side of the flats.

The superimposed nature of the Berkeley-De Lancourt River System suggests an ancient land surface sloping gently northwards. This surface is also indicated by the higher peaks in the present surface. In the south the elevations range up to 1250 feet, decreasing gradually to 750 feet in the north. Laterite in the north is a remnant of the Tertiary land surface preserved in many places on the Kimberley Plateau. The present surface slopes seawards near the coast.

Uplift has produced dissection of the surface and created the present landform. The lower tidal reaches of the Berkeley River are entrenched in a gorge 250 feet deep to sea level; this was probably deeper before drowning by the sea.

Coastal Features

Among the most striking physiographic features in the Medusa Banks Sheet area are those associated with the coastline. Two distinctly different coastlines are developed, one east and one west of Cambridge Gulf. The coast is essentially a coastline of submergence but slight recent emergence can be recognised.

The coast west and north-west of Cambridge Gulf is typical of a submerged coastline with drowned, very narrow, youthful river valleys and bold, steep, rocky headlands. Small coves have sandy beaches; near Cape St Lambert sand dunes rise up to about 350 feet above sea level. From Buckle Head north the seaward sides of rocky headlands have small fringing coral reefs; further south the water is too dirty due to mud introduced by the Ord River.

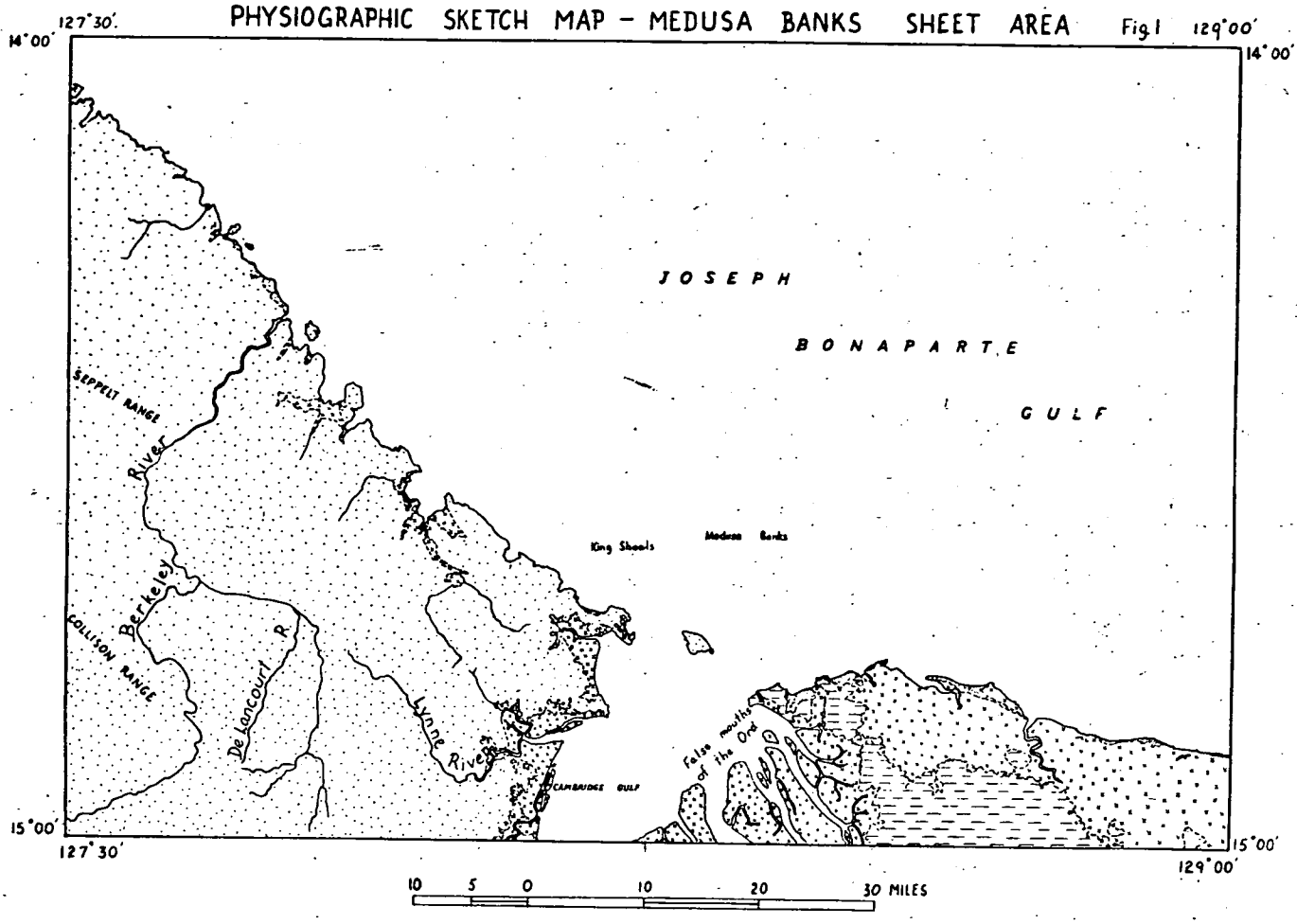
The tidal reaches of streams are bordered by depositional flats of silt and mud, the Tidal Flats. The outer edges of the flats, subject to daily tidal inundation, have mangroves. The major part of the flats are inundated by only the largest tides or by seasonal flooding and are covered by a salt crust.

Many bays on the seaward coast have small emerged lagoons represented by tidal flats with emerged off-shore bars on the seaward edge.

Three miles south-south-west of Buckle Head sea-shells were found embedded inblack soil on a sandstone ledge in Carson Volcanics 200 feet above present sea level. It has not been positively ascertained whether the deposit represents an old shore-line or an aboriginal midden. The age of the shells are unknown. Recognition of wave-cut terraces in the area is hampered by the strong structural control of physiography in the area.

PHYSIOGRAPHIC SKETCH MAP – MEDUSA BANKS SHEET AREA

Fig 1



KIMBERLEY PLATEAU Karunjie Plateau

CAMBRIDGE GULF LOWLANDS Tidal Flats
Sand dunes

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A striking feature is the relative straightness of the coast northwest of Cape Dussejour. It parallels the prominent northwest on-shore fault pattern suggesting some tectonic influence, either inherited or relatively young, in the shaping of the coast. The alignment of the King Shoals parallel to this trend suggests submarine fault scarps of unknown age.

A marked contrast is provided by the low-lying coast-line east of Cambridge Gulf. Practically all of the coast here is bordered by Tidal Flats, with typical salt crust and subject to seasonal or king-tide inundation. Adjoining Cambridge Gulf they are depositional plains of the Ord River and lines with mangroves in the zone of daily tidal inundation. Along the seaward coast the flats are lined with barrier sand ridges, breached in places by mangrove-lined tidal creeks. The present level of the tidal flats is best explained by assuming a small, recent, eustatic fall in sea level so that tidal flats are emerged lagoonal or estuarine deposits and the barrier sand ridges emerged off-shore bars.

Physiographic Divisions

In the area of Proterozoic rocks there is a striking relationship between topography and rock types. This greatly facilitates the use of air photographs in geological mapping.

The Sheet area contains two of the seven physiographic provinces defined by Plumb (in prep.). These are the Kimberley Plateau and Cambridge Gulf Lowlands. Their distribution is shown in Figure 1. Within the Kimberley Plateau Plumb has recognised several subprovinces but only one, the Karunjie Plateau, occurs in the Medusa Banks Sheet area.

Kimberley Plateau: The Kimberley Plateau is a broad dissected plateau which extends into the western part of the Sheet area. It is the most extensive province in the Kimberley Region. The bedrock is gently dipping Kimberley Group sediments. Elevations in Medusa Banks range up to 1250 feet in the south and the surface slopes northwards to a maximum elevation of 750 feet in the north.

The Karunjie Plateau has two distinctly different topographic zones in the Medusa Banks Sheet area. The first occurs north and west of the De Lancourt River. Here structural benches, plateaux and gently dipping cuestas, typical of the Karunjie Plateau elsewhere, are bounded by scarps up to 400 feet high. Benches are controlled by resistant sandstone beds from which overlying softer beds are being stripped by scarp retreat. Where widespread Warton Sandstone crops out broad sandstone plateaux, with little vegetation and numerous joints, are developed. The plateau surface follows, almost perfectly, the stratigraphic top of the Warton Sandstone over vast areas.

The second zone occurs east of the De Lancourt River. Here the topography is controlled by a system of north-west trending faults cutting across the strike of broad shallowly south-east dipping cuestas. Where the bed-rock is Warton Sandstone the fault blocks stand up as sandstone plateaux bounded by fault scarps up to 500 feet high. The plateaux passes southwards into a shallow cuesta as the sandstone dips beneath the overlying units. Where the bedrock is Elgee Siltstone and Pentecost Sandstone the local topography consists of the structural benches and cuestas typical of the Karunjie Plateau.

Cambridge Gulf Lowlands: The area east of Cambridge Gulf consists of low-lying plains, the Cambridge Gulf Lowlands. Elevations are mainly between sea-level and 50 feet but erosional remnants of the Palaeozoic bedrock produce local relief of up to 250 feet. Most of the plains are covered by widespread sand with alluvium along watercourses.

The Tidal Flats are the low lying areas surrounding estuaries and the coast line which are subject to tidal and seasonal inundation. They have been described under coastal features.

The Sand Dunes include two types of deposit, already described under coastal features. The first are beaches in small coves along the Kimberley Plateau. The second are the barrier ridges on the seaward side of the Tidal Flats which may in fact be emerged offshore bars.

STRATIGRAPHY

The rocks of the Sheet area are exposed in two distinct basins, the Carpentarian rocks in the Kimberley Basin and the Palaeozoic in the Bonaparte Gulf Basin. The Kimberley Basin succession is poorly exposed east of Cambridge Gulf and extends beneath the waters of the Joseph Bonaparte Gulf.

The subdivision of the Precambrian is by no means uniform. In these notes and the accompanying map the subdivision adopted by the Bureau of Mineral Resources (Dunn et al., 1966) is used. The Geological Survey of Western Australia (1965, 1967) uses a different system. They classify the rocks shown here as Carpentarian as belonging to the Lower Proterozoic.

The stratigraphy is summarized in Table 1.

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TABLE 1 : STRATIGRAPHIC TABLE - MEDUSA BANKS SHEET AREA

ERA	AGE	ROCK UNIT AND SYMBOL	THICKNESS (in feet)	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	PALAEONTOLOGY	REMARKS
CAINOZOIC	QUATERNARY	Qa	-	Alluvium	River flats	Universal	-	-
		Qa	-	Coastal silt and evaporite deposits	Low-lying tidal flats.	Around the estuaries of most streams. Widespread to east of Cambridge Gulf.	-	Subject to tidal and seasonal inundation. Mangrove mud flats on seaward side.
		Qs	-	Beach sand, sand dunes	Sand dunes, locally up to 350 feet high.	Scattered along coast	-	Occur on both seaward side of tidal flats and at heads of bays
	UNDIFFERENTIATED.	Czs	-	Sand, residual soil cover, alluvium.	Plateau surfaces and low-lying areas.	Throughout Sheet area	-	Includes widespread sand in Cambridge Gulf Lowlands. Generally older than Qa.
		Cz?	-	Lateritic soil and rubble.	Plateau capping	Northwest corner of Sheet area.	-	Derived from breakdown of laterite.
	TERTIARY	Tp	-	Laterite	Plateau capping	Northwest corner of Sheet area.	-	Outcropping laterite. Developed over Warton Sandstone.
	?PERMIAN	Keep Inlet Beds Pk	-	Calcareous sandstone, boulder conglomerate.	Low coastal outcrops	Southeast corner of Sheet area	-	Boulders of plutonic and metamorphic rocks and fossiliferous Cambrian limestone - ? glacials.
	? UNCONFORMITY							
	UPPER CARBONIFEROUS	Border Creek Formation Cub	365+ *	Quartz sandstone, conglomerate, siltstone.	Low outcrops amongst soil cover	Southeast of Knob Peak in southeast part of Sheet area.	Logs	Lies with regional unconformity above older rocks
	UNCONFORMITY							
	LOWER CARBONIFEROUS	Tanmurra Formation Clt	1000+	Limestone and sandstone	Subsurface only	East of Utting Gap in southeast part of Sheet area.	Brachiopods, ostracods, foraminifers	Known only from boreholes in adjacent Sheet area.
		Point Spring Sandstone Clp	900+	Quartz sandstone, minor conglomerate	Scarp and slope of low hills.	Utting Gap	Brachiopods, pelecypods, ostracods, worm-tubes, plants.	Conformably overlies Burvill Beds.
		Burvill Beds Clr	280+ *	Sandstone, shale, limestone	Poor outcrop at foot of low scarp	Utting Gap	Pelecypods, brachiopods, gastropods, trace fish	Unconformably overlies Utting Calcarenite.
		UNCONFORMITY						
		Utting Calcarenite Clu	400+	Skeletal sandy calcarenite	Low outcrops amongst soil	Utting Gap	Brachiopods, corals, trilobites, foraminifers, ostracods, conodonts, sharks.	Probably faulted against Ningbing Limestone.
PALAEOZOIC	UPPER DEVONIAN TO LOWER CARBONIFEROUS	Bonaparte Beds D-Cb	9000+ *	Dark shale, siltstone, sandstone	Subsurface only	East of Utting Gap in southeast part of Sheet area.	Brachiopods, pelecypods, ostracods, foraminifers, conodonts	Known only from boreholes in adjacent Sheet area. Facies of Upper Devonian-Lower Carboniferous succession further west.
	UPPER DEVONIAN	Ningbing Limestone Dun	1085+	Limestones of reef complex	Low rugged hills and pediments	Near Knob Peak and Utting Gap.	Calcareous algae, stromatoporoids, corals, brachiopods, ostracods, conodonts, fish, Leptophloeum	Probably faulted against Utting Calcarenite. Conformably overlies Cockatoo Formation.

* Thickness measured in Cambridge Gulf Sheet area. Other thicknesses estimated in this Sheet area.

ERA	AGE	ROCK UNIT AND SYMBOL	THICKNESS (in feet)	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	PALAEONTOLOGY	REMARKS
PALAEOZOIC	UPPER DEVONIAN	Cockatoo Formation Duc	5000	Quartz sandstone, minor limestone, conglomerate.	Hills, coastal outcrops, low outcrops amongst soil cover.	Between Cape Domett and Shakespeare Hill.	Gastropods, pelecypods.	Members cannot be determined; probably includes Kellys Knob, Westwood, and Cecil Members.
		Westwood Member Duw	2000	Quartz sandstone, limestone.	Low soil covered outcrops at the edge of tidal flats.	West of Knob Peak	Algae, brachiopods, conodonts, corals, crinoid ossicles, gastropods, stromatoporoids, ostracods, pelecypods, plants.	Abundant fossils. Conformably overlies Kellys Knob Member. Conformably overlain by Cecil Sandstone Member.
		Kellys Knob Sandstone Member Duk	1800*	Quartz sandstone	Low soil-covered outcrops.	West of Knob Peak.	Leptophloeum	Basal Member of Formation
		UNCONFORMITY						
PROTEROZOIC	CARPENTARIAN	Kimberley Group — Pentecost Sandstone Pkp	2000+	-	-	-	-	Three unnamed members recognized. Ripple-marks, cross-bedding, clay pellets common throughout. Top not preserved in Sheet area.
		Upper Ckpu	200+	Blocky to flaggy, subfriable, medium grained quartz sandstone, rare coarse grained sandstone at base.	Plateaux cappings above scarp forming bed at top of middle member,	Along southern margin of Sheet area, west of Cambridge Gulf and on Lacrosse Island.	-	Base defined by poorly out-cropping friable coarse-grained sandstone on dip slope above scarp of resistant sandstone at top of middle member, Only lower part of member preserved.
		Middle Ckpm	Ca 1000	Blocky to flaggy, pink to purple-brown, sub-friable or silicified, fine-medium-grained feldspathic sandstone, arkose and argillaceous sandstone; minor medium grained quartz sandstone. Interbedded fine-grained arkose flaggy-and purple-grey feldspathic-ferruginous-glauconitic sandstone and fissile micaceous shale near base.	Cuestas and plateaux with structural benches due to soft beds.	Seppelt Range; along southern margin of Sheet area west of Cambridge Gulf; western shores of Cambridge Gulf, Lacrosse Island.	-	Base defined by soft bed of glauconitic sandstone. Top marked by resistant scarp forming sandstone. Characterised by well bedded photo-pattern, relatively abundant feldspar and yellow limonite spots. Cross-bedding and clay pellets ubiquitous.
		Lower Pkpl	350 (Mount McMillan) and 500 (Slab Hill) to Ca 1000 (west of Sheet area).	Blocky, pink to white, medium-grained, silicified quartz sandstone and feldspathic sandstone. Interbedded white, fine-grained, fissile micaceous sandstone with abundant shale pellets and shale pellet conglomerate in soft marker bed in middle of unit.	Prominent cuestas above Elgee Siltstone.	Seppelt, Campbell and Collison Ranges and extending eastwards to Lyne River; north of Lyne River to Obstruction Hill.	-	Characterised by smooth, white photo-pattern. Cross-beds, shale pellets ubiquitous. Basal beds grade into Elgee Siltstone.
		Elgee Siltstone Pke	450 (Slab Hill) to 270 (Mt Casuarina)	Massive red-brown to cherry-red siltstone with thin flaggy green to red-brown, fine-grained micaceous and ferruginous sandstone interbeds. Alternating siltstone and blocky, fine-grained, ferruginous and feldspathic sandstone near top and base.	Very poorly exposed in scarps beneath Pentecost Sandstone.	Scattered throughout southwestern part of Sheet area.	-	Excellent stratigraphic marker. Outcrops scattered; generally covered by Pentecost Sandstone talus. Upper beds grade into Pentecost Sandstone.

ERA	AGE		ROCK UNIT AND SYMBOL	THICKNESS (in feet)	LITHOLOGY	TOPOGRAPHY	DISTRIBUTION	PALAEONTOLOGY	REMARKS
PROTEROZOIC	CARPENTARIAN	Kimberley Group	Warton Sandstone Pkw	ca 350	Massive to blocky, medium-grained, white to red-brown, quartz sandstone and argillaceous sandstone.	Resistant unit. Forms prominent cuestas and structural benches.	Throughout area west of Joseph Bonaparte and Cambridge Gulfs.	-	Cross-beds, clay pellets and oscillation ripple-marks observed. About 1400 feet thick in Drysdale-Londonderry Sheet area.
			Carson Volcanics Pkc	300 to 550	Massive, ophitic and amygdaloidal, quartz basalt; massive, thinly bedded, feldspathic or argillaceous quartz sandstone.	Crops out in scarp beneath Warton Sandstone. Scattered outcrop.	-	-	Irregular variations in thickness. Up to 1900 feet thick in Drysdale-Londonderry Sheet area. Three distinct members, a bed of sandstone about 50 feet thick with basalt above and below.
			King Leopold Sandstone Pkl	200+	Massive, medium to coarse-grained, argillaceous quartz sandstone. Scattered ½" quartz pebbles.	Resistant unit. Forms prominent structural bench.	-	-	Up to 4000 feet thick in Cambridge Gulf Sheet area. Cross-bedded. Oldest unit exposed in Sheet area.

PROTEROZOIC

CARPENTARIAN

Kimberley Basin Succession

Only about 2,500 feet of arenites, lutites, and minor volcanics are exposed in the Kimberley Basin in the Medusa Banks Sheet area; in Cambridge Gulf (Plumb and Veevers, in press) a fuller section totals over 17,000 feet. The Basin extends south-westwards to cover the greater part of the Kimberley Division.

The subdivisions of the rocks in the Kimberley Basin succession by Guppy et al. (1958) and by Harms (1959) have been redefined as a result of the present survey as shown in the following table. Formal definitions will appear in the more comprehensive study by Plumb (in prep.).

Redefined Kimberley Basin Units

Guppy et al. 1958	Harms 1959	Present Survey
Warton Beds	Pentecost Sandstone	Pentecost Sandstone
	Elgee Shale	Elgee Siltstone
	Warton Sandstone	Warton Sandstone
Mornington Volcanics	Mornington Volcanics	Carson Volcanics
King Leopold Beds	King Leopold Sandstone	King Leopold Sandstone

The age assigned to the rocks is based on isotopic dating (Bofinger, 1967) of rocks from elsewhere in the basin.

In the Kimberley Basin to the south the Kimberley Group is conformably overlain by the Bastion Group (not preserved in Medusa Banks) and conformably overlies the Speewah Group (not exposed in Medusa Banks) (Dow et al., 1964; Gellatly et al., 1965; Gellatly and Derrick, in press; Plumb and Dunnet, in press; Plumb and Veevers, in press).

Kimberley Group

The individual formations of the Kimberley Group are distinctive and can be readily mapped, both on the ground and on air-photographs.

The oldest unit in the Sheet area is the King Leopold Sandstone of which only the upper 200 feet are exposed. It is up to 4000 feet thick in the Cambridge Gulf Sheet area. Cross-bedding indicates that palaeocurrents came from the northwest.

The Carson Volcanics and Warton Sandstone are very much thicker to the west of the Sheet area. The basalts of the Carson Volcanics are tholeiitic.

Argillaceous sandstone is prominent at the base of the Warton Sandstone. Palaeocurrents in the sandstone came from the northeast in the north and northwest further south.

The sand-silt ratio in the Elgee Siltstone decreases towards the south-east. Outcrop is very poor.

The Pentecost Sandstone has been subdivided into three unnamed members mainly on the basis of distinctive marker beds defining the contacts. Coarse-grained sandstones at the base of the upper member are not so evident as in the Mount Elizabeth and Ashton Sheet areas. The boundary can be mapped by the scarp at the top of the middle member. Palaeocurrents in the middle member were from the north-west.

PALAEOZOIC

A thick section of arenites, lutites and carbonates, ranging in age from Lower Cambrian to Permian, was deposited in the Bonaparte Gulf Basin, but only a very incomplete section is exposed in Medusa Banks. A thick post-Permian section is expected in the off-shore parts of the Basin. The rocks are highly fossiliferous, and this allows precise dating and determination of facies variations.

Most of the exposed rocks were deposited on a platform but bore-holes in the north of Cambridge Gulf Sheet area indicate a basin facies in the subsurface in the eastern part of the Medusa Banks Sheet area. The original depositional limits of the Basin in the west are not known.

The stratigraphy of the Bonaparte Gulf Basin was originally described by Traves (1955). Further detailed investigations have been recently completed and are described by Veevers and Roberts (1968), and Kaulback and Veevers (1968).

UPPER DEVONIAN

The Cockatoo Formation is the oldest unit exposed in the Bonaparte Gulf Basin in the Sheet area. It probably overlies Cambrian, and possibly Ordovician, beds. The various Members of the Formation cannot always be recognized from the available outcrops.

The Ningbing Limestone is a reef complex developed on a horst. Four facies are recognized in Cambridge Gulf Sheet area, reef (massive, recrystallized limestone); fore-reef (breccia, conglomerate, calcarenite); back-reef (well-bedded calcarenite, birdseye limestone); and interreef (platy red and grey limestone).

UPPER DEVONIAN TO LOWER CARBONIFEROUS

The Bonaparte Beds, found only in the subsurface, are the basin equivalent of the platform facies Cockatoo Formation, Ningbing Limestone, Utting Calcarenite, and other Devonian and Lower Carboniferous platform sediments exposed in Cambridge Gulf Sheet area.

LOWER CARBONIFEROUS

From the outcrop pattern the Utting Calcarenite is interpreted as being faulted against the Ningbing Limestone but it is possible that the original contact was an abutment unconformity. The unit is poorly exposed.

The Tanmurra Formation, known only from the subsurface, is the off-shore facies equivalent of the near-shore Burvill Beds and Point Spring Sandstone

UPPER CARBONIFEROUS

No diagnostic fossils are known from the Border Creek Formation which is taken to be Upper Carboniferous in age.

PERMIAN(?)

A single brachiopod indicates a possible Permian age for the Keep Inlet Beds. A variety of scattered boulders suggests a glacial origin but no confirmatory evidence has been found.

CAINOZOIC

The laterite is a ferruginous detrital deposit containing weathered sandstone boulders and deposited on Warton Sandstone.

Residual soil is developed principally on Elgee Siltstone and thin superficial sand deposits are found on the top of sandstone plateaux. A widespread blanket of sand covers much of the Cambridge

Gulf Lowlands. Much of the Carson Volcanic outcrop is covered by soil and scree.

Quaternary and Recent alluvium has been deposited along major streams.

Recent coastal silt, sand and evaporite deposits border the coastline.

Beach and dune sands include two types of deposits. One is beach sand in bays along the Kimberley Plateau; dunes are up to 350 feet high. Sand ridges developed along the shoreline of the Cambridge Gulf Lowlands may be emerged off-shore bars.

STRUCTURE

The structure of the Medusa Banks Sheet area is dominated by parts of two sedimentary basins, the Proterozoic Kimberley Basin in the west and the Phanerozoic Bonaparte Gulf Basin in the east. The basins now occur as structural basins, the original limits of sedimentation are unknown.

The structures in each are simple. Faulting is the dominant feature, the age of which is uncertain, but it is likely that most faulting, even in the Kimberley Basin, is Phanerozoic, possibly extending into the Mesozoic and Cainozoic.

The structure is illustrated in Figure 2 and bouguer anomalies are shown in Figure 3.

Kimberley Basin

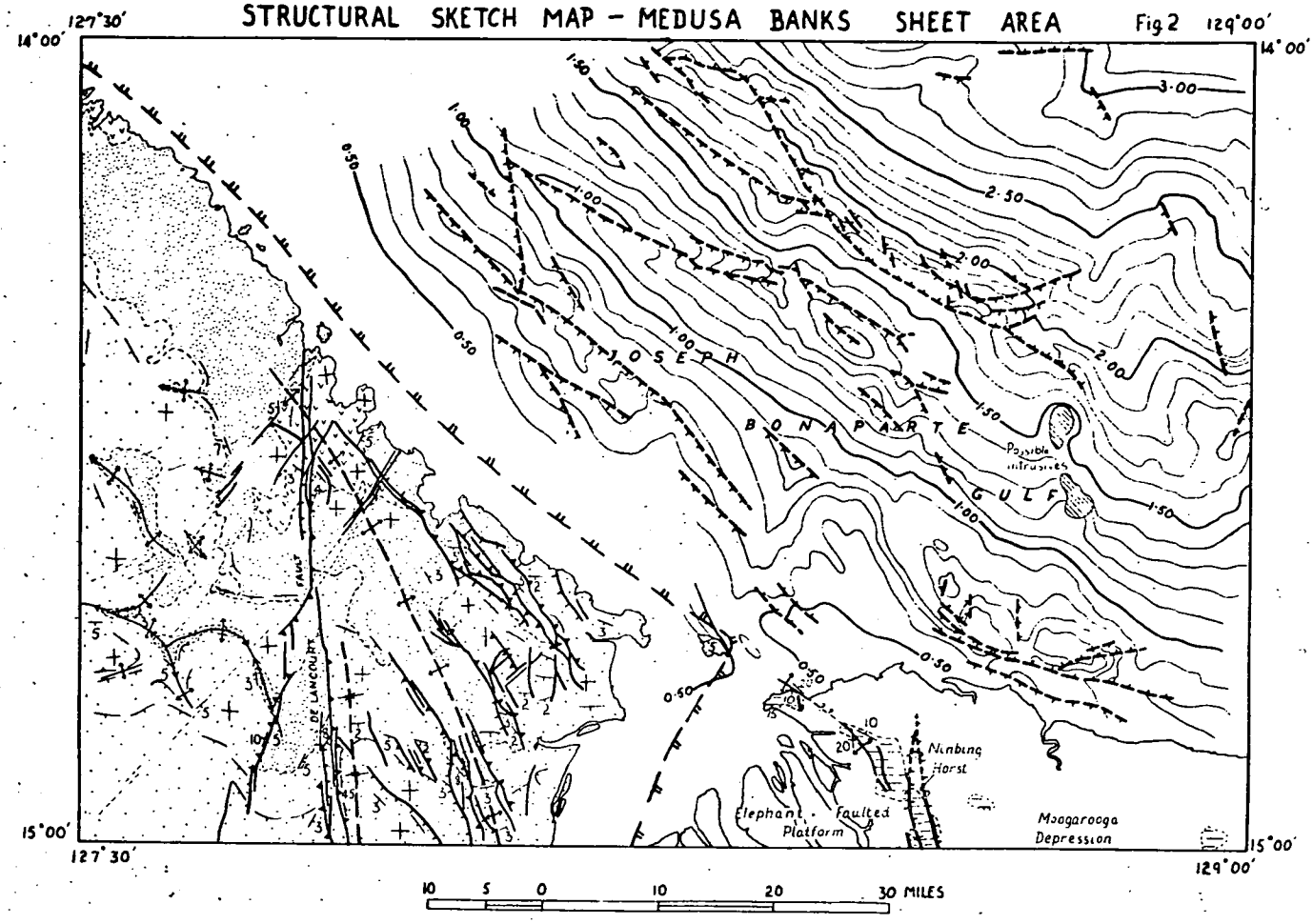
The exposed Kimberley Basin consists of two distinct zones, an eastern belt dominated by north-north-west trending faults and shallow regional folds and a western belt containing random, small local folds. The zones are separated by the north trending De Lancourt Fault.

Many fault scarps appear, on air photos, to follow actual fault planes and the faults appear to be normal faults with moderate to steep dips. Faults of unknown dip direction appear to be very steep. Throws range up to a maximum of about 2000 feet. The area is faulted into small horsts and grabens.

The fault scarps are exceptionally well preserved in places and it is common with many of the smaller faults for the identical, resistant, flat-lying bed to be exposed on both sides of the fault. The lack of erosion subsequent to these faults suggests a relatively young age, perhaps even Cainozoic, related to downwarping of the Bonaparte Gulf Basin. It is likely that all the faults may be Phanerozoic in age since they parallel the Bonaparte Gulf Basin and are concentrated along its margin.

STRUCTURAL SKETCH MAP – MEDUSA BANKS SHEET AREA

Fig 2



- Soil cover
- Palaeozoic
- Pentecost Sandstone/ Elgee Siltstone
- Warton Sandstone
- Carson Volcanics/ King Leopold Sandstone
- Geological boundary
- Strike and dip of strata
- Horizontal strata
- Anticlinal axis } Regional
- Synclinal axis } Regional
- Anticlinal axis with plunge - local
- Normal fault
- Fault with downthrown block; dip direction unknown; probably very steep
- Concealed fault from seismic data
- Fault; inferred, concealed
- Seismic reflection travel time contours in seconds; interval 0·1 secs Zone 3 after Young and Nicholls, 1966
- Approximate margin of Bonaparte Gulf Basin

To accompany Record 1969/97

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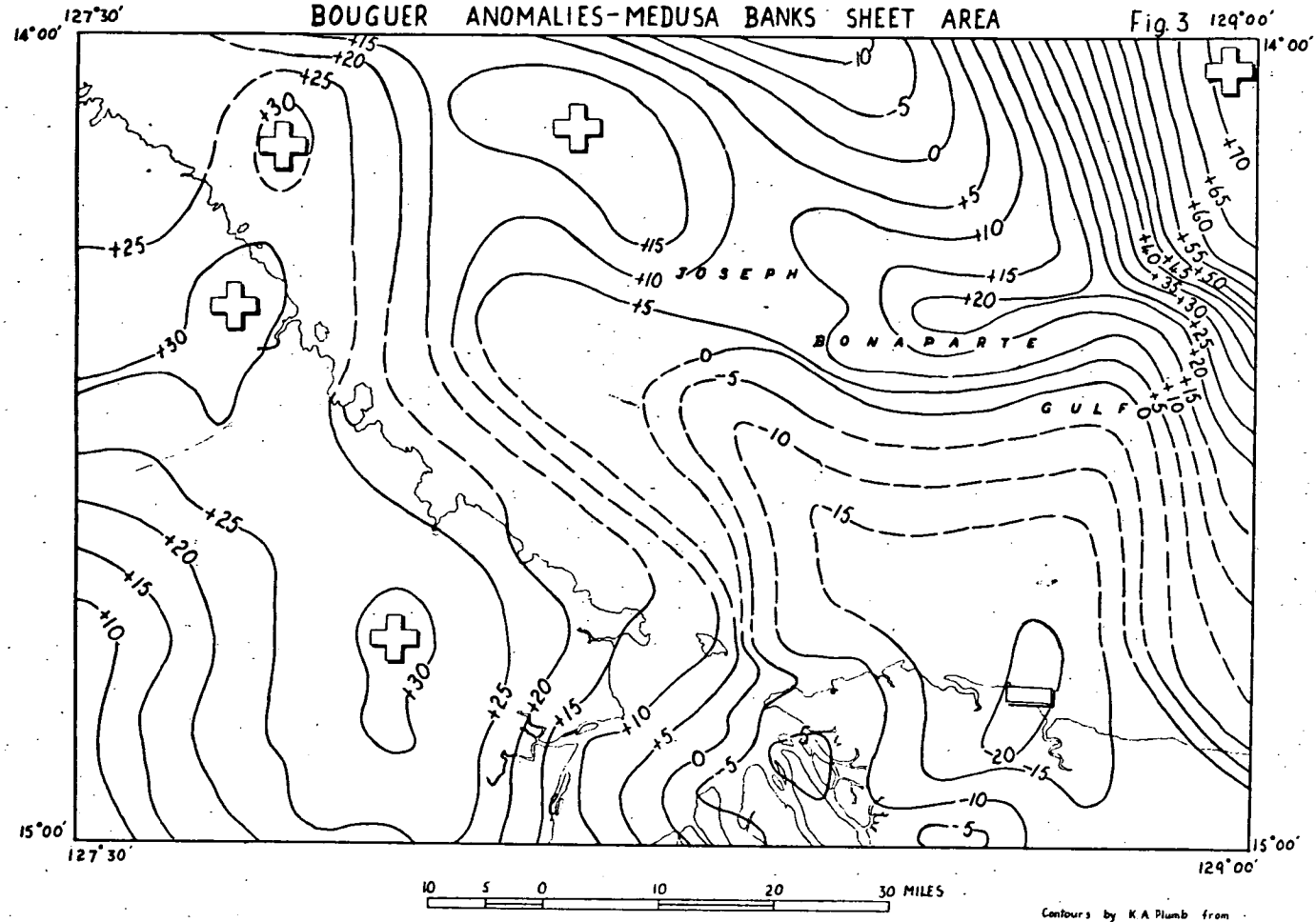
BOUGUER ANOMALIES - MEDUSA BANKS SHEET AREA

Fig. 3



Contours by K A Plumb from data supplied by Geophysical Branch, Bureau of Mineral Resources

-5 Isogal (5 milligal interval, dashed when approximate)

'High' anomaly

'Low' anomaly

To accompany Record 1969/97

D52/A10/9

The regional dip in the eastern block is shallow to the south-south-east. Folding consists of very shallow, broad folds parallel to, and controlled by, the faults.

West of the De Lancourt Fault faulting is confined to a few minor north-northeast to northeast trending secondary faults near the De Lancourt Fault; these extend into the eastern belt.

The regional dip is uniformly shallow to the south-south west. Small local folds have random trends and distribution and are probably formed in response to vertical movements in the basement. Locally dips can range up to 15°.

Bonaparte Gulf Basin

Deposition started in the Bonaparte Gulf Basin, in the Lower Cambrian and it is still actively receiving sediment today. Most of the basin is beneath the sea and knowledge of the structure mostly depends on seismic data. The stratigraphic position of the seismic horizon shown in Figure 2 is unknown.

The nature of the Basin margin is unknown. Submarine faulting has been suggested and the relatively straight coast-line supports this view. Also the apparent margin shown on Figure 2, based on magnetic data, coincides with the eastern, probably fault controlled, edge of the Inner King Shoal. Seismic data across the margin is required to positively determine its nature.

The beds dip uniformly shallowly to the north-east and are cut by numerous north-west trending grabens and horsts. Small domes occur near some faults. It has been noted during the seismic work that structural highs coincide with bathymetric highs. This is readily seen in the coincidence of the Middle King Shoal with a seismic fault and Medusa Banks with a horst. These features suggest a young age for many of the structures.

Veevers and Roberts (1968) recognise many structural blocks in the on-shore part of the Basin. The Elephant Faulted Platform to the south is characterized by the development of major steep north-north-east trending faults.

The Ningbing Horst marks the site of an Upper Devonian reef. The Moogarooga Depression is a depositional feature, an off-shore trough containing a very much thickened Visean sequence.

Bouguer Anomalies

Parts of two of the major gravity features described by Jones (in prep.) occur in the Medusa Banks Sheet area. The Wickham Gravity High is a large, north trending gravity ridge with a relief of about 100 milligals. Its crest lies along the eastern Sheet margin. Flavelle (pers. comm.) attributes the anomaly to a volume of dense material within the sedimentary cover and not to a change in basement depth.

The South Bonaparte Gravity Low forms a prominent V-shaped depression in the south-eastern part of the Sheet area. It is bounded in the north by an east-west ridge. Gravity trends along the western side of the depression reflect the direction but do not indicate the position of the margin of the Bonaparte Gulf Basin.

Outcropping Proterozoic sediments form a slight ridge.

ECONOMIC GEOLOGY

No mineral deposits are known from the Sheet area and prospects are considered to be poor. Laterites have been examined as a source of bauxite but are too ferruginous.

Petroleum

The Bonaparte Gulf Basin has long been considered one of the more promising oil prospects in Australia. Companies are carrying out extensive exploration in the area at present, but the evaluation of this work is still in progress and the ultimate prospects of the area cannot be assessed yet.

Two bores (Bonaparte 1 and 2) have been sunk to about 10,000 feet just south of the Sheet area, and one of these, Bonaparte No. 2, yielded a substantial but non-economic flow of gas of 1.5 million cubic feet per day from a sandstone in the Bonaparte Beds (lower Carboniferous).

Preliminary seismic work indicates several interesting structures off-shore and, apparently, a much thicker prospective section due to addition of younger beds to the top of the section.

Water

Most of the valleys suitable for a possible pastoral industry west of the Cambridge Gulf appear to contain adequate supplies of surface water for stock purposes. The main difficulty is establishing such an industry is access.

Surface water is lacking east of Cambridge Gulf but groundwater is available from Knob Peak Bore.

TABLE 2 : GEOLOGICAL HISTORY - MEDUSA BANKS SHEET AREA

AGE			EVENTS	REMARKS
PALAEOZOIC	LOWER CARBONIFEROUS	Late Visean to Early Namurian	Fluctuating sea level. Deposition of 1,200 feet of sandstones with minor conglomerate and limestone near-shore and 1,000 feet of limestone and sandstone off-shore in the Moogarooga Depression. Probable continued erosion of Precambrian	Burvill Beds (alluvial sand reworked as beach deposit) and Point Spring Sandstone (regressive deposit) near-shore. Tanmurra Formation off-shore
		Visean	Deposition of 400+ feet of skeletal sandy calcarenite on Ningbing Horst. Continued deposition of siltstones and shales in Moogarooga Depression.	Utting Calcarenite; Bonaparte Beds
		Tournaisian	Continued subsidence and deposition of shale and siltstone in Moogarooga Depression. Probable reef limestone on Ningbing Horst. Faulting, tilting, uplift and erosion of Elephant Faulted Platform and possibly Precambrian further west	Bonaparte Beds. Tournaisian reef limestone known from northern part of Cambridge Gulf Sheet area
	UPPER DEVONIAN	Famennian	Continued subsidence of Bonaparte Gulf Basin. Deposition of 1,100+ feet of carbonates in reef complex on Ningbing Horst. Tanmurra Fault Block and part of Elephant Faulted Platform. Deposition of off-shore shales and siltstones in Moogarooga Depression. Possible emergence of western part of Elephant Faulted Platform	Ningbing Limestone; Bonaparte Beds
		Frasnian	Subsidence of Bonaparte Gulf Basin along marginal faults. Deposition of 5,000 feet of white sandstone and minor limestone on platform. Shale and siltstone deposited in Moogarooga Depression. Erosion of Precambrian	Cockatoo Sandstone; Bonaparte Beds
	Middle Ordovician to Middle Devonian		No information. Probably uplift at an undetermined time and subsequent erosion of Bonaparte Gulf Basin	Correlation with events in Cambridge Gulf Sheet area
	Middle Cambrian to Lower Ordovician		No information. Probably subsidence of Bonaparte Gulf Basin and deposition of sandstone, shale and dolomite in shelf environment. Erosion of Precambrian	Correlation with outcrops in northwestern part of Cambridge Gulf Sheet area
	Late Lower Cambrian		No information. Probable uplift and erosion of volcanics	Correlation with events in Cambridge Gulf Sheet area
	Lower Cambrian		Widespread extrusion of basalt	Correlation with outcrops in northwestern part of Cambridge Gulf Sheet area
PROTEROZOIC	Carpentarian to Adelaidean		No information. Probably periods of very slight folding and faulting and extensive erosion. Possibly glaciation in late Adelaidean	
	Early Carpentarian		Subsidence of widespread Kimberley Basin. Deposition of sandstone and minor siltstone, shale and basic volcanics, possibly more than 10,000 feet thick	Only Kimberley Group exposed. Bastion Group may have been deposited and eroded; Speewah Group, if deposited, is not exposed
	Pre-Carpentarian		No information. Probably Lower Proterozoic or Archaean basement complex and earliest Carpentarian granites and acid volcanics	

BIBLIOGRAPHY

AYME, B.R., and HALL, S.W., 1965 - Tanmurra Seismic Survey, P.E127H, Western Australia Rep. by Petty Geophysical Engineering Company for Anacapa Corporation (unpubl.).

BIGG-WITHER, A.L., 1963 - Compilation and review of the geophysics of the Bonaparte Gulf Basin, 1962. Bur. Miner. Resour. Aust. Rec. 1963/165 (unpubl.).

BOFINGER, V.M., 1967 - Geochronology in the East Kimberley area of Western Australia. A.N.U. Ph. D. Thesis (unpubl.).

BRADY, T.J., JAUNCEY, W., and STEIN, D., 1966 - The geology of the Bonaparte Gulf Basin A.P.E.A., Jour., 1966, 7-11.

DERRICK, G.M., in press - Ashton, W.A. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SD/52-13.

DOW, D.B., GEMUTS, I., PLUMB, K.A., and DUNNET, D., 1964 - The Geology of the Ord River Region, Western Australia. Bur. Miner. Resour. Aust. Rec. 1964/104 (unpubl.).

DRUMMOND, J.M., 1963 - Compilation and review of the geology of the Bonaparte Gulf Basin, 1962. Bur. Miner. Resour. Aust. Rec. 1963/133 (unpubl.).

DUNN, P.R., PLUMB, K.A., and ROBERTS, H.G., 1966 - A proposal for the time stratigraphic subdivision of the Australian Precambrian. Geol. Soc. Aust. Jour. 13, 593-608.

EDWARDS, A.B., 1940 - Some Basalts from the North Kimberleys. Roy. Soc. W. Aust. Jour. 27, 79-93.

EDWARDS, A.B., and CLARKE, E. de C., 1940 - Some Cambrian Basalts from the East Kimberleys, Western Australia. Roy. Soc. W. Aust. Jour. 26, 77-101.

GELLATLY, D.C., and DERRICK, G.M., in press - Lansdowne, W.A. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SE/52-5.

GELLATLY, D.C., DERRICK, G.M., and PLUMB, K.A., 1965 - The geology of the Lansdowne 1:250,000 Sheet, SE52/5 Western Australia. Bur. Miner. Resour. Aust. Rec. 1965/210 (unpubl.).

GELLATLY, D.C., and SOFOULIS, J., in press - Drysdale - Londonderry, W.A. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SD52/5-9.

GEOL. SURV. W. AUST., 1965 - Provisional subdivisions of the Precambrian in Western Australia 1964. Geol. Surv. W. Aust. ann. Rep. for 1964.

GEOL. SURV. W. AUST., 1967 - Provisional subdivision of the Precambrian in Western Australia, 1966. Geol. Surv. W. Aust. ann. Rep. for 1966.

GEOPHYSICAL ASSOCIATES PTY LTD 1966 - Timor Sea - Joseph Bonaparte Gulf Marine Gravity and Seismic Sparker Survey. North-West Australia, 1965. Bur. Miner. Resour. Aust. Rec. 1966/116.

GLENISTER, B.F., 1960 - Carboniferous conodonts and ammonoids from Northwestern Australia. Quatrieme Cong. Strat. Geol. Carb. Heerlen, 1958, 1, 213-217.

GLOVER, J.J., RICHARDSON, L.A., and McGILVRAY, J.P., 1955 - Geological and geophysical report on the Keep River area, Bonaparte Gulf Basin. Rep. by Mines Administration Pty Ltd for Associated Australian Oilfields. NT/BG/20 (unpubl.).

GUILLAUME, R.E.F., 1966 - Petroleum Geology in the Bonaparte Gulf Basin, N.T. 8th Comm. Min. Metall. Cong. V.S. 183-196.

GUPPY, D.J., LINDNER, A.W., RATTIGAN, J.H., and CASEY, J.N., 1958 - The Geology of the Fitzroy Basin, Western Australia. Bur. Miner. Resour. Aust. Bull. 36.

HARMS, J.E., 1959 - The geology of the Kimberley Division, Western Australia, and of an adjacent area of the Northern Territory. M. Sc. Thesis Adelaide University (unpubl.).

JONES, B.F., in prep. - A marine geophysical survey of the Timor Sea 1967. Bur. Miner. Resour. Aust. Rec.

JONES, P.J., 1958 - Preliminary report on micropalaeontology of samples from the Bonaparte Gulf Basin. Bur. Miner. Resour. Aust. Rec. 1958/26 (unpubl.).

KAULBACK, J.A., and VEEVERS, J.J., 1968 - Lower Palaeozoic geology of the Bonaparte Gulf Basin. Bur. Miner. Resour. Aust. Rep. 109.

KING, P., 1926 - NARRATIVE OF A SURVEY OF THE INTERTROPICAL AND WESTERN COASTS OF AUSTRALIA, London, John Murray.

LE BLANC, M.C., 1964 - Alliance Oil Development Australia N.L. Completion Report. Bonaparte Well No. 1 P.E. 127 H, Western Australia. Report to Alliance Oil Development N.L. (unpubl.).

LE BLANC, M.C., 1965 - Idem, Bonaparte No. 2 Well. Ibid.

McDOWALL, A.J., and LEE, L.O., 1965 - Marine Seismic Refraction Survey, West Bonaparte Gulf, Australia. Interpretation Report. Rep. by Geophysical Services International Limited for Anacapa Corporation (unpubl.).

MAITLAND, A. GIBB, 1902 - Kimberley. Geol. Surv. W. Aust. Ann. Rep. 1901.

MATHESON, R.S., and TEICHERT, C., 1946 - Geological reconnaissance in the eastern portion of the Kimberley Division, Western Australia. Geol. Surv. W. Aust. ann. Rep. 1945.

NOAKES, L.C., " OPIK, A.A., and CRESPIN, I., 1952 - Bonaparte Gulf Basin, North Western Australia. 19th Cong. Int. Symp. Gond. Ser. 91-106.

" OPIK, A.A., 1950 - Notes on Palaeozoic stratigraphy, Cambridge Gulf Area. Bur. Miner. Resour. Aust. Rec. 1950/31 (unpubl.).

PATERSON, S.J., 1954 - General Report of the Survey of the Ord-Victoria area: Geomorphology. Sci. Ind. Res. Org. Melb. Land Res. Ser. 4.

PLUMB, K.A., in prep. - Precambrian Geology of the Kimberley Region - The Kimberley Basin. Bur. Miner. Resour. Aust. Bull.

PLUMB, K.A., and DUNNET, D., in press - Lissadell, W.A. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes. SD/52-10.

PLUMB, K.A., and VEEVERS, J.J., in press - Cambridge Gulf, W.A. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes. SD/52-14.

PRASTKA, R.L., and POLYNIAK, H.P., 1965 - Marine Seismic Reflection Survey, West Bonaparte Bay Offshore, Australia. Rep. by Geophysical Services International Limited for Anacapa Corporation (unpubl.).

REEVES, F., 1951 - Australian oil possibilities. Bull. Amer. Ass. Petrol. Geol. 35, 2479-2525.

REEVES, F., 1948 - Report on geology and oil possibilities in the Bonaparte Gulf Basin. Rep. to Standard Vacuum Oil Co. (unpubl.).

ROBERTS, H.G., and PERRY, W.J., in press - Mount Elizabeth, W.A. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SE52/1.

SCHNEEBERGER, W.F., 1960 - Report on a gravity survey in Permit 127H, Western Australia. Rep. by Mines Administration Pty Ltd via Ball Associates for Gulf Oil Syndicate (unpubl.).

SHARP, A., 1963 - THE DISCOVERY OF AUSTRALIA, Oxford, Clarendon Press.

SMITH, E.R., 1966 - Timor Sea/Joseph Bonaparte Gulf Marine Gravity and Seismic "Sparkarray" Survey, Northwest Australia, 1965. Bur. Miner. Resour. Aust. Rec. 1966/72.

SOFOULIS, J., 1966 - Bauxite deposits of the North Kimberley Region, Western Australia. Geol. Surv. W. Aust. ann. Rep. 1965.

STARKEY, L.J., 1959 - Report on a gravity survey in Permit 127H, Western Australia. Rep. by Mines Administration Pty Ltd, for Gulf Oil Syndicate (unpubl.).

STARKEY, L.J., and ABEL, K.W., 1961 - Carlton gravity survey, P.E. 127H, Western Australia. Rep. to Oil Development N.L. (unpubl.).

TINLINE, R.J., and FIFE, J.S., 1962 - Final report, Carlton seismic survey. Rep. by General Geophysical Company (Bahamas) Ltd to Oil Development N.L. (unpubl.).

THOMAS, G.A., 1963 - The Carboniferous stratigraphy of the Bonaparte Gulf Basin. Quatrieme Congr. Strat. Geol. Carb. Heerlen, 1958, in press.

THYER, R.F., STOTT, P.M., and NEUWMANN, F.J.G., 1959 - Report on a gravity survey in the Bonaparte Gulf Basin 1956-1958. Bur. Miner. Resour. Aust. Rec. 1959/20 (unpubl.).

TRAVES, D.M., 1949 - Preliminary report, Ord-Victoria region. Bur. Miner. Resour. Aust. Rec. 1949/22 (unpubl.).

TRAVES, D.M., 1955 - The Geology of the Ord-Victoria region, Northern Australia. Bur. Miner. Resour. Aust. Bull. 27.

UTTING, E.P., 1959 - Bonaparte Gulf Basin of Northern Australia. Preliminary statement on Permit 127H. Rep. to Gulf Oil Syndicate (unpubl.).

UTTING, E.P., 1960 - Surface exploration and oil prospects of Permit 127H, Western Australia. Rep. to Gulf Oil Syndicate (unpubl.).

UTTING, E.P., 1961 - Permit to Explore No. 127H, West Australia; Geological map with associated maps and notes. Rep. to Oil Development N.L. (May 11th, 1961). (unpubl.).

VEEVERS, J.J., 1967 - The Phanerozoic geological history of Northwest Australia. Jour. Geol. Soc. Aust. 14, 253-272.

VEEVERS, J.J., and ROBERTS, J., 1966 - Upper Devonian and Carboniferous Geology of the Bonaparte Gulf Basin. Western Australia and Northern Territory. Bur. Miner. Resour. Aust. Rec. 1966/113.

VEEVERS, J.J., and ROBERTS, J., 1968 - Upper Devonian and Carboniferous geology of the Bonaparte Gulf Basin. Bur. Miner. Resour. Aust. Bull. 97.

VEEVERS, J.J., ROBERTS, J., KAULBACK, J.A., and JONES, P.J., 1964 - New Observations on the Palaeozoic geology of the Ord River area, Western Australia and Northern Territory. Aust. J. Sci., 26(11), 352-53.

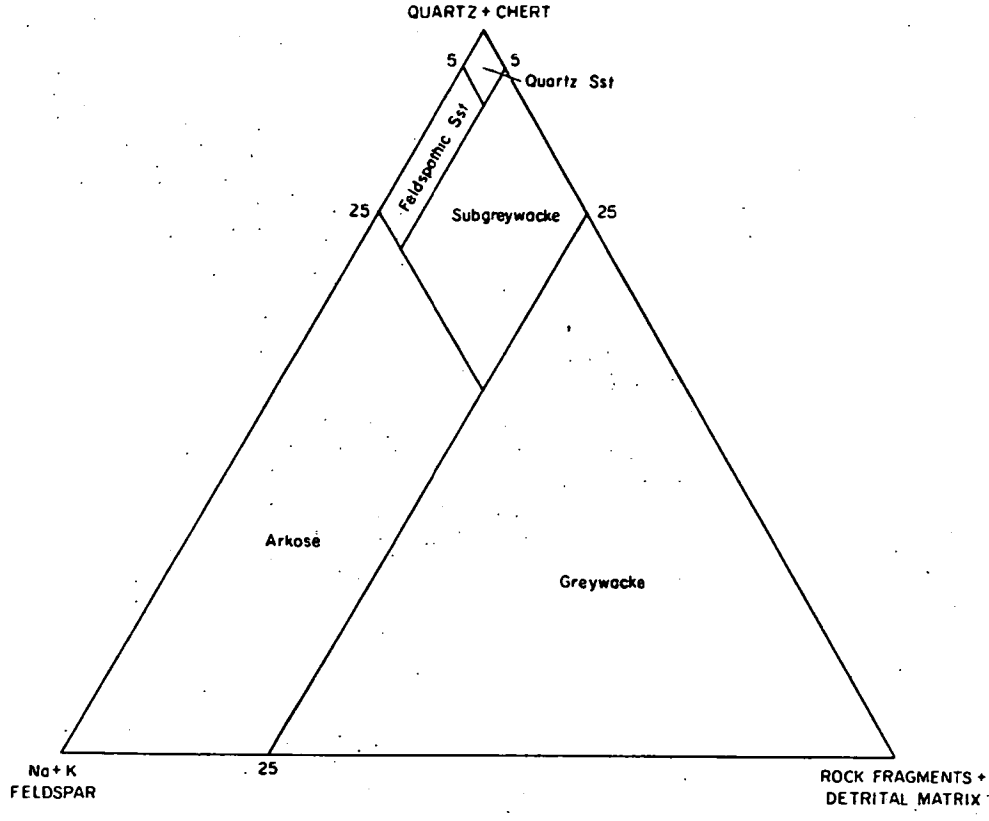
WILLIAMS, L.W., and WATERLANDER, S., 1959 - Preliminary report of an underwater gravity survey, Darwin-Wyndham, 1958. Bur. Miner. Resour. Aust. Rec. 1959/15 (unpubl.).

YOUNG, W.H., and NICHOLLS, C.W., 1966 - Final report, Medusa Banks marine seismic survey. Rep. by Western Geophysical Company of America for Anacapa Corporation (unpubl.).

APPENDIX 1.

Classification of Sandstones.

The sandstone classification used in this report, except the principal rock names in Appendix 3, is adapted from the classification proposed by Dapples, Krumbein and Sloss (1953). The essential features of this classification are shown in figure 1.



APPENDIX 2

Measured or Estimated Stratigraphic Sections - Kimberley Group

CARSON VOLCANICS

6 miles south of Buckle Head - Measured by Abney Level

	-	Warton Sandstone
120'	-	Quartz basalt, massive, black, medium grained, ophitic
55'	-	Argillaceous sandstone; blocky, white to pale red-brown, cross-bedded, subfriable; grades up into quartz sandstone; blocky, red-brown, medium grained, minor alkali feldspar.
200'+	-	No outcrop. Basalt
	-	King Leopold Sandstone
ca 375'+		

2 miles south of Buckle Head - Partial section; visual estimate

	-	Warton Sandstone
50' - 100'	-	No outcrop. Basalt beneath soil cover.
30'	-	"Sand-wave" Lense of cross-bedded, red-brown feldspathic sandstone. Foresets dip at 20°; occupy full height of wave.
50'	-	Feldspathic sandstone; thinly bedded, medium grained, white to pink, current ripple-marks.
100'+	-	No outcrop. Basalt beneath.
		No base exposed.
ca 250'+		

7 miles west of Thurburn Bluff - Partial section; visual estimate

	- Warton Sandstone
150' - 200'	- No outcrop. Basalt beneath soil cover
30'	- Feldspathic sandstone; blocky, red-brown, clay pellets
30'+	- Quartz basalt; massive, black chloritic amygdules
	No base exposed.
ca 250'+	

The following rough sections are based on thicknesses estimated with helicopter altimeter

6 miles west of Buckle Head

	- Warton Sandstone
200'	- Basalt
60'	- Sandstone
270'	- Basalt
	King Leopold Sandstone
530'	

6 miles south-south-west of Buckle Head

	- Warton Sandstone
140'	- Basalt
50'	- Sandstone
170'	- Basalt
	King Leopold Sandstone
360'	

The following estimates of thickness are for the top basalt only

Buckle Head - 100' - 150'

4 miles west of Buckle Head - 200'

2½ miles south of Buckle Head - 100' - 150'

6 miles south-south-west by west of Buckle Head - 350' - 400'

ELGEE SILTSTONE

Slab Hill - Measured with Abney Level.

- Pentecost Sandstone. Blocky, purple-pink, fine-medium grained feldspathic sandstone. Abundant shale pellets, cross-bedded.

TOP OF ELGEE SILTSTONE

33' - Interbedded sandstone; blocky to flaggy, deep red-brown, fine grained, and siltstone; fissile red-brown. Alternate in beds about 3' thick. Shale pellets common in sandstone.

300' - Siltstone; red-brown, with minor interbeds of sandstone; flaggy or thinly flaggy, grey-green, fine-grained, micaceous. Sandstone beds 6" to 1' thick about 15' to 20' apart. Increase in number towards top.

30' - No outcrop.

20' - Quartz sandstone; flaggy to blocky, grey, medium grained.

12' - Shale rubble

1' - Micaceous sandstone; flaggy, grey-green, fine-grained.

15' - No outcrop. Rubble of shale and fine sandstone.

15' - Feldspathic sandstone; blocky, grey to red-brown, medium-grained.

7' - Sandstone; flaggy, green-grey.

2' - Sandstone; blocky, grey.

16' - Shale; fissile, red-brown. Some interbeds of thinly flaggy, pale green, fine-grained micaceous sandstone near top.

TOP OF WARTON SANDSTONE

- Quartz sandstone; massive, medium to coarse grained

451'

9 miles south-west of Thurburn Bluff - Abney level and helicopter altimeter

- BASE OF PENTECOST SANDSTONE

40' - Alternating sandstone; red-brown, ferruginous, fine-grained, abundant clay pellets; siltstone; red-brown; and quartz sandstone; blocky, white, thinly-bedded, fine-grained

ca 300' - Siltstone; massive, red-brown to cherry-red. Interbeds of red-brown ferruginous sandstone near base.

50' - Interbedded feldspathic sandstone; massive, pink, fine grained; ferruginous and micaceous sandstone, blocky red-brown; and shale; red-brown. Thick shale bed marks base.

TOP OF WARTON SANDSTONE

ca 390'

1 mile west of junction of Berkeley and de Lancourt Rivers - Measured with Abney Level

- BASE OF PENTECOST SANDSTONE

135' - Very poor outcrop. Red sandstone scree. Some thin outcrops red-brown fine grained silty micaceous sandstone. Partings 1" to 12" thick.

11' - Silty sandstone; dull red-brown, fine-grained; bedding 4" to 6" thick, sometimes laminated, small scale cross-beds.

141'	- Micaceous shale; red-brown, silty. Thin (3") interbeds micaceous silty sandstone; grey, fine to coarse grained.
5'	- Silty micaceous sandstone grades into micaceous shale; red-brown with 3" to 9" interbeds of red-brown, fine-grained micaceous sandstone.
53'	- Silty micaceous sandstone; fine-grained, purple-grey, laminated, ½" to 3" partings.
27'	- Quartz sandstone; white, fine-grained, shale pellets, partings up to 6", current lineations, Mn stained patches.
38'	- Micaceous silty sandstone; purple-grey, fine-grained.
	TOP OF WARTON SANDSTONE
410'	

Partial section measured with Abney Level in the northern Seppelt Range 9 miles west-north-west of Mount Casuarina. No exposed top or base

25'	- Poorly exposed siltstone.
28'	- Silty sandstone; pink, very fine-grained, bedding 1" to 3" thick, pale green patches.
10'	- Kaolinitic sandstone; white, fine-grained, bedding 1" to 2" thick.
33'	- Silty sandstone; pink, very fine-grained, bedding 1" to 3" thick, pale green patches.
27'	- Interbedded silty shale; red brown, and micaceous silty sandstone; laminated, red-brown, very fine-grained.
7'	- Sandstone; coarse-grained, well rounded grains, red-brown clay cement, shale pellets, 3' beds interbedded with micaceous shale; chocolate-brown or red brown.

25'	- Sandstone; fine-grained, pink and white, banded, 3" bedding, iron stained, forms bench. Silty shale; chocolate or red-brown.
155' +	

Partial section measured with Abney Level 6 miles north of Mount Nicholls

	- BASE OF PENTECOST SANDSTONE
30'	- Intermittent exposures of sandstone.
13'	- Kaolinitic sandstone; purple-grey, fine-grained, very small red-brown shale pellets, beds up to 10".
43'	- Several minor benches. Probably mainly sandstone.
22'	- Micaceous silty sandstone; red-brown, red-brown shale pellets up to 10 mm, 6" bedding, forms series of benches.
53'	- No outcrop, steep slope, sandstone scree, probably shale
17'	- Sandstone bench.
14'	- No outcrop. Sandstone rubble. Shale (?)
2'	- Micaceous silty sandstone; purple-grey, fine-grained, red-brown shale clasts up to 10 mm across, bedding 2" to 6", laminated in places, ripple-marks, forms bench.
86'	- Shale; red-brown.
	- Micaceous siltstone, laminated, interbedded with red-brown silty shale.
280'+	No exposed base.

Total probably about 350'

Total thicknesses were estimated with a helicopter altimeter at the following localities:

Mount Casuarina	- 270'
Seppelt Range	- 330'
Campbell Range	- ca350'
South-west of Sheet area	- 300'

APPENDIX 3

Petrographic descriptions - Kimberley Group rocks

Descriptions and principal rock names by A.R. Turner, A.M.D.L.
Rock names in brackets are nomenclature used elsewhere in this report.
Registered numbers refer to B.M.R. numbers.

The following conventions are used to describe the specimens:

a. Grain Sizes
- Sedimentary rocks
According to Pettijohn (1957) "Sedimentary rocks" (2nd Ed) Harper and Bros, N.Y., p. 19, Table 5.
- Igneous Rocks fine-grained - less than 0.05 mm
medium-grained - 0.05 to 1mm.

b. All reported mineral assemblages were determined by a visual estimate.

c. The reported compositions of the plagioclase minerals has been determined in thin-section by interference figure identification and extinction angle measurements using the A-normal method.

d. The minerals, when listed in rock names, are in decreasing order of abundance.

e. Nomenclature
- Sedimentary Rocks - According to Pettijohn (1957) "Sedimentary Rocks (2nd Ed)" Harper and Bros, N.Y.
- Igneous Rocks - According to Hatch, Wells and Wells (1961) "Petrology of the Igneous Rocks (12th Ed)", Thomas Murby and Co., London.

CARSON VOLCANICS

Registered Number: 65.16.8001

Locality: 7 miles west of Thurburn Bluff

Military Co-ordinates: 6284003149700 Zone 3
The specimen is from the lower basalt.

Description: This specimen is an oversaturated basalt (quartz basalt). The rock is composed of laths of untwinned plagioclase feldspar and clinopyroxene set in a variolitic groundmass of partially devitrified glass and feldspar laths. The plagioclase of the phenocrysts has the

composition of labradorite (approximately An_{55} - An_{60}) and is partially altered to muscovite, sericite and chlorite. The clinopyroxene (?augite and ?pigeonite) is closely associated with the plagioclase in the form of anhedral to subhedral grains and laths. The groundmass is cryptocrystalline and brown under transmitted light. A variolitic texture is imparted to it by numerous brush or fanlike sprays of radially disposed fibres of feldspar. Microchemical staining techniques indicate the groundmass to contain considerable potash feldspar - probably of the sanidine - anorthoclase series. Throughout the groundmass are numerous needles and minute octahedra of ?titanomagnetite.

Products of alteration are common throughout the matrix and these include secondary quartz, a distinctive green chlorite, and epidote.

Registered Numbers: 65.16.8002 and 65.16.8003

Locality: 6 miles south of Buckle Head

Military Coordinates: 6202003155100 Zone 3

Specimens are from middle sandstone unit. 65.16.8002 grades up section into 65.16.8003.

Descriptions:

65.16.8002. This specimen is a medium- to coarse-grained protoquartzite (argillaceous quartz sandstone) composed essentially of detrital quartz grains set in a matrix of clay minerals accompanied by minor laths of muscovite.

The detrital quartz fraction is rounded to sub-angular and has a size distribution in the range 0.52 to 0.06 mm, with the majority belonging to the coarse grades. The grains are commonly chipped and pitted but surrounded by a layer of authigenic quartz which is separated from the detrital core by a fine veneer of dusty opaque minerals. Needles of apatite form inclusions within the quartz together with finely disseminated opaque mineral phases. The matrix of the rock is composed of sericite, muscovite, chlorite and minute quartz grains. The muscovite forms as stumpy plates randomly distributed throughout the rock but having a tendency towards a sub-parallel orientation. Accessory grains of chert and orthoclase are found together with apatite and zircon.

65.16.8003. This specimen is an authigenically cemented orthoquartzite (feldspathic quartz sandstone).

The rock is composed of numerous sub-rounded to sub-angular detrital quartz grains which have a size distribution in the range 0.48 to 0.08 mm. The detrital core is separated from the authigenic cement by a fine veneer of dusty opaque minerals. Minor amounts of clay minerals are also found in interstitial spaces. The rock is composed of more than 95% quartz with the remaining 4 to 5% being alkali feldspar with additional chert fragments. Accessory components include zircon and tourmaline.

Registered Number: 65.16.8004

Locality: As for 65.16.8002

Military Coordinates: 6199003155100

Specimen comes from the upper basalt.

Description:

This specimen is an oversaturated basalt (quartz basalt) and is similar in many respects to specimen 65.16.8001.

The major difference is in the nature of the groundmass. The optical properties are similar however microchemical staining techniques did not detect the presence of any potash feldspars.

The plagioclase phenocrysts are labradorite in composition but altered to epidote, chlorite and muscovite. Commonly they are included with numerous pyroxene grains. The pyroxene displays the affects of resorbtion around its margins and also alteration to a brown cryptocrystalline alteration product. The groundmass shows considerable alteration to a green chlorite, secondary quartz and epidote. The opaque ?titanomagnetite grains are somewhat coarser than in the previous specimen.

WARTON SANDSTONE

Registered Number: 65.16.8005

Locality: 7 miles west of Thurburn Bluff

Military Coordinates: 6278003149800 Zone 4

Specimen is from the base of the Warton Sandstone, immediately overlying the Carson Volcanics.

Description:

This specimen is an orthoquartzite (quartz sandstone) composed of numerous rounded to sub-rounded detrital quartz grains cemented by authigenic silica. The detrital grains have a size distribution in the range 0.9 to 0.09 mm and in general are poorly sorted. There is a tendency, however, for the coarser fraction to be confined to distinct layers which is probably a function of the primary bedding. Each of the detrital grains is outlined by a fine veneer of opaque minerals which distinguishes them from the surrounding authigenic, siliceous cement. The grains and cement are optically similar which indicates that both have undergone simultaneous recrystallization. Inclusions of tourmaline, zircon and finely disseminated opaque minerals are common and accessory amounts of clay minerals are incorporated within the authigenic cement. Rare grains of chert are found in the detrital fraction.

PENTECOST SANDSTONE

Registered Numbers: 65.16.8006 and 65.16.8007

Locality: 1 mile north of the Thompson River

Military Coordinates: 640900310340O Zone 3

The specimens belong to the basal glauconitic beds of the middle Pentecost Sandstone and are interbedded with each other.

Descriptions:

65.16.8006 This specimen is a fine-grained arkosic sandstone (arkose) which in hand specimen has a finely laminated tecture and a pinkish colouration.

The rock is composed of numerous rounded to sub-angular quartz, plagioclase and alkali feldspar grains set in a matrix of authigenic silica. Surrounding each of the grains is a layer of finely disseminated opaque minerals which impart the distinctive colouration to the rock. The plagioclase grains are fresh but the alkali feldspar has been subjected to kaolinization. Authigenic silica occupies all available interstitial spaces and has re-crystallized at the same time as the detrital grains which have a size distribution in the range 0.08 to 0.04 mm. Throughout the rock are isolated laths of muscovite which have an orientation parallel to that of the laminations in the rock. The laminated texture is due to small variations in grain size and percentage of disseminated opaque material. ?Glauconite, zircon, and tourmaline are the accessory constituents.

65.16.8007 This specimen is a laminated ?glauconitic sandstone which has a dark purplish colouration in hand specimen flecked by pellets of green ?glauconite.

The rock is composed of numerous rounded to sub-angular grains of quartz, minor alkali feldspar (microcline) pellets of ?glauconite, secondary hydrated iron oxides and minor muscovite. The rock has been subjected to recrystallization under the influence of a minor stress system which has caused the detrital grains to become elongated in a direction parallel to the minor stress axis and caused the formation of elongated laths of ?authogenic muscovite. Each of the detrital grains is surrounded by a rim of secondary hydrated iron oxides which impart the distinctive purplish colouration to the specimen. The grains are set in an authigenic siliceous cement and have a size distribution in the range 0.25 to 0.07 mm. The ?glauconite pellets tend to be elongated, have a sub-parallel orientation and are concentrated into layers which define the laminations in the rock. Accessory minerals include zircon, tourmaline and minor apatite.

All the optical properties and the nature of the green minerals's occurrence suggest it to be glauconite. Verification by X-ray diffraction techniques will be necessary as the optical properties are not sufficiently distinctive to adequately differentiate it from chlorite.

Registered Number: 65.16.8008

Locality: As for 65.17.8006

Military Coordinates: 6408003103400 Zone 3

From the middle Pentecost Sandstone. Immediately overlies the glauconitic beds of 65.16.8006 and 65.16.8007.

Description:

This specimen is a fine-grained, pink arkosic sandstone (feldspathic sandstone).

The rock is composed of numerous detrital quartz grains with additional microcline and plagioclase set in an authigenic siliceous cement. The detrital components are sub-rounded to sub-angular and well sorted. When in juxtaposition pressure solution features can be observed with the excess silica being deposited around the free margins of the grains. Many of the grains are surrounded by a veneer of finely disseminated opaque minerals which impart the pinkish colouration to the rock. The rock has been re-crystallized. Throughout the rock are small pods of isolated quartz grains set in a matrix of clay minerals and finely disseminated iron oxides. These pods are especially friable and lack the authigenic silica cement. Weathering has removed them from the exposed surfaces

of the specimen. Accessory minerals found throughout the rock include tourmaline, opaques, sphene, zircon and apatite and muscovite. The rock has a grain size in the range 0.05 to 0.01 mm.

Registered Number: 65.16.8009

Locality: ½ mile south-east of Obstruction Hill

Military Coordinates: 6518003139800

Specimen is from the lower Pentecost Sandstone.

Description:

This specimen is a medium-grained, pink arkosic sandstone (feldspathic sandstone).

The rock is similar to the previous specimen although two major differences were observed:

1. increase in grain size, distribution range 0.55 to 0.08 mm.
2. pods of quartz and clay minerals minor and considerably smaller.

The rock has been subjected to recrystallization with the formation of pronounced pressure solution features and the crystallization of authigenic silica in all available interstitial spaces. Accessory minerals include zircon and tourmaline.

Registered Number: 65.16.8010

Locality: Turtle Bay, Lacrosse Island

Military Coordinates: 6709003131000

Specimen is from the middle Pentecost Sandstone

Description:

This specimen is a medium-grained pale pink, arkosic sandstone.

The rock is similar to those previously described specimens but the following differences were recorded.

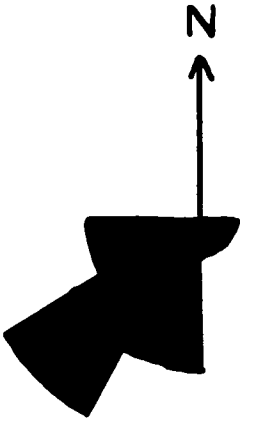
1. grain size 0.43 to 0.06 mm.
2. absence of pods of clay minerals.
3. decrease in the percentage of authigenic silica cement.
4. clay minerals and finely disseminated opaques form veneers on the detrital grains.
5. detrital grains display a sub-parallel orientation of their long axes.
6. accessory zircon, ?glauconite, muscovite and tourmaline.

Appendix 4

Palaeocurrent Directions

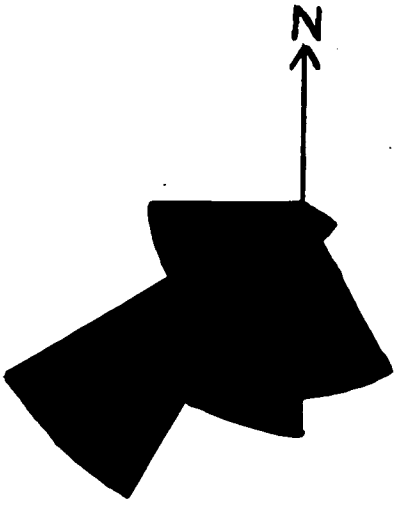
A limited number of determinations of palaeocurrent directions in Kimberley Group rocks were made by measuring the direction of dip of cross-bedding. The following rosette diagrams show these directions.

KING LEOPOLD SANDSTONE



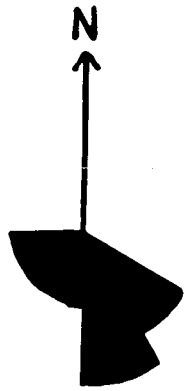
17 readings
Locality: 5 miles south-west of Buckle Head.

WARTON SANDSTONE

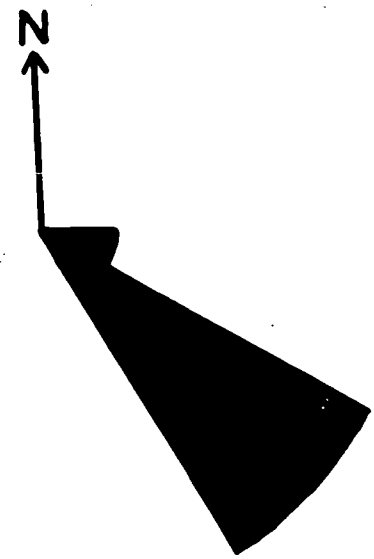


25 readings
Locality: 12 miles west of Elsie Island.

WARTON SANDSTONE (cont.)

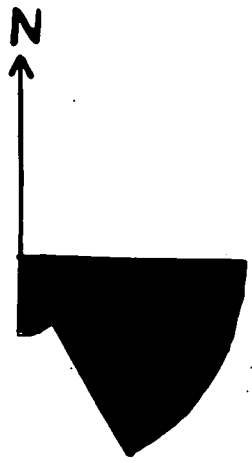


13 readings
Locality: 10 miles south-south-east of Buckle Head.



9 readings
Locality: 8 miles south-west of Thurburn Bluff.

MIDDLE PENTECOST SANDSTONE



11 readings,
Locality: Lacrosse Island.

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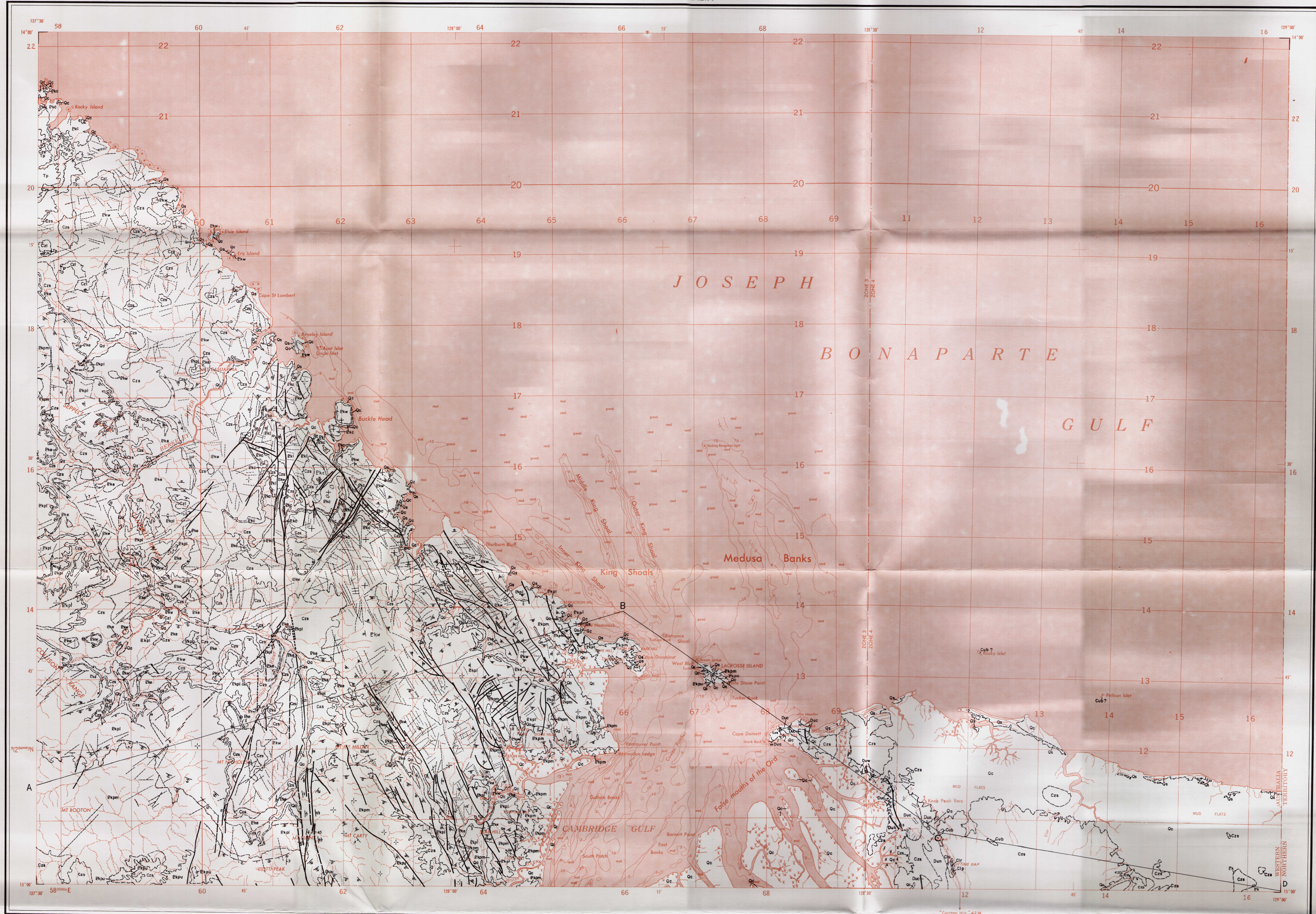


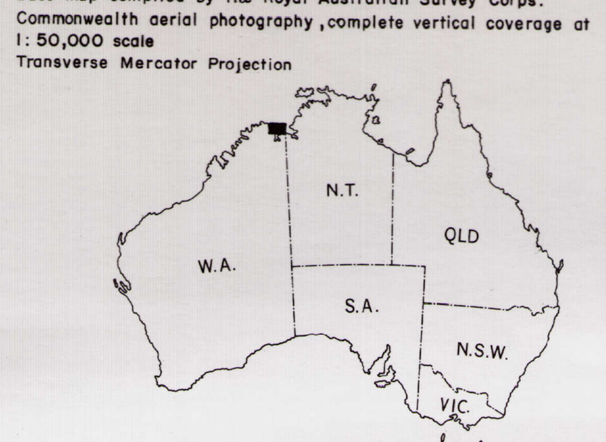
Reference

Era	Period	Unit	Symbol	Description
CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qc	Coastal silt and evaporite deposits
			Qs	Beach sand, sand dunes
			Czs	Sand, soil cover, alluvium
			Czl	Lateritic soil
	TERTIARY		Tp	Laterite
PALAEOZOIC	PERMIAN ?	Keep Inlet Beds	Pk	Calcareous sandstone, boulder conglomerate
	UPPER CARBONIFEROUS	Border Creek Formation	Cub	Quartz sandstone, conglomerate, siltstone
	LOWER CARBONIFEROUS	Tanmurra Formation	Clt	Limestone, sandstone (section only)
		Point Spring Sandstone	Clp	Quartz sandstone, minor conglomerate
		Burvill Beds	Clr	Sandstone, shale, limestone
		Utting Calcarenite	Clu	Skeletal sandy calcerenite
	UPPER DEVONIAN TO LOWER CARBONIFEROUS	Bonaparte Beds	D-Cb	Dark shale, siltstone, sandstone (section only)
	UPPER DEVONIAN	Ningbing Limestone	Dun	Limestone of reef complex
		Cockatoo Formation	Duc	Quartz sandstone, minor limestone, conglomerate
		Westwood Member	Duw	Quartz sandstone, limestone
		Kellys Knob Member	Duk	Quartz sandstone
PRECAMBRIAN	CARPENTARIAN (LOWER PROTEROZOIC *)	Kimberley Group: Pentecost Sandstone	Ekpu	Upper: blocky medium-grained quartz sandstone, coarse-grained sandstone at base
			Ekpm	Middle: blocky, fine to medium-grained feldspathic sandstone, arkose, argillaceous sandstone; minor quartz sandstone; glauconitic sandstone at base
			Ekpl	Lower: blocky medium-grained quartz sandstone, feldspathic sandstone; minor fissile micaceous sandstone, shale pellet conglomerate
		Elgee Siltstone	Eke	Massive red-brown siltstone; fine-grained micaceous, ferruginous and feldspathic sandstone interbeds
		Warton Sandstone	Ekw	Blocky medium-grained quartz sandstone
			Ekc	Quartz basalt; Massive feldspathic or argillaceous quartz sandstone
			Ekl	Massive medium to coarse-grained kaolinitic quartz sandstone

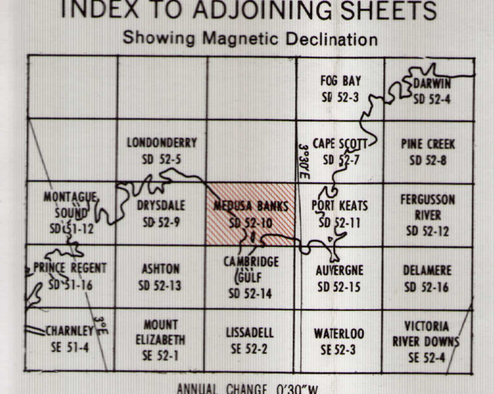
* Subdivision of the Precambrian time-scale used by Geological Survey of Western Australia shown in brown

- Geological boundary
- Anticline
- Fault
- Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes
- Strike and dip of strata
- Horizontal strata
- Dip < 5° (air-photo interpretation)
- Dip 5 - 15° (air-photo interpretation)
- Horizontal strata (air-photo interpretation)
- Trend lines (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Bore with windpump
- Sand dunes
- Mangroves
- Fathom line
- Rocks or reef bare awash
- Rocks or reef submerged
- Coral reef
- Vehicle track

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Western Australia. Issued under the authority of the Hon. David Fairbairn, Minister for National Development.
Base map compiled by the Royal Australian Survey Corps.
Commonwealth aerial photography, complete vertical coverage at 1:50,000 scale
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



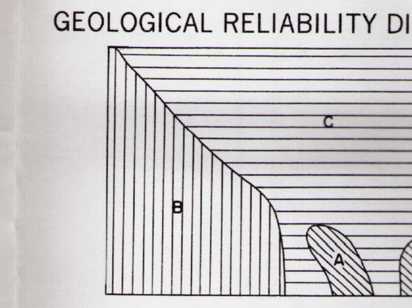
Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

Section
(Cainozoic sediments omitted)
Scale: $\frac{V}{H} = 2$

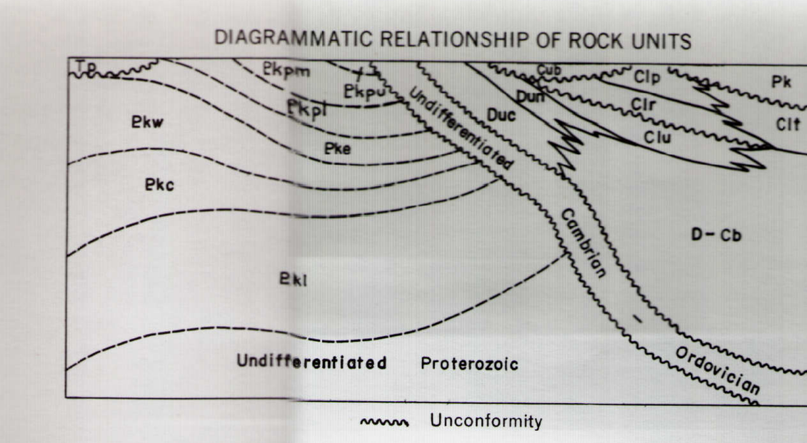
GEOLOGICAL RELIABILITY DIAGRAM



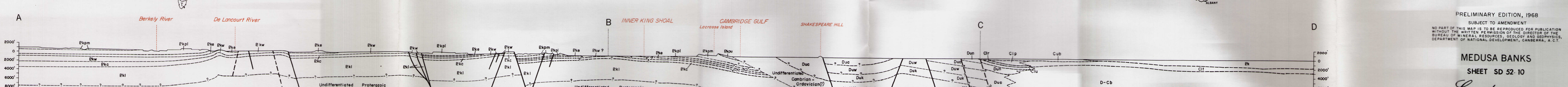
A Detailed mapping
B Reconnaissance; helicopter traverses and air-photo interpretation
C Air-photo interpretation

Geology, 1963-66, by: K.A. Plumb, W.J. Perry, J.J. Veevers, J. Roberts
Compiled, 1968, by: K.A. Plumb, Mrs. D.E. Green
Cartography by: Geological Branch B.M.R.
Drawn by: J.G.A. Den Hertog

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity



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