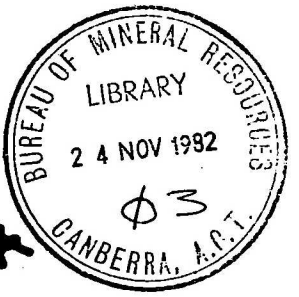

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1982/37

SOURCE ROCK DRILLING IN THE

PROTEROZOIC OF THE AMADEUS BASIN,

NORTHERN TERRITORY, 1980-81

by

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ABSTRACT

In 1980 and 1981, BMR drilled five fully-cored holes to test the petroleum source rock potential of Proterozoic rocks in the eastern Amadeus Basin. Three holes were drilled in the Bitter Springs Formation and one each in the Aralka and Pertatataka Formation. Each of these formations was considered to have some source potential, based on limited geochemical data, the presence of foetid carbonates in the Bitter Springs Formation, and of dark shales in the Aralka and Pertatataka Formation.

Samples from the Bitter Springs Formation had low total organic carbon values. One sample yielded a moderate amount of extract which contained too small a proportion of hydrocarbons to be rated as a good source rock. However, all the samples came from weathered material and the geochemical data obtained from them may not be fully indicative of the source potential of the Bitter Springs Formation.

Low values of total organic carbon were also obtained from samples of the Aralka and Pertatataka Formations. The Aralka Formation averaged 60 mg per gram of organic carbon of extracted organic matter containing 20% of hydrocarbons, whereas the Pertatataka Formation averaged 133 mg per gram of organic carbon of extract with 13 percent hydrocarbons. Neither unit is a good source rock in the areas tested. Petrophysical tests of these formations showed a lack of porosity and permeability, indicating poor reservoir potential and poor prospects for migration of any hydrocarbons generated.

INTRODUCTION

McKirdy (1977) and Saxby and Bruen (1978) reported a number of organic geochemical analyses of the Proterozoic rocks of the Amadeus Basin which suggested some source potential for these rocks.

As part of an on-going study of petroleum source potential of Cambrian and Proterozoic rocks in central Australian basins, BMR drilled three fully-cored holes in 1980 and two in 1981 to obtain samples from the Proterozoic Bitter Springs Formation, the Aralka Formation and the Pertatataka Formation. One hole, BMR Illogwa Creek No. 3, was drilled to test part of the Loves Creek Member, the upper member of the Bitter Springs Formation, and two holes, BMR Illogwa Creek Nos 4 and 5, were drilled to test the upper part of the underlying Gillen Member. BMR Illogwa Creek No. 3 encountered drilling difficulties at 32.4 m and was plugged and abandoned. No core was retained from this hole. The other two holes also failed to reach their target depths due to difficult drilling. In 1981 BMR Illogwa Creek No. 6 tested the lower part of the Aralka Formation and BMR Rodinga No. 4 tested the upper part of the Pertatataka Formation below the Julie Formation.

The locations of the drillholes are shown in Figure 1.

BMR ILLOGWA CREEK NOs 3, 4 and 5

Drillsite geology

BMR Illogwa Creek Nos 3, 4 and 5 were drilled in the Bitter Springs Formation on the southwestern limb of a major asymmetrical north-west-trending anticline. Arunta Complex and Heavitree Quartzite crop out in the core of the anticline. In this area the Gillen Member of the

Bitter Springs Formation, which overlies the Heavitree Quartzite, has been subdivided into five lithofacies units (Eug_1 - Eug_5)(Shaw & others, in prep.). The Gillen Member is in turn overlain by dark-coloured, bedded limestone of the Loves Creek Member.

Fine-grained siliciclastic and calcareous sedimentary rocks of the Areyonga, Aralka, and Pertatataka Formations crop out poorly on, or underlie, the plains to the west of the drillsites. Coarser-grained clastics of the Limbla Member of the Aralka Formation crop out in a ridge to the southwest of the road from Ringwood to Limbla stations.

Units penetrated

BMR Illogwa Creek No. 3 spudded in in the top of the Loves Creek Member of the Bitter Springs Formation. The Loves Creek Member consists of grey to dark grey limestone and dolomite with shale interbeds. The hole penetrated 32.3 m of intensely fractured and weathered carbonates with very steep dips. The hole was abandoned at this depth due to difficult drilling conditions. No core was retained.

BMR Illogwa Creek No. 4 spudded in in black medium-bedded dolomitic limestone with subdued outcrop, about 40 m stratigraphically below the top of unit Eug_5, the topmost lithofacies unit of the Gillen Member of the Bitter Springs Formation. The hole penetrated 41.4 m of grey limestone, dolomitic in part, with laminae and beds of claystone above 30 m and laminae and thin beds of quartz sandstone below that depth (Figure 2).

BMR Illogwa Creek No. 5 spudded in in yellow sandy limestone at the top of unit Eug_4 of the Gillen Member. The hole penetrated 36.1 m of weathered pink to tan limestone with green to purple shale interbeds

and rare laminae of chert or quartzite. A 70 cm-thick bed of medium- to coarse-grained, pink quartz sandstone was intersected at 17.46 m and a one metre thick bed of dark grey fissile shale was intersected at 29.4 m (Figure 3).

Summary of drilling operations

BMR Illogwa Creek No. 3

This hole is located at approximately longitude 135°08'E, latitude 23°59'S, elevation 354 m. It was drilled to a depth of 32.4 m with a Mayhew 1000 rig.

The hole was drilled to 4.0 m using a 20 cm Williams roller bit. Eleven cores were cut between 4.0 m and 32.4 m with a 3.05 m HQ wireline core barrel using a Triefus 8-step diamond corehead, and Spudmud drilling fluid. Core recovery was about 50 percent overall and the core was very broken. No core was retained. The hole was plugged and abandoned.

BMR Illogwa Creek No. 4

The hole is located at approximately longitude 135°08'E, latitude 23°58'55"S, elevation 350 m. It was drilled to 41.4 m using equipment as above.

Thirty-one cores were cut between 5.50 m and 41.40 m. The hole was plugged back by one metre at 18.50 m when circulation was lost. Core recovery above 32.2 m was about 90 percent; below 32.20 m, 100 percent. The core was broken throughout the hole.

BMR Illogwa Creek No. 5

The hole is located at approximately longitude 135°08'E, latitude 23°58'55" S, 250 m northeast of No. 4 drillhole, elevation about 360 m.

Twenty-five cores were cut between 3.0 and 30.4 m (total depth), using equipment as for No. 3 drillhole. Recovery was 95 percent. The core was badly broken throughout the hole.

BMR ILLOGWA CREEK NO. 6

Drillsite geology

BMR Illogwa Creek No. 6 was sited on gently dipping Proterozoic sediments (5^{o}-15^{o}) on the northeastern limb of the Limbla Syncline. The syncline is in weathered green calcareous siltstone, calcarenite, and stromatolitic dolomite of the Aralka Formation, underlain by diamictite, sandstone, and conglomerate of the Areyonga Formation, which in turn is underlain by dolomite and limestone of the Bitter Springs Formation (Preiss & others, 1978).

Units penetrated

The drillhole was spudded in at the base of a hill formed by the Ringwood Member of the Aralka Formation, close to the base of the Member as mapped and was cored entirely in the Aralka Formation within and below this Member. It penetrated 10 m of weathered green calcareous siltstone overlying fresh black to dark grey, pyritic calcareous siltstone which was present throughout the hole to total depth at 230 m (Figure 4). Pyritic carbonates of probable algal origin occur sporadically in the interval from 32.0 to 53.5 m at the base of the Ringwood Member as defined by Preiss & others (1978).

Summary of drilling operations

The drillhole is located at approximately $135^{o}19'$E longitude and $23^{o}45'$S latitude, elevation 365 m. It was drilled to 13.0 m using an Atlas Copco hammer and air circulation. Coring commenced at 13.0 m using equipment and mud circulation as for No. 3 drillhole.

Seventy three cores were cut between 13.0 and 230 m (total depth). Core recovery was 100 percent and coring was rapid, averaging 27 m per ten-hour shift. No drilling problems were encountered.

BMR RODINGA NO. 4

Drillsite geology

BMR Rodinga No. 4 was located on the gently dipping (12^{o}-15^{o}) southern limb of a syncline in the southeastern part of Phillipson Pound. The weathered grey green siltstones and shales of the Pertatataka Formation are overlain by scree and Quaternary aeolian sand.

Units penetrated

BMR Rodinga No. 4 was spudded in about 30 m from the base of a hill formed by the Julie Formation, close to the base of the formation. The drillhole penetrated about three metres of scree and aeolian sand, and then weathered greenish-brown silty mudstone, which was micaceous and pyritic, to 24 m.

From 24 m to the total depth of 170 m the core consisted of a monotonous sequence of dark greenish grey to greenish black silty mudstone with interlaminated, partly dolomitic siltstone, much of which was contorted and disrupted (Figure 5). Pyrite was finely disseminated throughout the sequence and also occurred both as laminae up to 5 mm thick and as irregular blebs up to 10 mm across. Calcite occurred as veinlets filling fractures, particularly in the intervals 15-42 m and 141-170 m. Some pyritic black shale fragments were present at 96 m and between 110 and 122 m. At total depth the hole was still in shales of the Pertatataka Formation.

Summary of drilling operations

BMR Rodinga No. 4 was located at approximately 134°36'E and 24°11'S, and was drilled to a total depth of 170 m using the geological equipment specified for BMR Illogwa Creek No. 3. Coring commenced at 15 m with mud circulation. Unical was added to the mud from 131 m. Core recovery was 100 percent, averaging 18 m per ten-hour shift. No drilling problems were encountered.

SOURCE ROCKS

Selected dark-coloured mudstone/shale and carbonate samples from the four wells drilled were submitted to AMDEL for source rock analysis. Sampling of the very uniform silty mudstone of the Aralka Formation in BMR Illogwa Creek No. 6 was done at 30-metre intervals. Samples from BMR Illogwa Creek No. 6 and BMR Rodinga No. 4 were analysed for total organic carbon in BMR Petroleum Technology Laboratory and only the relatively carbon-rich intervals were sampled again for further analysis by AMDEL. These samples were also examined microscopically to determine the type of organic matter present and its reflectance.

Bitter Springs Formation (BMR Illogwa Creek Nos 4 and 5)

The results of laboratory geochemical analyses by AMDEL from BMR Illogwa Creek Nos 4 and 5 are presented in Table 1. Based on the criteria of Dickey and Hunt (1972) all samples of the Bitter Springs Formation had low total organic carbon (TOC) content, less than the 0.5% TOC required as the minimum for a shale to be regarded as a petroleum source, and are rated as lean-barren. One sample yielded a moderate amount of solvent-extractable organic matter relative to the

amount of organic carbon contained, but the proportion of hydrocarbons in the extract was too small for the sample to be regarded as a good source, and it also is rated as lean-barren. However, the small number of samples and the weathered nature of the core material from which they were taken lessen the usefulness of these data.

Because of the low kerogen content, visual examination of the kerogen was not attempted. McKirdy (1977) concluded from geochemical data from the Bitter Springs Formation in BMR Alice Springs No. 3, 30 km northwest of BMR Illogwa Creek Nos 4 and 5, that the Bitter Springs Formation is overmature in this area.

Aralka Formation (BMR Illogwa Creek No. 6)

The Aralka Formation showed a narrow range of TOC values throughout (0.20-0.32% (Table 2) averaging 0.28%. The apparent slight increase with depth in TOC content indicated in the BMR Petroleum Technology Laboratory analyses (Table 3) was not corroborated by the AMDEL determinations; however the low values obtained are towards the lower limit of analytical accuracy for TOC determinations and must be interpreted with caution. In general there is good agreement between the TOC values determined by the two laboratories.

The TOC values are below 0.5% TOC. Several samples yielded moderate amounts of extract, and one (from 134.76 metres) contained 41 percent hydrocarbons in the extract. This sample could be rated as a fair hydrocarbon source.

A small number of vitrinite reflectance determinations on the sparse organic matter in the rock indicates that the kerogen is within the oil generation zone (Table 4).

The organic matter present was identified as vitrinite and exinite, which are sources of mainly gas and mainly oil respectively in a mature rock. However, the overriding factor in rating the unit as lean to barren is the sparse amount of organic matter present.

Pertatataka Formation (BMR Rodinga No. 4)

The TOC values for the Pertatataka Formation samples are very low (Tables 3, 5) and are approaching the lower limits of experimental accuracy, which accounts for the non-agreement of determinations by the two analytical laboratories. The high experimental error and the small number of samples analysed require a cautious interpretation of the data.

The TOC content of the samples is lower than the accepted minimum for a source rock (0.5% TOC). All but one samples have extremely low TOC's. The samples yielded moderate amounts of extract but the proportion of hydrocarbons in the extract is low. The samples are rated as lean.

One reflectance determination of 0.9% on a vitrinite-like maceral from Core 36 (119.71-119.77 m) indicated that the sample is mature i.e. in the oil-generating zone.

A fragment of high-reflecting organic matter tentatively identified as sclerotinite from Core 28 (96.98-97.03 m) had a reflectance of 1.4%.

A possible acritarch fragment from the same sample had a moderate to bright orange fluorescence, also an indicator of moderate maturity.

Data from the Pertatataka Formation in Exoil's Ooraminna No. 1 well, 45 km northwest of BMR Rodinga No. 4 indicate that the formation there is mature to overmature (McKirdy, 1977).

PETROPHYSICAL PROPERTIES

A representative core sample from each of BMR Illogwa Creek No. 6 and BMR Rodinga No. 4 drillholes was submitted to BMR's Petrophysical Laboratory for testing. The results are presented in Table 6. The sample from BMR Illogwa Creek No. 6 has very low porosity and permeability and a relatively high carbonate content. The shale sample from BMR Rodinga No. 4 showed unusually high porosity and grain density values considering its lithology (a fissile, calcareous shale). The porosity was not apparent when the sample was viewed under a binocular microscope and may be due to (1) very fine pore space, (2) microfractures parallel to the fissile layering, possibly induced during porosity testing. We feel that both the porosity and grain values are erroneously high and that the porosity was induced during testing, leading to an anomalously high value for the apparent grain density. Examination of the sample with

a binocular microscope showed rare disseminated pyrite, but not in sufficient quantity to account for the high grain density.

The permeability of the sample from BMR Rodinga No. 4 could not be determined because the shale is fissile and it fractured when attempts were made to obtain cylinders for testing.

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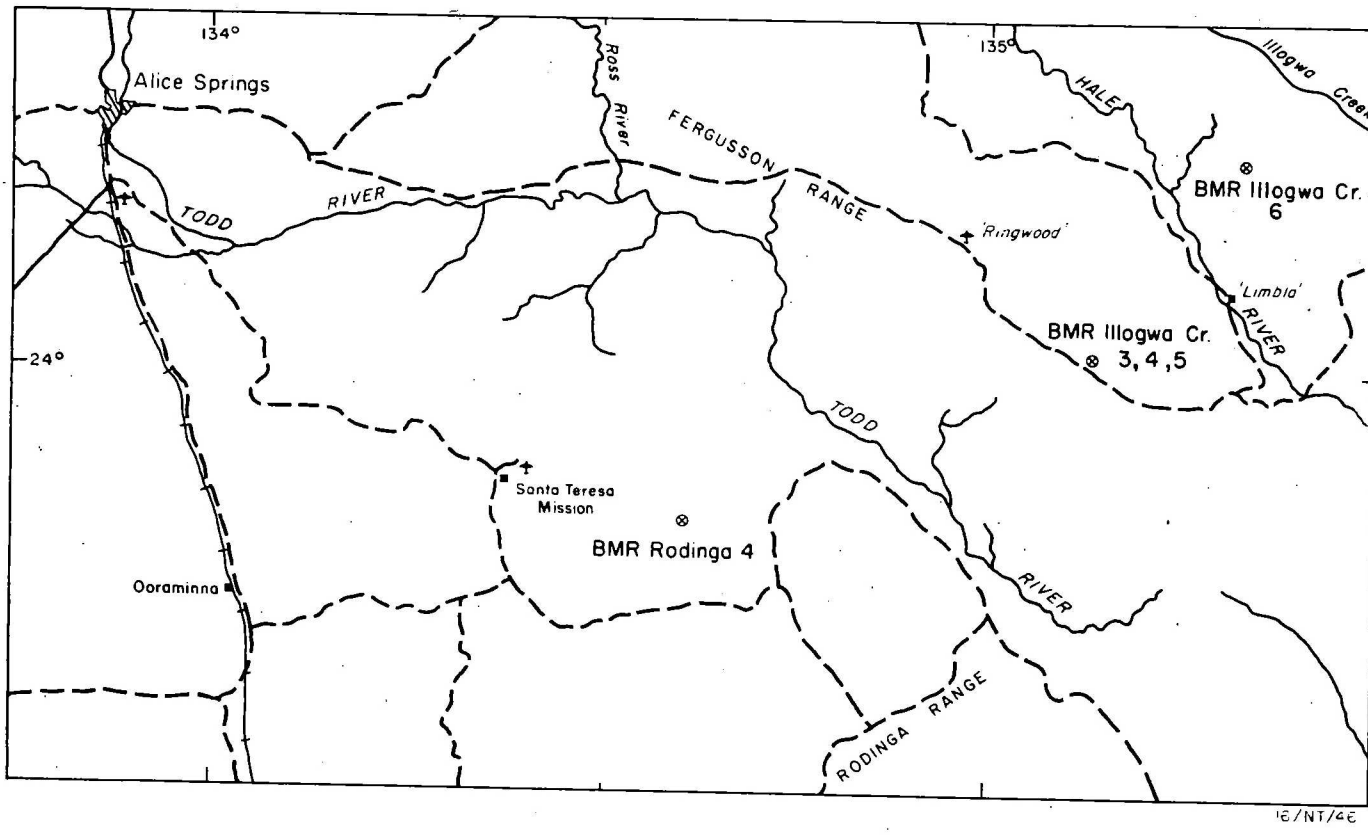
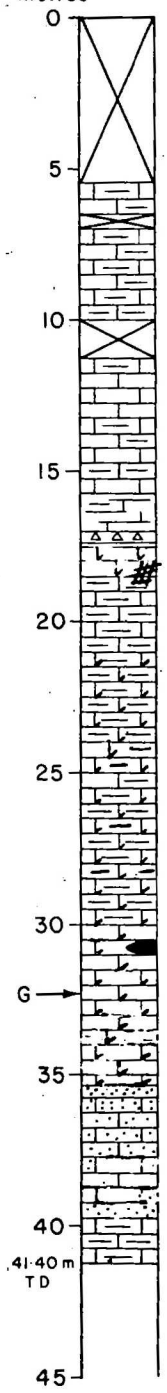


Fig. 1 Locations of BMR drillholes 1980–81, Amadeus Basin.

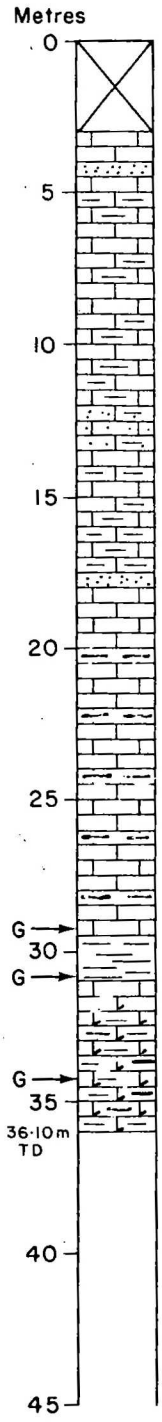


0 – 5 50m	*No recovery*
6·48 – 6 90m	*No recovery*
5·50 – 17·00m	*Limestone, weathered, grey to light grey, clayey, with claystone, weathered, buff to olive.*
10·15 – 11 20m	*No recovery*
17·00 – 17·40m	*Limestone, brecciated.*
17·40 – 18·30m	*Limestone, dolomitic, fractured. Fractures healed by calcite.*
18·30 – 21·00m	*Limestone, light grey, clayey, very broken. NK: 18·30 – 18·50m, 18·80 – 19·00m, 19·85 – 20·00m.*
21·00 – 29·80m	*Limestone, dolomitic, grey to light grey, clayey, laminated. Brecciated in part. Laminae are mainly claystone, rarely quartz sand.*
29·80 – 35·40m	*Limestone, dolomitic, grey, laminated, rarely dark grey with chert nodules. Dip 50°*
35·40 – 37·56m	*Quartz sandstone, grey, fine – medium, . . limestone, grey, clayey with quartz sandstone laminae. Quartz sandstone band near base; ?erosional base.*
37·56 – 38·87m	*Limestone, grey, laminated, wavy bedding. Vughs to 3cm long in bedding plane. Dip 50°. Sandy laminae near base.*
38·87 – 39·43m	*Quartz sandstone, grey, very fine, pyritic. Base gradational. Dip 50°*
39·43 – 41·40m	*Limestone, light grey, clayey, fractured, iron stained.*

G = geochemical sample point (32·20m)

16/NT/47

Fig. 2 Field lithological log, BMR Illogwa Creek 4.



0 – 3·00m — *No recovery*

3·00 – 13·60m — *Limestone, weathered, pink to yellow, clayey. Beds grey-green laminated claystone. Bedding in Ls 20–30cms thick. Bed of medium to coarse pink quartz sandstone with 10% grey-green claystone laminae from 4·10–4·50m, grading down to fine pink clayey and calcareous sandstone. Sandy bands and scattered quartz sand grains in lower 1·00m of unit. Dip 45°*

13·60 – 17·46m — *Limestone, weathered, tan, clayey with interbedded green and purple shale. Ls beds 25cms thick. Shale micaceous with irregular chert or quartzite laminae, rare tabular hematite nodules. Gradational base.*

17·46 – 18·15m — *Medium to coarse quartz sandstone, weathered, pink, with well-rounded grains and occasional green lithiclastic granules.*

18·15 – 29·40m — *Limestone, weathered, tan, interbedded shale, friable, green and purple with rare indurated white quartzite bands. NK: 18·80–19·00m.*

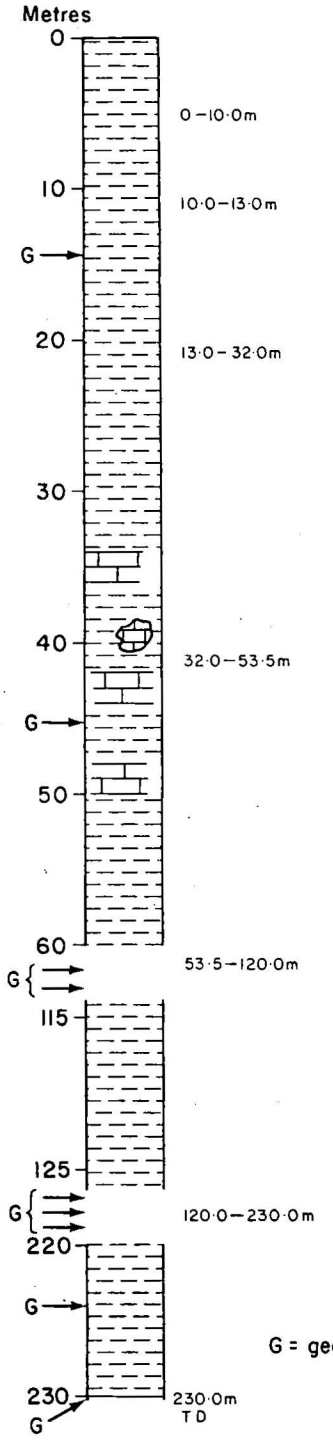
29·40 – 31·40m — *Shale, weathered, fissile, dark grey, black and green with dark slickensided partings. Rare chert or quartzite laminae. Dip 45°*

31·40 – 36·10m — *Limestone, weathered, tan, grading to light grey ? dolomitic limestone and shale, friable, grey, at 31·60m. Gypsum laminae at 31·65–31·70m. Pyrite wisps at 33·40m. Unit is brecciated throughout. Dip 45°*

G = geochemical sample point (29·50m)
(30·90m)
(34·30m)

16/NT/48

Fig. 3 Field lithological log, BMR Illogwa Creek 5.



0–10·0m — *Cuttings. Siltstone, calcareous, weathered, olive grey.*

10·0–13·0m — *Cuttings. Siltstone, calcareous, in part weathered, light olive grey to grey-black.*

13·0–32·0m — *Siltstone, dark grey, muddy, pyritic; light grey calcareous siltstone laminae to 2mm thick; ripple cross-lamination, flame structures, disturbed bedding. Vertical and oblique joints with calcite and pyrite. Dip 05°.*

32·0–53·5m — *Siltstone, dark grey, black, muddy, pyritic, calcareous laminae, sedimentary structures as above. Interbeds and clasts of ? algal limestone with coarse pyrite. Dip 05° to 45° near some limestone beds.*

53·5–120·0m — *Siltstone, dark grey, black, muddy, pyritic as above. Light grey calcareous siltstone laminae increased in number and thickness (to 4mm); lenticular in part. Fractures, joints and microfaults common, calcite-filled.*

120·0–230·0m — *Siltstone, dark grey, black, muddy, pyritic; light grey calcareous laminae to 2mm. Increased number of disturbed and wavy beds. Vertical and oblique joints with calcite and pyrite. Zone vertical fractures to 10mm wide between 124·00–132·15m.*

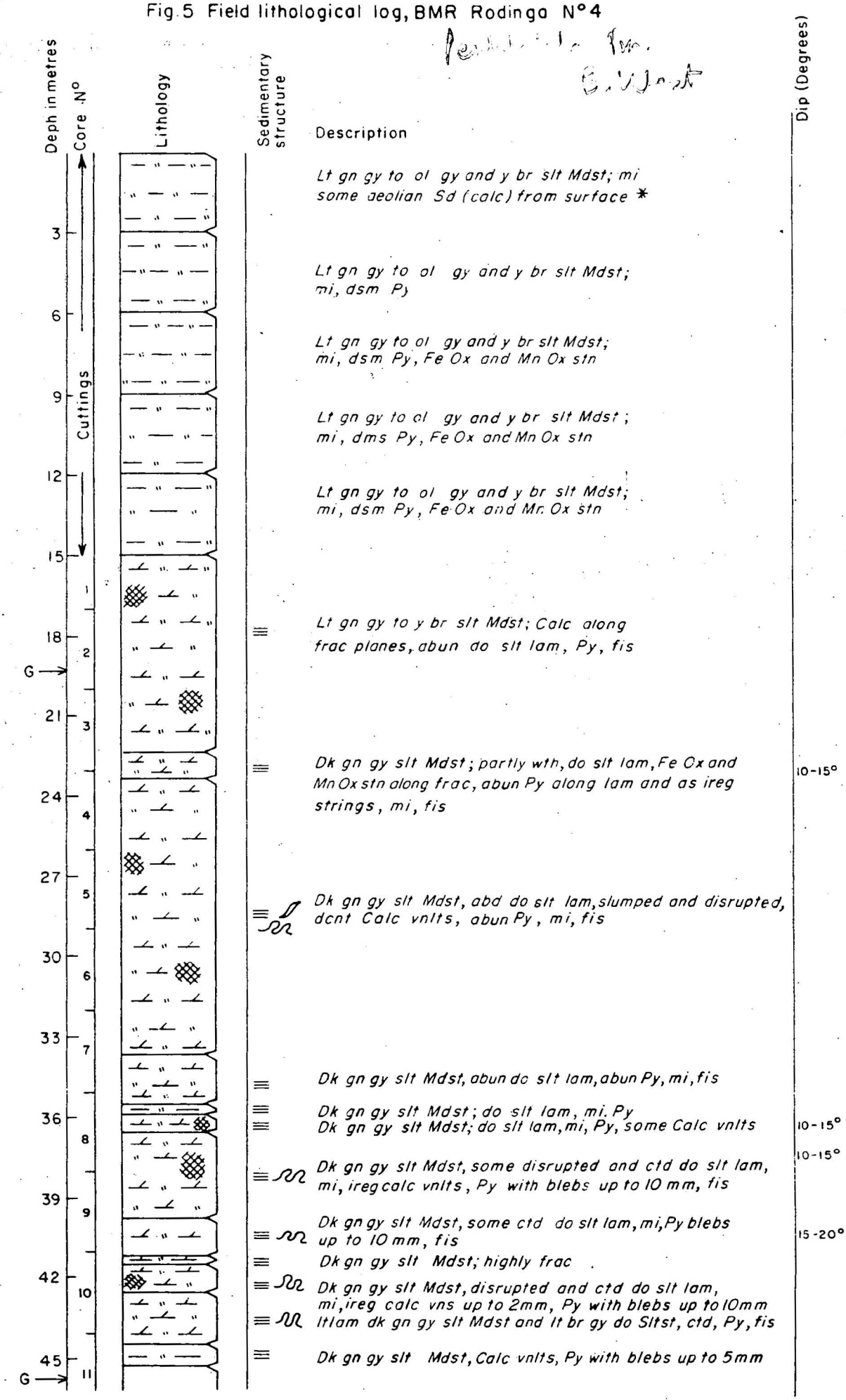
G = geochemical sample point (14·44m) (45·33m) (74·67m) (104·19m) (134·76m) (164·19m) (194·26m) (224·03m) (230·38m)

16/NT/49

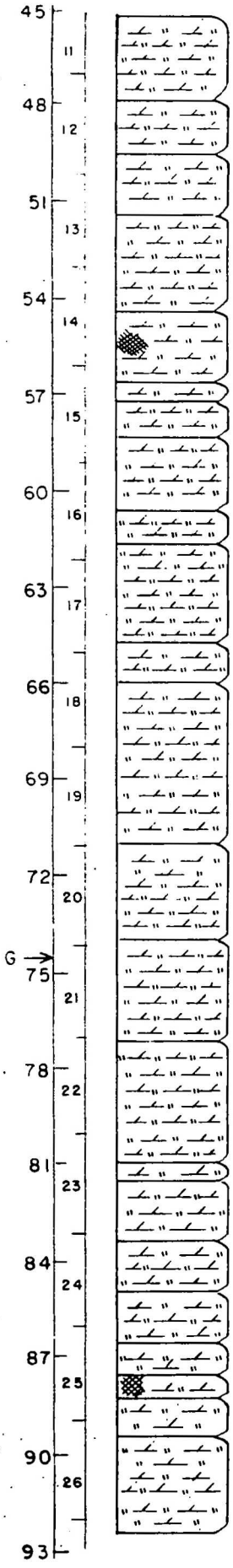
Fig. 4 Field lithological log, BMR Illogwa Creek 6.

Arrilla Fm.
Reynolds Member

Fig. 5 Field lithological log, BMR Rodinga N°4



* BMR preferred abbreviations, 1981



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gn bk to dk gn gy slt Mdst with some ctd do slt lam, Calc vns up to 2mm, Py, fis

itlam dk gn gy slt Mdst and lt br gy do Sltst, some slt lam grd, Py. fis

itlam dk gn gy to gn gy do Sltst; Py with blebs up to 10 mm, fis

itlam dk gn gy slt Mdst and lt br gy do Sltst, Py with strings ctg across lam and blebs up to 10 mm, ctd and distrupted lam, grd, fis

itlam dk gn gy slt Mdst and lt br gy do Sltst, slt lam are ctd and slumped, Py, with strings and blebs up to 2mm, fis

Dk gn gy slt Mdst; highly frac with Calc vnlts up to 20 mm, Py

itlam gn bk slt Mdst and lt br gy do Sltst; Py with blebs up to 5mm, fis

itlam gn blk slt Mdst and lt br gy dol Sltst; some slt lam ctd, Py with blebs up to 5mm, fis

itlam dk gn gy slt Mdst and lt br gy do Sltst, very ctd and wavy, Py, fis

itlam gn bk slt Mdst and lt br gy do Sltst, slt lam often disrupted and ctd, Py, fis

itlam gn bk slt Mdst and lt br gy do Sltst; Py

itlam gn bk slt Mdst and lt br gy do Sltst; with slt intraclasts up to 0·5 mm, Py, fis

itlam gn bk slt Mdst and lt br gy do Sltst; with some slt intraclasts up to 0·5 mm, Py, fis

itlam gn bk slt Mdst and lt br gy do Sltst, abun abun Py incl blebs up to 5 mm, fis

itlam gn bk slt Mdst and lt br gy do Sltst; abun Py incl blebs and strings, Py lam up to 5mm, fis

itlam gn bk slt Mdst and lt br gy do Sltst; slt lam very ctd

itlam gn bk slt Mdst and lt br gy do Sltst with abun Py, fis

itlam gn bk slt Mdst and lt br gy do Sltst with abun Py, fis

itlam gn bk slt, Mdst and lt br gy do Sltst with abun Py

itlam gn bk slt Mdst and lt br gy do Sltst, slt lam often ctd, Py, fis

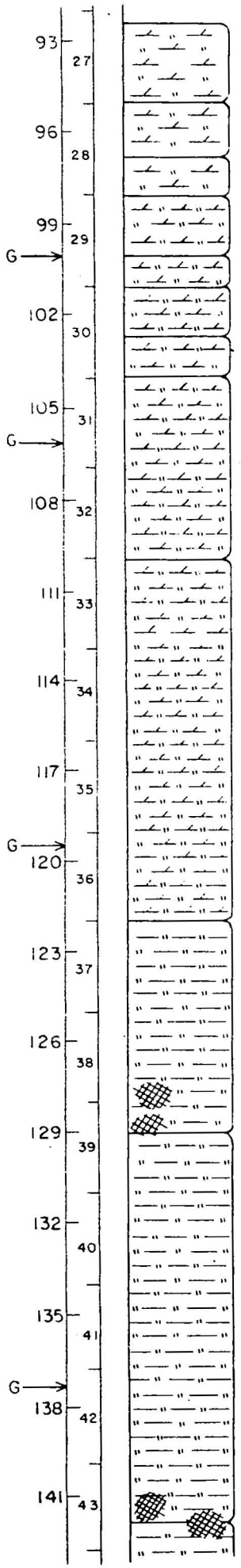
itlam gn bk slt Mdst and lt br do Sltst, slt lam often ctd, Calc vnlts in frac

Dk gn bk slt Mdst with some ctd do slt, lam, Py

itlam gn bk slt Mdst and lt br gy do Sltst, ctd, Py, fis

15-20°

Pentlebakelea fm. (B. West)



itlam gn bk slt Mdst and lt br gy do Sltst; slt lam are ctd, shows grd and s scale scouring, Py, fis

itlam gn bk slt Mdst and lt br gy do Sltst; some iregly dispersed dk gy sh clasts up to 40 mm x 10 m, Py, some slt lam grd, fis

Gn bk to br bk slt Mdst with some lt br gy do ? Sltst, Py

Dk gn gy to gn bk slt Mdst with some lt br gy do ? Sltst, ctd and Py

Dk gn gy to gn bk slt Mdst with lt br gy do Sltst; some dk gy sh clasts up to 5 mm, Py, fis

itlam gn bk slt, Mdst with lt br gy do ? Sltst; ctd and disrupted, some grdlam, Py, some Calc vnlts filling frac

itlam gn bk slt Mdst with lt br gy do Sltst; ctd and disrupted, Py

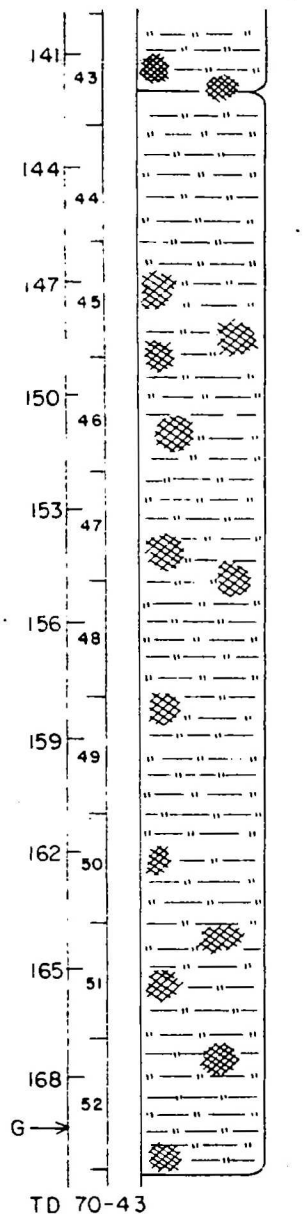
Dk gn gy to gn bk slt Mdst; Py with occ lt br gy slt lam, fis

itlam dk gn gy to gn bk slt Mdst and Sltst; some ireg Py lam and bk sn clasts, slt lam often ctd, fis

itlam dk gn gy to gn bk slt Mdst; occ ctd slt lam, abun Py, Calc filling frac, fis

Dk gn gy to gn bk slt Mdst with some poss do ? slt lam; often ctd or slumped, Py, fis

Dk gn gy to gn bk slt Mdst with some poss do ? slt lam, often ctd or slumped, fis



≡ *Dk gn gy to gn bk slt Mdst; occ slt lam, num Calc vnlts filling frac, Py, fis*

≡ *Dk gn gy to gn bk slt Mdst; occ slt lam, num Calc vnlts filling frac, Py, some py bk sh lam, fis*

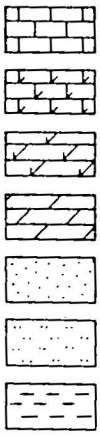
15-20°

G = geochemical sample point

DATE: Aug. 1981
GEOLOGIST: B. G. West
MAP SHEET RODINGA 1:250 000

Symbols used on lithological log

Graphic log: lithologies



Limestone

Dolomitic limestone

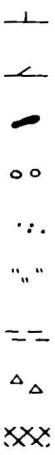
Calcareous dolostone

Dolostone

Sandstone

Siltstone

Shale, mudstone



Calcareous

Dolomitic

Chert nodules

Conglomeratic

Sandy

Silty

Shaly, muddy

Brecciated

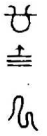
Veins

Sedimentary structures

Lamination

Cross-lamination

Slumped lamination



Scour channels

Graded lamination

Contorted lamination

Abbreviations used on lithological log

Rock Type

Mdst Mudstone
Sltst Siltstone

Color

dk Dark
lt Light
bk Black
br Brown
gn Green
gy Grey
ol Olive
y Yellow

Mineralogy

Calc Calcite
Fe Ox Iron oxides
Mi Mica
Mn Ox Manganese oxides
Py Pyrite

Diagenetic features

abun Abundant
calc Calcareous
dsm Disseminated
do Dolomitic
fis Fissile
frac Fracture
itlam Interlaminated
ireg Irregular
lam Laminae
mi Micaceous
py Pyritic
slt Silty
stn Stain,-ed
wth Weathered
vnlts Veinlets

TABLE 1. SOURCE ROCK DATA, BMR ILLOGWA CREEK NOs 4 AND 5.

Depth (m)	TOC %	EOM (ppm)	SATS (ppm)	AROM (ppm)	POLAR (ppm)	ASPH (ppm)	Pr/nC_{17}	Ph/nC_{18}	Pr/Ph	Rock type	Source rating
32.20*	0.15	65	11.2	1.6	5.6	40.1	0.76	0.97	0.59	Lam. shaly lst	Lean-barren
29.50†	0.20	157	19.6	6.0	19.6	110.0	0.63	0.81	0.88	Gy-bk shale, ?bituminous laminae	
30.90†	0.15	58	7.7	5.4	16.2	27.0	0.63	0.43	1.48	Gy-bk shale	Lean-barren
34.30†	0.10	38	5.5	4.0	11.1	15.0	0.98	0.53	1.70	Gy dolomitic shale	Lean-barren

* BMR Illogwa Creek No. 4

† BMR Illogwa Creek No. 5

TOC - total organic carbon

EOM - extractable organic matter

SATS - saturated hydrocarbons in extract

AROM - aromatic hydrocarbons in extract

POLAR - polar (N,S,O) compounds in extract

ASPH - asphaltenes in extract

Pr/nC_{17} - ratio of contents of pristane to normal alkane of carbon number 17

Ph/nC_{18} - ratio of contents of phytane to normal alkane of carbon number 18

Pr/Ph - pristane to phytane ratio

TABLE 2. SOURCE ROCK DATA, BMR ILLOGWA CREEK NO. 6

Depth† (m)	TOC %	EOM (ppm)	SATS (ppm)	AROM (ppm)	POLAR (ppm)	ASPH (ppm)	Pr/nC_{17}	Ph/nC_{18}	Pr/Ph	Rock type	Source rating
45.33	0.25	113	22.3	8.9	16.4	47.6	1.07	0.22	2.67	Black pyritic siltstone	Lean-barren
74.67	0.20	376	28.2	3.0	58.7	227.5	0.82	0.27	1.67		
104.19	0.32*	73	3.8	5.0	20.1	32.7	0.74	0.33	0.73		
134.76	0.30	144	38.4	21.2	19.2	57.6	0.91	0.29	1.84		
164.19	0.25	201	24.3	11.1	26.5	125.8	1.14	0.21	2.89		
194.26	0.32*	104	11.0	6.1	18.3	51.4	0.53	0.39	1.64		
224.03	0.30*	45	3.5	1.2	8.3	26.0	0.63	0.35	1.49		
230.38	0.32*	70	7.0	5.8	18.7	26.8	0.56	0.44	1.07		
Av.	0.28	141	17.3	7.8	23.3	71.5	0.80	0.31	1.88		

*TOC determination by BMR Petroleum Technology Laboratory

TABLE 3. TOTAL ORGANIC CARBON (TOC) VALUES,

BMR ILLOGWA CREEK NO. 6 AND BMR RODINGA NO. 4.

Sample No.	Well name	Core No.	Depth† (m)	%TOC in whole rock	%TOC in residue*
1	BMR Illogwa Creek	1	14.44	0.18	0.26
2	No. 6	11	45.33	0.25	0.32
3		22	74.67	0.29	0.40
4		31	104.19	0.32	0.45
5		41	134.76	0.24	0.32
6		51	164.19	0.24	0.38
7		61	194.26	0.32	0.45
8		72	224.03	0.30	0.41
9		73	230.38	0.32	0.43
1	BMR Rodinga	2	19.20	0.08	0.09
2	No. 4	11	45.48	0.14	0.16
3		21	74.66	0.21	0.23
4		28	97.03	0.20	0.23
5		31	106.00	0.31	0.35
6		36	119.75	0.23	0.26
7		42	137.56	0.16	0.18
8		52	169.42	0.18	0.21

* Whole rock less acid-soluble components

† Average over range of 5-6 centimetres of core

TABLE 4. REFLECTANCE DATA, BMR ILLOGWA CREEK NO. 6

AND BMR RODINGA NO. 4

	Core no.	Depth (m)	Reflectance R_o (%)	No. of determinations
BMR Illogwa Creek No. 6	11	45.33	0.60	10
	22	74.67	0.45	7
	41	134.76	0.64	6
	51	164.19	0.73	6
BMR Rodinga No. 4	36	119.75	0.90	1

TABLE 5. SOURCE ROCK DATA, BMR RODINGA NO. 4

Depth (m)	TOC %	EOM (ppm)	SATS (ppm)	AROM (ppm)	POLAR (ppm)	ASPH (ppm)	Pr/nC_{17}	Ph/nC_{18}	Pr/Ph	Rock type	Source rating
74.62-74.70	0.10	155	24.5	4.0	55.8	65.3	0.95	0.30	2.11	Dark greenish-grey silty mudstone. Pyritic.	Lean-barren
96.98-97.03	0.10	211	18.4	1.5	42.2	120.9	0.53	0.23	1.94		
105.95-106.00	0.31*	293	11.1	3.8	28.4	205.4	0.53	0.25	1.85		
119.71-119.77	0.10	202	28.3	10.7	34.9	114.5	0.75	0.24	2.05		

*TOC determination by BMR Petroleum Technology Laboratory

TABLE 6 PETROPHYSICAL DATA, BMR ILLOGWA CREEK NO. 6 AND BMR RODINGA NO. 4

Sample	Porosity (% of bulk volume)	Permeability (md)	Dry bulk density (gm/cm^3)	Apparent grain density (gm/cm^3)	Acid solubility (% by weight)
BMR Illogwa Creek No. 6 223.85-223-95m (Core 71)	0.2, 0.88, 0.13	<0.01	2.69, 2.71, 2.70	2.70, 2.74, 2.70	24.0
BMR Rodinga No. 4 92.83-92.90m (Core 27)	10.9, 11.2, 5.6	N.D	2.60, 2.62, 2.65	2.91, 2.95, 2.81	9.7