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SANTOS LIMITED

THE PROSPECTS OF COMMERCIAL OIL ON BATHURST & MELVILLE ISLAND, NORTHERN TERRITORY.

BY: R C Sprigg M Sc

Report Appended : Reconnaissance gravity survey of Bathurst and Melville Islands, by D M Pegum B Sc

Plans to accompany report :

1. Relation of Bathurst-Melville Islands to Oil bearing Island Arc System, North of Australia.
2. Geological Section along South Coast of Island, by Dr B Daily
3. Geological map of Bonaparte Gulf-Bathurst Island Area
4. Graphic log of Strata, Bonaparte Gulf Area
5. Reconnaissance gravity profiles along the South Coast of Bathurst & Melville Islands, and through Apsley Strait.
6. Interpretative Geological (E-W) Section through Bathurst & Melville Islands.

FORWARD

Santos Limited holds exclusive oil exploration rights over Melville and Bathurst Islands, approximately 2,850 square miles in area, and also over the surrounding shallows.

The area was selected on behalf of Santos by Dr M F Glaessner and R C Sprigg by reason of its situation opposite the prolific oil-bearing island arc chain (sumatra-Java-Timor) in a position comparable with that of Saudi Arabia in relation to the Persian Gulf oil fileds. Also the Islands lay along the projected seaward extensions of the Bonaparte Gulf structure in a position favourable to a thinckened sedimentary column, and a wide variety of structural and sedimentation traps, suitable for the accumulation of commerical oil.

INTRODUCTION

In 1954, Dr B Daily, of the University of Adelaide, at the request of Santos Limited, under difficult conditions, investigated the stratigraphy of the Islands and confirmed earlier reports by H L brown (1905) that the principal sediments of the Island were Marine Cretaceous overlain in part by Tertiary leaf bearing, fresh water beds.

Subsequently (1955 & 1956) two geolpgical parties and one geophysical party from Geosurveys of Australia Limited respectively led by R C Sprigg, R O Brunnschweiler, D Pegum have worked the islands and extended these explorations.

THE AREA AND ACCESSABILITY

Bathurst and Melville Islands are outlying, low-lying, developments on the Austrlaian Continental Shelf, situated some 70 miles out from Darwin in the Arafura or Timor Sea. The islands can be reached by sea or air, having several small coastal landind piers, and at least three operative airstrips.

The islands rise only 200 to 300 feet above sea level, and are jungle clad in lower areas with Savanah woodlands on the Plateaux. Tidal and swampy inlets, heavily margined by mangroves, cut deeply into the islands on the north side, but the south coasts are backed by shaley cliffs, and expose numerous flat shelves or "reefs" of clay shales over big tidal areas. The tide range is more than 30 feet, producing fast and treacherous currents amongst dangerous shoals particularyly around the southern coasts.

The islands are strictly patrolled Native Reserves, inhabited by a fine and useful type of island native. Well-run church missions are situated on both islands, and in addition there is a Native Affairs Settlement on Snake Bay. Entry onto the islands is strictly controlled but responsible mining companies are now being encouraged to develop local resources in the best interests of the country. The current exploration programme by Santos is enthusiastically supported by the Darwin Administration.

Wharfing facilities on the island are limited, but should be readily improved to handle preliminary drilling operations. Airfields aituated at strategic intervals about western Melville Islnd & on bathurst Island provide excellent operational bases for expanded exploration of the islands. tracks are strictly limited, and limited to dry season usage.

PREVIOUS INVESTIGATIONS

In 1905, before South Austrli had relinquished its northern areas to the Commonwealth, the State Government Geologist, Mr H Y L Brown visited the islands briefly and reported the presence of Marine Cretaceous believed to be an extension of sediemtns about Darwin.

Professor David, in sections accompanying his Geological Map of Australia (1934) assumed the possible presence of Marine Permian at shallow depth beneath the Cretaceous, but otherwise little has been written geologically of the Islands.

In 1954, Daily's geologcial investigations along the islands south coast demonstrated a minimum thickness of approximately 300 feet of Cretaceous Marine shales and mudstones with an abundant ammonite fauna. The beds lay subhorizontal, or dip gently to the west (or north west), consequently with younger sedimetns outcropping in the more westerly limits. The Tertiary leaf beds of hte northern most peninsula of Melville Island effectively obscured the Marine Cretaceous in that area.

In 1955-6, aerial reconnaissance by R C Sprigg confirmed Daily's structural observations, but could add little more. Dips of more than 2 or 3 degrees are exceptional and are usually associated with small faults (landslides).

More recently R O Brunschweiler assited by I Fraytag and I McLeod carried out further surveys along the south coast, and Apsley Strait, again confirming Daily's findings and noting some interesting erosional changes in geomorphic types from south to north along Apsley Straits which may be related to the northerly superposition of the Tertiary fresh water beds.

Geophysicist, D Pegum accommpanied this survey party, and made gravity observations (Worden instrument) at intervals along the south coast, and through Apsley Strait. His findings, while permitting two alternative interpretations, lend support to the projected extension of the Bonaparte Gulf negative structure at depth beneath western Bathurst Island.

REGIONAL GEOLOGY

Bathurst Island and the western limit of the Melville Island lay astride the projected trend of the Bonaparte NE-SW lineament (geosuture). This presumed ancient crustal feature has had a complex geologcial history markedly affecting the distribution of land and sea since early Paleozoic times. The lineament is thought to reflect a major deep-seated crustal, transcurrent, fault of some (diagonal) world pattern. It lies at right angles to the equally well developed "Kimberley" linement which it meets some 200 miles to the south west of Darwin. The Bonaparte lineament is a complex zone of hinge-faulting with NW side also down to the north. A wedge of sediments attaining many thousands of feet in thickness is preserved in the asymmetrical trough so formed, and includes representative sediments of all but one Palaeozoic Era. The lineament is marked by numerous subparallel and branching normal faults, frequently lying across local sedimentary structure. These relations are clearly depicted in the regional plan somewhat generalized after D M Traves (1955) of the Bureau of Mineral Resources.

Sedimetnary sequences in the Bonaparte Gulf area as summarized by Traves, aggregate a maximum thickness in excess of 18,000 feet [post Antrim Palteau (Lower Cambrian) volcanics]. A big Proportion of these are marine sediemtns, and practically all of the pre-Mesozoic strata plunge north easterly beneath the gulf, and, therefore, probably also Bathurst Island.

A summary of the section is as follows:- (see Appendix A and fig. for more detail)

CRETACEOUS : 300 feet

Marine sands, clay and shales with cincretions Acanthoceras, Turrilites, Hamites, Baculites, etc. (Melville Island).

JURASSIC - TRIASSIC : c. 200 feet

Sandstones with Estheria)
Sandstones with Otozamites)

PERMIAN : 1500 (+) feet.

Pt. Keats beds: Sandstones with shaley beds and carbonaceous shales and coal: Glossopteris.

Weaber Group: Sandstones shales, conglomerates and cross-bedded sandstones with Cardiates, Calamites, Stigmaria, Productus, Spirifer.
Limestones, sandy, and shaley with Spirifer syringopora, Euomphalus, Chonetes, Crinoids.

Ripple marked and flaggy sandstones with increasing conglomerate below.

Massive conglomerates with sandstone beds.

UNCONFORMITY

LOWER CARBONIFEROUS: 1350±

Septimus Limestone:

Massive ans sandy limestone with Crinoids, Spirifer, Athyris, Syringopora.

Enga Sadnstone:

Reddish cross bedded sandstone with marine fossils.

UPPER DEVONIAN: 6800'

Transition (to Devonain) bdes (285')
Calcerous sandstones and sandy and shaley limestones with crinoids.

Burt Range Limestone: (c;4000')

Limestones, shaley, limestone and shales, Chonetes, Productella, Spirifer, Atrypa, Syringopora, Stromatopora, ostracods.

Cockatoo Sandstone: (2500')

Massive reddish sandstone overlain by flaggy red sandstones, calcerous sandstones and crystalline limestones. Some marine fossils.

UNCONFORMITY

DEVONAIN: 550 feet

Pander Greesnsand:

Glauconitic and phosphatic sandstones, with Lingulella conodonts and trilobites.

MIDDLE AND UPPER CAMBRIAN: 4900'

Carlton Group:

Mostly sandstones with interbedded limestones conglomerates near base: Dickelocephalid trilobites Hyolithes, Billingsella.

Negri River Group:

Flaggy limestones, chocolate and grey shales: Redlichia, Xystridura Biconulites Girvanella.

LOWER CAMBRIAN: 3,300±

Antrim Plateau Volcanics (basaltic).

Total Thickness (excluding Antrim Plateau Vlocanics) 18,000 feet.

The section contains several unconformities and considerable gaps in sedimentation. A wide range of wedge-outs is indicated consequent upon rapid lateral and vertial facies changes. More than 70 percent of the section appears to be marine, and the ratios of the various sediments are measured in the sections approximately as follows:-

Limestones	27%
Shales	21%
Sandstones	43%
Conglomerates	9%

In all but the Permian Era, marine conditions appear to have dominated in the region, and many of the marine limestones are richly fossiliferous. The marine sediment are mostly shallow water products, and include many paralic facies. Fresh water sedimetns figured prominantly amongst the continental deposits, and contain come coals (Permian).

OIL SEEPAGES IN TEH BONAPARTE GULF-ORD RIVER REGIONA.

Minor seepages of oil occur near the junction of the Ord and Negri Rivers (south east of Bonaparte Gulf) in Antrim Plateau Basalts (of Lower Cambrian Age). The asphaltic residues occur in steam vesicles and crevices, and appear to have been destructively distilled, along with the basalt extrusions, from pre-existing Late Proterozoic or Lower Cambrian Sediments. They were first reported in 1924.

More recently there have been rumours of minor seepages along the eastern coast of Bonaparte Gulf, presumbably in the Permian Sediments. These appear not to have been authenticated, but the area is little inhabited, and seepages may well pass unnotices in the area.

BATHURST AND MELVILLE ISLANDS:

(a) STRATIGRAPHY:

Daily (1955) has shown that Marine Cretaceous sedimetns outcrop principally along the south coasts of the two islands. In the north their presence is obscured by Tertiary leaf-bearing sands and clays, more than 100 feet in thickness. No other strata are known to outcrop on the island, and rumours of basement outcrop on melville Island are strongly discounted. It has been argued that rutile-bearing heavy mineral beach sands indicate a nearby granitic source, possibly on the isalnd. A more probable explanation is that the sands are multi-cycle and long-travelled products of erosion being re-concentrated from the nearby Tertiary fluviatile deposits typical of the Cap Van Diemen Peninsula.

Log of Strata (daily 1955).

Cretaceous:

30 feet	Mottled sediemtns with lateritic cap.
70 feet	interbedded mottled argillaceous to silty and sandy sediments.
7 feet	glauconitic sands with band clay.
18 feet	interbedded glauconitic sands and clays.
8 feet	glauconitic sands and clays, contianing keeled ammonites, bivalves and gastropod moulds.
35 feet	green glauconitic sands, rich in muscovite marcasite nodules and boulders of consolidated sand near top. Ammonites near base.
10 feet	Dark green glauconitic clay, with thin sand partings; Lignite particles and fragment of bivalve.
50 feet	Section covered.
30 feet	Glauconite clays and thin sands, ferruginized nodules; Lignitic particles.
8 feet	Glaucontic clays; thin sands. Acanthoceras, inoceramus.
8 feet	Glauconitic sands with thin clays; crabs.
11 feet	Strongly cross-bedded glauconitic sands with ferruginized nodules Acanthoceras lobster, tree trunk.
5 feet	Glauconitic sands, cross bedded; ferruginized nodules. Acanotheroceras, Turrilites, Baculites, Inoceramos, gastropods, bivalves.
25 feet	Interbedded glauconitic sands and clays; some feruginous nodules flattened along bedding: fossils as in proceeding plus Hamites.
15-20 feet	Interbedded glaucontitic clays and sands, with boulders up to 2 feet in diameter. Fissils as above. Belemnites at base.

NOTE : Succession of shales sandstones continuous below, out to sea and include also scaphites, teeth and bones.

(b) STRUCTURE:

Almost continuous cliff outcrops along the south coast of Melville Island, 65 miles from Cape Gambier to the western extremity of Bathurst Island, indicate the Cretaceous beds to be subhorizontal at least in the direction of Cliff section. Broad undulations of 2 to 3 degrees are observed , and localized somewhat steeper dips have also been observed. Daily's sectioning along this coast indicates almost complete horizontality for 30 to 40 miles west from Cape Gambier, thereafter the beds dip gently west a total of perhaps 200 feet in 20 odd miles.

Nothing certain is known of structure in the more northerly portions of the island, but the sandstone and shales of the south coast appear to pass gently below sea level in this direction, and are overlain by Tertiary sands and clays. Cliffs only appear where laterites protect the underlying soft sedimetns and none of characteristics geomorphological forms of the south west coast is apparent in the north. Steeper sedimentary dips have been recorded half way along Apsley Straits.

To the south, across the Arafura sea the Marine Cretaceous thins until in the Darwin area is little more than a veneer, and eventually disappears completely a few miles from the present coast.

(c) GRAVITY DATA: (see also appended report).

Late in 1956, geophysicist D Pegum made a brief gravity survey through Apsley Strait, and along the south coast of Melville and Bathurst Islands west from the Cape Van Diemen (see appended report). By and large, these findings appear to indicate that the eastern half of Bathurst Island, and most of Melville Island, appears to be underlain by relatively shallow bedrock, (less than 1-2000 feet) perhaps shelving gently to the north, continuing the gentle dip evident in the Marine Cretavceous extending from the mainland near Darwin. Reasonably large negative gravity anomalies recorded along a line of section from south of Darwin, via Apsley Strait to Cape Van Diemen, all appear referable to granite bodies intruding the lower Proterozoic sedimentary section in this zone. Along the eastwest section, a much stronger negative anomaly appears towards the south western extremity of the island. Interpretation of a granite intrusion appears insufficient to account for this anomaly, and a greater depth to basement is assumed. This is in keeping with the suggested projection of the Bonaparte structure beneath the western portion of Bathurst Island. An extension of these surveys is planned for 1957.

OIL POSSIBILITIES ON MELVILLE AND BATHURST ISLAND

Several inportant regional features must be taken into account in dealing with the oil propects of these islands. Firstly the restricted sedimentary section exposed on the island gives practically no clues to developments at depth. Secondly Bathurst Island lies directly in line with the down faulted Bonaparte Gulf Structure which is bounded on its south eastern margin by a major crusted lineament structure or "geosuture". This structure has had a complex history, and has almost certainly exercised an important control upon thick sedimentation and rapid lateral facies changes in its vicinity. Thirdly, Bathurst and Melville Islands lie in the up dip direction from the deeply down-warped geosynclinal trough if the Sumatra-Java-Timor island arc system. Comparison of the Melville-Bathurst Island shelf location opposite this oil bearing province, (fig.) suggests important analogies with the Saudi Arabien Shelf and Alpine Arc System of the Persian Gulf area.

If it can be reasonably assumed that the seaward plunging sediments of the Bonaparte Gulf structure do persist beneath Bathurst Island, then a considerable thickness of Palaeozoic-Mesozoic strata can be anticipated in depth in this area. Much, if not all, the composite stratigraphic section illustrated by Traves in the Bonaparte Gulf area may be expected to be present. The sediment would almost certainly be mostly marine in character, and have direct connection with sediments extending perhaps fully across the Arafura (Sahul) shelf into the sphere of the Timor geosyncline.

(a) Source Beds:

Minor (?) Cambrian source beds are known in the area, but the thick marine succession postulated to extend beneath the islands, at least on the west, offer a considerable variety of fine grained source beds. Many of the Palaeozoic sediments are highly fossilliferous, and would undoubtedly contain plentiful source materials for pertroleum generation. If anything, sediments can be expected to become finer-grained away from the coast, and also be more dominanatly marine. There should, therefore, be no lack of source beds favourably located in relation to Bathurst (and Melville) Islands.

(b) Traps:

Gentle fold and warping structures are well developed in Pre-Permian sediments in the approaches to the Bonaparte "lineament to the south west of Bathurst Island. Comparable structures may well be expected at depth below th eisland if the foregoing genreal thesis is correct. Such folds could only be delineated by drilling, or by seismic surveys. Small scale faulting is common about the Bonaparte "line" and fault traps may also be important.

Sedimentary traps in the form of wedge-outs, unconformities, facies changes, and permeability changes can be expected in profusion. There should be no shortage of these, although their delineation will not be simple.

SUMMARY AND CONCLUSIONS:

Melville and Bathurst Islands are remnant platforms of Marine Cretaceous sediments passing ently below sea level (and fresh water Tertiery beds) to the morth. A minor tilt also to the west is also observed along the western half of the south coast of Bathurst Island. Nothing is known of Pre-Cretaceous sediments on the island. A reconnaissance gravity survey (by D Pegum) has suggested a possible thickening wedge of sedimetns beneath the western limits of Bathurst Island, which is in keeping with the writer's regional geological concepts on the area. Projection of the Bonaparte "lineament" from the southwest would bring it centrally beneath Bathurst Island, and the sedimentary section would then presumably thicken rapidly to the west in depth.

Sediments of the Bonaparte Gulf area to the south are dominantly Marine, containing plentiful potential source beds (shales and limestones) excellent reservoir storage beds, and a great profusion of potential sedimentary and structural traps.

The island's favourable situation on the Arafura shelf facing the oil bearing Timor (and Sumatra-Java) geosyncline encourages comparison with the Arabian shelf relationships with the Permian Gulf geosyncline.

RECOMMENDATIONS:

Santos or an associate should drill a deep stratigraphic hole in the south western promontory of Bathurst Island to demonstrate the stratigraphic sequence, to test the fluid content of the sediments encountered, and to provide correlation for subsequent seismic exploration or shallower structure drilling.

Reg. C Sprigg
MANAGING DIRECTOR

RECONNAISSANCE GRAVITY SURVEY OF BATHURST AND MELVILLE ISLANDS

BY

D Pegum B.Sc.

SUMMARY

A gravity reconnaissance was carried out in October November 1956 on behalf of Santos Limited over the western portion of Bathurst and Melville Islands in the Northern Territory of Australia. The results are presented in the form of a plan showing the Bouguer Anomaly of the stations established and profiles of the anomaly including the profile of a regional traverse from Katherine to Darwin. The results show the presence of large gravity variations along the southern coast of Bathurst Island which indicate the possibility of considerable depth of sediment under western Bathurst Island.

PREVIOUS GEOLOGICAL AND GEOPHYSICAL WORK.

The geology of the area is the subject of a detailed report by Dr. R O Brunschweiler which accompanies this report. No known previous geophysical work has been done in the area.

RESULTS.

The absolute value of gravity was determined by reoccupation of the Commonwealth Bureau of Minreal Resources Pendulum Station at Darwin (value 978-3155 cms/sec^2). An ainal gravity tie was made from this situation to stations established at Bathurst Island, Garden Point, and Snake Bay airstrips. The first two of these were used as base stations fro the present survey.

Stations were established along the coast at high levels and located on the Melville Island 4 mile series military sheet. Correction for the variation of water level near the stations was made together with correction for instrument drift by reoccupation of selected stations. The results are presented in teh form of a plan showing the location of the stations and value of the Bouguer Anomaly and other showing the profile of the Bouguer Anomaly for the stations of the present survey and for a regional traverse from Katherine to Darwin made by the Commonwealth Bureau of Mineral Resources.

INTERPRETATIONS.

The regional traverse from Katherine to Darwin shows an irregular gravity profile across the Precambrian rocks with marked negative anomalies over and near areas of granite outcrops. There is a regional gradient trending positive toward the coast. The traverse through Apsley Strait shows variations of the gravity anomaly of the same order as these observed over Precambrian, rocks on the mainland and is in agreement with the idea of shallow Cretaceous capping over Precambrian in this area. The most negative area along the traverse is in the Garden Point region which may indicate the presence of granite, deeper Cretaceous cover or a shallow sedimentary basin in this area for a normal density contrast (0.25 to 0.4). The depth of sediment would be approximately 2000 feet.

The traverse along the south coast of Bathurst Island however shows, running west from Bathurst Island Mission, first a rise in gravity of 20 milligals followed by a drop of 36 milligals. The first rise is about equal to those observed on the margin of granites on the mainland. So the traverse may ne interpretated as indicating possible granite underlying Bathurst Island mission followed by Precambrian sediments further west followed by a 36 milligal negative anomaly near Cape Fourcroy. This anomaly is larger than those observed over granites on the mainland and if indication of a sedimentary basin for normal density contrast would indicate a depth of sediments of the order of 10,000 ft. thinning very rapidly to the east. Alternatively, if Bathurst Island Mission is considered to be underlain by precambrian rocks then the anomaly at Cape Fourcroy is of the oder of those over granites on the mainland and there is an unexplained positive anomaly of 20 millgals along the coast. This is more difficult to interpreta as no such anomaly is observed on the available traverse over the mainland.

The first Interpretation seems the more geologically feasible as the sttep gravity drop lies on teh northward projection of the steep eastern margin of the Bonaparte Gulf. Basin suggesting the possible presence of palaeozoic rocks underlying the western part of the Bathurst Island.

CONCLUSIONS.

The traverse along the south coast of Bathurst Island shows gravity variations which indicated the possibilities of a considerable depth of sediment under western Bathurst Island. An eastwest gravity traverse on the mainland where the geology is known would provide useful information to aid the interpretation of the results so far ontained. Further gravity work on the islands would give a better idea of the nature and extent of the gravity anomalies found in this survey. A seismic survey or test drilling in the area should indicate the corrections or otherwise of the interpretation advanced here for the gravity survey.

Associated Drawings

San. 78.
San. 79.

COMPOSITE LOG OF STRATA

BONAPARTE GULF, NORTHERN TERRITORY

after

D M TRAVES (B.M.R., 1955)

CRETACEOUS - 200'		Laterite; marine graey shales and blue clays (Ammonites, Aucella, Baculites)
Pt. Keats Group	:	PERMIAN TO JURASSIC - 1660'
	1500'	Otozamites sandstone. JURASSIC
		M-C. gr. sandstone, Arkosic in part with shale partings. Estheris.
		Shale bands in soft sandstone
		Carbonaceous shales and sandstone. (Glossopteris)
		soft sandstone with shaley streaks and lenses.
	80'	Coal, sandstone and shale.
	80'	Shale
Weaber Group	:	PERMIAN - 2995'
	120'	Sandstone with thin shales.
	160'	Limestones, shaley impure limestone, shale. Productus, Spirifer, (?) Cordaites, Calamites, Stigmaria.
	75'	Arkosic and friable sandstone.
	70'	Conglomerate.
	150'	Cross-bedded ferruginous sandstone
	250'	Brown and grwy sandstone with shaley limestone, sandstone and limestone with fossils
	120±'	Siliceous limestone with fossils) Spirifer,
	100'	Sandy grey limestone with fossils) Syringopora,
	150±'	Grey crystalline limestone,) Eumophalus
		numerous fossils) Crinoids, Chonetes
		Trachyte
	C.800'	Nigli Gap sandstone
		sandstone, ripple-marked and flaggy with conglomerate bands.
	C.1000'	Massive Conglomerate with sandstone lenses.
		(Extensive overlap onto basement at this level : very slight unconformity)
Septimus	:	LOWER CARBONIFEROUS - 355'
Limestone	90'	Massive crinoidal limestone.
	125'	Sandy crinoidal limestone, current bedded and ripple-marked.
	140'	Crinoidal limestone. Spirifer, Athyris, Syringopora
Enga Sandstone	:	LOWER CARBONIFEROUS - 1000'
	c.1000'	Reddish Medium-grained friable sendstone : Marine fossils.
Transitional		UPPER DEVONIAN to LOWER CARBONIFEROUS - 390'
	85'	Calcerous Sandstone and Sandy Limestone with Crinoids
	30'	Crystalline limestone and Shaley limestone : abundant fossils
	75'	Grey snady limestone and Calcerous Sandstone :
	200±'	

Burt Range Limestone : UPPER DEVONIAN - C.4000

C.4000' Limestone, interbedded shales. Chonetes, Productus, Spirifer, Atryoa, Syringopora, Stromatoporoids, Ostracods etc.

Cockatoo Sandstone : UPPER DEVONIAN - 2,500'

300' Red medium-coarse grained Sandstone, ripple-marked and with mud-pellets
400' Cross-bedded Sandstones
300' Dense, well-bedded crystalline limestone and calcareous sandstone
200' Reddish felspathic sandstone, in part flaggy
1300' Reddish medium-coarse grained felspathic sandstone, well-bedded with fossils.

- Unconformity -

Pander Greensand : ORDOVICIAN - 550±

550±' Glauconitic and phosphatic sandstone (Red and green) Ripple-marked, worm burrows. Lingulella, Conodonts, Trilobites

Clarke R. Sandstone : MIDDLE - UPPER CAMBRIAN - 600±'

600±' Dark greenish and reddish galuaconitic sandstone and friable red sandstone. Dikelocephalid, Trilobites, Brachiopods, Gastropods etc.

Pretlove Sandstone : MIDDLE - UPPER CAMBRIAN - 400±'

400±' Friable felspathic sandstone : some glauconite. Crepicephalus

Shewthorpe Formation : MIDDLE - UPPER CAMBRIAN - 410'

20' Grey and green shale
200' Grey crystalline limestone, with sandy limestone and Oolite
90' Soft sandstone, sandy limestone ; worm burrows
?100'

Hart Spring Sandstone : MIDDLE - UPPER CAMBRIAN - 600'

600' Red sandstone, ripple-marked, sun cracked ; few impure limestones. Hvolithes, Billingsella

Ragged Range Conglomerate : MIDDLE - UPPER CAMBRIAN - 600'

600' Fine Coarse grained sandstone with conglomerate bands

Hudson Shale : LOWER - MIDDLE CAMBRIAN - 750'

750' Shale

Corbin Limestone : LOWER - MIDDLE CAMBRIAN
Laminated limestone

Negri R Shale : LOWER - MIDDLE CAMBRAIN - 250'
shale

Shadylamp Limestone : LOWER - MIDDLE CAMBRIAN - 145'

145' Shale and limestone with trilobites, Girvanella Redlichia, Xystridura, Biconulites

??nton Shale : LOWER - MIDDLE CAMBRIAN - 200'

200' Chocoalte and grey shale

Kinnekar Limestone : LOWER - MIDDLE CAMBRIAN - 70'

70' Flaggy limestone with Calcerous shale and chert Redlichia, Biconulites, Girvanella

Nelson Shale : LOWER - MIDDLE CAMBRIAN - 600'

600' Grey blue and brown shales

Headley Leimstone : LOWER - MIDDLE CAMBRAIN
Grey Limestone
Massive Hard crystalline limestone. No recorded fossol

Antrim Plateau Volcanics : LOWER CAMBRIAN - 3,330±'

3300;' Basalts, amygdaloidal basalts, agglomerates, ash

PROTEROZOIC AND ARCHEAN
"Basement" complex

SUMMARY TABLE

Maximum Recorded Thicknesses. (sedimentary Sequence Only)

JURASSIC & CRETACEOUS	200±
PERMIAN	4655±
LOWER CARBONIFEROUS	1445
UPPER DEVONIAN	6800
ORDOVICIAN	550+
CAMBRIAN	4625+
Total	18275+ feet