COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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MEDA No. 1 WELL, WESTERN AUSTRALIA

OF

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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

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by

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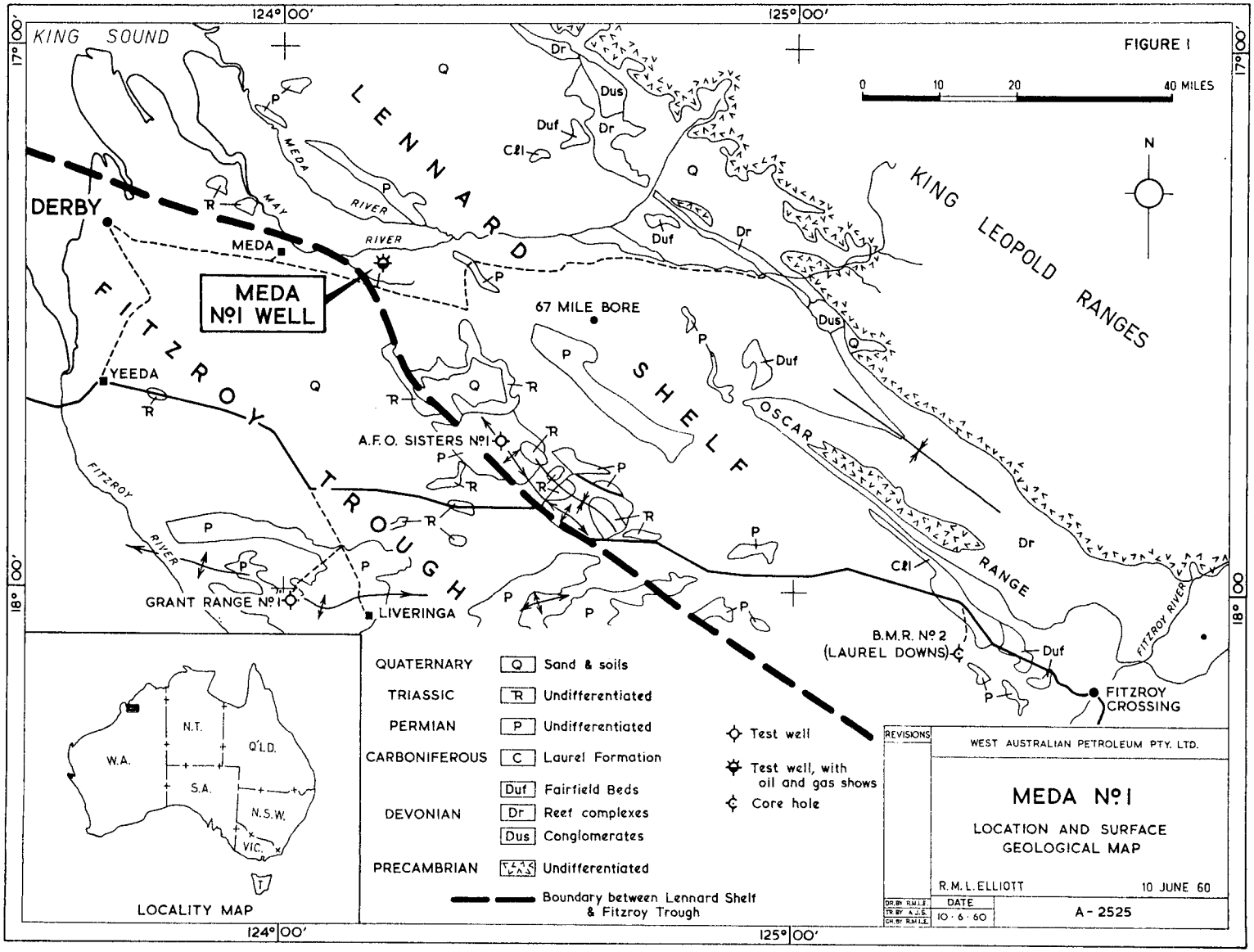

ENCLOSURE No. 2

SUMMARY

The Meda No. 1 Well was drilled with WAPET's National 100 rig to the total depth of 8,809 feet. The well was spudded in alluvium, which overlies the Blina Shale to 60 feet. Below the Blina Shale, the Permian sequence was penetrated, consisting of the Liveringa Formation, Noonkanbah Formation, Poole Sandstone with its Nura Nura Member, and Grant Formation. A disconformity is present between the Poole Sandstone and the Grant Formation.

The Grant Formation unconformably overlies the Anderson Formation (Upper Carboniferous) at 4,201 feet. The Laurel Formation (Lower Carboniferous) was penetrated from 4,935 to 5,483 feet. The boundary between the Lower Carboniferous and Upper Devonian (5,483 feet) is tentatively picked at the change from interbedded limestone and siltstone to oolitic limestone. The main objective of the test, the Upper Devonian reef complex, was penetrated at 6,620 feet and drilled to the basal conglomerate at 8,360 feet. Precambrian basement was encountered at 8,663 feet. The Permian and Carboniferous sequences could be correlated with the equivalent sequences in The Sisters No. 1 Well. Because of different facies, no formation correlations could be made in the Devonian sequence.

The test resulted in the recovery of several gallons of paraffin-base crude oil. The oil-bearing zone is in the upper part of the Laurel Formation and is confined to a bed of fine-grained slightly porous, calcareous and dolomitic sandstone between 5,125 and 5,133 feet. However because of slight permeability and high water saturation this zone is of no commercial value in this well.

Numerous gas zones were penetrated in the Upper Devonian reef complex but they yielded only weak gas flows, predominantly of methane.

The discovery of hydrocarbons in the Laurel Formation and Devonian reef complex makes Meda No. 1 of great importance in oil exploration of the Kimberley district.

The drilling results show that future oil exploration on the Lennard Shelf should have two main objectives:

(a) structural closures in the Lower Carboniferous

(b) Devonian reef facies.

INTRODUCTION

Meda No. 1 is located 35 miles east of Derby, Western Australia. It is the first exploratory well drilled by West Australian Petroleum Pty Limited (WAPET) on the Lennard Shelf. This shelf is located immediately north of the Fitzroy Trough and is the northern marginal zone of the Canning Basin (see Fig. 1).

Gravity data show elongated maximum anomalies in the area, with a linear trend from 10 miles west of Meda No. 1 to A.F.O. The Sisters No. 1. Gravity surveys in the Oscar Range demonstrated that similar anomalies in these areas represent basement highs with which large Devonian reefs are associated.

It was assumed that the positive gravity anomalies on the margin of the Lennard Shelf near the deep basin are associated with basement ridges with possible reef development in the Devonian section. The possibility of a reef structure was also indicated by a seismic survey, which showed terracing and thinning of the sediments over the suspected Devonian reef and some erratic dips suggested reefing. The main structural feature of the area is a terracing in the regional dip of the Devonian and Carboniferous strata over the basement high, with a few very small anticlinal closures.

Meda No. 1 was located near a positive gravity anomaly, with the objective of testing for hydrocarbons in possible stratigraphic traps formed by the Devonian reef complex. The exact location was obtained from a seismic survey, which outlined a small closure and erratic dips (possibly indicating a reef complex) in the Devonian sequence in the vicinity of a gravity maximum. It was expected that the Fairfield Beds and Laurel Formation would provide suitable cover beds.

Meda No. 1 penetrated a section of Triassic, Permian, Carboniferous, and Devonian rocks before reaching Precambrian basement at a depth of 8,663 feet. A Devonian reef was encountered in the well and basement was reached at approximately the depth predicted. Thus this well is a good example of a successful geophysical and geological interpretation.

WELL HISTORY

General Data

Location	:	Transverse Mercator Co-ordinates -
		Latitude : 17° 24' 00" S.
		Longitude : 124° 11' 30" E.
Permit to Explore	:	30H
License to Prospect	:	54H
District	:	Kimberley
Total Depth	:	8,809 feet
Date Spudded	:	8th June, 1958
Date Suspended	:	21st November, 1958
Elevation	:	Derrick Floor 100'
		Ground Level 88'

Drilling record summary

The hole was drilled with WAPET's National-100 Rig (No. 4) by Oil Drilling & Exploration (W.A.) Pty Ltd.

Hole size	:	20" from surface to 415' 13 3/4" from 415' to 4,060' 9 7/8" from 4,060' to 8,809' (T.D.)
Casing	:	395' of 16" x 65 lb/ft casing cemented at 412' 4,047' of 10 3/4" x 40.5 lb/ft casing cemented at 4,060' 6,723' of 7" x (at the bottom 4,802' x 23 lb/ft, in the middle 815' x 26 lb/ft, at the top 1,106' x 29 lb/ft), casing cemented at 6,738'.

Perforation of 7" casing

All perforations were done with a jet-gun (type SC4") shooting 4 shaped charges per foot:

Perforated Intervals	Number of Shots	Remarks
5,106-5,108'	8	WSO No. 3
5,107-5,108'	4	WSO No. 3 re-perforation
5,110-5,133'	92	
5,150-5,152'	8	WSO No. 4
5,246-5,248'	8	WSO No. 2
5,250-5,264'	56	
5,270-5,310'	160	
6,590-6,592'	8	WSO No. 1
6,594-6,610'	64	
6,625-6,640'	60	
6,670-6,676'	24	
6,688-6,695'	28	

Plugs

Plug No. 1, set at 7,669', using 125 sacks cement
Plug No. 2, set at 6,738', using 50 sacks cement
Plug No. 3, Baker K bridge plug plus 4 sacks of cement, set at 5,350'.
Plug No. 4, Baker K bridge plug plus 4 sacks of cement, set at 5,200'.
Plug No. 5, 5,001-5,100', using 28 sacks of cement.

Equipment left in the hole

All three strings of casing were left in the hole.

Ditch Samples

Ditch Samples were collected from the surface to T.D., at 10-foot intervals during drilling and at 5-foot intervals while coring.

Cuts of the washed ditch samples were made for the Bureau of Mineral Resources, the Mines Department of W.A., Associated Freney Oil Fields, N.L., and WAPET.

WAPET's cuts from the pre-Permian section are at the Perth Office, and the rest have been stored in the Derby Warehouse.

All bulk (unwashed) samples have been stored in WAPET's Norma Road Corehouse, Melville, W.A.

Coring

28 cores were cut using Hughes type 'J' core barrel with 7 7/8 inch soft and hard formation core heads and D.S. Truco core barrel with 8 3/4 inch diamond corehead. The diamond corehead was used in fractured rocks of the Devonian reef complex, where the conventional core barrel gave very poor recovery.

Details of the cores are given in Appendix C.

A total of 265 feet of formation was cored, giving 170 feet or 64% recovery. Two attempts were made to cut a bottom core (Nos. 27 & 28) using conventional and diamond core barrels. Both attempts failed because of the very hard nature of the basement rocks.

Core cuts were distributed in the same manner as the ditch samples. The bulk of the cores has been stored in the Norma Road Corehouse.

Sidewall Coring

35 sidewall cores were shot and recovered with Schlumberger's chronological sample taker, at the following depths and dates:

1,269',	1,280',	1,289',	1,335',	1,343'	7th July, 1958.
1,576',	1,580',	1,581',	2,134',	2,140')	23rd July, 1958.
2,145',	2,150',	2,159',	2,164',	2,169')	
2,195',	2,200',	2,205',	2,244',	2,250')	
2,255',	2,450',	2,455',	2,460',	2,550')	
5,113',	5,119',	5,125',	5,128',	5,130')	
5,133',	5,137',	5,140',	5,144',	5,148')	

Electrical Logging

The following Schlumberger logs were run:

Electrical log, Laterolog, Gamma Ray-Neutron,
Microlog - Caliper, Temperature Log, and Dipmeter.

The logs are listed in Appendix G.

The composite log (Plate 1) includes selected electric logs. Below 5,400 feet the gamma ray-neutron log has been used instead of the electric log because the electric log is not considered to be diagnostic in predominantly carbonate sequences.

The original electric logs, from which the published logs have been reduced and redrafted, are held by West Australian Petroleum Pty Limited. Prints from all the original electric logs are available for inspection at the Bureau of Mineral Resources, Canberra.

Drilling Time and Gas Log

Five-foot drilling time was recorded while drilling and one-foot drilling time was taken while coring.

Drilling times and lithology together with JW gas detector readings have been graphically recorded on a separate log (Plate 2).

Formation Tests

Six Drill Stem Tests were run in the open hole and three Drill Stem Tests were performed through the perforated 7" casing. DST No. 9 resulted in the recovery of several gallons of crude oil. Details of these tests are listed in Appendix E.

Four water-shutoff tests were run in the 7" casing.

Deviation Record

Deviations were recorded with an Eastman Deviation Recording Device for 48 levels. Also two runs were made with the Schlumberger Directional Log.

GEOLOGY

Formation descriptions

The formations penetrated in this well are discussed below. The Permian and Carboniferous sequences are discussed in some detail and are compared with the same sequences in other wells in the Canning Basin. The Devonian section is different from that penetrated in any other well in the area and at present the lithological units of the Devonian reef complex are un-named.

The section in the well is set out in Table I.

TABLE I

Formations in Meda No. 1

Age	Formation	Formation Tops		Thickness
		Depth D.F.	Depth Subsea	
Quaternary	Alluvium	12'	+88'	48'
Permian or Triassic?	Blina Shale	60'	+40'	654'
Permian	Liveringa Formation	714'	- 614'	589'
	Noonkanbah Formation	1,303'	-1,203'	922'
	Poole Sandstone	2,225'	-2,125'	201'
	Grant Formation	2,426'	-2,326'	1,775'

TABLE 1 (Cont'd)

Age	Formation	Formation Tops Depth D.F.	Depth Subsea	Thickness
Carboniferous (Upper)	Anderson Formation	4,201'	-4,101'	734'
Carboniferous (Lower)	Laurel Formation	4,935'	-4,835'	548'
Devonian	Fairfield Beds(?) Equivalent	5,483'	-5,383'	1,137'
Devonian (Reef Complex)	(Reef	6,620'	-6,520'	111'
	(Dolomitized Reef	6,731'	-6,631'	504'
	(Terrigenous (Member	7,235'	-7,135'	368'
	(Fore-reef	7,603'	-7,503'	757'
	(Basal Conglom- (erate	8,360'	-8,260'	303'
Precambrian	Schist	8,663'	-8,563'	146'+
	T.D. 8,809'			

Quaternary:

Alluvium, 12 - 60 feet

The Quaternary is represented by alluvial sand deposited on the flood plain by floodwaters of adjacent rivers.

The sand is medium grey near the surface, but brownish yellow at the bottom. It is fine to medium-grained with occasional coarse-grained beds, poorly-sorted, containing abundant silt and clay matrix. Quartz grains grade from sub-angular to sub-rounded.

Permian or Lower Triassic:

Blina Shale, 60 - 714 feet (Kazanian-Scythian)

Underlying the alluvial sand is 40 feet of greyish-yellow sandy and silty clay. It was thought to be of alluvial origin, but is now considered to be the weathered top of the Blina Shale. The unweathered formation consists of interbedded shale and siltstone with some lenses of very fine sandstone. In the upper part (100-280') the lithology is predominantly shale, medium grey, with some dark brown-grey lenses, micaceous. slightly pyritic, poorly-laminated, soft. Interbedded with this shale are a few thin beds of medium grey, thinly bedded siltstone, fine to coarse, containing in parts fine, dark brown quartz sand grains and occasional pelecypods. In the middle part (280-450 feet) the number of siltstone beds increases, and siltstone lithology becomes dominant. Some siltstone lenses grade into very fine sandstone containing very fine glauconite grains. Brown coloured beds are common and they contain ferruginous

sand grains, limonite grains, pinkish siliceous nodules (porcellanite), brown chert and some silicified bone fragments.

The colour of the interbedded shales of this section is greenish grey. Fossils are mostly conchostracans and fish teeth. Numerous specimens of the small bivalved conchostracan Isaura were identified during micropalaeontological examination of cuttings between the surface and 720 feet by the Bureau of Mineral Resources.

The bottom section (450-714 feet) of the formation in its upper part consists mostly of shale, but changes towards the base to siltstone as above, with thin beds of sandstone. This sandstone is of medium to light grey colour, very fine-grained, micaceous, finely glauconitic, non-porous to moderately porous and friable. Some silty sandstone beds contain abundant spots of light brown silt.

The Blina Shale is characterised by a Lueckisporites (s.s.) microflora (Balme, Appendix A). However, the age of the formation at present is uncertain. It was previously regarded as basal Triassic, but reports on later fossil collections seem to indicate an Upper Permian age.

Permian:

Liveringa Formation, 714 - 1,303 feet (Upper Artinskian-Tatarian)

The upper part of the formation (714-750 feet) consists predominantly of sandstone: light to medium grey, fine-grained, well-sorted, porous to moderately porous, pyritic and carbonaceous. This sandstone is interbedded with minor thinly bedded, dark to medium grey, micaceous and carbonaceous siltstone.

The middle part of the sequence (750-950 feet) is represented mostly by siltstone as in the upper part, in places grading into shale with some medium brown coloured beds and thin beds of fine-grained, light grey, carbonaceous sandstone. In the upper part of this lithological unit, the sandstone contains abundant carbonised plant fragments, but at the base it is medium-grained and only slightly carbonaceous.

The lower part of the formation (950-1303 feet) comprises a sequence of sandstones with some siltstone beds. At the top of this sequence (950-1,155 feet) light grey, porous sandstone grades from fine to coarse, containing silty and carbonaceous beds. It is interbedded with siltstone: dark-grey and medium to light brown-grey, micaceous and carbonaceous, with lenses of black and dark-brown coal. The lower part (1,155-1,303 feet) of the sequence contains predominantly silicified beds of sandstone and siltstone. The fine to coarse sandstone of this basal unit is grey and brownish-yellow, with siliceous cement, in parts containing siliceous oolites. Near the base, the colour of the sandstone becomes dark to light greyish-green and in parts the sandstone contains abundant lenses of limonitic (?) oolites. The interbedded dark grey and light brown siltstone with siliceous and carbonaceous lenses contains pelecypods and some brachiopods.

The lithology of the basal unit strongly indicates the Lightjack Member of the Liveringa Formation. Very probably this member is represented by the lower part of the formation (950-1,303 feet). The correlation of the middle (750-950 feet) and upper (714-750 feet) parts of the section is uncertain. There is no definite indication of the presence of the

Hardman Member, which in outcrop contains a rich marine fauna at its base.

It is probable that the section from 714-950 feet represents the Middle (unnamed) Member of the Liveringa Formation. The Liveringa Formation is included in the zone of the Tholosporites microflora assemblage (Balme Appendix A).

Noonkanbah Formation, 1,303 - 2,225 feet (Artinskian)

The Liveringa Formation conformably overlies a sequence of thinly interbedded shales, siltstones, sandstones and some limestones.

The shales are black, micaceous, friable and generally poorly laminated, in parts grading into claystone. The siltstones vary from black to dark grey and light grey. They are micaceous, fine to coarse-grained and contain lenticular marcasitic patches. The light-coloured, coarse-grained beds are fairly calcareous. The thinly bedded, light grey to white sandstones are very fine-grained, silty, micaceous, calcareous to very calcareous, in parts slightly glauconitic, moderately porous to non-porous. Some sandstone beds grade into very sandy calcarenite. The limestones of the sequence are represented by a few thin beds of yellow sandy coquinite, consisting predominantly of brachiopod and bryozoan fragments. The lower part of the formation contains beds of silty and slightly sandy limestone. This limestone is brownish grey, very finely crystalline, micaceous, in parts very silty, and hard. It contains brachiopods, foraminifera and ostracods.

The cores show current-bedding and slumping.

The marine origin of the formation is indicated by the presence of a comparatively rich marine fauna and the absence of carbonaceous material. The formation has a uniform lithology throughout most of the section; the change to a more calcareous sedimentation occurs only in the lower part. Two lithological sub-units could be established tentatively on this basis.

The upper part of the formation (1,303-1,945 feet) consists of thinly interbedded shale, siltstone, sandstone and a few beds of coquinite, and the lower part (1,945-2,225 feet) consists of interbedded shale, siltstone, silty limestone, and coquinite. This lower unit contains one bed of sandstone from 2,140-2,170 feet, light grey and light brown to cream, fine-grained, very calcareous and fossiliferous (mostly bryozoans).

The upper boundary of the formation is well established by a rich foraminiferal fauna characteristic of the Noonkanbah Formation (I. Crespin, Appendix A), and by Striatitites microfloral assemblage (Balme, Appendix A).

The bottom of the formation is defined by lithology and a definite break on the Electrical and Gamma Ray logs. Palaeontological evidence could not be used in the lower part of the formation because of the poor preservation of the fossil material (brachiopod fragments and foraminifera in Core No. 2, 1,943-1,963 feet). On palynological evidence from Core No. 2 and sidewall cores 15, 16 & 17 (2,200 feet) Balme (Appendix A) equates the basal part of the formation to the Poole Sandstone in wells on the Broome Ridge. A Cirratriradites microflora in the above-mentioned samples, is also present in The Sisters No. 1 Well, Core No. 2 1,821-1,841 feet. Core No. 2 in The Sisters No. 1 originally was considered to come from the Poole Sandstone. However, comparing electrical logs from The Sisters No. 1 and Meda No. 1

(very good S.P. and resistivity markers) it seems that Core No. 2 in The Sisters No. 1 well was cut in the base of the Noonkanbah Formation. The lithology, which is predominantly shale, also indicates Noonkanbah Formation.

It is evident that the assemblage of the Cirratriradites microflora is present in the Noonkanbah Formation and it does not indicate Poole Sandstone. This assemblage could be used in the sub-division of the Noonkanbah Formation.

Poole Sandstone, 2,225 - 2,426 feet (Lower Artinskian)

The top of this formation is shown well by electrical and gamma ray log markers.

The formation consists predominantly of sandstone: light grey to white, fine-grained, subangular quartz grains well-sorted, moderately porous, slightly micaceous, in parts slightly glauconitic and containing calcareous beds. The sandstone is interbedded with dark grey, grey brown, and light grey micaceous siltstone. The siltstone contains some black shale lenses. Scattered through the formation are some pyrite nodules and pyritized fossil wood fragments.

The basal part of the unit (2,372-2,426 feet) is interbedded with light brown, medium-grained very calcareous bryozoan sandstone, grading into very sandy calcarenite with very abundant bryozoa and some brachiopods, and a few beds of medium brown, sandy, fossiliferous limestone. Crespin (Appendix A) indicates that Core No. 3 (2,361-2,375 feet) contains a rich foraminiferal assemblage which is characteristic of the Callytharra Formation of the Carnarvon Basin, and its equivalent, the Nura Nura Member of the Poole Sandstone in the Fitzroy Basin. Dr. Crespin states that the lithology of this core is similar to 'that of Core No. 19 at 1,545-1,555 feet in the Dampier Downs No. 1 well which contains a delicate test of Tetrataxis and which was tentatively regarded as Grant Formation.'

The Poole Sandstone and its basal member - Nura Nura - in Meda No. 1 can be correlated by means of lithology, electrical logs and, especially, gamma ray logs, with other wells in the Fitzroy Basin (Table I).

Probably the best correlation is with Dampier Downs No. 1 Well. The Nura Nura Member in both wells has the same lithology; light brown bryozoan sandy calcarenite and bryozoan, very calcareous sandstone. The gamma ray logs are also very similar, in that they show a very sandy upper part of the formation, sandstone interbedded with siltstone in the middle part, and interbedded sandy calcarenite at the base. Gamma ray logs from Roebuck Bay No. 1 and Nerrima No. 1 show a similar pattern. The lithologies of the upper part of the Poole Sandstone in Meda No. 1 and Roebuck Bay No. 1 are very similar and consist of fine, sub-angular glauconitic sandstone.

The basal member of the formation in Roebuck Bay No. 1 consists of sandy, bryozoan calcarenite. No sample descriptions are available at present for A.F.O. Nerrima No. 1 Well. However, the composite log shows calcilutite beds in the interval which, on the gamma ray log, is correlated with the Nura Nura Member in other wells.

No gamma ray logs were run in The Sisters No. 1 and Myroodah No. 1 Wells, but correlation of the top of the Poole Sandstone is possible on electrical logs, where the formation top appears as a highly resistive bed in these wells. Because no carbonate rocks were noticed

either in The Sisters No. 1 or Myroodah No. 1 during drilling, it is difficult to establish the top of the Nura Nura Member in these wells. Highly resistive beds on the electrical log in the lower part of the Poole Sandstone in Myroodah No. 1 seem to indicate the presence of an equivalent of the Nura Nura Member. This evidence is also supported by fairly good correlation of the upper part of the Grant Formation with other wells. The top of the possible Nura Nura Member in The Sisters No. 1 is less certain, because of several highly resistive beds at the bottom of the Poole Sandstone. However, the base of the formation contains beds of shale, which have been described as dark brown, siliceous, sandy, and hard. It is very possible that these beds are equivalent to the brown, sandy, hard limestone beds in the Nura Nura Member of Meda No. 1.

TABLE II

Table of correlations of Canning Basin wells

Tops of the Grant Formation are placed on the upper siltstone beds.
Depths are given in feet from D.F. with subsea depths in brackets.

Wells	FORMATION				Logs used
	Noonkanbah Fm.	Poole Sandst.	Nura Nura Member	Grant Fm.	
Meda No. 1	1303 (-1203)	2225 (-2125)	2373 (-2273)	2426 (-2326)	Gamma Ray & E log
The Sisters No. 1	878 (- 573)	1853 (-1548)	2085? (-1780)	2184 (-1879)	E log
Nerrima No. 1		1588 (-1198)	1825 (-1435)	1901 (-1511)	Gamma Ray & E log
Myroodah No. 1	1357 (- 947)	2627 (-2217)	2866 (-2456)	2920 (-2510)	E log
Dampier Downs No. 1		1277 (- 814)	1538 (-1075)	1583 (-1120)	Gamma Ray, E log & Laterolog
Roebuck Bay No. 1		1765 (-1627)	1993 (-1855)	2039 (-1901)	Gamma Ray & E log
Goldwyer No. 1		1535 (-1267)	2002 (-1734)	2032 (-1764)	Gamma Ray & E log

Grant Formation, 2,426 - 4,201 feet (Sakmarian)

To establish the top of the formation, electrical and gamma ray-neutron logs were used. The choice of the upper boundary was also supported by the presence of the Nuskoisporites microfloral assemblage in SWC's 21, 22 & 23 (2,450-2,460 feet). This assemblage is considered by Balme (Appendix A) to be characteristic of the Grant Formation. The lithological break between the Poole Sandstone and Grant Formation is uncertain. Both formations at their contact have similar dominant lithologies (except the fossiliferous beds of the Nura Nura Member); light grey, very coarse, quartzose siltstone and very fine white sandstone. It is therefore possible that the top of the Grant Formation could be higher (up to 2,398 feet). From a study of the logs of other wells in the Canning Basin it is apparent that a disconformity exists between the Poole Sandstone and the Grant Formation in Meda No. 1.

The formation consists of three distinctive lithological units:

a) Upper fluvioglacial Member,
b) Glacial Member, and
c) Lower fluvioglacial Member.

a) Upper Fluvioglacial Member, 2,426 - 3,236 feet: This unit consists of sandstone: light grey to white, fine to coarse-grained, well sorted and poorly sorted silty beds, porous to moderately porous, calcareous and kaolinitic, with dark brown carbonaceous partings and lenses containing fossil plants. Some sandstone beds grade into conglomerate with pebbles of quartzite, jasper and granite. In some very calcareous beds, calcareous cement is completely recrystallized to clear calcite. Interbedded with the sandstones are beds of dark to light grey, brown-grey and greenish grey micaceous siltstone. The light grey coloured siltstone beds are predominantly coarse-grained and in parts grade into very fine quartzose sandstone.

b) Glacial Member, 3,236 - 3,505 feet: The unit is represented by dark grey, massive, unsorted sandy siltstone (quartz greywacke) of tillite type. Sand grain size varies from fine to coarse, with some pebbles of quartzite and granite. In parts fine-grained, slightly sandy siltstone beds grade into very finely micaceous claystone, which contains fossil plants. Rocks of a similar lithology in outcrops of the Grant Formation have been considered to be marine glacial deposits or, sometimes, terrestrial tillites.

c) Lower Fluvioglacial Member, 3,505 - 4,201 feet: The unit consists predominantly of sandstone and pebble conglomerate as in the upper fluvioglacial Member. The sandstone is moderately to poorly sorted and in parts contains abundant kaolinitic matrix. The lower part of the member contains interbedded light tan and cream-coloured, feldspathic sandstone. The basal part of the formation contains calcitic cement and hard greenish-coloured sandstone lenses.

These three members very probably represent one glacial and two interglacial periods of Sakmarian age. It is possible that the upper member represents the post-glacial phase of the Lower Permian.

Upper Carboniferous:

Anderson Formation, 4,201 - 4,935 feet

The Grant Formation overlies a sequence of interbedded multicoloured siltstones and white sandstone considered to be the Anderson Formation. A comparison with other wells suggests the presence of an unconformity between these formations.

The Lycospora microflora, which is considered representative of the Upper Carboniferous, is present in the section.

The formation consists of two distinctive lithological units.

Unit A: 4,201 - 4,552 feet. This unit predominantly multi-coloured siltstones: grey, yellow, red-brown and green, micaceous, lignitic and sandy. Some very sandy, poorly sorted beds show tillite-type lithology. The siltstone is interbedded with some grey and green claystone, and sandstone: white, fine to medium-grained, moderately sorted, slightly porous, with kaolinitic and siliceous cement.

Unit B: 4,552 - 4,935 feet. The unit consists of white and pink sandstone, fine to medium-grained, well-sorted, micaceous, containing some siliceous cement. It is thinly bedded and cross-bedded. Some carbonaceous lenses contain fossil plant leaves and pyritized wood.

The Anderson Formation was not previously recognised in other wells of the Fitzroy Basin, except in Grant Range No. 1 and in Fraser River No. 1 as undifferentiated Upper Carboniferous. However, the latest studies on microfloral assemblages by Balme, indicate the presence of the formation in several wells. In A.F.O. Nerrima No. 1 its top is at 8,010 feet and in Grant Range No. 1 at 6,090 feet. No Lycospora microflora has been observed in The Sisters No. 1. However the top of the underlying Laurel Formation in both Meda No. 1 and The Sisters No. 1 provides good correlation on the electrical log. The electrical log also indicates a sequence of very highly resistive sandstone beds overlying the Laurel Formation in Sisters No. 1. This sequence, with its top at 5,040 feet, very probably represents the sandstone member of the Anderson Formation (Unit B in Meda No. 1).

Lower Carboniferous:

Laurel Formation, 4,935 - 5,483 feet

The formation includes all rocks of Lower Carboniferous age which were penetrated in the well. The Laurel Formation in Meda No. 1 consists of two different lithological units:

Upper Member, 4,935 - 5,168 feet: The unit consists of interbedded siltstone and sandstone. The siltstone is grey-brown with some green colour in the uppermost part; thinly laminated, fissile, micaceous and carbonaceous with some plant impressions. The white sandstone is fine to very fine-grained, non-porous to slightly porous, calcareous and dolomitic, in parts grading into sandy dolomite. The interval 5,125-5,134 feet contained brown crude oil staining, and a formation test from 5,110-5,133 feet recovered a few gallons of crude oil.

The Grandispora microflora indicates a Lower Carboniferous age for the member.

The fauna is poor and only ostracods of the genus Cryptophyllus have been observed. The identified species are the same as those occurring in the Lower Carboniferous Laurel Beds in outcrop, in shales of Lower Carboniferous age in the Bonaparte Gulf Basin, and in the L. Carboniferous of The Sisters No. 1 (Jones, Appendix A).

The member could be tentatively correlated with The Sisters No. 1 Lower Carboniferous formation.

Lower Member, 5,168 - 5,483 feet: The member contains a sequence of interbedded dolomitic, fine, crystalline limestones, light grey and brown sandy calcarenites, and dark grey, thinly bedded micaceous siltstones. The siltstones in part grade into black shale. The sequence contains a few beds of white, fine-grained calcareous sandstone.

In contrast to the upper member, this unit is richly fossiliferous, containing ostracods, brachiopods, pelecypods, fish remains and conodonts.

P.J. Jones (Appendix A) recognizes Lower Carboniferous ostracods including Cryptophyllus sp., Cavellina spp., and Graphiadactyllis sp. This fauna is similar to that in the BMR No. 2 (Laurel Downs), Core No. 3, 253 feet.

Thomas (Appendix A) regards the brachiopods from Core 9 (5,239 - 5,245 feet) as indicating a Lower Carboniferous age and probable correlation of the beds with the Laurel Formation.

A large and well-preserved fauna of conodonts indicates an Osagean (Middle Mississippian) age for the formation (Glenister and Furnish, Appendix A). This member could be correlated with The Sisters No. 1 richly fossiliferous Lower Carboniferous formation No. 2 (5,610-6,182 feet).

Traces of hydrocarbons, appearing as a brown staining in thin sandstone beds, were observed in the interval 5,260-5,300 feet. However, only a slight gas flow was produced in the formation test of this zone.

Devonian:

Fairfield Beds (?) Equivalent, 5,483 - 6,620 feet.

The Fairfield Beds are represented by light grey-brown to cream calcarenite: it is fine, recrystallized and oolitic, containing clear crystalline calcitic cement. The rock grades in places into oolitic limestone and is in part sandy, with fine subangular to subrounded quartz grains. Stylolites are common, and stylolitic solution voids are filled with green, pyritic silts and sandy claystone.

At the bottom some orange-coloured beds appear and the formation becomes coarser, grading into coarse recrystallized calcarenite and calcirudite, with coarse sand grains and pebbles. The base of the section consists of calcareous, quartz pebble conglomerate.

The fauna is poorly preserved and consists predominantly of ostracods with occasional algae. Core No. 10 (5,694-5,703 feet) yielded no condonont material. The age of the formation is at present doubtful. The only palaeontological evidence (Core No. 11) on which it is possible to separate Upper Devonian and Lower Carboniferous consists of few conodonts; Polygnathus sp. - two specimens, and conodont gen. nov. - 1 specimen (Glenister and Furnish, Appendix A).

Polygnathus sp. is common in the upper part of the Virgin Hills Formation, but has not been found yet in the Fairfield Beds and Laurel Formation. However, one specimen of conodont gen. nov., has been observed before in the Fairfield Beds. The section is therefore tentatively placed in the Fairfield Beds.

Correlation of this formation with other wells is at present uncertain.

Reef Complex, 6,620 - 8,360 feet (Frasnian)

The basal conglomeratic bed of the Fairfield Beds overlies a complex of reef facies similar to that in the Napier and Oscar Ranges.

This reef complex constituted the main object of the test.

Two reef facies have been recognized in Meda No. 1 Well, namely, reef and fore-reef. The reef complex contains also one terrigenous member, which could be compared with the beds of conglomerate in the Napier Range reef complex. Below are given descriptions of the individual facies.

Reef, 6,620 - 6,731 feet: This section of the complex consists predominantly of recrystallized calcarenite: light grey-brown, medium to coarse-grained, moderately sorted, compact. Fragments of limestone and fossils are subrounded to rounded. In parts the calcarenite contains some algal limestone. Thin sections reveal that this limestone contains irregular algal growth, and also minute 'ghost' algae (Renalcis) characteristic of the reef and the shallow parts of the fore-reef facies in the Oscar Range reef complex.

The fairly rich fauna consists of brachiopods, gastropods, ostracods and straight nautiloids. Diagnostic conodonts indicate a Frasnian age (Manticoceras Zone I).

The age is confirmed by a new actinosiphonate nautiloid genus which is associated with Manticoceras guppyi in outcrops of the basal part of the Virgin Hills Formation (Glenister & Furnish, Appendix A). The reef is thus contemporary with the basal Virgin Hills Formation.

Some porous beds in the reef contain natural gas, consisting predominantly of methane. The amount of gas is small, and is considered non-commercial.

Dolomitized Reef, 6,731 - 7,235 feet (Frasnian)

The unit consists predominantly of dolomite: light to medium grey, finely crystalline, silty in parts and stylolitic. Cores in this interval indicate a slight vuggy porosity. Interbedded with the dolomite are some beds of recrystallized calcarenite: cream, light grey-brown and pink-coloured, medium to coarse-grained, with slight vuggy porosity. Abundant calcite patches in the calcarenite probably represent replaced fossils. The unit is traversed by numerous veins of calcite. No fossils are preserved in the dolomite, but calcarenite beds contain a fauna of brachiopods and ostracods. This fauna could be compared directly with the fauna of the reef facies in the Oscar Range. Both fauna and lithology indicate a reef or upper fore-reef facies.

The conodont fauna suggests an earliest Frasnian age for the unit (Glenister & Furnish, Appendix A).

Like the upper part of the reef, the dolomitized reef also contains several thin porous beds with a small amount of natural gas.

Terrigenous Member, 7,235 - 7,603 feet

The member consists of dolomite, calcarenite, sandstone, siltstone and boulder conglomerate with a matrix of dolomite and calcarenite and resembles conglomerate beds in the Napier Range.

Silty and sandy dolomite beds are predominant in the upper part of the member. The dolomite is light grey-brown, cream and pink, calcareous, and contains finely disseminated pyrite. In part, due to an increase in the sand and silt content, it grades into dolomitic siltstone and sandstone.

The calcarenites are light grey and cream-coloured, coarse-grained and very commonly oolitic. The intercalated siltstones are grey-brown, coarse-grained, sandy, calcareous, dolomitic and very finely pyritic. Light grey, pink and red-brown sandstones are fine to coarse-grained, poorly sorted, pyritic, calcareous and dolomitic, and non-porous.

The basal part of the member consists of conglomerate: pebbles and boulders of quartzite in an unsorted, calcareous and dolomitic sandstone matrix.

No fossils were found in the cores, but the age of the member is very probably Upper Devonian.

At the top of the conglomerate some very thin beds of sandstone are present. This sandstone is brown-grey, fine to very fine, silty, moderately porous. It contains a brown staining probably due to crude oil. However, no hydrocarbons were recovered in the formation test of this zone.

Dolomitized Fore-Reef, 7,603 - 8,360 feet

The unit consists of dolomite: grey, brown, pink, and yellow, finely crystalline, calcareous, stylolitic, fractured, with abundant calcite veins. In parts the clastic nature of the member could be observed well. Polished cores (Nos. 21 & 22) show that the rock consists of dolomite breccia, indicating fore-reef facies.

The very base of the terrigenous member and the top of the fore-reef member contain an interesting zone of high radioactivity from 7,590-7,690 feet. The high radioactivity is confined to three beds: 7,590-7,603 feet, 7,638-7,645 feet and 7,680-7,691 feet.

Usually this radioactivity would indicate shale beds; but the microlog-caliper shows that these beds are permeable. Also ditch samples indicate that the upper bed consists of dolomitic conglomerate, and the two lower beds of dolomite. It is evident that the high radioactivity is caused by radioactive minerals. Condon & Walpole (1955) indicate a peculiar association of uranium mineralization with the reef facies of Proterozoic sediments. The authors conclude that at least part of the uranium metallic ions are precipitated directly from solution in the favourable environment of the reef facies. It seems that this conclusion is confirmed by radioactive beds in the Meda No. 1 reef complex.

The porosity of the fore-reef member is very good and is caused by vugs up to 3 inches in diameter. The vugs are interconnected, giving very good permeability.

All fossils were destroyed by dolomitization, and no age determination is possible. Very probably, however, the unit is of Upper Devonian age.

A formation test indicates that this section contains saline water, with slight gas saturation in its upper part.

Basal chloritic conglomerate, 8,360 - 8,663 feet

The unit is a typical basal conglomerate, of probable Devonian age.

It consists of conglomerate: grey and green, dolomitic, with pebbles and cobbles of quartzite and mica and chlorite schists. The upper part of the basal conglomerate contains some beds of sandy conglomeratic dolomite and fine dolomitic sandstone. The predominantly green coloured lower part is silicified, and the conglomerate matrix grades into quartzite. Cores cut in this quartzite show distinctive current bedding.

Precambrian Basement, 8,663 feet - T.D.

The basal conglomerate overlies Precambrian basement, consisting of green quartzite-chlorite schist and dolomitized sericite-chlorite-quartz schist. These moderately hard schists are underlain by a very hard, dark grey quartz-mica schist.

Because the basal conglomerate is derived from the rocks of the schistose Precambrian basement the boundary between it and the basement is not distinct.

Structure

Cores recovered in the Permian and Carboniferous sections indicate a predominantly flat dip of the beds. Exceptions have been observed in the Grant Formation interval, where dips up to 30° (Core No. 4) are present in the upper part. In the lower part of the formation dips up to 16° (Core No. 6) were recorded. With these comparatively high dips is associated slickensiding, fracturing and brecciation. It is evident that the high dips in the Grant Formation indicate the proximity of faulting, probably of a minor nature.

Dipmeter readings and cores from the Devonian section show erratic dips varying from flat to 25°. These dips emphasize the reef complex nature of the Devonian sediments.

Hydrocarbon Zones

No signs of hydrocarbons were found in the Permian and Upper Carboniferous sections in Meda No. 1 Well. Below the Upper Carboniferous, numerous hydrocarbon-bearing horizons were penetrated. The shows of hydrocarbons are confined to two separate zones:

a) the upper part of Lower Carboniferous (Laurel Formation)
b) the Upper Devonian reef complex.

These two zones are separated by more than 1,100 feet of dense, non-porous, poorly fossiliferous, oolitic limestone, calcarenite and calcilutite of Upper Devonian age.

The Laurel Formation hydrocarbon-bearing zone contains predominantly oil and only a negligible amount of gas. The Devonian reef complex on the other hand, contains almost exclusively gas, with one doubtful zone of oil staining in its terrigenous member.

The zones containing hydrocarbons are shown in Table III.

Laurel Formation Hydrocarbon-bearing Zone: Below the porous sandstone of the Anderson Formation is an impermeable sequence about 200 feet thick of siltstone and non-porous sandstone of the Laurel Formation. While drilling the interval 5,120-5,140 feet ditch samples revealed chips of porous dolomitic sandstone containing fluorescent oil staining. Side-wall cores showed that the staining is confined to the sandstone bed from 5,125 to 5,133 feet. The first drill stem test did not recover any hydrocarbons in this interval. This failure very probably was caused by the short duration of the test. After total depth was reached and 7" casing run, drill stem tests were conducted through the perforated casing, from 5,110-5,133 feet. On 9th November, 1958, DST No. 9 recovered several gallons of crude oil. This was the first crude oil recovered by WAPET in the Kimberley District of Western Australia. After acidizing, more DSTs were run but recovery consisted only of salt water with traces of crude oil varying from one to seven percent. Electrical logs indicate that the water saturation in the interval tested exceeds 50%, thus making oil production non-commercial.

Electrical logs also indicated a thin bed - 5,196-5,202 feet - very similar to the bed above, with the same water saturation. This bed was not tested.

Drilling in the interval 5,260-5,310 feet recovered oil-stained sandstone chips similar to these from the first oil-bearing bed. A bed containing gas (5,268-5,270 feet) was also indicated on microlog-caliper (see Devonian reef complex hydrocarbon-bearing zone).

Formation tests run through the perforated 7" casing at 5,250-5,264 feet and 5,270-5,310 feet intervals recovered only fluorescent salt water, with a weak intermittent gas flow.

Most probably the source rock of the oil in the Laurel Formation is the fossiliferous limestone in that formation.

Devonian Reef Complex Hydrocarbon-bearing Zone: The first signs of hydrocarbons in the zone were noticed after about 60 feet of reef complex had been penetrated. While drilling from 6,683-6,686 feet the drilling mud became strongly gas cut, giving a maximum reading on the JW gas detector.

DST No. 2 was run in the interval 6,654-6,696 feet and recovered gas, flowing through the 1,000 feet of water cushion. The initial flow was about 100 MCF/day, which after two-and-a-half hours testing dropped to approximately 30 MCF/day. This interval gave the strongest gas flow in the well.

Several thin beds containing gas were penetrated (see table III) in the reef and fore-reef facies above the basal conglomerate. Because of poor porosity and permeability, no gas flowed to the surface in DSTs from the reef facies beds. As a result of high water saturation, the porous beds of the fore-reef facies yielded no gas flow. One of these porous

TABLE 3

HYDROCARBON ZONES IN MEDA No. 1

Interval (in feet from D.F.)	Formation	Initial Hydrocarbon Shows	Rock Type	Porosity	Permeability	DRILL STEM TESTS			
						No.	Interval (in feet from D.F.)	Recovery	Remarks
5,125-5,133	Laurel Fm.	Staining & fluorescence in ditch samples & sidewall cores	Very fine dolomitic sandstone	Good	Moderate to slight	1	5,082-5,163	Dry test	Open hole
						9	5,110-5,133	Few galls crude oil & salt water with traces oil	Through 7" perforated casing
						9 A-C	5,110-5,133	Salt water with traces oil	Acidizing
5,196-6,202	Laurel Fm.	Oil indication on E -log and Micro-Caliper	Very fine dolomitic sandstone	Good	Moderate to slight				
5,260-5,300	Laurel Fm.	Staining & flourescence in ditch samples	Dolomitic sandstone & limestone	Good	Good	8	(5,250-5,264 (5,270-5,310	Salt water giving green flourescence & intermittent weak gas flow	Acidizing through 7" perforated casing
5,268-5,270	Laurel Fm.	Gas indication on Micro-Caliper log	Dolomitic sandstone & limestone	Good	Good				
6,683-6,686	Upper Devonian	Gas in drilling mud JW 100	Calcarenite	Poor	Poor	2	6,654-6,696	Salt water & gas flow - 100 MCF/day	Open hole
6,686-6,696	Reef Complex	Positive flame test in core barrel	Calcarenite	Poor	Poor	7	(6,594-6,610 (6,625-6,640 (6,670-6,676 (6,688-6,695	Moderate gas flow & gas-cut spent acid	Acidizing through 7" perforated casing
6,883	"	Gas in drilling mud JW 100.	Dolomite	Poor	Poor	3	6,845-6,888	Dry test	Open hole

TABLE 3 (Continued)

HYDROCARBON ZONES IN MEDA No. 1

Interval (in feet from D.F.)	Formation	Initial Hydrocarbon Shows	Rock Type	Porosity	Permeability	DRILL STEM TESTS			
						No.	Interval (in feet from D.F.)	Recovery	Remarks
7,045-7,046	Upper Devonian reef complex	Slight gas in drilling mud. JW 45	Dolomite	Poor	Poor				
7,082-7,084	"	Gas in drilling mud JW 100	Interbedded dolomite & calcarenite	Poor	Poor	4	7,062-7,089	Gas cut drilling mud	Open hole
7,498-7,504	Terrigenous member	Staining & flourescence in ditch samples	Conglomerate with thin beds of sandstone	Moderate	Poor	5	7,419-7.510	Dry test	Open hole
7,504-7,510	"	Slightly gas-bleeding core	"	Moderate	Poor				
7,594-7,669	Fore-reef	None	Dolomite	Moderate	Good	6C	7,594-7,669	Gas-cut salt water	
7,680-7,690	Fore-reef	Hydrocarbon indication on Neutron, Latero- & Micrologs	Dolomite	Good	Good				Porosity 20% water saturation not over 30%
7,718-7,728	Fore-reef	Gas-bleeding core	Dolomite	Good	Good				
7,780-7,790	Fore-reef	Slight gas in drilling mud	Dolomite	Good	Good				
7,800-7,810	Fore-reef	Slight gas in drilling mud	Dolomite	Good	Good				

beds, however, is of some interest: A. Poupon of Schlumberger, Paris (written comm.) has interpreted the interval 7,680-7,690 feet as showing 20% porosity with water saturation not exceeding 30%. The interval was not tested.

Zones containing gas are conspicuous markers on microlog-caliper and neutron logs. They are shown as beds from 1 foot to 3 feet thick, with high porosity on microlog, with deep caving up to 3 inches on the caliper, and minimum peaks on the neutron log. It is possible that these features of the logs are associated with a gas accumulation in the rock cavities.

The only signs of oil in the reef complex were observed in the terrigenous member. While drilling the interval 7,495-7,504 feet, a few porous, fine-grained, fluorescent sandstone chips were observed, showing brown oil staining. The microlog-caliper indicated thin porous beds as follows: 7,497-7,499 feet, 7,500-7,501 feet and 7,502-7,503 feet. DST No. 5 was run in the interval 7,419-7,510 feet, but gave a dry test. The source rock for the hydrocarbons of the Devonian reef complex is in part probably the reef complex itself. The presence of terrigenous sediments in the complex indicates rapid burial of the reef and the preservation of rich organic matter from oxidation.

The facies developed deeper in the basin could also be a source rock. In that case lateral migration of the hydrocarbons is facilitated by fore-reef beds which are dipping towards the basin.

Porosity and Permeability

Porosities and permeabilities of hydrocarbon-bearing zones are noted in Table III.

The dolomitic sandstone of the Laurel Formation has a good porosity (about 20%) and moderate to good permeability. Permeability could be greatly improved by acidizing. The Devonian reef and terrigenous facies show only poor porosity and permeability. The appearance of gas in the mudstream is mostly confined to very thin permeable beds (1-3 feet) showing porosity (on microlog) from 10-15%. It is possible that this porosity is associated with cavities and fractures. No appreciable porosity could be observed in cores in the interval.

Fore-reef facies of the zone have mostly good permeability. Cores from this section showed a very good vuggy porosity. The neutron log interpretation (A. Poupon, written comm.) indicates porosities of 7-9% only (except the interval 7,680-7,690 feet with 20% porosity). It is possible that the porosity is distributed sporadically throughout the rock.

Contributions to Geological Concepts

A comparatively good correlation of the Permian sequence has been established in the wells of the Fitzroy Basin. The correlation suggests that a disconformity exists between the Poole Sandstone and the Grant Formation.

The Anderson Formation (Upper Carboniferous) has been recognised in the well. No marked unconformity could be recognized between the Anderson Formation and the Laurel Formation (Lower Carboniferous) in Meda No. 1 and The Sisters No. 1 Wells, but the Anderson Formation is much thinner on and adjacent to the Lennard Shelf than in the deep Fitzroy Trough (Grant Range No. 1, Fraser River No. 1).

The presence of oil has been noted in the Laurel Formation, thus marking Lower Carboniferous as a primary objective in oil exploration.

The drilling also proved the existence of a hydrocarbon-bearing Upper Devonian reef complex buried under younger sediments along the margins of the Lennard Shelf.

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APPENDIX A

PALAEONTOLOGICAL REPORTS

PALYNOLOGICAL EXAMINATION OF SAMPLES FROM MEDA No. 1 - PERMIAN SECTION

by

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Introduction

Most of the samples discussed here are sidewall cores which provide ideal material for palynological work. Their only disadvantage is that some of the more friable rock types are difficult to free entirely from drilling mud. Some contamination of the maceration residues is, therefore, possible. However, it is not considered that such contamination would affect the interpretation of the results.

If Core 2 from The Sisters No. 1 Well comes from the basal Noonkanbah Formation it seems clear that the "Cirratriradites" - microflora characterises both the Poole Sandstone and the lower part of the Noonkanbah Formation. There is, of course, no reason to suppose that microfloral and lithological "breaks" will coincide in the absence of a considerable time hiatus, and it would be going to far to attempt to establish formation boundaries on the palynological evidence alone.

In the following table the distribution of certain key genera and species in the Permian section has been set out, together with their biostratigraphical implications. For completeness several samples already reported upon have been included in the table.

Discussion on Microfloral Data

Before discussing variations in the microfloras there are one or two points which may have some palaeogeographical significance. Firstly almost all the Permian samples treated contained a good deal of chloritic material which was difficult to remove using normal maceration techniques. Such material is not characteristic of Permian sediments from the southern Fitzroy and Canning Basins. These chloritic minerals may have some implications as to the provenance of the Permian sediments.

Secondly, the abundance of microplankton in the sediments above about 2,200 feet is noteworthy. The forms present are not particularly distinctive and consist of a variety of spinose hystrichosphaerids. None of the types appears to have a restricted vertical range. Microplankton are, however, not common in Permian sediments from the southern part of the Canning Basin where they are virtually confined to the Liveringa Formation. Their abundance in samples from a thick section of Permian strata at Meda suggests that marine influences

may have been stronger along the northern margin of the Fitzroy Basin than in the southerly areas.

The microfloral succession set out in the attached table shows one major and a number of minor "breaks." The major break occurs between 610 feet and 790 feet and almost certainly coincides with the base of the Blina Shale. At this horizon the typically Permian microfloras are replaced by an entirely different suite of spores and pollen grains. Some of the microplankton species carry over the break but the Blina Shale also contains forms not found in the definitely Permian sediments.

Between 1,250 and 1,280 feet there are also occur some minor changes in the assemblages. Marsupipollenites sinuosus Balme and Hennelly and Acanthotriletes ericianus Balme and Hennelly do not occur below 1,250'. This may coincide approximately with the base of the Liveringa Formation. However it must be stressed that no comparative material is available across the Liveringa-Noonkanbah boundary. In addition the assemblages from 1,280 feet and 1,289 feet are poorly preserved and difficult to assess quantitatively.

The sample from 1,385 feet 6 inches is the highest which appears to be clearly Artinskian. It contains a species of Verrucosisporites which is not known from sediments of post-Noonkanbah age, as well as a small granulate trilete form which is particularly abundant in the Lower Permian of Western Australia.

Cirratriradites cf. splendens Balme and Hennelly occurs in the sample from 1,943-1,963 feet in which the proportions of striatitid pollens also decline. This assemblage probably comes from the lower part of the Noonkanbah Formation, if this unit has been correctly identified in the Dampier Downs and Jurgurra Creek wells.

The assemblage from 2,134 feet differs notably from any occurring above it. Species of Cirratriradites dominate the microflora and Granulatisporites trisinus Balme and Hennelly no longer occurs. Verrucosisporites, an important genus in the Poole Sandstone and lower Noonkanbah Formation in other parts of the Canning Basin, is also common. Whether this sample should be placed in the Poole or Noonkanbah is impossible to say on the palynological evidence alone. Punctatisporites gretensis Balme and Hennelly, a form which has not previously been found in sediments above the Poole Sandstone, occurs at 2,159 feet, and below this depth microplankton become insignificant components of the microflora. These considerations have weighed in placing the Noonkanbah-Poole boundary somewhere between 2,130 feet and 2,160 feet. Here again, however, closely sampled comparative material for this interval at other localities is lacking.

For similar reasons it is difficult to suggest a precise upper limit for the Grant Formation. P. gretensis is an important microfloral component in the sample from 2,361-2,375 feet and below that depth the genus Cirratriradites declines in abundance. The species of Cirratriradites in the lower samples also differ from those in the upper part of the well. The microflora from 2,464 feet is indistinguishable from Grant Formation assemblages in other parts of the Fitzroy Basin and it differs from the microflora of the Nura Nura Member in the Dampier Downs No. 1 Well. For these reasons I am inclined to place the top of the Grant Formation somewhere between 2,255 feet and 2,460 feet.

MICROFLORA DISTRIBUTION

MEDA No. 1 - PERMIAN SECTION

Depth in feet	Preservation of Microflora	Leiotriletes n. sp.	Granulatisporites trisinus Balme & Hennelly	G. n. sp. (Granulate)	Punctatisporites gretensis Balme & Hennelly	Calamospora diversiformis Balme & Hennelly	Acanthotriletes cf. ericianus Balme & Hennelly	Verrucosisporites cf. pseudoreticulatus Balme & Hennelly	V. n. sp. (heavy warts)	Vestigisporites cf. rudis Balme & Hennelly	Cirratriradites cf. splendens Balme & Hennelly	C. spp.	cf. Endosporites n. sp.	Entylissa cymbatus Balme & Hennelly	Marsupipollenites triradiatus Balme & Hennelly	M. sinuosus	Tholosporites spp.	Nuskoisporites sp.	Lueckisporites (s.s.)	Striatitid pollens (Lunatisporites, Striatites, etc.)	Pityosporites sp.	MICROPLANKTON	Suggested Age	Suggested Formation	Microflora (Report GDP31)
240-270	Good												C						C			A	?L. Triassic	Blina Shale	Lueckisporites (s.1)
590-610	Good												R						R			A	?L. Triassic	Blina Shale	Lueckisporites (s.1)
790-820	V.Good		C				R					C			C	C	R	R		A	C	C	U. Permian	Liveringa Fm	Tholosporites
1220-1250	V.Good		A				C					C			C	C		C		A	C	C	U. Permian	Liveringa Fm	?Tholosporites
1280	Poor		C									R			R			R		A	C	C	U. Artinskian -U.Permian	?Noonkanbah Fm	?Striatites
1289	V.Poor		R									R								C	R	R	do.	?Noonkanbah Fm	?Striatites
1335'6"	V.Poor		A									C						R		A	C	R	?U.Artin.	?Noonkanbah Fm	?Striatites
1343'6"	Poor		C	R		R			R			R						R		A	C	A	Artinskian	Noonkanbah Fm	Striatites
1410-1430	Poor		C	C								C			R			R		A	C	A	Artinskian	Noonkanbah Fm	Striatites
1576	Poor	R	C	R				R	R			C			C			R		A	A	A	Artinskian	Noonkanbah Fm	Striatites
1580	Poor	R	C	R		R		R	R			C						R		A	C	C	Artinskian	Noonkanbah Fm	Striatites
1581	Poor	R	C	R		R		R	R			C								A	R	A	Artinskian	Noonkanbah Fm	Striatites
1943-1963	Fair	R	C	C		R			R		C	C								C	A	C	Artinskian	?L.Noonkanbah	?Cirratriradites
2134	V.Good	R	?	C		C		C	C		A	A			R			C		C	C	R	L.Artin.	L.Noonkanbah or Poole	Cirratriradites
2140	V.Good	R	?	A		C		C	C		A	C			R			R		C	R	R	L.Artin.	L.Noonkanbah or Poole	Cirratriradites
2145	Good	R		C		R		R	R		A	R						R		C	A	C	L.Artin.	do	Cirratriradites
2150	V.Poor			C					R		C									R	C	C	?L.Artin.		Cirratriradites
2159	Good	R	?	A	R			R	C		C	R						C		C	C	C	L.Artin.	?Poole Sst.	Cirratriradites
2164	V.Poor			C							R	C						R		R	C		?L.Artin.		Cirratriradites
2169'6"	Good	R		A	R			R	R	R	A	R						R		C	C		L.Artin.	Poole Sst.	Cirratriradites
2195	V.Good	R		A	R			R	C	R	A	A		C.				C		C	A		L.Artin.	Poole Sst.	Cirratriradites
2200	Good	R		A	R			C	C		R	A		C				R		C	A	R	L.Artin.	Poole Sst.	Cirratriradites
2205'6"	Good			A	R			R	C	R	A	C		C				C		C	A	R	L.Artin.	Poole Sst.	Cirratriradites
2250	V.Poor			C	R				R		C									R	C		?L.Artin.		Cirratriradites
2255	V.Poor			C					R		C	R								R	R		?L.Artin		Cirratriradites
2361-2375	Fair	R		A	C			R	C	R	C	A		C				C		C	A		L.Artin. -U.Sakmarian	Poole or Grant	Cirratriradites
2450	Fair			A	C				R		R	C		C				C		C	R		do.	Poole or Grant	Cirratriradites
2455	V.Poor			C	R							R						R		R	C				?Nuskoisporites
2460	Good			A	C				R	C		C		R				A		C	R		U.Sakmarian	Grant Fm	Nuskoisporites
2494'6"	Poor	C		A	A				R	R		C						R		R	C		?U.Sakmar.	Grant Fm	Nuskoisporites

A = > 15%

C = 2 - 15%

R = 1% or less

FORAMINIFERA IN CORES Nos. 1, 2 & 3 FROM MEDA No. 1

by

Irene Crespin

Bureau of Mineral Resources

Cores Nos. 1, 2 & 3 from Meda No. 1 were examined for foraminifera. Permian foraminifera occurred commonly in Cores Nos. 1 & 3, with fragmentary tests in Core No. 2. The well geologist suggested that the hole penetrated the Noonkanbah Formation at 1,320 feet, the Poole Sandstone at 2,235 feet and the Grant Formation at 2,540 feet.

Details of the examination are as follows:

Core No. 1: 1,410-1,430 feet

The rock was light to dark grey, micaceous sandy siltstone with irregular markings of ?carbonaceous material and a few fragments of brachiopods. The material when crushed contained a rich assemblage of well-preserved foraminifera, chiefly calcareous species and including many new forms recently described by Crespin (1958). Many tests of Frondicularia and Nodosaria were unusually large. The assemblage of species is characteristic of subsurface sections of the Noonkanbah Formation of the Canning Basin. The species are as follows:

Ammodiscus nitidus Parr
Frondicularia parri Crespin (common)
F. woodwardi Howchin (common)
F. sp. nov.
Geinitzina caseyi Crespin (common)
G. striatosulcata Crespin (common)
G. triangularis Chapman and Howchin (common)
Hyperammina sp.
Nodosaria decoris Crespin
N. raggatti Crespin
N. sp. nov.
Pseudohyperammina radiostoma Crespin
Rectoglandulina serocoldensis (Crespin) (common)
Reophax ellipsiformis Crespin
Thuramminoides sphaeroidalis Plummer

Core No. 2: 1,943-1,963 feet

The rock was a grey sandy siltstone with foraminifera scarce in the washings (Hyperammina sp.). This core is included in the Noonkanbah Formation by WAPET geologists.

Core No. 3: 2,361-2,375 feet

This core was a grey fossiliferous silty sandstone in which the quartz grains were

mostly subrounded to rounded. White fragments of decomposed bryozoa and glauconitic replacements of foraminiferal tests were present on the surface of the core. The washings yielded numerous tests of calcareous imperforate foraminifera, many of which were entirely replaced by clear calcite; others were partially replaced by glauconite.

Foraminifera:

Hemigordius schlumbergi (Howchin)
Nodosaria irwinensis Howchin
Tetrataxis sp.
Trepeilopsis australiensis Crespin

The above assemblage of species is characteristic of the Callytharra Formation of the Carnarvon Basin and its equivalents in the Irwin and Canning (including Fitzroy) Basins. According to the well geologist, this core comes within the Poole Sandstone. Up to the present, foraminifera have only been found in the Nura Nura Member of that formation which is usually represented by limestone lithology. It is possible that Core 3 is a sandy equivalent of the Nura Nura Member. However, the lithology is similar to that of Core 19 at 1,545 - 1,555 feet in Dampier Downs No. 1 which contains a delicate test of Tetrataxis and which was tentatively regarded as Grant Formation.

Reference

CRESPIN, I., 1958. Permian Foraminifera of Australia. Bur. Min. Resour. Aust. Bull. 48.

CONODONTS FROM MEDA NO. 1

by

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Portions of twelve cores from Meda No. 1 were digested in a 20% concentration of acetic acid. Cores 9, 11, 13, 14 and 17 yielded conodont faunas which permit confident age assignment for the parent strata. Cores 10, 12 and 18 contained either fish remains or fragmentary conodonts; and Cores 15, 16, 21 and 22 produced only small residues, which were barren of microfossils. Conodont studies indicate that Cores 9-18 (5,239 - 7,101 feet) represent strata ranging in age from Upper Devonian to Mississippian.

Core 9, 5,239 - 5,245 feet

Cavusgnathus sp.
Pseudopolygnathus sp.
Polygnathus s. l.
indeterminate conodont fragments
ornate fish plates

This well-preserved fauna is unquestionably of early Carboniferous age and is characteristic of the faunas recovered from the Laurel Formation in other parts of the Fitzroy Basin. Similar faunas are known from the Middle Mississippian beds of the Bonaparte Gulf Basin (Glenister, in press).

Cavusgnathus ranges down into the Osagean of North America (Hass, 1953) and is common in the late Mississippian and Pennsylvanian. Similar forms appear, together with *Sporadoceras* cf. *S. posthumum*, in the transitional beds between the Virgin Hills Formation and the Fairfield Beds in the Fitzroy Basin. However, these Famennian species may differ sufficiently from typical *Cavusgnathus* to warrant generic differentiation. The specimens of *Cavusgnathus* from Core 9 are conspecific with forms from exposures of the Laurel Formation near 12-Mile Bore (125° 16' E., 17° 56' S.), in the Oscar Range.

Pseudopolygnathus is known from the Upper Devonian, and is particularly common in the Kinderhookian of North America. Its known range extends as high as the Osagean Fern Glen Limestone of Missouri. Typical species of *Polygnathus* are abundant from the Middle Devonian to the Lower Mississippian, but a few forms with an unusually large basal cavity occur as high as the early Chesterian (Rexroad, 1957). The species of *Polygnathus* in Core 9 is similar to the forms recorded from beds younger than Lower Mississippian.

The many species of highly ornate fish plates from Core 9 are typical of those previously recovered from the Mississippian strata of the Fitzroy Basin and the Bonaparte Gulf Basin. They are unlike the numerous Upper Devonian plates from the same general areas.

It can be concluded that the fauna of Core 9 is most probably of Osagean (Middle Mississippian) age, and the parent strata should be correlated with the Laurel Formation.

Core 10, 5,694 - 5,703 feet

Polygnathus sp.

The single specimen recovered from this core does not permit the confident designation of a restricted age for the parent stratum.

Core 11, 6,175 - 6,185 feet

Spathognathodus sp.
Hindeodella sp.
Prioniodina sp.
Polygnathus cf. P. normalis Miller & Youngquist, 1947
Pelekysgnathus communis Thomas, 1949

All of the forms obtained from Core 11, with the exception of Polygnathus cf. P. normalis, are known from exposures of the Fairfield Beds. Polygnathus normalis is common in the upper Virgin Hills Formation, but has not yet been recovered from exposures above this horizon. The failure to secure polygnathids from the Fairfield Beds is doubtless due to inadequate sampling.

Pelekysgnathus is a relatively rare genus which is restricted to the Famennian and is characteristic of the upper part of this stage. Pelekysgnathus communis was described originally from the Maple Mill Shale of Iowa, and it is one of the more common species in the sparse fauna recovered from exposures of the Fairfield Beds. Pelekysgnathus is not known in the abundant conodont faunas secured from other Devonian formations in the Fitzroy Basin.

Conodont evidence therefore enables confident correlation of the parent stratum of Core 11 with the Fairfield Beds of the Fitzroy Basin. A late Famennian age seems probable.

Core 12, 6,606 - 6,616 feet

Indeterminate conodont fragments.

Core 13, 6,686 - 6,696 feet

Palmatolepis (Manticolepis) triangularis Sannemann, 1955.

Palmatolepis is perhaps the most chronologically valuable of all Devonian conodonts. It is exceedingly common and mondeal in its distribution, and is confined to the Upper Devonian. Practically all of the thirty species have restricted chronological ranges within the Upper Devonian, but are widespread geographically. P. (M.) triangularis is restricted to the middle and late Frasnian [Manticoceras Stage I ($\beta\gamma$), Iδ] in North America, Europe, North Africa and Australia. It occurs in the basal Virgin Hills Formation in Bugle Gap, together with Beloceras sagittarium and Manticoceras guppyi. Core 13 is unquestionably of Frasnian age and should be correlated with the basal part (Manticoceras beds) of the Virgin Hills Formation.

Core 13 has also yielded a distinctive nautiloid. It represents a new actinosiphonate genus, but the same species occurs in the basal Virgin Hills Formation where it is associated with Beloceras sagittarium and Manticoceras guppyi. The presence of this nautiloid thus confirms the age of the strata from which Core 13 was taken.

Core 14, 6,696 - 6,706 feet

Palmatolepis (Manticolepis) triangularis Sannemann, 1955
cf. Scutula sp.
Ligonodina sp.
Prioniodina sp.

Frasnian - correlative of basal Virgin Hills Formation (see under Core 13).

Core 15, 6,883 - 6,888 feet

Barren.

Core 16, 6,970 - 6,975 feet

Barren.

Core 17, 6,975 - 6,980 feet

Palmatolepis (Manticolepis) triangularis Sannemann, 1955

Frasnian - correlative of basal Virgin Hills Formation (see under Core 13).

Core 18, 7,089 - 7,101 feet

Hindeodella sp.
Icriodus sp.

Neither of these forms allows the designation of a restricted geological age, but both are closely similar to species from the Gogo Formation and thus suggest an earliest Frasnian age.

Core 21, 7,718 - 7,728 feet

Barren.

Core 22, 8,007 - 8,017 feet

Barren.

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MICROPALAEONTOLOGICAL EXAMINATION OF THE LOWER CARBONIFEROUS - UPPER DEVONIAN SEQUENCE OF MEDA No. 1

by

P.J. Jones

Bureau of Mineral Resources

These notes summarize the current stage of micropalaeontological investigation of the cores and cuttings taken from the Lower Carboniferous - Upper Devonian sequence.

The occurrence of the ostracod Cryptophyllus sp. nov. in cuttings at 5,000 - 5,010 feet is the first indication of Lower Carboniferous sediments. This species has been found in the Lower Carboniferous Laurel Formation in outcrop, and in the BMR No. 2, (Laurel Downs). Cryptophyllus sp. nov. also occurs in the Lower Carboniferous - Upper Devonian sequence of The Sisters No. 1 well (6,435 - 7,650 feet). This species will be described shortly (Jones, in press).

CORE 8, 5,055 - 5,063 feet also contains Cryptophyllus sp. nov.

A rich ostracod fauna is found in cuttings taken between the depths of 5,180 feet and 5,420 feet, and in CORE 9 (5,239 - 5,245 feet). Nine undescribed species were determined:

	RANGE IN CUTTINGS	
Birdsallella sp.	5,220 - 5,239 feet	
Cavellina spp. (2)	5,180 - 5,420 feet	; also present in CORE 9
Cryptophyllus sp. nov.	5,000 - 5,430 feet	; also present in CORE 9
Graphiadactyllis sp.	5,239 - 5,380 feet	; also present in CORE 9
Knoxiella sp.	5,180 - 5,420 feet	
Leptoprimitia ? sp. nov.	5,400 - 5,410 feet	
Macrocypris sp.	5,210 - 5,239 feet	
Paraparchites cf. nicklesi	5,180 - 5,420 feet	

These species belong to ostracod Assemblage C (Jones, in Veevers and Wells, in press) which indicates a Lower Carboniferous (Tournaisian) age.

No fossils were found in CORE 10 (5,694 - 5,703 feet), CORE 11 (6,175 - 6,185 feet), and CORE 12 (6,606 - 6,616 feet), but indeterminate ostracods occur in cuttings at 6,220 - 6,230 feet.

CORE 18 (7,089 - 7,101 feet) yielded small brachiopods, ostracods and a species belonging to the Coniconch genus Tentaculites. Many of the ostracods were smooth and featureless, and could not be separated from the surrounding matrix, and generic determination of these forms was impossible.

Three ostracod specimens were isolated from the core, all belonging to the genus Aparchites, one of which is the species previously found in the Sadler Formation, at the WAPET/BMR locality Dud 276, 1 1/2 miles south-east of the northern entrance of Menjou's Gap. This locality is in the upper part of the saltica zone of Veevers (1959). The stratigraphical range of this species of Aparchites is not known at present, as the Dud 276 locality is the only occurrence known so far.

In North America and Europe the genera Aparchites and Tentaculites are both known to range from the Ordovician to Devonian. A Devonian age for CORE 18 (7,089 - 7,101 feet) is suggested by the occurrence of the species of Aparchites previously found at locality Dud 276.

References

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PRELIMINARY IDENTIFICATIONS OF MACROFOSSILS

FROM MEDA No. 1

by

G. A. Thomas

Bureau of Mineral Resources

Core No. 1: 1,410 - 1,430 feet

Strophalosia sp., spinose form
Linoproductus? sp.
martiniopsid gen. et sp. nov.
Streptorhynchus? sp.
pelecypod indet.

These fossils are of Permian age but are difficult to compare with specimens from outcrop. From the assemblage they could possibly be from the Noonkanbah Formation.

Core No. 2: 1,943-1,963 feet

Unidentified fragment of a large spiriferid.

Core No. 9: 5,239-5,245 feet

Camarotoechia sp.
Linoproductus sp.
orbiculoid brachiopods:
cf. *Lindstroemella* sp.
Orbiculoidea sp.

The *Camarotoechia* sp. is possibly *C. tripla* common in the Laurel Formation and the *Linoproductus* is of the Lower Carboniferous type. An orbiculoid with radial and concentric ornament similar to the specimen from Core 9 was noted in core from 253 feet in B.M.R. No. 2 (Laurel Downs).

From the above a Lower Carboniferous age is indicated and the beds are probably to be correlated with the Laurel Formation.

REPORT ON FOSSILS FROM MEDA NO. 1, CORE 18

(LOWER 2 feet: 7,089-7,101)

by

J.J. Veevers

Bureau of Mineral Resources

The core samples submitted for palaeontological examination consist of pure, white, saccharoidal limestone. The core contains brachiopods and some poorly preserved ostracods. The brachiopods include:

Pugnax cf. acuminatus (Martin)
P. cf. pugnus (Martin)
Atrypa desquamata kimberleyensis Coleman 1951
(?) Crurithyris apena Veevers 1959
and a ribbed spiriferid, according to G.A. Thomas, ascribable to the group of Cyrtospirifer.

These fossils all indicate Upper Devonian.

Among the Upper Devonian fossil assemblages from the Fitzroy Basin, the assemblage from Core 18 resembles most closely that of WAPET Sample 0/73, from the Oscar Formation near Palm Spring in the apena and/or saltica zone in the Frasnian (Veevers, 1959) Sample 0/73 includes:

Hypothyridina margarita Veevers 1959
Nervostrophia bunapica Veevers 1959
Pugnax cf. pugnus
P. cf. acuminatus
Atrypa desquamata kimberleyensis
(?) Crurithyris apena

Reference

VEEVERS, J.J., 1959 - Devonian brachiopods from the Fitzroy Basin, W.A. Bur.Min.Resour.Aust.Bull. 45.

CARBONIFEROUS - DEVONIAN CONTACT

IN MEDA NO. 1, THE SISTERS NO. 1, AND B.M.R. NO. 2 (LAUREL DOWNS)

by

P.E. Playford

West Australian Petroleum Pty Limited

Carboniferous-Devonian Boundary, Meda No. 1

Owing to the lack of reliable data the boundary between the Carboniferous and the Devonian in Meda No. 1 cannot be placed with any degree of reliability. The lowest definite Lower Carboniferous in the well is Core 9 (5,239-5,245 feet), the age being established by conodonts, ostracods, and brachiopods. Core 11 (6,175-6,185 feet) appears to be Upper Devonian based on the conodonts, though this is not certain. One conodont species obtained from this core has been found previously only in the Fairfield Beds.

The first marked formation break below Core 9 is at 5,483'. Below this depth the lithology is monotonous limestone; above it the Lower Carboniferous sequence is an interbedded succession of limestone, siltstone and sandstone. The first marked electric log break above Core 11 is at 6,150 feet, though cuttings do not indicate an important lithological break at this depth. The first important lithological break above Core 11 seems to be at 5,483 feet, and for these reasons the contact between the Devonian and the Carboniferous is tentatively placed at this depth, though the interval from 5,483 feet to 6,150 feet is in doubt.

Carboniferous-Devonian Boundary, The Sisters No. 1

As with Meda No. 1, the boundary between the Carboniferous and the Devonian in The Sisters No. 1 is very uncertain. The lowest definite Carboniferous is at 6,093 feet based on corals in Core 8 (6,083 - 6,093 feet), and the first definite Devonian, based on ostracods, was identified in cuttings from 6,865 - 6,870 feet. Palynological results over the interval in doubt are inconclusive.

The contact between the Devonian and the Carboniferous is tentatively placed at 6,107 feet. This is the first marked lithological break above the proved Devonian and below the proved Carboniferous in the well. It coincides with the boundary at 5,483 feet in Meda No. 1, marking the break from an interbedded sequence of limestone, siltstone, and sandstone to a sequence dominated by limestone.

At 6,475 feet there is a lithological and E-log break which is tentatively taken as the top of the definite Devonian. Below this depth the rocks are strongly dolomitized.

Carboniferous-Devonian Boundary, BMR No. 2 (Laurel Downs)

The contact between the Carboniferous and the Devonian in BMR No. 2 is very hard to place. There appears to be little lithological change between the Laurel Formation and the Fairfield Beds. The contact lies between 1,090 feet and 1,707 feet, but there is no palaen-

tological information over this interval. The Bureau of Mineral Resources pick 1,420 feet as the break, based on differences in dip in cores on each side of this point and an E-log break. However, the most pronounced E-log break seems to be at a depth of 1,110 feet, and I prefer this as the thickness of Carboniferous using this figure is more in keeping with the thickness in The Sisters No. 1 and Meda No. 1. Also it apparently marks the break between the more porous, sandy Laurel Formation and the tight Fairfield Beds (?), which are nevertheless still sandy.

The top of the Upper Devonian Virgin Hills Formation is now picked at 1,870 feet by the BMR, but examination of the E-log and the sample descriptions shows that 1,805 feet is a more likely figure.

APPENDIX C

CORES AND THEIR SPECIFIC GRAVITIES

Core	Interval	Recovery	Specific Gravity	Lithology	Formation & Age
1	1,410-1,430'	20'	2.25	Siltstone, shale & sandstone	Noonkanbah Fm Artinskian
2	1,943-1,963'	8'	2.27 2.34	2' Shale 3' Siltstone & limestone 3' Shale	Noonkanbah Fm Artinskian
3	2,361-2,375'	14'	2.31	10' Siltstone 3' Sandstone 1' Bryozoal sandstone	Poole Sandstone L. Artinskian
4	2,955-2,975'	16'	2.45 2.30	2' Siltstone 14' Sandstone	Grant Formation Sakmarian
5	3,447-3,450'	3'	2.53	Claystone	Grant Fm. Sakmarian
6	4,045-4,060'	5'		Sandstone	Grant Fm. Sakmarian
7	4,644-4,660'	14'	2.47	Sandstone	Anderson Fm. U. Carboniferous
8	5,055-5,063'	3'	2.57 2.61	Siltstone Sandstone	Laurel Formation L. Carboniferous
9	5,239-5,245'	5'	2.70	Calcarenite & siltstone	Laurel Formation L. Carboniferous
10	5,694-5,703'	4'	 2.68	1' Calcarenite 3' Calcilutite	Fairfield Beds U. Devonian
11	6,175-6,185'	4'	2.70	Calcarenite	Fairfield Beds U. Devonian
12	6,606-6,616'	8'	2.70	2' Calcirudite 5' Calcarenite 1' Conglomerate	Fairfield Beds U. Devonian
13	6,686-6,696'	6"	2.68	Calcarenite	Reef complex U. Devonian

Core	Interval	Recovery	Specific Gravity	Lithology	Formation & Age
14	6,696-6,706'	9"	2.70	Calcarenite	Reef complex U. Devonian
15	6,883-6,888'	1'	2.81	Dolomite	Reef complex U. Devonian
16	6,970-6,975'	4"	2.77	Dolomite	Reef complex U. Devonian
17	6,975-6,980'	1'	2.79	Dolomite	Reef complex U. Devonian
18	7,089-7,101'	8'	2.82 2.74	6' Dolomite 2' Calcarenite	Reef complex U. Devonian
19	7,298-7,308'	7'	2.75	Dolomite	Reef complex U. Devonian
20	7,504-7,510'	6'	2.64	Conglomerate	Reef complex U. Devonian
21	7,718-7,728'	10'	2.78	Dolomite	Reef complex U. Devonian
22	8,007-8,017'	10'	2.79	Dolomite	Reef complex U. Devonian
23	8,420-8,426'	6'		Conglomerate	Basal conglomerate U. Devonian?
24	8,586-8,590'	4'	2.73	Conglomerate	Basal conglomerate U. Devonian?
25	8,685-8,694'	9'	2.78 2.66	8' Schist 1' Quartzite	Precambrian
26	8,744-8,752'	4'	2.68	Schist & quartzite	Precambrian
27	8,805-8,808'	Nil			
28	8,808-8,809'	Nil			

APPENDIX D

ANALYSIS OF CORES FROM MEDA No. 1

by

Petroleum Technology Laboratory

Bureau of Mineral Resources

The following are descriptions and results of tests carried out on two cores from Meda No. 1 with Ruska equipment and using a "small plug" technique:

Core No. 21: 7,718 - 7,728 feet

Two 3/4" long and 3/4" diameter core plugs were drilled out perpendicularly to the axis of the core at the spot marked on the core. They were marked (1) and (2) and the following results were obtained:

(1)	Porosity	3.9%
	Permeability to nitrogen	zero
(2)	Porosity	7.3%
	Permeability to nitrogen	0.42 md.

Core No. 22: 8,007 - 8,017 feet

Two 1 3/4" long and 3/4" diameter core plugs were drilled out perpendicularly to the axis of the core at each of two points marked on the core. Each core plug was cut in two 3/4" long pieces and marked respectively (1), (1a); (2), (2a) and the following results were obtained.

(1)	Porosity	4.6%
	Permeability to nitrogen	zero
(1a)	Porosity	3.7%
	Permeability to nitrogen	zero
(2)	Porosity	2.6%
	Permeability to Nitrogen	zero
(2a)	Porosity	8.0%
	Permeability to nitrogen	3.34 md.

Two core plugs 3/4" long and 7/8" diameter were cut out parallel to the axis of the core at opposite ends of the core. They were marked (1) and (2) respectively, and the following results were obtained:

(1)	Porosity	1.25%
	Permeability to nitrogen	zero

(2)	Porosity	2.3%
	Permeability to nitrogen	zero

In conclusion, it may be remarked that the "small plug" technique used in these tests is, perhaps, not suitable for rocks of vugular porosity; the porosity and permeability thus determined cannot be considered truly representative for the core as a whole. However, the visual examination of the vugs tends to confirm the results of porosity and permeability measurements inasmuch as the connexion between vugs appears to be very poor and only locally developed.

At least three types of porosity were observed, i.e. intergranular; vuggy - partly filled; vuggy - open, pin-head. No fractures were observed.

APPENDIX E

FORMATION TESTS, MEDA No. 1

DST. No.1	5082' - 5163'	Cushion: 500' fresh water; test duration : 16 min. Recovery: 500' cushion water and 450' drilling mud.
DST. No.2	6653' - 6696'	Cushion: 1000' fresh water; test duration : 145 min. Recovery: 11.8 bbl. (990') cushion water - 3000 ppm NaCl. 3.34 bbl. drilling mud - 5300 ppm NaCl. 1.62 bbl. salt water - 32,600 ppm NaCl. Natural gas flowing through water cushion at rate of 30 - 100 MCF/day.
DST. No.3	6845' - 6888'	Cushion: 1000' fresh water; test duration : 63 min. Recovery: 11.14 bbl. cushion water - 1950 ppm NaCl. 1 bbl. drilling mud - 6000 ppm NaCl.
DST. No.4	7062' - 7089'	Cushion: 1000' fresh water; test duration : 60 min. Recovery: 15.3 bbl. cushion water - 2200 ppm NaCl. 8 bbl. drilling mud, gas cut - 6000 ppm NaCl.
DST. No.5	7419' - 7510'	Cushion: 1000' fresh water; test duration : 69 min. Recovery: 13 bbl. cushion water. 1 bbl. drilling mud.
DST. No.6	7585' - 7675'	Cushion: 90' water; tool did not open.
DST. No.6A	7582' - 7675'	Cushion: 90' water. Test mechanically unsuccessful.
DST. No.6B	7571' - 7696'	Cushion: 90' water. Test mechanically unsuccessful.
DST. No.6C	7594' - 7669'	Cushion: 90' water. Test duration : 188 min. Recovery: 1 bbl. cushion water 9.6 bbl. drilling mud 15.1 bbl. mud cut with water and gas. 30.7 bbl. salt water, gas cut - 50,700 ppm NaCl. Gas sample collected from the gas cut water, the gas not reaching the surface during the test.
DST. No.7	6594' - 6695'	through perforated 7" casing; zone acidized with 1000 gal. 15% HCl. Test duration : 8 hours. Recovery: Displacing water, flowing at rate of 5 gal/min., 25 bbl. produced. Natural gas of moderate flow.

DST. No.7A	6594' - 6695'	swabbing for 13 hours. Recovery: drilling mud, displacing water and weak gas flow.
DST. No.7B	6594' - 6695'	formation reacidized with 1000 gal. 15% HCl; 12 hours swabbing.
DST. No.7C	6594' - 6695'	Cushion: nil; test duration 222 min. Recovery: 15.3 bbl. spent acid, strongly gas cut; natural gas, flowing through fluid column, with sample collected in steel cylinder under 25" Hg pressure.
DST. No.7D	6594' - 6695'	Cushion: nil; test duration : 5 hours 40 min. (swabbing 4 hours) Recovery: 25.6 bbl. gas cut spent acid.
DST. No.8	5250' - 5310'	through perforated 7" casing; the interval acidized with 1000 gal. 15% HCl. Recovery: 24.4 bbl. displacing water, cut with spent acid.
DST. No.8A	5250' - 5310'	Cushion: nil; test duration : 17 hours (swabbing 8 hours) Recovery: 61 bbl. salty water, cut with gas and spent acid; green fluorescence. 30 bbl. gas cut salty water - 21,000 ppm NaCl. pH 7, green flourescence. intermittent slight gas flow.
DST. No.9	5110' - 5133'	through perforated 7" casing. Cushion: nil; test duration : 70 min. Recovery: estimated 3 gal. CRUDE OIL 0.5 bbl. water - 4,600 ppm NaCl.
DST. No.9A	5110' - 5133'	formation acidized with 1000 gal. 15% HCl; test duration: approx. 45 hours (swabbing, bailing, air jetting, reverse circulation.) Recovery: 38 bbl. displacing water, gas cut. 1.5 bbl. active acid. 1.5 bbl. spent acid. 65.5 bbl. gas cut salty water - 10,500 ppm. NaCl. with traces CRUDE OIL from 1% to 4%. slight gas show giving positive flame test.
DST. No. 9B	5110' - 5133'	Cushion: nil; test duration : 2 hours. Recovery: 1.5 bbl. salty water - 14,800 ppm NaCl. gas cut with traces of OIL.

8 bbl. brownish salty water - 10,800 ppm NaCl, gas cut with 7% CRUDE OIL.
20.5 bbl. light brown water - 10,800 ppm NaCl, gas cut with traces of OIL.

After wellhead was left open for 4 hours, a free flow started discharging annulus water and CRUDE OIL; 4 1/2 gals. of CRUDE OIL were collected by skimming in 30 hours.

DST. No.9C	5110' - 5133'	Cushion: nil; Recovery: 450 bbl. slightly gas cut water - 9000 ppm NaCl, with estimated 1% CRUDE OIL.

APPENDIX F

OIL, GAS AND WATER ANALYSES

by

Petroleum Technology Laboratory

Bureau of Mineral Resources

Evaluation of Crude Oil from Meda No. 1

(Formation Test No. 9, Interval 5,110 - 5,133').

A sample, supplied by West Australian Petroleum Pty Limited, of crude oil obtained from exploratory drilling (interval 5,110 - 5,133 feet) was examined. The sample as supplied had been separated from water by skimming from the top of a tank at the well location.

The sample is characterized by very low contents of water, salt, sulphur, sediment and ash.

Preliminary evaluation suggests that the oil is probably a paraffin-base crude.

The method of analysis was based on the "Standard Methods for Testing Petroleum and its Products", published by the Institute of Petroleum, 1957. A reference to the serial designation of the tests carried out is made under each specific determination.

1. Examination of the Sample as Received:

1.1 Description of sample. The sample was fairly mobile at room temperature and was dark greenish-brown in colour. It had a faint sweet smell.

1.2 Water Content. Dean and Stark method, IP74/57, with toluene as the carrier liquid.

Only a slight trace found, less than 0.1%.

1.3 Ash. IP4/53, Method A; 11g. of sample used. Ash, as percentage of original sample : 0.04%W. Colour of ash: light, orange-brown.

1.4 Sediment by extraction. IP53/55T; Sediment by extraction : 0.04%W.

1.5 Viscosity. (a) Kinematic viscosity in C.G.S. units, IP71/57, at 100°F (37.8°C) : 6.60 centistokes.

(b) Redwood No. 1, (estimated), at 100°F : 42.5 sec.

2. Examination of the Dehydrated Sample

The trace of water in the sample was removed by shaking with anhydrous calcium chloride and then, after standing overnight, filtering through two thicknesses of filter paper.

2.1 Specific gravity. IP71/57, Westphal balance method. Specific gravity 60/60°F : 0.836.

2.2 Viscosity. IP71/57
Kinematic viscosity at 100°F : 7.00 centistokes.

2.3 Flash-point. IP 33/55
Flash-point by the Abel apparatus : 94°F (atmospheric pressure 29.37").

2.4 Cloud and pour points. IP 115/55.
Cloud point : Could not be observed as sample too opaque. Pour point: 36°F.

2.5 Salt content. IP 77/51T.
Salt content of sample : Nil.

2.6 Sulphur content. Bomb method, IP 61/57
Sulphur content of sample : 0.10%W.

2.7 Asphaltenes. Precipitation with normal heptane, IP 143/57.
Asphaltenes content of sample: 0.06%W.

3. Distillation of the Dehydrated Light Crude Oil

100 ml. of the dehydrated sample was distilled according to method IP 24/55. The volume of distillate obtained at each multiple of 25°C, up to a maximum of 300°C, when the distillation was stopped, was as follows:

Temperature, °C.	Volume of distillate collected, ml.
100	nil
125	1
150	4
175	9
200	15.5
225	23.5
250	32.0
275	39.5
300	48.5

3.1 Distillate at 300°C. Light greenish yellow in colour; blue fluorescence when viewed down measuring cylinder.

Volume: 48.5 per cent of total crude.
Specific Gravity (IP 59/57) by Westphal balance : 0.786 at 60/60°F (15.5°C).

3.2 Residue at 300°C. Dark, brown liquid.

Volume of residue at 60°F : 51.8 per cent of total.
Specific Gravity (IP 59/57) by specific gravity bottle (sample very viscous at 60°F) : 0.882 at 60/60°F (15.5°C).

The distillation curves for the dehydrated crude oil sample are given in Figure 2.

4. General Comments.

The crude oil examined was characterised by very low contents of water, salt, sulphur, sediments and ash.

Approximately half of the oil was distilled at temperatures below 300°C, the light oil fraction below 150°C being very small.

Type of Crude. Preliminary evaluation of the sample suggests that it is probably a paraffin-base crude. This is supported by the following:

(i) Low specific gravity. According to the U.S. Bureau of Mines method which classifies crudes on the basis of the specific gravity of their fractions, the low specific gravity of the oil would put it in the paraffin class.

(ii) Low asphaltenes content.

(iii) Waxy appearance of final residue.

(iv) Low sulphur content. Sulphur is more frequently associated with asphaltic rather than with paraffinic oils.

(v) Sweet odour.

(vi) Relatively high pour-point.

Generally, paraffin-base crudes yield good quality kerosenes, gas oils and lubricants, but the gasoline is usually of low octane value.

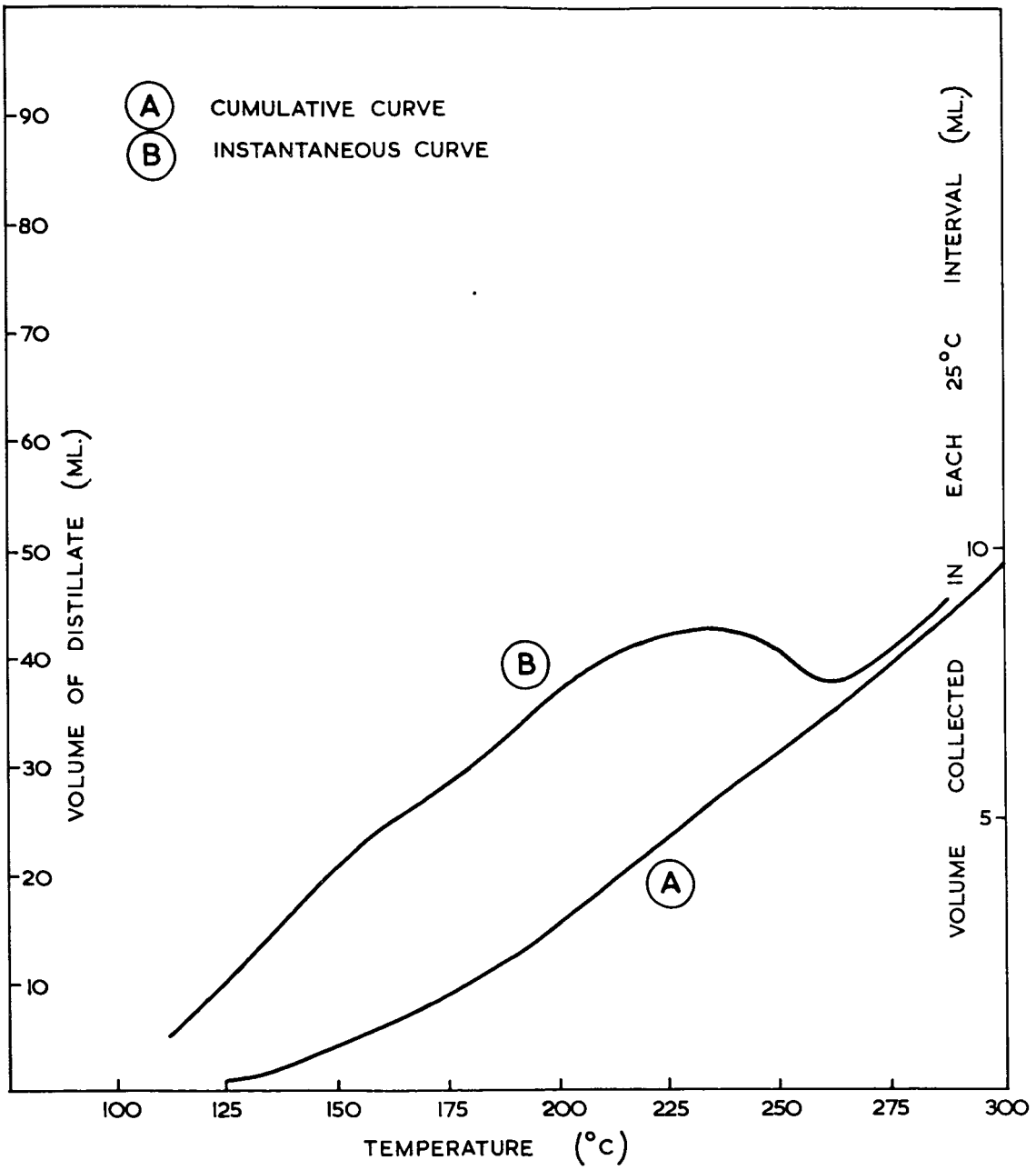


FIG. 2 DISTILLATION CURVES FOR THE DEHYDRATED CRUDE OIL

A - 2751

Gas Analyses

Component (in % by volume)	Sample from DST No. 6C (7,594 - 7,669')	Sample from DST No. 7C (6,594 - 6,695')	Sample from DST No.9(A-C) (5,110 - 5,133')
CO_2	1.5	6.5	0.5
C_nH_{2n}	N.D.	N.D.	N.D.
O_2	3.1	11.2	18.8
H_2	N.D.	2.9	19.3
CO	N.D.	N.D.	N.D.
CH_4	75.2	56.7	0.4
C_2H_6	0.9	1.2	0.03
C_3H_8	0.14	0.37	0.005
N. C_4H_{10}	0.02	0.09	N.D.
Iso. C_4H_{10}	0.02	0.12	N.D.
C_5H_{12}'s	N.D.	Trace	N.D.
N_2	19.4	21.2	61.1
	100.3	100.3	100.1

REMARKS: (1) N.D. - not determined.

(2) Plastic bottles containing samples from DST No. 6C & DST No. 9(A-C) were collapsed by approximately 1/5th original volume, and were under a reduced pressure on receipt.

(3) High 0_2 and $0_2/N_2$ ratio of samples from DST No. 6C and DST No. 9(A-C) were thoroughly checked.

Analyses of Water Samples, Meda No. 1

Tested	WSO Test No. 4, 5150-5152', 46th-50th Stand		DST No. 3, 6845-6888' 65th Stand		DST No. 6C, 7594-7669', 73rd Stand		DST No. 8A, 5250-5310', 50th Stand		DST No. 9C, 5110-5133', Swab sample	
	P P M.	ME/L.	P P M.	ME/L.	P P M.	ME/L.	P P M.	ME/L.	P P M.	ME/L.
Total solids (105°C)	53,955	-	2,970	-	42,060	-	50,910	-	37,035	-
Suspended matter filtered from decanted liquid & ignited (800°C)	402	-	15	-	543	-	615	-	783	-
Colloidal matter precipitated by boiling	* 400 Fe	-	Nil	-	Nil	-	Nil	-	Nil	-
Calcium	4,117	205.8	343	17.1	2,700	135	2,060	103	840	42.0
Magnesium	101	8.4	Nil	-	Nil	-	78	6.5	135	11.3
Iron	244	-	Nil	-	Nil	-	166	-	50	-
Aluminium	80	-	18	-	62	-	582	-	441	-
Sodium	10,750	467.0	600	26.2	10,150	442	5,170	224.8	12,000	522.0
Potassium	80	2.2	20	0.5	120	3	100	2.6	20	0.5
Bicarbonate	774	12.9	504	8.4	420	7	504	8.4	430	7.1
Sulphate	562	11.7	272	5.7	393	8.2	333	6.9	131	2.7
Chloride	23,100	650.0	1,064	30.0	20,135	570.0	12,262	344.5	21,000	592.0
pH	6.6		7.6		8.35		6.8		7.0	

Remarks: ME/L. Milli-equivalents per litre
* Actual weight was 373 ppm Fe_2O_3

No determination was made of organic matter in solution.

APPENDIX G

ELECTRICAL LOGGING, MEDA No. 1

The following Schlumberger logs were run:

Log		Interval	Date
Electrical Log	ES-1	4051 - 412'	7th July, 1958
	ES-2	5162 - 4060'	23rd July, 1958
	ES-3	6185 - 5058'	7th August, 1958
	ES-4	8808 - 6050'	8th October, 1958
Laterolog	LL-1	6693 - 4800'	18th August, 1958
	LL-2	7506 - 6600'	7th September, 1958
	LL-3	8122 - 6600'	19th September, 1958
	LL-4	8805 - 8050'	8th October, 1958
Microlog	ML-C-1	6694 - 4888'	17th August, 1958
	ML-C-2	6886 - 6590'	21st August, 1958
	ML-C-3	7507 - 6748'	7th September, 1958
	ML-C-4	8123 - 7400'	19th September, 1958
	ML-5	8806 - 8000/4060'	8th October, 1958
Gamma Ray-Neutron	GRN-1	6186 - 200'	8th August, 1958
	GRN-2	6697 - 6090'	18th August, 1958
	GRN-3	7510 - 6585'	7th September, 1958
	GRN-4	8126 - 7400'	19th September, 1958
	GRN-5	8809 - 8000'	8th October, 1958
Gamma Ray	GR-6	6709 - 5000'	18th October, 1958
Section Gauge	SG-1	4050 - 412'	7th July, 1958
	SG-2	5160 - 4060'	23rd July, 1958
	SG-3	6183 - 4060'	7th August, 1958
Temperature Log		180 - 3220'	12th July, 1958
		4400 - 6888'	21st August, 1958
		5300 - 8125'	20th September, 1958
		3230 - 6708'	18th October, 1958
Directional Log	DR-1	6100 - 500'	8th August, 1958
	DR-2	8800 - 6100'	8th October, 1958
Dipmeter	1	4979 - 5000')	19th September, 1958
		5705 - 5718')	
		5030 - 5054')	
		6617 - 6640')	

Dipmeter (Cont)	1	5110 - 5116')	
		6730 - 6735')	
		5116 - 5134')	
		6735 - 6753')	
		5232 - 5254')	
		7080 - 7090')	
		5299 - 5320')	19th September, 1958
		7090 - 7105')	
		5592 - 5613')	
		7234 - 7252')	
		5697 - 5705')	
		7319 - 7350')	

APPENDIX H

DEVIATION RECORD, MEDA No. 1

The following deviations were recorded with an Eastman Deviation Recording Device:-

Level	Deviation°	Level	Deviation°
380'	1/2	6395'	1 1/4
1900'	1	6515'	1 1/4
2340'	1/2	6606'	1
2745'	1/2	6675'	1/2
2950'	1	6820'	2
3110'	1 1/4	6965'	1 3/4
3445'	1/2	7065'	1 3/4
3619'	1/2	7190'	1 3/4
3845'	1 3/8	7290'	1 1/2
4005'	3/4	7405'	1 1/2
4275'	1	7470'	1 1/2
4600'	1 3/4	7504'	2
4860'	1 3/4	7560'	2
5020'	3/4	7602'	2
5239'	1/2	7715'	1 3/4
5415'	3/4	8007'	2
5694'	2	8125'	2
5759'	2	8265'	2
5865'	2 3/4	8415'	2
5985'	2 1/2	8490'	2
6081'	2 1/4	8580'	2 1/4
6175'	2	8680'	2
6272'	1 1/2	8744'	2 1/4

Also the Schlumberger Directional Log was run (2 runs) - from the surface to 4,100 feet at 500-foot intervals (without direction) and from 4,100 feet to T.D. at 200-foot intervals (giving both amount and direction of deviation).

Plate 1

COMPANY: WEST AUSTRALIAN PETROLEUM PTY LTD.

COMPOSITE WELL LOG

WELL NUMBER: **MEDA Nº I**

REGION: CANNING BASIN

COUNTRY: WESTERN AUSTRALIA

FILE No. C-2616

LOCATION:
LATITUDE: 17° 24′ 00″ S
LONGITUDE: 124° 11′ 32″ E
CO-ORDINATES:
YARDS EAST 189 920
YARDS NORTH 2 810 200

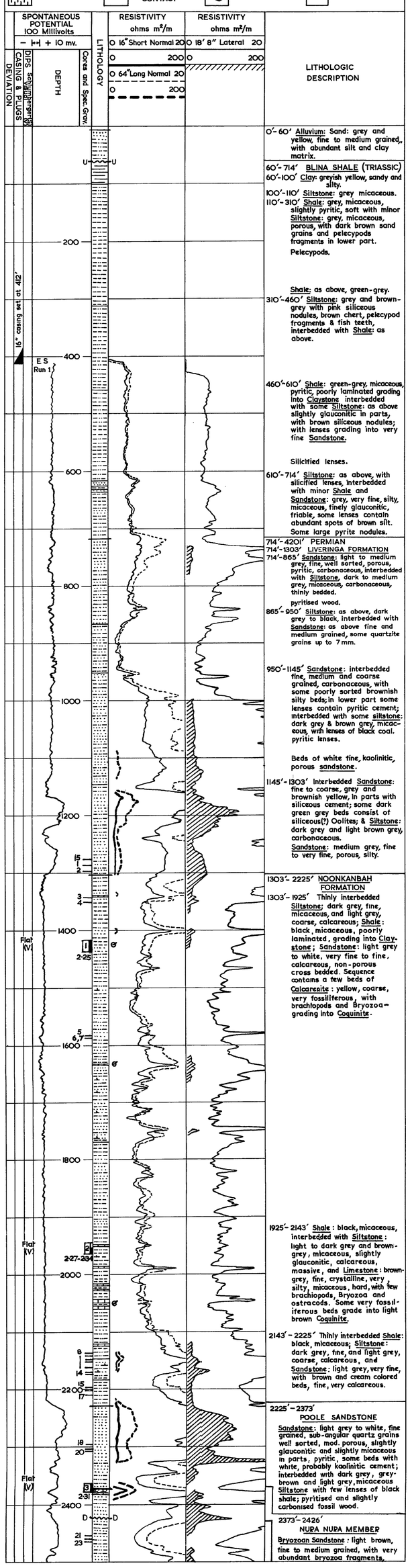
ELEVATION DERRICK FLOOR FT. 100
ELEVATION GROUND FT. 88
TOTAL DEPTH FROM DERRICK FLOOR FT. 8809
PLUG BACK FROM DERRICK FLOOR FT. 5001
DATE SPUDDED: 8 JUNE 58
DATE COMPLETED: 21 NOVEMBER 58
COMPILED BY: V. PUDOVSKIS
LITHOLOGY BY: V. PUDOVSKIS
M.H. JOHNSTONE
R.M.L. ELLIOTT
R.E. PLAYFORD

ELECTRIC LOG DATA:

RUN NUMBER:	1	2	3	4
DATE:	7 JULY 58	23 JULY 58	7 AUG 58	8 OCT 58
INTERVAL RECORDED	4051 - 412	5162-4060	6185-5058	8808-6050
MUD NATURE	clay base	clay base	clay base	clay base
MUD RESISTIVITY	2.25 @ 80°	2.00 @ 75°	1.15 @ 85°	1.10 @ 76°
MUD RESISTIVITY B.H.T.	1.3 @ 140°	0.93 @ 162°	0.52 @ 182°	0.8 @ 256°
MUD WEIGHT	83	77	76	82
MUD VISCOSITY	51	44	48	80
MUD WATER LOSS	15	12	10·5	6·2
MUD pH	9	8	8	7

OTHER LOG COVERAGE:
LATEROLOG: LL1, 4800 - 6693'; LL2, 6600'-7506'; LL3, 6600-8122'; LL4, 8050 - 8805'.
MICROLOG CALIPER: MLC1, 4888 - 6694'; MLC2, 6590 - 6886'; MLC3, 6748-7507'; MLC4, 7400-8123'; MLC5, 8000 - 8806'.
GAMMA RAY NEUTRON: GRN1, 200 - 6186'; GRN2, 6090 - 6697'; GRN3, 6585-7510'; GRN4, 7400 - 8126'; GRN5, 8000 - 8809'.

CONGLOMERATE
SANDSTONE
SILTSTONE
CLAYSTONE
SHALE
CALCARENITE
LIMESTONE
DOLOMITE
SCHIST
UNCONFORMABLE CONTACT
CONFORMABLE CONTACT
DISCONFORMABLE CONTACT
OIL SHOW
GAS SHOW
DOLOMITIC
CALCAREOUS
FOSSILIFEROUS
MICACEOUS
OOLITIC
CORE (RECOVERY BLACK)
SPECIFIC GRAVITY
SIDE WALL CORE
PERFORATED
CASING SHOE



0′-60′ Alluvium: Sand: grey and yellow, fine to medium grained, with abundant silt and clay matrix.

60′-714′ BLINA SHALE (TRIASSIC)
60′-100′ Clay: greyish yellow, sandy and silty.
100′-110′ Siltstone: grey micaceous.
110′-310′ Shale: grey, micaceous, slightly pyritic, soft with minor Siltstone: grey, micaceous, porous, with dark brown sand grains and pelecypods fragments in lower part.
Pelecypods.

Shale: as above, green-grey.
310′-460′ Siltstone: grey and brown-grey with pink siliceous nodules, brown chert, pelecypod fragments & fish teeth, interbedded with Shale: as above.

460′-610′ Shale: green-grey, micaceous, pyritic, poorly laminated grading into Claystone interbedded with some Siltstone: as above slightly glauconitic in parts, with brown siliceous nodules; with lenses grading into very fine Sandstone.

Silicified lenses.
610′-714′ Siltstone: as above, with silicified lenses, interbedded with minor Shale and Sandstone: grey, very fine, silty, micaceous, finely glauconitic, friable, some lenses contain abundant spots of brown silt.
Some large pyrite nodules.

714′-4201′ PERMIAN
714′-1303′ LIVERINGA FORMATION
714′-865′ Sandstone: light to medium grey, fine, well sorted, porous, pyritic, carbonaceous, interbedded with Siltstone, dark to medium grey, micaceous, carbonaceous, thinly bedded.
pyritised wood.
865′-950′ Siltstone: as above, dark grey to black, interbedded with Sandstone: as above fine and medium grained, some quartzite grains up to 7 mm.

950′-1145′ Sandstone: interbedded fine, medium and coarse grained, carbonaceous, with some poorly sorted brownish silty beds; in lower part some lenses contain pyritic cement; interbedded with some siltstone: dark grey & brown grey, micaceous, with lenses of black coal. pyritic lenses.

Beds of white fine, kaolinitic, porous sandstone.
1145′-1303′ Interbedded Sandstone: fine to coarse, grey and brownish yellow, in parts with siliceous cement; some dark green grey beds consist of siliceous(?) Oolites; & Siltstone: dark grey and light brown grey, carbonaceous.
Sandstone: medium grey, fine to very fine, porous, silty.

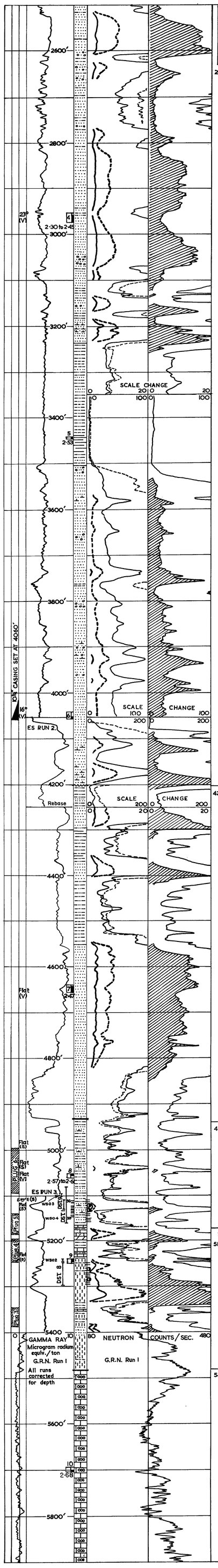
1303′-2225′ NOONKANBAH FORMATION
1303′-1925′ Thinly interbedded Siltstone; dark grey, fine, micaceous, and light grey, coarse, calcareous; Shale: black, micaceous, poorly laminated, grading into Claystone; Sandstone: light grey to white, very fine to fine, calcareous, non-porous cross bedded. Sequence contains a few beds of Calcarenite: yellow, coarse, very fossiliferous, with brachiopods and Bryozoa — grading into Coquinite.

1925′-2143′ Shale: black, micaceous, interbedded with Siltstone: light to dark grey and brown-grey, micaceous, slightly glauconitic, calcareous, massive, and Limestone: brown-grey, fine, crystalline, very silty, micaceous, hard, with few brachiopods, Bryozoa and ostracods. Some very fossiliferous beds grade into light brown Coquinite.

2143′-2225′ Thinly interbedded Shale: black, micaceous; Siltstone: dark grey, fine, and light grey, coarse, calcareous, and Sandstone: light grey, very fine, with brown and cream colored beds, fine, very calcareous.

2225′-2373′
POOLE SANDSTONE
Sandstone: light grey to white, fine grained, sub-angular quartz grains well sorted, mod. porous, slightly glauconitic and slightly micaceous in parts, pyritic, some beds with white, probably kaolinitic cement; interbedded with dark grey, grey-brown and light grey, micaceous Siltstone with few lenses of black shale; pyritised and slightly carbonised fossil wood.

2373′-2426′
NURA NURA MEMBER
Bryozoan Sandstone: light brown, fine to medium grained, with very abundant bryozoa fragments, foraminifera tests replaced by glauconite and some brachiopods, grading to very sandy Calcarenite: calcareous cement in parts recrystallized to clear calcite, interbedded with Sandstone and Siltstone, and a few beds of Limestone: brown.



2426′-4201′
GRANT FORMATION
2426′-2475′ Siltstone: light grey, very coarse, and some Sandstone: white, very fine grained.
2475′-3236′ Sandstone: light grey to white, fine to coarse grained, well sorted, with some poorly sorted silty beds calcareous in parts with recrystallized calcitic cement, kaolinitic, porous to moderately porous; with carbonaceous partings and lenses containing fossil plants. Some beds grade into Conglomerate: with pebbles of quartzite, jasper and granite; with some beds of Siltstone; dark to light grey, brown grey and greenish grey, micaceous, slightly calcareous.
Slickensided, fractured, and coarsely brecciated.

Very calcareous.

3236′-3505′ Siltstone (Tillite): dark grey, sandy to very sandy, massive, interbedded with Claystone: dark grey, very finely micaceous, slightly sandy, containing fossil plants.

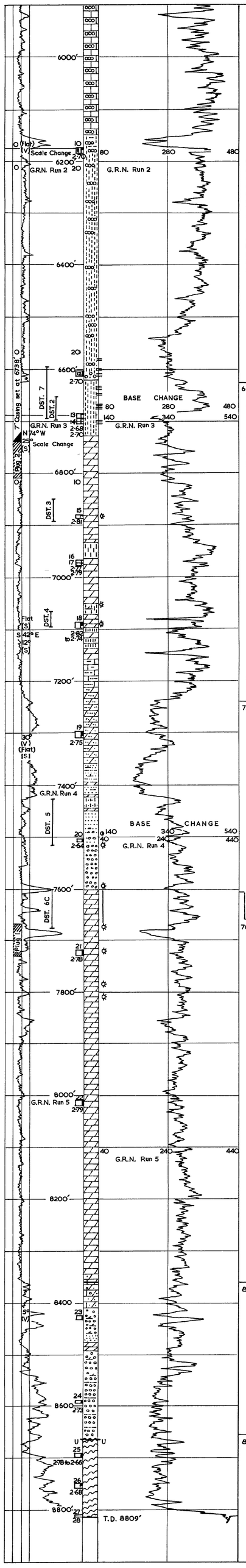
3505′-4201′ Sandstone: light grey to white, in upper part, fine to medium grained, in lower part medium to coarse grained, with beds of pebble conglomerate, porous, moderately to poorly sorted, with beds containing calcareous and kaolinitic cement; below 3900′ tan and cream colored beds contain feldspar grains.
Kaolinitic
Calcareous
Abundant kaolin
Silty
Kaolinitic
Light tan and cream, calcareous, felspathic.
Recrystallized calcitic cement
Kaolinitic
Abundant kaolin
Very kaolinitic
Calcitic cement. Hard greenish lenses.

4201′-4935′
ANDERSON FORMATION
UPPER CARBONIFEROUS
4201′-4552′ Siltstone: multi-colored, grey, yellow, red-brown, and green, micaceous, lignitic, sandy in parts, with some very sandy, poorly sorted, tillite type beds; massive to poorly laminated, some grey and green beds grade into Claystone: interbedded with few beds of Sandstone: white, fine to medium grained, moderately sorted, slightly porous, with kaolinitic and siliceous cement, pyritic in parts.
lignitic
4552′-4935′ Sandstone: white and pink, fine to medium grained, well sorted, micaceous, with some recrystallised siliceous cement, cross-bedded and thinly bedded, carbonaceous lenses contain plant remains — leaves and pyritized wood.

4935′-6150′
LOWER CARBONIFEROUS
4935′-5168′
LAUREL FORMATION
Upper Member
4935′-5168′ Interbedded Siltstone: brown grey, micaceous, carbonaceous, thinly laminated, fissile, contains ostracods and Sandstone: white, fine to very fine grained, non-porous to slightly porous, calcareous in upper part, dolomitic in lower part grading into sandy Dolomite.
5125′-5139′ Brown hydro-carbon staining showing strong fluorescence.

5168′-5483′
LAUREL FORMATION
Lower Member
Interbedded Limestone: fine, crystalline, dolomitic, grading downwards to Calcarenite: light grey and brown, fine to medium, sandy, and Siltstone: dark grey, micaceous, thinly bedded, grading into black Shale: few beds of white, fine, calcareous Sandstone; formation richly fossiliferous with brachiopods and ostracods.
5260′-5300′ Thin sandstone beds show brown hydro-carbon staining and strong bluish and greenish-white fluorescence.

5483′-8663′ DEVONIAN
5483′-6620′
FAIRFIELD BEDS EQUIVALENT
Limestone: white, light greyish-brown and cream, slightly sandy, oolitic, non-porous; in parts Calcarenite and Calcilutite texture could be recognised, stylolitic solution voids filled with green pyritic and Claystone are common.
Fauna poorly preserved and consists predominantly of ostracods with rare algae.



Calcarenite, light grey-brown to cream, fine, recrystallised with clear crystalline calcitic cement, sandy, with fine, sub-angular to sub-rounded quartz grains; in parts oolitic; stylolitic solution voids filled with micaceous, pyritic, and sandy siltstone and green claystone, some thin beds grade into Calcilutite.
At the bottom the calcarenite becomes coarser, grading into Calcirudite: sandy and pebbly, in turn grading into calcareous Quartz Pebble Conglomerate.

Some orange-coloured beds.

6620′-8360′ REEF COMPLEX
6620′-6731′ REEF
Calcarenite: recrystallised, light grey-brown, medium to coarse grained, moderately sorted, compact, with some Algal Limestone.
The fauna consists of brachiopods, ostracods and nautiloids. Some gas in porous beds.
Dolomite: light to medium grey recrystallised, finely saccharoidal, silty in part, traversed by calcite veins, stylolitic, slight vuggy porosity; abundant calcitic patches - probably representing replaced fossils.
Brachiopods common.
Several thin porous zones contain gas.

Silty.

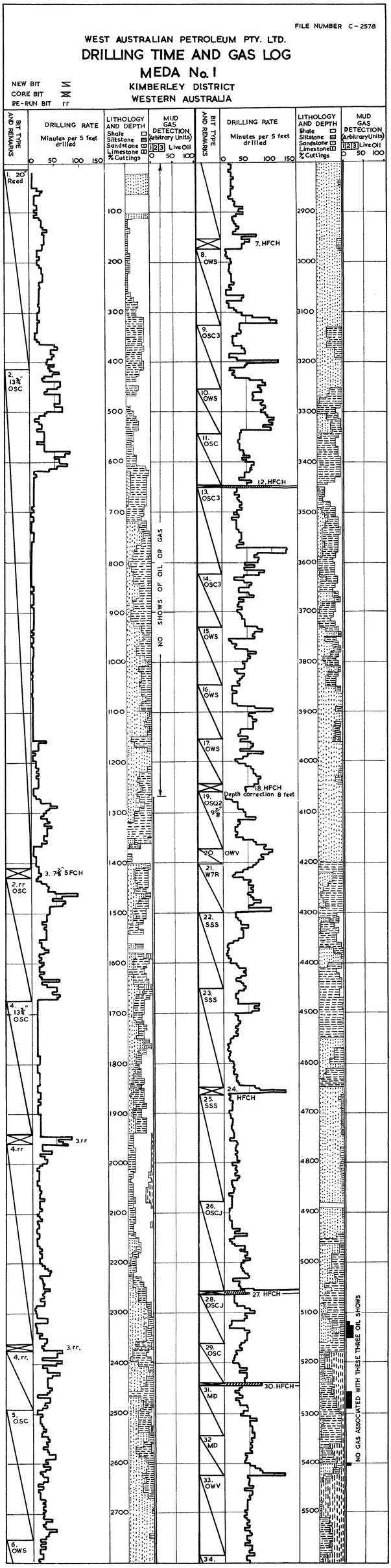
7235′-7603′ TERRIGENOUS MEMBER
Terrigenous intercalation with Dolomite: light grey-brown, cream and pink, calcareous, silty and sandy, with finely-disseminated pyrite.
Calcarenite: light grey and cream, coarse, oolitic.
Siltstone: grey-brown, coarse, sandy, calcareous, dolomitic, with finely-disseminated pyrite.
Sandstone: light-grey, pink, and red-brown, fine to coarse grained, poorly-sorted, pyritic, calcareous, dolomitic, non-porous.
and
Conglomerate: (in lower part): with pebbles and boulders of quartzite in a matrix of Sandstone: unsorted, calcareous, and dolomitic.
7498′-7504′: some thin beds of Sandstone: brown-grey, fine to very fine, silty, moderately porous, with brown staining and strong golden-yellow fluorescence.

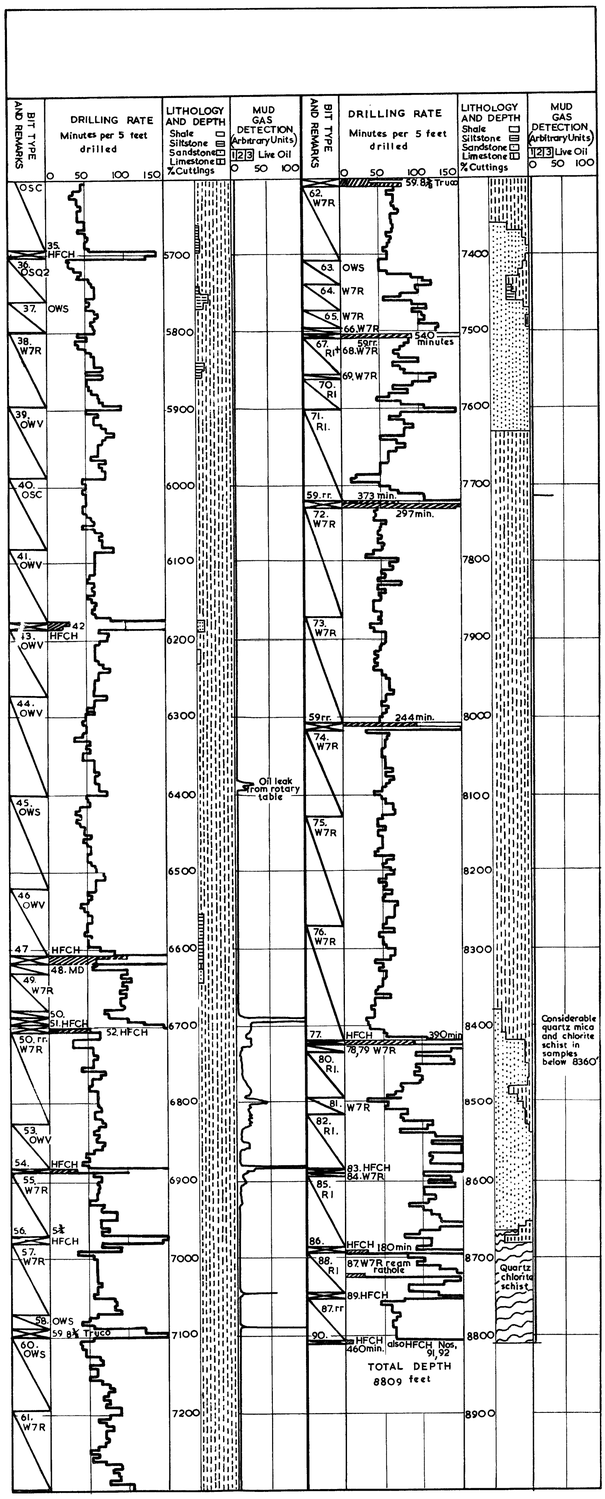
7603′-8360′ DOLOMITIZED FORE REEF
Dolomite: grey, brown, pink, and yellow, fine, crystalline, calcareous, stylolitic, fractured, with abundant calcite veins; in part grading into Breccia; good vug porosity and permeability.
The saline formation water contains minor amounts of gas in the upper part of the formation.

8360′-8663′
BASAL CHLORITIC CONGLOMERATE
Conglomerate: grey and green, dolomitic, with pebbles of quartzite, muscovite schist, and chlorite schist. Interbedded with sandy and conglomeratic Dolomite and fine dolomitic Sandstone, in the upper part of the unit.
In the lower part of the unit, the colour is predominantly green due to abundant chlorite in the matrix. Towards the base, the matrix grades into quartzite.

Current bedding.

8663′ — T.D.
PRECAMBRIAN BASEMENT
8663′-8791′ Quartz Chlorite Schist in the upper part and Dolomitised Sericite-Chlorite-Quartz Schist towards the base.
8791′-T.D.
Sericite-Quartz Schist, very hard.


FILE NUMBER C-2578
WEST AUSTRALIAN PETROLEUM PTY. LTD.
DRILLING TIME AND GAS LOG
MEDA No. 1
KIMBERLEY DISTRICT
WESTERN AUSTRALIA
NEW BIT
CORE BIT
RE-RUN BIT
BIT TYPE AND REMARKS
DRILLING RATE
Minutes per 5 feet drilled
LITHOLOGY AND DEPTH
Shale
Siltstone
Sandstone
Limestone
% Cuttings
MUD GAS DETECTION (Arbitrary Units)
Live Oil
NO SHOWS OF OIL OR GAS
NO GAS ASSOCIATED WITH THESE THREE OIL SHOWS


BIT TYPE AND REMARKS
DRILLING RATE
Minutes per 5 feet drilled
LITHOLOGY AND DEPTH
MUD GAS DETECTION (Arbitrary Units)
Live Oil
Oil leak from rotary table
Considerable quartz mica and chlorite schist in samples below 8360'
Quartz chlorite schist
TOTAL DEPTH
8809 feet