Tirrengowa 1

Well Completion Report

Hartogen Energy Limited

Tirrengowa 1

Well Completion Report

TIRRENGOWA NO. 1

PEP 100

WELL COMPLETION REPORT

HARTOGEN ENERGY LIMITED
GAS AND FUEL EXPLORATION N.L.

D.A. SHORT AND R.I. HARRIS

HARTOGEN ENERGY LIMITED

15 YOUNG STREET

SYDNEY

JULY 1987

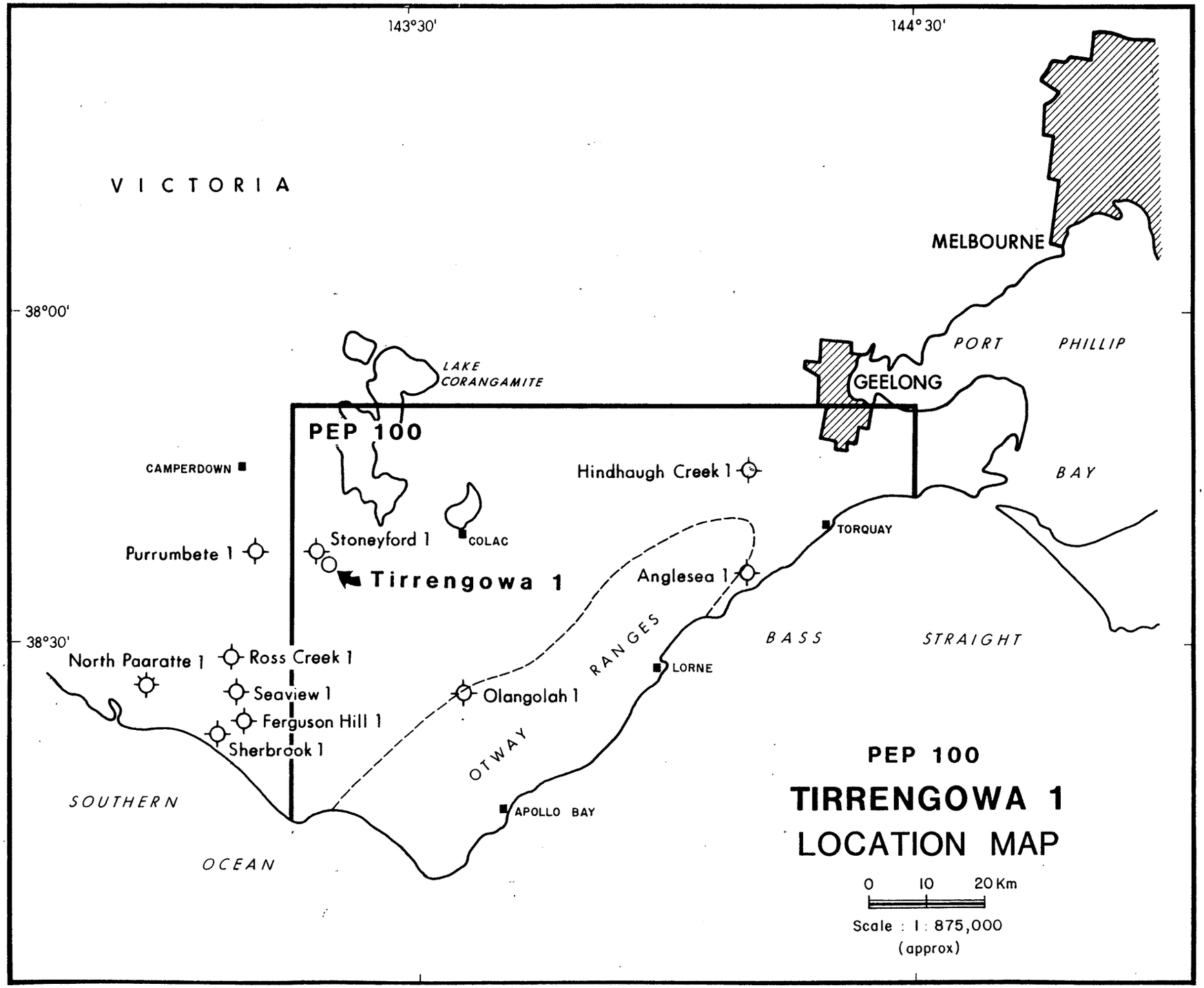
WKM06R11

CONTENTS PAGE

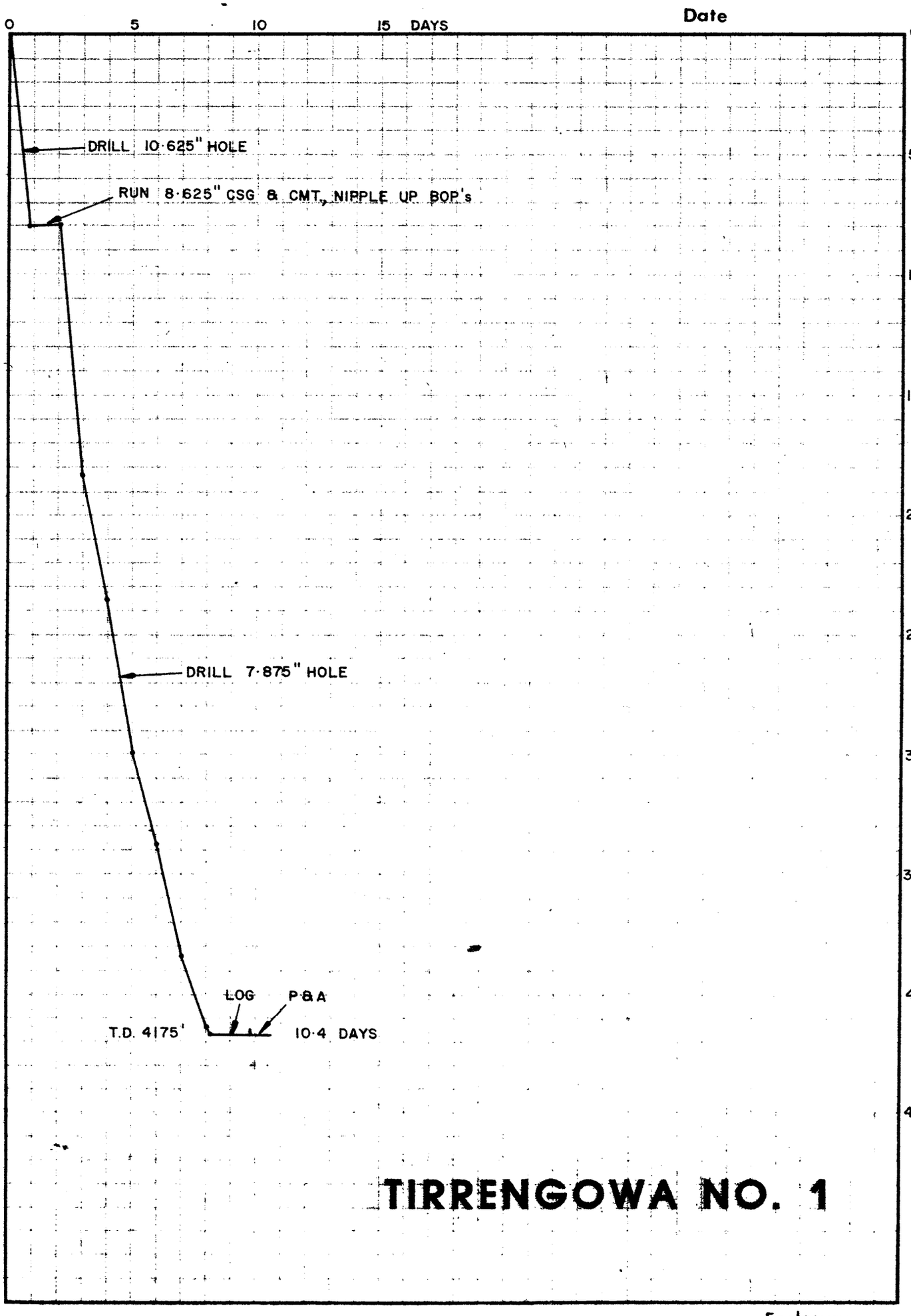
ILLUSTRATIONS

ENCLOSURES

APPENDICES


143°30'
144°30'
VICTORIA
MELBOURNE
38°00'
PORT
PHILLIP
LAKE
CORANGAMITE
GEELONG
PEP 100
CAMPERDOWN
Hindhaugh Creek 1
BAY
Stoneyford 1
COLAC
TORQUAY
Purrumbete 1
Tirrengowa 1
Anglesea 1
38°30'
RANGES
BASS
STRAIGHT
North Paaratte 1
Ross Creek 1
LORNE
Seaview 1
Olangolah 1
Ferguson Hill 1
OTWAY
Sherbrook 1
SOUTHERN
APOLLO BAY
OCEAN
PEP 100
TIRRENGOWA 1
LOCATION MAP
0 10 20 Km
Scale : 1 : 875,000
(approx)

DRILLING DEPTH PLOT



TIRRENGOWA NO. 1

Enclosure

1. SUMMARY

Tirrengowa No. 1 was drilled for Hartogen Energy Limited and Gas & Fuel Exploration N.L. by OD & E Pty Limited on the Tirrengowa Structure in the west of PEP 100, Victoria. The well is located approximately 22 km west-southwest of the town of Colac in southwestern Victoria. The closest well to Tirrengowa No. 1 is GFE Stoneyford No. 1 which was drilled in 1984.

The well spudded on 14 March 1987 and a total depth of 4175 ft/1272.5 m (driller and logger extrapolated) was reached on 22 March 1987. The rig was released on 24 March 1987.

The primary target was the Pretty Hill Sandstone which has excellent reservoir quality. Secondary targets were the Pebble Point Sandstone and the sands of the Eumeralla Formation.

Weak oil shows in the form of dull to occasionally bright yellow-gold fluorescence with a weak crush cut were recorded from sands in the Eumeralla Formation and Pretty Hill Sandstone. These sands were tight with the exception of the basal Pretty Hill sands which had good porosity but were water saturated. The only gas peaks observed were from thin coals in the Eumeralla Formation and were 100 per cent C1 with an occasional trace of C2.

After reaching total depth, wireline logs were run and these in combination with mudlog and sample data did not indicate any hydrocarbon zones and the well was then plugged and abandoned.

2. WELL HISTORY

2.1. GENERAL DATA

Well Name

Tirrengowa No. 1

Name and Address of Operator

Hartogen Energy Limited
15 Young Street
Sydney NSW 2000

Name and Address of Titleholders

Gas and Fuel Exploration N.L.
171 Flinders Street
Melbourne Vic 3000

Petroleum Title

PEP 100

Location

Latitude	38° 22' 58.60" south (surveyed)
Longitude	143° 20' 20.67" east (surveyed)
Seismic	VP 289 Line 83-02

Elevation

Kelly Bushing	471 ft (143.6 m) (surveyed)
Ground Level	456 ft (139.0 m) (surveyed)

Total Depth

Drillers' Depth	4175 ft (1272.5 m)
Loggers' Depth	4175 ft (1272.5 m) extrapolated

Date Spudded

14 March 1987

Date Total Depth Reached

22 March 1987

Date Rig Released

24 March 1987

Status

Plugged and abandoned

2.2. DRILLING DATA

2.2.1. Name and Address of Drilling Contractor

OD&E Pty. Ltd.
Westport Road,
Elizabeth West S.A. 5113

2.2.2. Drilling Plant

Rotary Rig No.19 Kremco K600H

Power

GM 8V92 T.A. (435 HP @ 2100 rpm)
Allison Model CLT5861-5 Converter & Transmission

Mast

Kremco 109 ft 270,000 lbs
Hydraulic Raise & Telescope

Mud Pumps

1 Gardner-Denver PZ-7 (550 HP) Triplex.
Caterpillar D379 TAC Engine.

1 Gardner-Denver PAHBFC (275HP) Triplex.
Detroit Diesel 8V92T Engine.

Blowout Preventors

NL Shaffer spherical 11" - 5000 psi flanged bottom, studded top Annular BOP.
Shaffer LWS 11" - 5000 psi studded top and bottom ram BOP.

Drill Pipe

7,000 ft x 4.5" (OD) Grade "E" 16.6 lb/ft with 4" IF connections. Internally plastic coated.
6 joints HWDP - 4.5" (OD) with 4" IF connections.

Drill Collars

6 only 8" (OD) with 6.625" Regular connections.
24 only 6.5" (OD) with 4" IF connections.

2.2.3. Hole Sizes and Depth

10.625" (270 mm) to 800 ft (242.0 m) (D)
7.875" (200 mm) to 4175 ft (1272.5 m) (D)

2.2.4. Casing and Cementing Details

	Surface
Size (in/mm)	8.625/219
Weight (lbs/ft-kg/m)	24/35.7
Grade	J-5555
Range	3
Setting Depth (ft/m)	794/242.0
Shoe	Guide shoe + float collar
Plugs	Top+bottom
Centralizers	2
Cement (sacks)	350
Additives	0.5% $CaCl_2$
Cemented to (ft/m)	Surface

2.2.5. Drilling Fluids (refer also Appendix 4)

2.2.5.1. Surface to 800 ft/244 m - flocculated bentonite and lime

2.2.5.2. 800 ft/244 m to 1100 ft/335 m - fresh water KCl polymer

2.2.5.3. 1100 ft/335 m to total depth - KCl polymer

2.2.5.4. Physical Properties:

Weight	9.6 - 9.9	lbs/gal
Viscosity	38 - 40	seconds
Water Loss	6.0 - 8.4	ccs/30 mins
pH	9.5 - 10.0	
Sand Content	trace	
Filter Cake	1	32nds/inch
KCl	4.5 - 6.0	per cent
Solids	8 - 9	per cent

2.2.5.4. Mud and Chemicals Used:

Bentonite	20	sacks	905	kg
Caustic	10	sacks	250	kg
KCl	263	sacks	13,150	kg
Soda Ash	5	sacks	200	kg
Lime	4	sacks	100	kg
PAC-R	70	sacks	1,750	kg

2.2.6. Water Supply

Water was carted from Pirron Yallock, a distance of approximately 10 km.

2.2.7. Plugging Back

The following plugs were run:-

Plug	Interval	Cement (sacks)	Remarks
1	4065 - 3900 ft 1240 - 1190 m	50	Across top of Pretty Hill Sst
2	1300 - 1135 ft 395 - 345 m	50	Across top of Wangerrip
3	890 - 725 ft 270 - 220 m	60	Across top of Nirranda

Plug No. 3 tagged at 723 ft/220.4 m with 10,000 lbs.

4 10 sack surface plug and welded cap/plate, located 3 ft below G.L.. Cellar filled in.

2.3. FORMATION SAMPLING

2.3.1. Ditch Cuttings

Cuttings were collected at 30 ft/10 m intervals from surface casing shoe to 1500 ft/460 m and then at 10 ft/3 m intervals to total depth. These were examined for indications of oil and gas, lithologically described, split and bagged. A complete set of cutting samples was sent to the Victorian Department of Industry, Technology and Resources for storage.

2.3.2. Coring

None

2.3.3. Sidewall Cores

Number shot: 30 Number recovered: 29

2.4. LOGGING AND SURVEYS

2.4.1. Wireline Logs (run by Schlumberger)

DLL-GR	794-4154 ft/242-1266 m
MSFL	994-4134 ft/303-1260 m
BHCS-GR	794-4166 ft/242-1270 m
LDL-CNL-GR	1000-4160 ft/305-1268 m

2.4.2. Penetration Rate and Well Log

Mud logging services were provided by EXLOG and total gas and gas composition in the mud was monitored from surface to total depth. A mudlog recording lithology, penetration rate, mud gas and other data was prepared and is an enclosure to this report.

2.4.3. Deviation Surveys

The following were recorded with a Totco Drift Indicator:-

Depth (ft/m)	Deviation (degrees)	Depth (ft/m)	Deviation (degrees)
100/ 30	1/4	2320/ 707	1-1/4
502/153	1/4	2792/ 851	1-1/2
780/238	1/2	3106/ 947	1-1/2
1278/390	3/4	3232/ 985	1-1/4
1581/482	1	3550/1082	1-1/2
1875/572	2	3833/1168	2
2033/620	1-3/4	4147/1264	1-3/4

2.4.4. Temperature Surveys

Nil. During wireline logging the following bottom hole temperatures were recorded:-

DLL	151°F/66.1°C	5.3 hours after circulation
LDL	160°F/71.1°C	10.7 hours after circulation
BHC	166°F/74.4°C	15.5 hours after circulation

The extrapolated bottom hole temperature is 174°F/79°C at 4175 ft/1272.5 m.

2.4.5. Velocity Survey

A velocity survey was run by Schlumberger.

2.5. TESTING

No drill stem tests were conducted.

2.6. DRILLING SUMMARY

2.6.1. 10.625" Hole (0-800 ft)

Tirrengowa No. 1 was spudded at 0430 hours on 14 March 1987 with a lime flocculated gel spud mud. Drilling proceeded through loose, coarse surface sand. For the first single, then into the Gellibrand Marl, which continued through to 800 ft.

20 joints of 8.625" 24 ppf, J55, ST&C, 8 round casing were landed at 794 ft and cemented with 350 sacks of Class "A" cement with 0.5% CaCl. The cement was displaced with water and the plug bumped with 1000 psi.

After waiting on cement, the BOP's were nippled up and successfully tested prior to drillout.

2.6.2. 7.875" Hole (800-4175 ft)

Approximately 100 bbls of mud from the surface hole was retained while nippling up and the remaining mud tanks filled with premixed KCl-Polymer mud with 4% KCl. The shoe was drilled out to 830 ft, where a pressure integrity test was run. This gave a 13.0 ppg mud weight equivalent. The mud was changed over to the KCl-Polymer mud.

Drilling proceeded to 2074 ft, where a trip for the bit was made. A stabilizer was also added to the BHA. As a result, the bit had to be reamed and washed to bottom from 1152 ft.

Drilling continued to 3260 ft. From 2360 ft, connection gas was evident and the mud weight was allowed to gradually increase to 9.9 ppg. A bit change was made.

Drilling progressed through the Eumeralla siltstone, the Pebble Point sand and into the basement granulite to T.D. at 4175 ft. Towards T.D., the mud weight was allowed to reduce to 9.7 ppg. At 3852 ft, the bit was pulled due to a locked cone.

Following a wiper trip, Schlumberger were rigged up and the open hole logs run. The well was plugged and abandoned with three plugs:

Plug No. 1 - 50 sacks Class "A" neat (3900-4065 ft)
Plug No. 2 - 50 sacks Class "A" neat (1130-1300 ft)
Plug No. 3 - 60 sacks Class "A" neat (725 -890 ft)
Plug No. 3 was tagged at 723 ft with 10,000 lbs and the rig released at 1500 hours, 24 March 1987.

2.7. WELL STATUS

The well was plugged and abandoned with the casing cut 3 ft below ground level and the cellar was filled in.

3. GEOLOGY

3.1. REGIONAL GEOLOGY

The Late Jurassic-Early Cretaceous to Recent Otway Basin developed as a result of the pull-apart of Antarctica and Australia. The basin extends eastward from Robe in South Australia where sediments onlap basement, to Geelong in Victoria where sediments merge with those of the Torquay Basin. Along the northern margin of the basin sediments onlap basement, while to the south they prograde onto oceanic crust.

3.1.1. Stratigraphy

Basement is composed of Early-Mid Palaeozoic regional metamorphics and granitic intrusives which are part of the Tasman Geosynclinal sequence.

The Otway Group sediments (Pretty Hill Sandstone and Eumeralla Formation) are the oldest in the basin and directly overlie basement.

Pretty Hill Sandstone deposition began in the Late Jurassic-Early Cretaceous with fluvio-deltaic sands being deposited directly on Casterton Volcanics or more commonly on Palaeozoic meta-sediments and intrusives of the Tasman Geosynclinal sequence.

The Pretty Hill Sandstone has a strong quartz provenance which has given rise to excellent quality reservoir sandstones, making the unit the main objective for petroleum exploration in PEP 100. Intercalated shales and siltstones within this formation are regarded as having good source potential.

Little is known about its depositional history although southeast to northwest deltaic progradation is evident in the western part of the permit, indicating a southeasterly provenance for this part of the basin.

The Pretty Hill Sandstone is interpreted on seismic to be conformable with the overlying Eumeralla Formation in the eastern part of the Otway Basin, although a major erosional unconformity is evident at this level in the western part of the basin.

The Eumeralla Formation is a sequence of fluvial volcanogenically derived sandstones, siltstones, shales and coals indicating a major change in provenance from the Pretty Hill Sandstone. It is unknown where the volcanogenic provenance areas existed for none are recognizable today and depositional trends are unknown.

Although sandstones within the Eumeralla Formation have little if any reservoir potential, the siltstones, shales and coals do have good source potential. The Eumeralla Formation is also regarded as being a good regional seal for the Pretty Hill Sandstone.

The Late Cretaceous sediments of the Sherbrook Group are well developed in the central parts of the basin to the west of PEP 100 and in the offshore areas, however, they are absent by onlap in PEP 100.

The principal formations of this group are, from bottom to top, the Waare Sandstone, Belfast Mudstone, Paaratte Formation and the Curdies Formation. All these formations have a quartzose provenance.

Deposition was continuous throughout the Tertiary in PEP 100, however, Late Tertiary to Recent erosion subsequent to major faulting and folding has removed most of these sediments from the area of the Otway Ranges.

The Tertiary sediments are in three groups, from bottom to top, the Wangeripp Group, Nirranda Group and the Heytsbury Group, all of which exhibit a strong marine influence.

The Paleocene Wangeripp Group sediments are comprised of the Pebble Point and Dilwyn Formations. The Pebble Point Formation is a glauconitic sandstone and conglomerate with minor shale, thought to be a transgressive marine deposit widespread throughout the basin. In PEP 100 it directly overlies the highly erosional top Eumeralla Formation unconformity and may be absent in some parts of the permit, particularly the north, by onlap. It has limited outcrop and is blanketed by the more extensive Dilwyn Formation.

The major secondary objective for oil and gas exploration in PEP 100 is the Pebble Point Formation, although distribution of reservoir quality sandstones can be sporadic.

Conformably overlying the Pebble Point Formation is the Dilwyn Formation with a marine shale at its base, the Pember Mudstone, overlain by sandstones. The Pember Mudstone is the seal for reservoir sandstones in the Pebble Point Formation.

The Eocene Nirranda Group sediments are made up of marine sandy limestones of the Mepunga Formation and marine marls of the Narrawaturk Marl. These units are widespread throughout the permit and are time equivalent to the Demons Bluff Formation in the Torquay Basin.

The Oligocene to Miocene Heytesbury Group is a wholly marine sequence composed of limestones in the Clifton Formation overlain by marls of the Gellibrand Marl and limestones of the Port Campbell Limestone.

The whole sequence is in part covered by late Tertiary to Quaternary tholeitic Newer Volcanics. These have their major concentration in the north of the permit.

3.1.2. Structure

The Otway Basin has developed as the result of north-south pull apart and is located at the northern side of the rift and as such is characterized by east-west normal faults downthrown to the south. As a result of these fault throws, difficulty has been experienced in the basin demonstrating closure back to the north (basin margin) on structural leads at the top of each prospective reservoir unit. Onshore toward the basin margin, and particularly in PEP 100, there is a strong antithetic or down-to-the-north component to the normal faults, which has strengthened the likelihood of four-way closures. Other problems associated with normal fault block plays are fault independent closure and fault seal.

Major unconformities exist in the basin associated with periods of normal faulting expressed as rotational uplift and erosion of the fault blocks. The main ones are:-

1. Top Pretty Hill Sandstone - best developed in the South Australian part of the basin;
2. Top Eumeralla Formation - developed across the basin; and
3. Top Late Cretaceous - developed over most of the basin.

The eastern Otway Basin, mainly that area covered by PEP 100, has had a late Tertiary compressional overprint resulting in large faulted anticlines associated with wrench faults. Many of the younger wrench faults have occurred along the pre-existing normal faults which in PEP 100 have a northeast-southwest trend. The Otway Ranges are a series of large faulted anticlines of Late Tertiary age.

The major direction of compression has been northwest-southeast. Major erosion is associated with this structuring with all the Tertiary sedimentary section having been removed from the area of the Otway Ranges.

Late Tertiary tectonics are age equivalents and similar in style to those in the Gippsland Basin which have proven play potential. The late stage faulting and folding has added another positive component to hydrocarbon trapping with the addition of folds and wrench faults.

3.2. PREVIOUS INVESTIGATIONS

PEP 100 is located in the eastern portion of the Late Jurassic-Early Cretaceous to Recent Otway Basin. The permit is in southwestern Victoria and extends from longitude 144° 30′ east to 143° 15′ east and from latitude 38° 10′ south to the southern coastline. It encompasses the towns of Colac, Winchelsea, Apollo Bay, Lorne, Torquay and part of Geelong.

The earliest seismic in the permit was the Torquay Seismic Survey recorded for Oil Development N.L. in 1960. A number of gravity and aeromagnetic surveys were carried out in the 1960's and the Warnambool-Pomporneit, Paraparp and Colac-Geelong Seismic Surveys were recorded in the late 1960's to early 1970's. Gas and Fuel Exploration N.L. recorded the Colac Seismic Survey in 1983 and on assuming operatorship in 1984, Hartogen Energy Limited recorded the 215 km Stoneyford Seismic Survey in 1985. The 188 km Tomahawk Creek Seismic Survey was recorded early in 1986.

Four petroleum exploration wells have been drilled within the confines of the permit; Anglesea No. 1 (1962), Hindhaugh Creek No. 1 (1970), Olangolah No. 1 (1982) and most recently Stoneyford No. 1 (1984), drilled 4 km northwest of the proposed Tirrengowa No. 1. Although none of the wells encountered significant hydrocarbons, only Stoneyford No. 1 penetrated through to the Pretty Hill Sandstone. Minor gas shows were reported in Hindhaugh Creek No. 1 from sands in the upper part of the Eumeralla Fm. Relevant exploration wells drilled outside the permit include Purrumbete No. 1 (1968), 12 km to the west of Tirrengowa No. 1, and Ross Creek No. 1 (1974), Seaview No. 1 (1981), Ferguson Hill No. 1 (1964) and Sherbrook No. 1 (1963), all to the southwest of the proposed well. Of these wells, only Ross Creek No. 1 penetrated the Pretty Hill Sandstone.

3.3. TIRRENGOWA PROSPECT

Tirrengowa No. 1 is located to test a fault dependent closure on the upthrown, southeastern side of a major northeast-southwest trending normal fault. Seismic data indicated a vertical closure of 170 msecs at basement level over an area of approximately 2.4 sq km.

The primary targets were the sands of the Early Cretaceous Pretty Hill Sandstone. Juxtaposition of these sands against siltstones and shales of the Early Cretaceous Eumeralla Formation on the downthrown northwestern side of the major fault was expected to provide the necessary seal. At Tirrengowa No. 1 sample and wireline log data showed the basal Pretty Hill sands to have good porosity but also to be water saturated.

Sands of the Paleocene Pebble Point Formation provided a secondary target. However, despite structuring at this level being present in the form of anticlines associated with Late Tertiary wrench faulting, there is little mapped closure at this horizon. These sands had excellent porosity but were water saturated.

Sands in the upper Eumeralla Formation were also a secondary target but, as in other wells, they were tight at Tirrengowa No. 1.

3.4. LITHOLOGY

NEWER VOLCANICS

15 - 50 ft
5 - 15 m

Thickness: 35 ft
11 m

Sandstone - clear, orange-yellow, light to medium brown (iron stained), coarse to very coarse, sub-rounded to rounded, moderate to well sorted, loose to friable, minor brown argillaceous matrix, good porosity.
Basalt - dark purple brown, hard to very hard, vesicular, crystalline, weathered.

GELLIBRAND MARL

50 - 637 ft
15 - 194 m

Thickness: 587 ft
179 m

Marl - off-white, light to medium olive-grey, becoming medium olive-grey and medium grey-green with depth, soft, very sticky, common bryozoa and shell fragments, trace fine to coarse sand grains, trace glauconite, rare pyrite, occasional dolomite and calcite crystal fragments.

CLIFTON FORMATION

637 - 890 ft
194 - 271 m

Thickness: 253 ft
77 m

Marl - medium light to medium grey-green, olive-grey, occasional medium brown, soft, very sticky, common bryozoa and shell fragments, common very fine to fine, sub-rounded quartz grains, trace to common dark green glauconite pellets, rare pyrite, trace carbonaceous material.

NARRAWATURK MARL

890 - 1102 ft
271 - 336 m

Thickness: 212 ft
65 m

Marl - medium to dark brown, soft, dispersive, sticky, common bryozoa and shell fragments, trace to common clear and white, very fine to dominantly coarse, frosted, sub-rounded to rounded, quartz grains, trace to common calcite crystals, trace glauconite.

DILWYN FORMATION

1102 - 1206 ft
336 - 368 m

Thickness: 104 ft
32 m

1102 - 1152 ft Sandstone - white, light grey, light brown, very fine to very coarse, dominantly fine, sub-angular to sub-rounded, poorly sorted, off-white to brown argillaceous matrix, quartz grains, brown stained in part, trace brown and grey lithics, trace glauconite and black carbonaceous flecks, minor calcareous cement, poor to good porosity.

1152 - 1206 ft Dolerite - light to medium grey, medium to dark green, speckled, crystalline, very hard where fresh, weathering to a soft medium grey clay, feldspar, brown to green-black ferro-magnesian mineral.

PEBBLE POINT FORMATION

1206 - 1252 ft
368 - 382 m

Thickness: 46 ft
14 m

Sandstone - clear, light grey-brown, medium to very coarse, sub-rounded to rounded, moderate to well sorted, loose to friable, minor silty argillaceous matrix, common brown lithics and yellow-brown stained quartz grains, very good porosity.

EUMERALLA FORMATION

1252 - 3611 ft
382 - 1101 m

Thickness: 2359 ft
719 m

1252 - 1547 ft Claystone with minor sandstone and rare coal.
Claystone - light to medium grey, minor brown, soft, very dispersive, micro-micaceous in part, carbonaceous and coally laminae and detritus, silty and sandy in part.
Sandstone - white, light grey, very fine to fine, occasional medium, sub-angular to sub-rounded, moderate sorted, abundant silty/argillaceous matrix, weathered feldspar, grey and red-brown lithics, carbonaceous and coally laminae, weak calcareous cement, tight to poor porosity. 40% of the sandstone in the interval 1400-1413 ft had dull patchy yellow-gold fluorescence with a weak dull pale yellow-white crush cut.
Coal - earthy, grading to carbonaceous shale.

1547 - 1604 ft	Sandstone with minor claystone. Sandstone - white, cream, light grey, fine to medium, sub-angular to sub-rounded, moderate sorted, abundant silty/argillaceous matrix, weathered feldspar, grey and red-brown lithics, carbonaceous and coally laminae, trace volcanic grains and pyrite, weak calcareous cement, tight to poor porosity. 35% of the sandstone in the interval 1586-1604 ft had very dull yellow-gold fluorescence with a weak dull pale yellow-white crush cut. Claystone - light to medium grey, minor brown, soft, very dispersive, micro-micaceous in part, carbonaceous and coally laminae and detritus, becoming very silty.
1604 - 2653 ft	Interbedded sandstone, siltstone, claystone and minor thin coals. Sandstone - white, cream, light grey, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, clay/argillaceous matrix, weathered feldspar, common grey, grey-green lithic and volcanic fragments, black coally and carbonaceous material, tight to poor porosity. The intervals 1970-2000 ft, 2144-2150 ft, 2220-2240 ft and 2340-2430 ft have up to 80% dull to moderately bright yellow-gold fluorescence with a very weak dull white crush cut. Siltstone - light to dark brown, medium to dark grey/ grey-green, light green, sandy, soft to firm, trace glauconite, weathered feldspar, carbonaceous material, slightly calcareous, trace volcanics, grading to claystone. Claystone - light to medium grey, light grey-green, soft, very dispersive, silty, trace carbonaceous material, calcareous in part, micro-micaceous, grading to siltstone. Coal - medium to dark brown to black, firm, shaley in part, minor pyrite in part.
2653 - 2952 ft	Claystone with interbeds of siltstone and sandstone and rare coal. Claystone - light to medium grey, soft to firm, very dispersive, trace micro-micaceous, common coally and carbonaceous material, trace pyrite, very silty in part. Siltstone - light to medium grey, soft to firm, sub-fissile, very dispersive, grading to claystone in part, trace micro-micaceous, weathered feldspar, carbonaceous material, calcareous in part. Sandstone and Coal - as for 1604-2653 ft.
2952 - 3611 ft	Interbedded claystone and siltstone with minor sandstone and coal. Claystone - light to medium grey, medium grey-brown to dark brown, dispersive, soft to firm, common coally and carbonaceous flecks and laminae, slightly calcareous in part, silty, grading to shale in part. Siltstone - light to medium grey, light grey-brown, soft, amorphous to blocky, very argillaceous, carbonaceous.

Sandstone - white, light grey, light grey-brown, very fine to fine, occasional medium, silty, sub-angular to sub-rounded, moderate to well sorted, white clay/ argillaceous matrix, common grey lithics, calcareous in part, tight to poor porosity. The sandstone in the interval 3400-3611 ft has up to 50% dull to moderately bright pale yellow-gold patchy fluorescence with a very weak milky blue-white crush cut.
Coal - very dark brown to black, sub-vitreous lustre, earthy, silty, trace pyrite.

PRETTY HILL SANDSTONE

3611 - 4084 ft
1101 - 1245 m

Thickness: 473 ft
144 m

3611 - 4005 ft

Interbedded claystone and siltstone with minor sandstone.
Claystone - light to medium grey, grey-brown, buff, dispersive, very soft, sticky, very silty in part.
Siltstone - light to medium grey, occasional light to medium grey-brown, firm, very sandy and argillaceous in part, sub-fissile, very dispersive, carbonaceous flecks and laminae, trace altered feldspar, trace pyrite.
Sandstone - white to off-white, light grey, very fine to fine, silty, sub-angular to sub-rounded, moderate to well sorted, abundant white clay matrix, feldspathic, calcareous cement in part, tight to poor porosity. The sandstone has up to 40% dull to moderately bright yellow patchy fluorescence with a weak milky white cut.

4005 - 4084 ft

Sandstone with siltstone interbeds.
Sandstone - clear, white, light brown, very fine to coarse, sub-angular to sub-rounded, moderate sorted, loose grains in part, trace to moderate clay/argillaceous matrix, trace siderite, weak to moderate silica cement, poor to good porosity. The sandstone has up to 50% dull yellow-gold fluorescence with a very weak slow diffuse yellow-white cut.
Siltstone - light to medium grey, occasional light to medium grey-brown, firm, very sandy and argillaceous in part, sub-fissile, very dispersive, carbonaceous flecks and laminae, trace altered feldspar, trace pyrite.

BASEMENT

4084 - 4175 ft
1245 - 1273 m

Thickness: 91 ft
28 m

Granulite/Meta-sediment - white, grey, light to dark green, minor pink-purple, blue-grey, hard, siliceous, micaceous, pyritic, dark ferro-magnesian mineral, schistose, micro-crystalline.

TOTAL DEPTH

Logger: 4175 ft/1272.5 m (extrapolated)
Driller: 4175 ft/1272.5 m

4. SELECTED BIBLIOGRAPHY

ABELE, C., KENLEY, P.R., HOLDGATE, G., and RIPPER, D., 1976 - Otway Basin (Tertiary), in Geology of Victoria, Geological Society of Victoria Special Publication No. 5, 198-229.

BOUEF, M.S., and DOUST, H., 1975 - Structure and Development of the Southern Margin of Australia. APEA Journal 15(1), 33-43.

DAVEY, L.K., 1984 - Gas & Fuel Exploration N.L. Stoneyford No. 1 Well Completion Report. G.F.E. Technical Report 10.

DENHAM, J.I. and BROWN, B.R., 1976 - A New Look at the Otway Basin. APEA Journal 16(1), 91-98.

MIDDLETON, M.F., and FALVEY, D.A., 1985 - Maturation Modelling in Otway Basin, Australia. AAPG Bulletin 67(2), 271-9.

WOPFNER, H., KENLEY, P.R., and THORNTON, R.C.N., 1971 - Hydrocarbon Occurrences and Potential of the Otway Basin, in Special Bulletin of Geological Surveys of South Australia and Victoria, Chapter 21, 383-451.

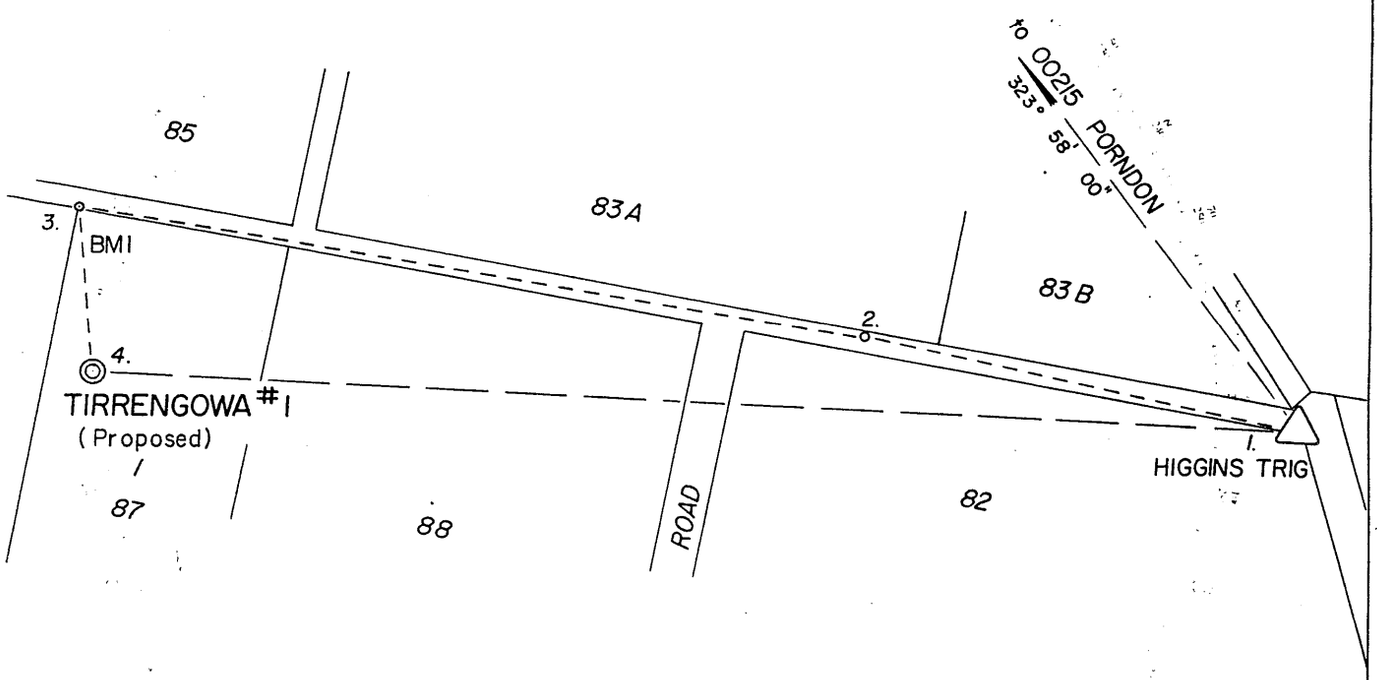
STRATIGRAPHIC TABLE

TIRRENGOWA NO. 1

Group/Formation		Age	Depth (KB) ft	m	Subsea Depth ft	m	Thickness ft	m
Newer Volcanics		Quaternary	150	0.0	+456	+139.0	35	10.7
Heytesbury	Gelibrand Marl	Tertiary	50	15.2	+421	+128.3	587	178.9
	Clifton		637	194.2	-166	-50.6	253	77.1
Nirranda	Narrawaturk		890	271.3	-419	-127.7	212	64.6
Wangerrip	Dilwyn		1102	335.9	-631	-192.3	104	31.7
	Pebble Point		1206	367.6	-735	-224.0	46	14.0
Otway	Eumeralla	Cretaceous	1252	381.6	-781	-238.0	2359	719.0
	Pretty Hill Sst		3611	1100.6	-3140	-957.1	473	144.2
Basement		Palaeozoic	4084	1244.8	-3613	-1101.2	91	27.7+
Total Depth			4175	1272.5	-3704	-1129.0		

APPENDIX 1

WELL LOCATION SURVEY PLAN



TRAVERSES

LINE	BEARING	DISTANCE
1-2	282° 7' 30"	422·404
2-3	279° 18' 30"	758·960
3-4	174° 40'	164·5
1-4	92° 22' 45"	1147·65 calc.

REFERENCE MARKS

STN	TO	BEARING	DIST	REMARKS
3	Cen. RFP	192° 30'	0·5	
4	BM 1	354° 40'	164·5	Deep driven star picket with cast concrete collar.

APPROXIMATE GEOGRAPHIC CO-ORDS

STN	LATITUDE	LONGITUDE
1	S 38° 22' 59"02	E 143° 21' 7"82
3	S 38° 22' 53"12	E 143° 20' 19"74
4	S 38° 22' 58"42	E 143° 20' 20"54

APPROXIMATE A.M.G. CO-ORDINATES. ZONE 54.

STN	EAST	NORTH	CONVERGENCE	R.L. AHDD
1	705 449·7	5 749 048·1	1° 27' 38"	135·8
3	704 287·53	5 749 259·61	1° 27' 08"	138·82
4	704 302·8	5 749 095·8	1° 27' 08"	138·6 G.L.

FIELD NOTES LODGED | LINES NOT SURVEYED | STNS | CORNERS NOT MARKED | STNS

FILE REF	DATE CAT	DRAWN	CHARTED	DUP/WARD

PLAN OF TIRRENGOWA #1 (Proposed)

EXAM.	CHECK.	PASS.	LOCALITY	MINING FIELD
			COLAC VICTORIA	

PARISH CARPENDEIT
COUNTY
MINING DISTRICT

MAP REFERENCE	PROC SURVEY AREA	SURVEYED BY	MERIDIAN	SCALE
		A.L. OWEN 29/1/87	A.M.G.	1:5 000

Cat.No.

DEPARTMENT OF MINES,

CERTIFICATE – PART A

I, Andrew Lieth Owen

hereby certify I/the company have surveyed the land comprised in this plan ...personally.....

.....

that the plan is accurate, that the said survey was performed in accordance with the 'Surveyors Act 1977-1983' and the Surveyors Regulations 1978 and that the said survey was completed on .....29-1-87.....

.....

Signature of Licensed Surveyor

Date .....16-4-87.....

Council of the ..... of .....

.....

certifies that all the requirements of this Council, the Local Government Acts of 1936 to 19 and all the By-laws have been complied with and approves this Plan of Subdivision .....

.....

.....

.....

Dated this ..... day of 19

..... Mayor or Chairman

..... Town or Shire Clerk

I/We .....

.....

as lessee(s) of Miners Homestead .....

agree to this plan of subdivision .....

Signature(s) of lessee(s) .....

.....

CERTIFICATE – PART B

.....

hereby certify that I/the company have made this plan pursuant to Regulation 29 of the Surveyors Regulations 1978 and that the plan is accurate.

.....

Signature of Licensed Surveyor

Date: .....

APPENDIX 2

LIST OF LOGS

TIRRENGOWA NO. 1

LIST OF WIRELINE LOGS

Type	Interval
DLL-GR	794-4154 ft/242.0-1266.1 m
MSFL	994-4134 ft/303.0-1260.0 m
BHCS-GR (to surface)	794-4166 ft/242.0-1269.8 m
LDL-CNL-GR	1000-4160 ft/304.8-1268.0 m
CST	30 cores shot, 29 recovered
WST	Velocity Survey

Logging was carried out by Schlumberger. Logs are presented on 1:240 and 1:600 scales.

COPIES OF LOGS HAVE BEEN FORWARDED PREVIOUSLY.

APPENDIX 3

BIT RECORD

Baroid Australia PTY. LTD./NL INDUSTRIES INC.

BIT RECORD

COMPANY *HARTOGEN ENERGY LTD* WELL *TIRRENGOWA NO. 1* CONTRACTOR/RIG *O.D.E.*

LOCATION *P.E.P. 100, OTWAY BASIN, VICTORIA* SPUD DATE *14/03/87* DATE REACHED T.D. *22/03/87*

COMPANY SUPERVISORS *BARRY BEETWON* TOOLPUSHERS *R. PYNE*

PUMPS: MAKE, TYPE *GARDNER, DENVER PZGBFB / PAHBFC.* LINERS USED *5½" / 5"* DRILL COLLARS *6½"* DRILL PIPE *4½"*

MUD SYSTEMS, DEPTHS *LIME FLOCCULATED GEL / NATIVE CLAY TO 800 FT. KCL/POLYMER TO T.D.*

DATE 1987	No.	SIZE	MAKE	TYPE	JETS 32nd"	DEPTH OUT FT	FEET DRILLED	HOURS	FEET/ HR	ACCUM DRLG HOURS	BIT WEIGHT 1000 lb	RPM	VERT DEV'N	PUMP PRESSURE p.s.i.	PUMP RATE spm	WT S.G.	MUD VIS sec	CONDITION T	B	G	FORMATION	REMARKS
14/3	1	10-5/8	SEC	S33S	3 x 16	800	786	12	65.5	12	5-10	120	½	800	115/ 115	9.0	40	3	3	I	Marl.	Pull for casing.
17/3	2	7-7/8	HTC	X 3A	1 x 11 2 x 10	2074	1274	22	58	34	15-25	100	1-3/4	750	110	9.6	33	2	3	I	Sand/CLST-SLST.	
19/3	3	7-7/8	TSK	3MSS-2	1 x 11 2 x 10	3260	1186	41½	28.6	75½	25-30	90/100	1½	800	100	9.9	40	6	4	I	CLST-SLST.	
21/3	4	7-7/8	TSK	3MSS-2	1 x 11 2 x 10	3853	593	29	20.4	104½	30	90	2	825	100	9.7	38	5	8	I	CLST-SLST.	Locked Bearing.
22/3	5	7-7/8	TSK	3MSS-2	1 x 11 2 x 10	4175	322	21	15.3	125½	30	90	1-3/4	825	100	9.7	38	7	8	I	SST, Basement. T.D.	

APPENDIX 4

DRILLING FLUID DETAILS

TIRRENGOWA NO. 1

DAILY MUD PROPERTIES

DATE	DEPTH	WEIGHT	VIS.	PV	YP	GELS	pH	W.L.	CAKE	Cl-	KCL	SOLIDS	SAND
14/3	800	9.3	40										
15/3	800	8.5	32								3.50%		
16/3	1,760	9.4	36	10	8	1/3	9.5	8.0	1/32	22.0K	4.00%		
17/3	2,280	9.6	33	9	5	1/3	9.5	8.4	1/32	25.0K	4.50%		
19/3	3,100	9.8	38	16	10	3/10	10.0	8.4	1/32	30.5K	4.75%	8	TR.
20/3	3,530	9.9	40	20	14	4/11	9.5	6.5	1/32	30.0K	4.75%	9	TR.
21/3	3,810	9.9	40	17	15	4/10	9.5	6.0	1/32	29.0K	4.75%	9	TR.
22/3	4,175	9.7	38	16	14	3/5	9.5	6.2	1/32	27.0K	5.50%	8	TR.
23/3	4,175	9.7	38	16	15	3/5	9.5	6.0	1/32	28.5K	6.00%	8	TR.

APPENDIX 5

SWC DESCRIPTIONS

12	3/4"	3,280	SHALE, medium grey, massive, silty.
13	1/2"	2,940	SHALE, as for SWC 12, carbonaceous fragments.
14	1"	2,545	SANDSTONE, white, grey, very fine to fine, sub-rounded, well sorted, clay matrix, cream feldspar, grey-black lithics, calcareous cement, tight to poor porosity. NO FLUORESCENCE.
15	1-3/4"	2,350	SHALE, brown-black, sub-fissile to blocky, carbonaceous, grading to coal.
16	1-1/4"	2,234	SILTSTONE/SANDSTONE, as for SWC 14, grading to argillaceous siltstone. NO FLUORESCENCE.
17	1-1/2"	2,196	SILTSTONE/SANDSTONE, as for SWC 16.
18	1/2"	2,185	SILTSTONE/SANDSTONE, as for SWC 16, minor carbonaceous laminae.
19	1-1/2"	1,965	SHALE/CLAYSTONE, medium to dark grey-brown, massive.
20	2"	1,567	SANDSTONE, as for SWC 14. NO FLUORESCENCE.
21	1-1/4"	1,550	SANDSTONE, as for SWC 14. NO FLUORESCENCE.
22	1-3/4"	1,404	SANDSTONE, as for SWC 14. NO FLUORESCENCE.
23	1-1/2"	1,224	SANDSTONE, brown, loose, very fine to fine, sub-rounded, well sorted quartz grains, brown iron stain, good porosity. NO FLUORESCENCE.
24	1"	1,220	SANDSTONE, as for SWC 23 NO FLUORESCENCE.
25	2"	1,198	DOLERITE/SANDSTONE, green, black, medium to coarse, mafic grains, feldspar and quartz. NO FLUORESCENCE.
26	2"	1,192	DOLERITE/SANDSTONE, as for SWC 25.
27	2"	1,120	SANDSTONE, translucent very dark brown to black, fine to coarse, sub-rounded to rounded, poor to moderate sorted, friable, loose grains, good porosity. NO FLUORESCENCE.
28	2"	1,108	SANDSTONE, translucent brown-black, medium, sub-rounded, moderate to well sorted, brown-black shaley argillaceous matrix, trace green lithics, friable, fair porosity. NO FL.
29	2"	1,106	SANDSTONE, brown-black, as for SWC 28. NO FL.
30		1,000	NO RECOVERY.

TIRRENGOWA #1 - SIDEWALL CORE DESCRIPTIONS.

No.	REC.	DEPTH	DESCRIPTION
1	1/2"	4,155	GRANULITE, white, pink-purple, blue-grey, light to dark green, siliceous, quartzitic, schistose and micro-crystalline grains, trace mica and pyrite, feldspar (weathered in part), mafic minerals, calcite veining in part, hard.
2	1-1/2"	4,100	GRANULITE, white, pink-purple, blue-grey, light to dark green, siliceous, quartzitic, schistose and micro-crystalline grains, trace mica and pyrite, feldspar (weathered in part), mafic minerals, calcite veining in part, hard.
3	1"	4,035	SANDSTONE, white, fine to coarse, sub-angular, moderate sorted, moderate to abundant clay matrix, trace black lithics and pyrite, fair porosity. NO ELUORESCENCE.
4	1"	4,033	SANDSTONE, as for SWC 3 - friable. NO ELUORESCENCE.
5	1"	4,031	SANDSTONE, as for SWC 3 - friable. NO ELUORESCENCE.
6	1/2"	4,014	SANDSTONE/SILTSTONE, laminated. SANDSTONE, white, grey-white, very fine, sub-rounded, moderate sorted, silty, argillaceous matrix, carbonaceous laminae, tight to poor porosity. SILTSTONE, grey, sub-fissile, grading to very fine sandstone, carbonaceous. PATCHY TO SOLID DULL YELLOW GOLD ELUORESCENCE WITH INSIANI STREAMING MILKY WHITE CUT.
7	3/4"	4,006	SANDSTONE, white, brown, fine to medium, minor coarse, sub-angular to sub-rounded, moderate sorted, clay matrix, friable (fractured), carbonaceous material, grey lithics, minor silty bands and laminae, poor porosity. SPOTTED MINOR BRIGHT BLUE-WHITE AND MOSTLY DULL YELLOW ELUORESCENCE. BLUE WHITE ELUORESCENCE HAS INSIANT STREAMING MILKY WHITE CUT.
8	3/4"	3,885	SHALE, dark grey-brown, massive, silty.
9	1"	3,713	SHALE, as for SWC 8.
10	1/2"	3,620	SANDSTONE, white, grey, very fine to fine, sub-rounded, well sorted, clay matrix, grey-black lithics, cream feldspar, calcareous cement, tight to poor porosity. NO ELUORESCENCE.
11	3/4"	3,600	SHALE, as for SWC 8.

APPENDIX 6

SAMPLE DESCRIPTIONS

TIRRENGOWA #1 : SAMPLE DESCRIPTIONS.

Feet		Description
30	80	SANDSTONE, orenge-yellow, iron stained, coarse, sub-rounded to rounded, moderate to well sorted, loose quartz grains, trace clay matrix, good porosity.
	20	BASALT, red, brown to purple-grey, crystalline, hard, weathered, vesicular.
60	40	SANDSTONE, a.a.
	10	BASALT, a.a.
	50	MARL, white, grey, abundant fossils - bryozoa, forams, gastropods, pelecypods and abundant shell fragments. soft, sticky, dispersive.
90	10	SANDSTONE, a.a.
	10	BASALT, a.a.
	80	MARL, white, grey, abundant fossils, argillaceous, silty, dispersive.
120	50	SANDSTONE, a.a.
	10	BASALT, a.a.
	40	MARL, a.a.
150	100	MARL, medium grey, dispersive, silty, minor fossil fragments.
180	100	MARL, a.a. light to medium grey, minor fossil fragments.
	Tr.	SANDSTONE & BASALT, a.a.
210	100	MARL, a.a. white to light grey, medium grey.
240	100	MARL, a.a. light to medium grey.
270	100	MARL, a.a. light to medium grey, medium grey-brown, commonly fossiliferous.
300	100	MARL, a.a. trace fossiliferous.
330	100	MARL, a.a. light to medium grey, grey-green in part, commonly fossiliferous.
360	100	MARL, light to medium grey, minor fossiliferous, rare pyrite, silty.
390	100	MARL, a.a. light grey, commonly fossiliferous.
420	100	MARL, a.a. also light brown, sandy - calcarenite, dolomitic? commonly fossiliferous, trace pyrite.
450	100	MARL, grey, silty, minor fossiliferous.
480	100	MARL, grey, silty/sandy, minor fossiliferous.

510 100 MARL, a.a. trace coarse sand.

540 100 MARL, a.a. trace coarse sand.

570 100 MARL, a.a. fossiliferous.

600 100 MARL, a.a. abundantly fossiliferous.

630 100 MARL, greenish-grey, fossiliferous, trace glauconite.

660 100 MARL, greenish-grey, a.a. also white, brownish-grey and pinkish fossils, trace glauconite.

690 100 MARL, a.a. also iron stained, coarse rounded quartz grains and trace basalt.

720 100 MARL, a.a. loose, iron stained quartz grains, trace glauconite, rare pyrite, fossiliferous.

750 100 MARL, grey-green, grey-brown, green glauconite, sticky, dispersive, minor calcarenite. fossiliferous.

780 100 MARL, a.a. abundant glauconite, white to cream calcarenite.

800 100 MARL, a.a.

840 100 MARL, a.a.

870 100 MARL, light to medium grey-green, silty to sandy, glauconitic, very calcareous.

900 100 MARL, light to medium grey-green, a.a. also brown, grey-brown, fossiliferous.

930 10 SAND, clear, coarse to very coarse, sub-rounded to well rounded, loose quartz grains.
90 MARL, brown, silty to sandy, soft, dispersive, trace to minor pyrite.

960 30 SAND, a.a. also loose fine to medium.
70 MARL, a.a. minor to common pyrite, fossiliferous.

990 40 SAND, a.a.
60 MARL, a.a. minor to common pyrite, abundant shell fragments. (Argillaceous fraction of the marl washes out of the sample and thus the sand content of the sample is disproportionately high).

1020 40 SAND, a.a.
60 MARL, a.a.

1050 50 SAND, a.a.
50 MARL, a.a.

1080 90 SAND, clear, medium to coarse, loose.
10 MARL, brown, dispersive, fossiliferous, washes away.

1110 100 SAND, a.a.
Tr. MARL, a.a. washing away.

1140 80 SAND, a.a.
20 SHALE/MUDSTONE, cream to predominantly brown, firm, blocky, trace pyrite.

1170 100 DOLERITIC INTRUSIVE, white to grey-green, feldspars? greenish-brown to black ferro-magnesians, crystalline, hard, weathered in part.

1200 100 DOLERITIC INTRUSIVE, a.a.

1230 100 SANDSTONE, clear, coarse to very coarse, sub-rounded to rounded, moderate to well sorted, loose quartz grains, good apparent porosity.

1260 100 SANDSTONE, white, lught grey. very fine to occasional medium, sub-angular, well sorted, clay matrix, grey lithics, trace carbonaceous material, weathered feldspar, tight to poor porosity.

1290 100 SANDSTONE, a.a.
Tr. COAL.

1320 60 SANDSTONE, white, grey-white, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, clay matrix, feldspathic, lithic, tight to poor porosity.
30 SILTSTONE, grey, firm, sandy, argillkaceous, lithic,
10 SHALE, brown, firm, blocky, carbonaceous, dispersive in part.

1350 100 SANDSTONE, a.a. minor pyrite.
Tr. SILTSTONE, a.a.

1380 60 SANDSTONE, a.a. silty.
40 SILTSTONE, a.a. grades to vrey fine sandstone.

1410 70 SANDSTONE, a.a. tr. volcanics.
20 SILTSTONE, a.a.
10 SHALE, a.a.
SANDSTONE HAS 40% DULL PATCHY YELLOW-GOLD FLUORESCENCE WITH DULL PALE YELLOW-WHITE CRUSH CUT.

1440 30 SANDSTONE, a.a. tr. volcanics.
40 SILTSTONE, a.a. - dispersive, washes out.
30 SHALE, a.a. - dispersive, washes out.
Tr COAL.

1470 30 SANDSTONE, a.a. - 50% WITH FLUORESCENCE a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.

1500
30 SANDSTONE, a.a. - lithic, argillaceous, volcanics.
60 SILTSTONE, a.a.
10 SHALE, a.a.
Tr COAL.

1510
40 SANDSTONE, a.a. - lithic, argillaceous, silty.
50 SILTSTONE, grey-white, argillaceous.
10 SHALE, brown, carbonaceous. Clay washes out.
Tr SHELL FRAGMENTS & PYRITE.

1520
40 SANDSTONE, a.a. - volcanics, calcareous in part.
50 SILTSTONE, argillaceous, clay washes out.
10 SHALE, brown, carbonaceous. Clay washes out.

1530
60 SANDSTONE, white, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, argillaceous matrix, volcanic fragments, lithic, minor loose coarse grains, tight to poor porosity.
30 SILTSTONE, clay washes out.
10 SHALE, a.a. clay washes out.
Tr COAL.

1540
50 SANDSTONE, a.a. volcanics, feldspathic, argillaceous.
40 SILTSTONE, a.a.
10 SHALE, a.a.

1550
40 SANDSTONE, a.a. TRACE FLUORESCENCE a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL

1560
100 SANDSTONE, a.a. medium grained, very argillaceous with about 70% clay washing out.
Tr. SILTSTONE, SHALE & COAL.

1570
90 SANDSTONE, a.a. medium grained.
10 COAL.

1580
90 SANDSTONE, a.a. fine to medium grained.
10 COAL.

1590
100 SANDSTONE, white, cream, grey, fine to medium, sub-angular to sub-rounded, moderate to well sorted, argillaceous matrix washing out, lithic, feldspathic, trace volcanic fragments, slightly calcareous, tight to poor porosity. TRACE FLUORESCENCE a.a.

1600
100 SANDSTONE, a.a. trace carbonaceous. TRACE FLUORESCENCE a.a.

1610
50 SANDSTONE, a.a. minor green volcanic grains, trace pyrite.
30 SILTSTONE, white, grey, sandy, argillaceous, dispersive.
10 SHALE, grey, soft, dispersive, also brown, firm, carbonaceous.
10 COAL.

1620
50 SANDSTONE, a.a. clay matrix washing out. TRACE EL.
30 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL.

1630
50 SANDSTONE, white, cream, green (volcanics), very fine to medium, sub-angular, moderate sorted, argillaceous, lithic, trace carbonaceous, slightly calcareous, tight to poor porosity.
40 SILTSTONE, white, argillaceous, soft to firm, grading to claystone - washes out.
10 SHALE, a.a. grey, soft, also brown, firm.

1640
50 SANDSTONE, a.a. TRACE FLUORESCENCE a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.

1650
70 SANDSTONE, a.a.
30 COAL, shaley, a.a.

1660
70 SANDSTONE, a.a.
30 COAL, shaley, a.a.

1670
40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

1680
40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

1690
30 SANDSTONE, a.a. white, very fine, silty.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.

1700
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
10 COAL, a.a.

1710
30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.

1720 50 SANDSTONE, a.a.
30 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

1730 50 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.

1740 50 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
Tr COAL, a.a.

1750 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1760 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
Tr COAL, a.a.

1770 30 SANDSTONE, a.a. - clay matrix washing out.
40 SILTSTONE, a.a.
30 SHALE, a.a. - mostly white to grey, soft.

1780 20 SANDSTONE, a.a.
40 SILTSTONE, a.a.
40 SHALE, a.a.

1790 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1800 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1810 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1820 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1830 50 SANDSTONE, a.a.
30 SILTSTONE, a.a.
20 SHALE, a.a.

1840 50 SANDSTONE, a.a.
30 SILTSTONE, a.a.
20 SHALE, a.a.

1850 30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.

1860 30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.

1870 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1880 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

1890 30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.
Tr COAL, a.a.

1900 40 SANDSTONE, a.a.
30 SILTSTONE, a.a.
30 SHALE, a.a.

1910 30 SANDSTONE, white, cream, very light grey, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, abundant clay matrix - washes out, trace green volcanics, trace carbonaceous, feldspathic, slightly calcareous, tight to poor porosity.
40 SILTSTONE, white, light grey, very argillaceous, dispersive, carbonaceous.
30 SHALE, grey, dispersive.

1920 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

1930 20 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
20 COAL, a.a.

1940 20 SANDSTONE, a.a.
30 SILTSTONE, a.a.
20 SHALE, a.a.
30 COAL, black, brownish-black, shaley.

1950 20 SANDSTONE, a.a.
30 SILTSTONE, a.a.
20 SHALE, a.a.
30 COAL, a.a.

1960 20 SANDSTONE, a.a.
40 SILTSTONE, a.a.
40 SHALE, a.a.

1970 40 SANDSTONE, a.a.
30 SILTSTONE, a.a.
30 SHALE, a.a.
20-30% DULL YELLOW FLUORESCENCE WITH TRACE SLOW STREAMING CUT AND TRACE CRUSH CUT.

1980 30 SANDSTONE, a.a.
20 SILTSTONE, a.a.
20 SHALE, a.a.
30 COAL, a.a.
20-30% DULL YELLOW FLUORESCENCE WITH TRACE SLOW STREAMING CUT AND TRACE CRUSH CUT.

1990 20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
20-30% DULL YELLOW FLUORESCENCE WITH TRACE SLOW STREAMING CUT AND TRACE CRUSH CUT.

2000 20 SANDSTONE, a.a.
30 SILTSTONE, a.a.
30 SHALE, a.a.
20 COAL, a.a.
20-30% DULL YELLOW FLUORESCENCE WITH TRACE SLOW STREAMING CUT AND TRACE CRUSH CUT.

2010 20 SANDSTONE, a.a.
30 SILTSTONE, a.a.
20 SHALE, a.a.
30 COAL, a.a.

2020 40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

2030 30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
Tr COAL, a.a.

2040 30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2050 20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.

2060 20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.

2070
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2080
20 SANDSTONE, white, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, argillaceous / clay matrix - washes out, volcanics, feldspathic, lithics, slightly calcareous, tight to poor porosity.
40 SILTSTONE, white, light grey, soft to firm, sandy in part, argillaceous, carbonaceous specks.
40 SHALE, light to medium grey, silty, also light to dark brown, carbonaceous.

2090
30 SANDSTONE, a.a. - greenish volcanics.
40 SILTSTONE, a.a.
30 SHALE, a.a. grading to coal.
Tr PYRITE.

2100
50 SANDSTONE, a.a. also greenish volcanics.
30 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

2110
50 SANDSTONE, a.a. Tr FLUORESCENCE a.a.
30 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

2120
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.

2130
30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.

2140
30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.

2150
70 SANDSTONE, clear, white, very fine to fine, sub-angular, moderate sorted, argillaceous / clay matrix, feldspathic, lithic, trace carbonaceous material, green volcanics, calcareous cement in part, poor porosity.
20 SILTSTONE, a.a.
10 SHALE, a.a.
80% DULL TO MODERATELY BRIGHT PATCHY YELLOW FLUORESCENCE WITH A WEAK PALE YELLOW MILKY WHITE CRUSH CUT.

2160
40 SANDSTONE, a.a. calcareous.
30 SILTSTONE, grey-brown, carbonaceous, a.a. also grey-green, green, volcanics, feldspathic, calcareous.
30 SHALE, brown, grey, grey-green, soft, dispersive, trace pyrite.

2170
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.
20% FLUORESCENCE a.a.

2180
20 SANDSTONE, a.a. - minor coarse.
50 SILTSTONE, a.a.
30 SHALE, a.a.
20% FLUORESCENCE a.a.

2190
10 SANDSTONE, a.a.
30 SILTSTONE, a.a.
30 SHALE, a.a.
30 DOLERITE, green-white, weathered, crystalline, hard.

2200
50 SANDSTONE, white, fine, minor coarse, sub-angular to sub-rounded, moderate to well sorted, tight to poor porosity.
40 SILTSTONE, a.a.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

2210
50 SANDSTONE, a.a. - carbonaceous, lithic, volcanics.
40 SILTSTONE, a.a. - trace carbonaceous specks.
10 SHALE, a.a.

2220
50 SANDSTONE, a.a.
40 SILTSTONE, a.a. - sandy in part.
10 SHALE, a.a.

2230
40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

2240
60 SANDSTONE, a.a.
30 SILTSTONE, a.a.
10 SHALE, a.a.

2250
60 SANDSTONE, a.a. - calcareous, volcanics.
30 SILTSTONE, a.a.
10 SHALE, a.a.
20% DULL TO MODERATELY BRIGHT YELLOW GOLD FLUORESCENCE WITH A VERY WEAK PALE YELLOW MILKY WHITE CRUSH CUT.

2260
50 SANDSTONE, a.a.
30 SILTSTONE, a.a.
20 SHALE, a.a.
Tr COAL, a.a.

2270
60 SANDSTONE, a.a. - increase in green volcanic grains.
20 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

2280
40 SANDSTONE, a.a.
40 SILTSTONE, a.a. - also greenish volcanics.
20 SHALE, a.a.

2290
40 SANDSTONE, a.a.
40 SILTSTONE, a.a. - volcanic and feldspar grains.
20 SHALE, a.a.

2300
30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 DOLERITE/VOLCANICS, grey-brown, green, very fine to medium, crystalline, feldspar.

2310
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
10 DOLERITE/VOLCANICS, a.a.

2320
10 SANDSTONE, a.a.
50 SILTSTONE, white, grey-white, green, soft to firm, sandy in part, calcareous in part, trace volcanics, carbonaceous, feldspathic, a.a.
40 SHALE, grey, grey-green, brown, soft, dispersive, silty, washes away.

2330
40 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

2340
50 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

2350
30 SANDSTONE, a.a.
60 SILTSTONE, a.a. - predominantly grey, carbonaceous specks.
10 SHALE, a.a.
50% DULL TO MODERATELY BRIGHT YELLOW GOLD FLUORESCENCE WITH A VERY WEAK PALE YELLOW MILKY WHITE CRUSH CUT.

2360
Tr SANDSTONE, a.a.
50 SILTSTONE, light to medium grey, firm, argillaceous, lithic, trace carbonaceous, grading to very fine sandstone.
50 SHALE, medium grey, soft-firm, silty.
40% FLUORESCENCE a.a.

2370
40 SANDSTONE, white, light grey, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, argillaceous matrix, trace feldspar, lithics, green volcanic grains, trace carbonaceous material and pyrite, calcareous cement in part, tight to poor porosity.
40 SILTSTONE, a.a.
20 SHALE, a.a. - light to dark grey.
20% FLUORESCENCE a.a.

2380
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
20% FLUORESCENCE a.a.

2390
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
20% FLUORESCENCE a.a.

2400
30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a. - brown-black, shaley.
10% FLUORESCENCE a.a.

2410
30 SANDSTONE, a.a. Tr-5% FLUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2420
20 SANDSTONE, a.a. Tr-5% FLUORESCENCE a.a.
60 SILTSTONE, light to medium grey, light to medium brown, firm, sub-fissile, calcareous in part, carbonaceous material.
20 SHALE, light to medium grey, light grey-green, silty.

2430
30 SANDSTONE, a.a. Tr-5% FLUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2440
20 SANDSTONE, a.a. Tr FLUORESCENCE a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.

2450
30 SANDSTONE, a.a. Tr FLUORESCENCE a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.

2460
30 SANDSTONE, a.a. Tr FLUORESCENCE a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.

2470	40	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	10	SHALE, a.a.
	10	COAL, a.a.
2480	30	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	50	SILTSTONE, a.a.
	20	SHALE, a.a.
2490	40	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	20	SHALE, a.a.
2500	30	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	50	SILTSTONE, a.a.
	20	SHALE, a.a.
	Tr	COAL, a.a.
2510	50	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	30	SILTSTONE, a.a.
	10	SHALE, a.a.
	10	COAL, a.a.
2520	40	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	20	SHALE, a.a.
2530	30	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	50	SILTSTONE, a.a.
	20	SHALE, a.a.
2540	30	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	60	SILTSTONE, a.a.
	10	SHALE, a.a.
2550	50	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	10	SHALE, a.a.
2560	50	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	10	SHALE, a.a.
	Tr	COAL, a.a.
2570	50	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	10	SHALE, a.a.
2580	40	SANDSTONE, a.a. Tr ELUORESCENCE a.a.
	40	SILTSTONE, a.a.
	20	SHA_E, a.a.
	Tr	COAL, a.a.

2590 40 SANDSTONE, a.a. In ELUORESCENCE a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

2600 30 SANDSTONE, clear, white, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, argillaceous, calcareous cement in part. In EL a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2610 30 SANDSTONE, white-grey, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a. - grey, carbonaceous, lithic.
10 SHALE, a.a. - grey and brown, carbonaceous.
10 COAL, a.a. - brown-black, shaley.

2620 20 SANDSTONE, a.a. In ELUORESCENCE a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
Tr COAL, a.a.

2630 50 SANDSTONE, a.a. In ELUORESCENCE a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
Tr COAL, a.a.

2640 30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2650 30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2660 20 SANDSTONE, a.a. In ELUORESCENCE a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.

2670 20 SANDSTONE, a.a. In ELUORESCENCE a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
Tr COAL, a.a.

2680 40 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.

2690 20 SANDSTONE, a.a. In ELUORESCENCE a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.

2700 40 SANDSTONE, a.a. In ELUORESCENCE a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.

2710
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
60 SILTSTONE, a.a. - carbonaceous stringers.
10 SHALE, a.a.

2720
20 SANDSTONE, a.a. In ELUORESCENCE a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.

2730
10 SANDSTONE, a.a. In ELUORESCENCE a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.

2740
10 SANDSTONE, a.a. In ELUORESCENCE a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.

2750
10 SANDSTONE, a.a. In ELUORESCENCE a.a.
60 SILTSTONE, a.a.
30 SHALE, a.a.

2760
10 SANDSTONE, a.a. - white, fine, tight. In EL a.a.
70 SILTSTONE, a.a. - carbonaceous, argillaceous.
20 SHALE, a.a. - silty, carbonaceous.

2770
10 SANDSTONE, white, grey-white, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, clay matrix, trace carbonaceous, feldspathic, lithic, calcareous in part, tight to poor porosity. In EL a.a.
80 SILTSTONE, grey, argillaceous, carbonaceous, feldspathic.
10 SHALE, grey, silty, very dispersive, carbonaceous.

2780
10 SANDSTONE, a.a. In ELUORESCENCE a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.

2790
20 SANDSTONE, a.a. In ELUORESCENCE a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.

2800
10 SANDSTONE, a.a. In ELUORESCENCE a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.

2810
10 SANDSTONE, a.a. In ELUORESCENCE a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, shaley, brown-black, earthy.

2820
20 SANDSTONE, a.a. In ELUORESCENCE a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.

2830
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2840
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2850
30 SANDSTONE, a.a. white, very fine. In ELUORESCENCE a.a.
50 SILTSTONE, a.a. - laminated carbonaceous bands/specks.
20 SHALE, a.a.

2860
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.

2870
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a. - grey carbonaceous.
20 SHALE, a.a. very dispersive.

2880
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2890
30 SANDSTONE, a.a. In ELUORESCENCE a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

2900
50 SANDSTONE, a.a. grey-white, very fine. In EL a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.

2910
30 SANDSTONE, off-white to light grey, very fine to fine, sub-angular to sub-rounded, moreate sorted, clay / argillaceous matrix, silty, calcareous in part, tight to poor porosity.
60 SILTSTONE, light to medium grey, light grey-brown, soft to firm, very argillaceous, carbonaceous.
10 SHALE, a.a. - very dispersive.

2920
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.

2930
20 SANDSTONE, a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.

2940
20 SANDSTONE, a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.
Tr COAL, a.a.

2950	20	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
2960	20	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
2970	30	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	10	SHALE, a.a.
2980	30	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	10	SHALE, a.a.
2990	30	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	10	SHALE, a.a.
3000	30	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	10	SHALE, a.a. - trace coal.
3010	20	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
3020	20	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
3030	10	SANDSTONE, a.a.
	70	SILTSTONE, a.a.
	20	SHALE, a.a.
3040	10	SANDSTONE, a.a.
	70	SILTSTONE, a.a.
	20	SHALE, a.a. - also brown, carbonaceous, coally.
	Tr	COAL, a.a.
3050	10	SANDSTONE, a.a.
	70	SILTSTONE, a.a.
	20	SHALE, a.a.
3060	20	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
3070	20	SANDSTONE, a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
3080	Tr	SANDSTONE, SILTSTONE & SHALE, a.a.
	100	COAL, a.a.

3090 30 SANDSTONE, a.a.
40 SILTSTONE, a.a.
20 SHALE, a.a.
20 COAL, a.a.

3100 30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.

3110 10 SANDSTONE, a.a.
70 SILTSTONE, a.a.
20 SHALE, a.a.

3120 40 SANDSTONE, a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.

3130 40 SANDSTONE, clear, white, grey, very fine to fine, occasionally medium, sub-angular, moderate sorted, clay matrix, lithic, feldspathic, carbonaceous, calcareous in part, tight to poor porosity.
50 SILTSTONE, a.a.
10 SHALE, a.a.

3140 30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

3150 70 SANDSTONE, clear, brownish-white, cream, very fine to medium, sub-angular, moderate sorted, hard, clay matrix, calcareous cement, tight to poor porosity.
30 SILTSTONE, a.a.
Tr SHALE & COAL, a.a.

3160 40 SANDSTONE, a.a. - very calcareous, TRACE VERY DULL PAICHY YELLOW FLUORESCENCE WITH A VERY WEAK MILKY WHITE CRUSH CUT.
40 SILTSTONE, a.a.
20 SHALE, a.a.

3170 40 SANDSTONE, a.a. minor brown, calcareous. Tr EL a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.

3180 40 SANDSTONE, a.a. Tr EL a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

3190 10 SANDSTONE, a.a. white, fine, calcareous cement in part. Tr EL a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.

3200
40 SANDSTONE, a.a. Ir..EL.a.a.
40 SILTSTONE, a.a. - grading to shale.
10 SHALE, a.a. - dispersive, silty.
10 COAL, a.a. - shaley in part.

3210
20 SANDSTONE, a.a. Ir..EL.a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.

3220
20 SANDSTONE, a.a. Ir..EL.a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.

3230
10 SANDSTONE, a.a. Ir..EL.a.a.
60 SILTSTONE, a.a.
30 SHALE, a.a.

3240
20 SANDSTONE, a.a. Ir..EL.a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.

3250
20 SANDSTONE, a.a. also brown calcarenite. Ir..EL.a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.
10 COAL a.a. - grades to carbonaceous shale.

3260
30 SANDSTONE, a.a. Ir..EL.a.a.
40 SILTSTONE, a.a.
30 SHALE, grey-brown, silty, also chocolate brown, carbonaceous.

3270
30 SANDSTONE, a.a. Ir..EL.a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

3280
30 SANDSTONE, a.a. Ir..EL.a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.

3290
20 SANDSTONE, white, very fine to occasional medium, sub-angular to sub-rounded, moderate to well sorted, clay matrix, trace grey-black lithics, cream weathered feldspar, carbonaceous specks, calcareous cement in part, tight to poor porosity. Ir..EL.a.a.
60 SILTSTONE, grey, argillaceous, sandy, carbonaceous specks and laminae.
10 SHALE, grey, silty, carbonaceous.
10 COAL, a.a.

3300
30 SANDSTONE, a.a. Ir..EL.a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.
10 COAL, a.a.

3310	30	SANDSTONE, a.a. In. EL. a.a.
	50	SILTSTONE, a.a.
	10	SHALE, a.a.
	10	COAL, a.a.
3320	30	SANDSTONE, a.a. In. EL. a.a.
	50	SILTSTONE, a.a.
	10	SHALE, a.a.
	10	COAL, a.a.
3330	20	SANDSTONE, a.a. In. EL. a.a.
	50	SILTSTONE, a.a.
	20	SHALE, a.a.
	10	COAL, a.a.
3340	10	SANDSTONE, a.a. In. EL. a.a.
	50	SILTSTONE, a.a.
	30	SHALE, a.a.
	10	COAL, a.a.
3350	10	SANDSTONE, a.a. In. EL. a.a.
	60	SILTSTONE, a.a.
	20	SHALE, a.a.
	10	COAL, a.a.
3360	20	SANDSTONE, a.a. In. EL. a.a.
	50	SILTSTONE, a.a.
	20	SHALE, a.a.
	10	COAL, a.a.
3370	10	SANDSTONE, a.a. In. EL. a.a.
	60	SILTSTONE, a.a.
	30	SHALE, a.a.
3380	10	SANDSTONE, a.a. In. EL. a.a.
	50	SILTSTONE, a.a.
	30	SHALE, a.a.
	10	COAL, a.a.
3390	10	SANDSTONE, a.a. In. EL. a.a.
	30	SILTSTONE, a.a.
	20	SHALE, a.a.
	40	COAL, a.a.
3400	20	SANDSTONE, a.a.
	40	SILTSTONE, a.a.
	[illegible]	
	20	COAL, a.a.

30% DULL YELLOW GOLD PATCHY FLUORESCENCE WITH A VERY WEAK SLOW MILKY BLUE WHITE CRUSH CUT.

3410
20 SANDSTONE, a.a.
50 SILTSTONE, a.a. - grey-brown, carbonaceous.
20 SHALE, a.a.
10 COAL, a.a.
30% DULL YELLOW GOLD PATCHY FLUORESCENCE WITH A VERY WEAK SLOW MILKY BLUE WHITE CRUSH CUT.

3420
10 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
10 COAL, a.a.
30% FLUORESCENCE a.a.

3430
10 SANDSTONE, a.a.
60 SILTSTONE, a.a.
30 SHALE, a.a.
30% FLUORESCENCE a.a.

3440
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3450
10 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.
20 COAL, a.a.
40% FLUORESCENCE a.a.

3460
10 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
20 COAL, a.a.
50% FLUORESCENCE a.a.

3470
10 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, light to medium grey, grey-brown, soft to firm, sub-fissile to blocky, carbonaceous in part.
20 COAL, a.a.
50% FLUORESCENCE a.a.

3480
20 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.
20 COAL, a.a.
30% FLUORESCENCE a.a.

3490
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
30% FLUORESCENCE a.a.

3500
10 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
10 COAL, a.a.
30%_FLUORESCENCE_a.a.

3510
10 SANDSTONE, a.a.
40 SILTSTONE, a.a.
30 SHALE, a.a.
20 COAL, a.a.
30%_FLUORESCENCE_a.a.

3520
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.
30%_FLUORESCENCE_a.a.

3530
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
30%_FLUORESCENCE_a.a.

3540
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.
30%_FLUORESCENCE_a.a.

3550
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
10 COAL, a.a.
30%_FLUORESCENCE_a.a.

3560
20 SANDSTONE, white to light grey, hard, very fine to fine, silty, sub-angular to sub-rounded, moderate sorted, abundant altered feldspar, abundant white argillaceous matrix, trace grey lithics, trace to occasionally strong calcareous cement, tight to poor porosity.
60 SILTSTONE, a.a.
20 SHALE, a.a.
30%_FLUORESCENCE_a.a.

3570
10 SANDSTONE, a.a.
70 SILTSTONE, a.a.
20 SHALE, a.a.
30%_FLUORESCENCE_a.a.

3580
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
Tr COAL, a.a.
30%_FLUORESCENCE_a.a.

3590
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
30% FLUORESCENCE a.a.

3600
10 SANDSTONE, a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

3610
10 SANDSTONE, a.a.
80 SILTSTONE, a.a.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

3620
20 SANDSTONE, a.a.
70 SILTSTONE, light to medium grey, occasionally light to medium brown, dispersive, soft to firm, argillaceous, sandy, sub-fissile, common carbonaceous flecks and laminae, trace pyrite.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

3630
40 SANDSTONE, white, very fine to medium, sub-angular to sub-rounded, very calcareous, tight.
50 SILTSTONE, a.a.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

3640
30 SANDSTONE, a.a.
60 SILTSTONE, a.a. - brown, carbonaceous.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

3650
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
40% FLUORESCENCE a.a.

3660
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
40% FLUORESCENCE a.a.

3670
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
40% FLUORESCENCE a.a.

3680
40 SANDSTONE, a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.
40% FLUORESCENCE a.a.

3690
40 SANDSTONE, a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.
40%_FLUORESCENCE_a.a.

3700
40 SANDSTONE, a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.
40%_FLUORESCENCE_a.a.

3710
40 SANDSTONE, a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a.
40%_FLUORESCENCE_a.a.

3720
30 SANDSTONE, white, grey-white, brownish, fine to occasional medium, sub-angular to sub-rounded, moderate sorted, clay matrix, grey lithics, white feldspar, carbonaceous specks and laminae, calcareous cement in part, tight to poor porosity.
60 SILTSTONE, a.a. - grey-brown, carbonaceous.
10 SHALE, a.a. - brown, carbonaceous.
40%_FLUORESCENCE_a.a.

3730
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
60%_FLUORESCENCE_a.a.

3740
20 SANDSTONE, a.a.
70 SILTSTONE, a.a.
10 SHALE, a.a.
50%_FLUORESCENCE_a.a.

3750
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
50%_FLUORESCENCE_a.a.

3760
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
40%_FLUORESCENCE_a.a.

3770
30 SANDSTONE, a.a.
60 SILTSTONE, a.a. - grey, soft to firm, dispersive.
10 SHALE, a.a. - grey, dispersive.
30%_FLUORESCENCE_a.a.

3780
50 SANDSTONE, white, very fine to medium, lithic, calcareous in part, tight to poor porosity.
50 SILTSTONE, grey, brown, carbonaceous.
Tr SHALE, a.a.
40%_FLUORESCENCE_a.a.

3790
50 SANDSTONE, a.a.
40 SILTSTONE, a.a.
10 SHALE, a.a.
20% FLUORESCENCE a.a.

3800
40 SANDSTONE, a.a.
50 SILTSTONE, a.a.
10 SHALE, a.a. - light to medium grey, brown, buff, very soft, dispersive, sticky, silty.
30% FLUORESCENCE a.a.

3810
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
50% FLUORESCENCE a.a.

3820
30 SANDSTONE, white, light grey, very fine to fine, sub-angular to sub-rounded, moderate to well sorted, abundant white clay matrix, feldspathic, trace to common calcareous cement, tight to poor porosity.
50 SILTSTONE, a.a.
20 SHALE, a.a.
50% FLUORESCENCE a.a.

3830
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3840
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3850
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3860
10 SANDSTONE, a.a.
50 SILTSTONE, a.a.
40 SHALE, a.a.
30% FLUORESCENCE a.a.

3870
10 SANDSTONE, a.a.
50 SILTSTONE, a.a.
40 SHALE, a.a.
30% FLUORESCENCE a.a.

3880
10 SANDSTONE, a.a.
70 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3890
30 SANDSTONE, a.a.
60 SILTSTONE, a.a.
10 SHALE, a.a.
30% FLUORESCENCE a.a.

3900
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
30% FLUORESCENCE a.a.

3910
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
30% FLUORESCENCE a.a.

3920
20 SANDSTONE, a.a.
50 SILTSTONE, a.a.
30 SHALE, a.a.
30% FLUORESCENCE a.a.

3930
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3940
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3950
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3960
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3970
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

3980
20 SANDSTONE, a.a. - tight.
50 SILTSTONE, brown, firm, sub-fissile to blocky, shaley in part, micaceous, carbonaceous.
30 SHALE, grey-brown, carbonaceous.
30% FLUORESCENCE a.a.

3990
30 SANDSTONE, a.a.
50 SILTSTONE, a.a.
20 SHALE, a.a.
30% FLUORESCENCE a.a.

4000
20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 SHALE, a.a.
30%_FLUORESCENCE_a.a.

4010
50 SANDSTONE, clear, white, minor brownish, very fine to coarse, dominantly medium, sub-angular to sub-rounded, poor to moderate sorted quartz grains, argillaceous / clay matrix, silica cement, minor siderite, tight to poor porosity.
40 SILTSTONE, a.a.
10 SHALE, a.a.
30%_FLUORESCENCE_a.a. (Fl. with siltstone and tight sandstone.)

4020
50 SANDSTONE, a.a. - fine, minor medium to coarse.
50 SILTSTONE, a.a.
30%_FLUORESCENCE_a.a. (Fl. with siltstone and tight sandstone.)

4030
70 SANDSTONE, clear, white, minor brownish, very fine to fine, occasional medium to coarse, sub-angular to sub-rounded, moderate to well sorted loose quartz grains, minor aggregates with trace clay matrix, fair to good porosity.
30 SILTSTONE, a.a. - GREY, GREY-BROWN, carbonaceous.
30%_OF_SAMPLE_HAS_DULL_YELLOW-GOLD_FLUORESCENCE_WITH_A_VERY_WEAK_SLOW_DIFFUSE_MILKY_WHITE_CRUSH_CUT.

4040
70 SANDSTONE, a.a.
30 SILTSTONE, a.a.
50%_OF_SAMPLE_HAS_DULL_YELLOW_GOLD_FLUORESCENCE_WITH_VERY_WEAK_SLOW_DIFFUSE_WHITE_CUT.

4050
90 SANDSTONE, a.a. - sub-angular, loose, minor clay matrix.
10 SILTSTONE, a.a.
20%_FLUORESCENCE_a.a.

4060
80 SANDSTONE, a.a. - coarse, fair porosity.
20 SILTSTONE, a.a.
20%_FLUORESCENCE_a.a.

4070
90 SANDSTONE, clear, white, medium to very coarse, sub-angular to rounded, moderate to well sorted, predominantly loose, minor aggregates with white clay matrix. Good apparent porosity.
10 SILTSTONE, a.a.
10%_FLUORESCENCE_a.a.

4080
90 SANDSTONE, a.a.
10 SILTSTONE, a.a.
10%_FLUORESCENCE_a.a.

4090 90 SANDSTONE, a.a. also white, fine to medium, abundant clay matrix, trace green and pink lithics, tight to poor porosity.
10 SILTSTONE, a.a.
20% FLUORESCENCE a.a.

4100 60 SANDSTONE, a.a.
30 SILTSTONE, a.a.
10 BASEMENT, - granulite - green-grey, quartzitic grains with pinkish white weathered feldspar.
10% FLUORESCENCE a.a.

4110 20 SANDSTONE, a.a.
60 SILTSTONE, a.a.
20 BASEMENT, - granulite - white, pink-purple, blue-grey, light to dark green, siliceous, quartzitic, schistose and micro-crystalline grains, trace mica and pyrite, feldspar (weathered in part), mafic minerals, calcite veining in part, hard.

4120 40 SANDSTONE, a.a.
20 SILTSTONE, a.a.
40 BASEMENT, a.a.

4130 20 SANDSTONE, a.a.
20 SILTSTONE, a.a.
60 BASEMENT, a.a.

4140 100 BASEMENT, a.a.

4150 100 BASEMENT, a.a.

4160 100 BASEMENT, a.a.

4170 100 BASEMENT, a.a.

4175 100 BASEMENT, a.a.

APPENDIX 7

PALYNOLOGICAL REPORT

PALYNOLOGY OF HARTOGEN TIRRENGOWA-1,

OTWAY BASIN, AUSTRALIA

BY

ROGER MORGAN

FOR HARTOGEN ENERGY LTD. JUNE, 1987.

APPENDIX I

PALYNOMORPH OCCURRENCE DATA

PALYNOLOGY OF HARTOGEN TIRRENGOWA-1,

OTWAY BASIN, AUSTRALIA

BY

ROGER MORGAN

CONTENTS

I SUMMARY

1106 ft. (swc) : middle N. asperus Zone : late Eocene : slightly brackish : immature

lower N. asperus (late Eocene) to C. striatus (Albian) Zones not seen

1965 ft. (swc)-3600 ft. (swc) : upper C. hughesi Zone : late Aptian : non-marine : marginally mature except early mature at 3600 ft.

3885 ft. (swc) : lower C. hughesi Zone : early Aptian : non-marine : early mature

4014 ft. (swc) : F. wonthaggiensis Zone : late Neocomian : non-marine with lacustrine influence : early mature

II INTRODUCTION

Seven sidewall cores were examined from Hartogen Tirrengowa-1 for biostratigraphy and spore colour. All yielded excellent microfloras. These are assigned to four palynological zones based on the supporting data presented here as Appendix I. The Mesozoic zonation used is basically that of Helby, Morgan and Partridge (1987), which draws on all previous work and is designed for pan-Australian use. Minor modification for Otway Basin use has been necessary. The zones of Dettmann and Douglas (1976) have proved very difficult to use due to scarcity of some zone fossils. Zone equivalents are given in the CSR zonation of Price et al. (1985) which was essentially designed for Eromanga Basin use. The Tertiary zonation is that of Stover and Partridge (1973) and Stover and Evans (1973) as modified by Partridge (1976).

Maturity data was generated on the Thermal Alteration Index (TAI) Scale of Staplin and plotted on Figure 2 as a Maturity Profile. The oil and gas windows on Figure 2 follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (2.7) to dark brown (3.6) and would correspond to Vitrinite Reflectances of 0.6% to 1.3%. Geochemists, however, have not reached universal agreement on these values and argue variations based on kerogen type, basin type and basin history. The maturity interpretation is thus open to reinterpretation using the basic colour observations as raw data. However, the range of interpretation philosophies is not great, and would probably not move the oil window by more than 500 feet. Instrumental geochemistry offers quantitative and repeatable raw data.

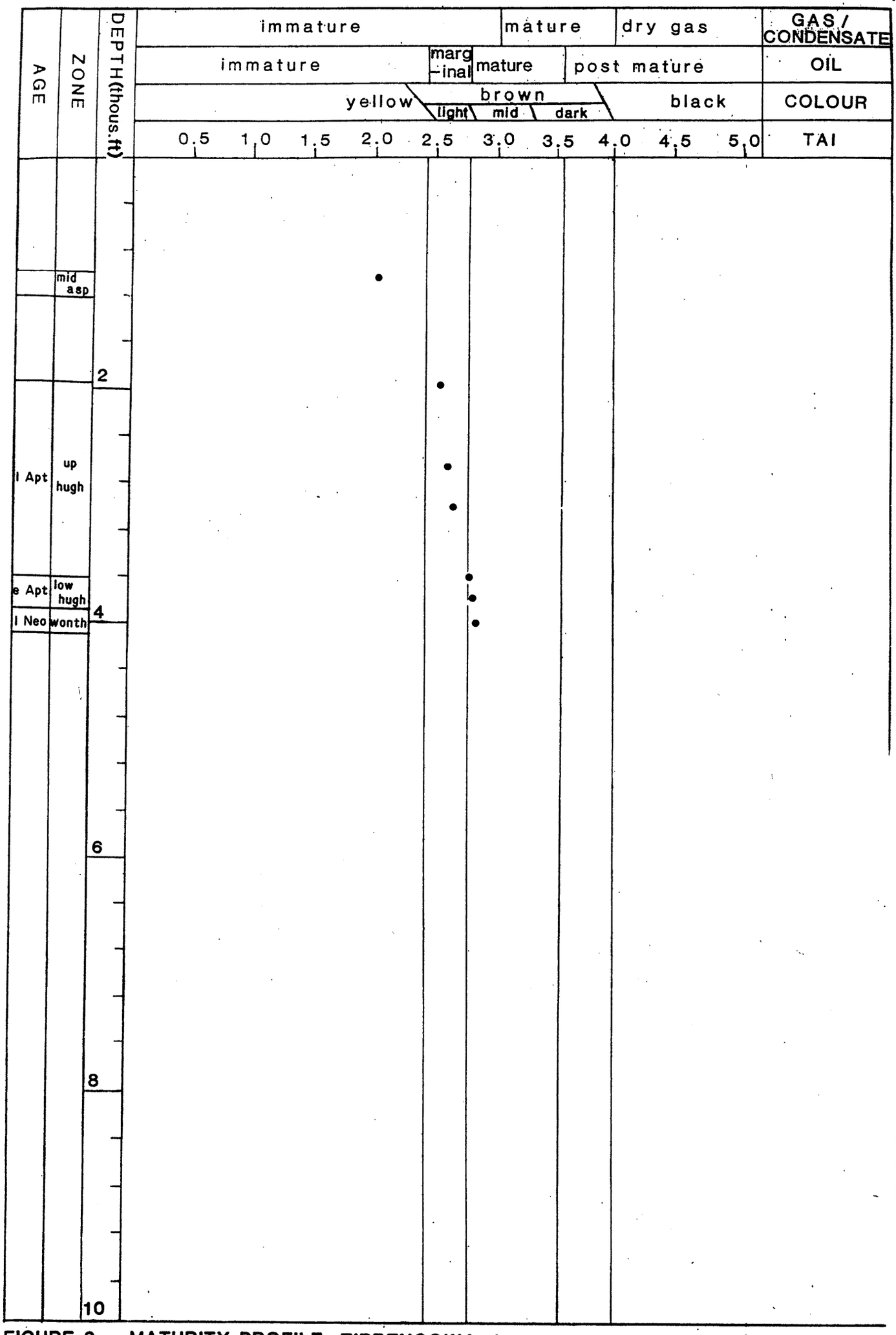


FIGURE 2 MATURITY PROFILE, TIRRENGOWA-1

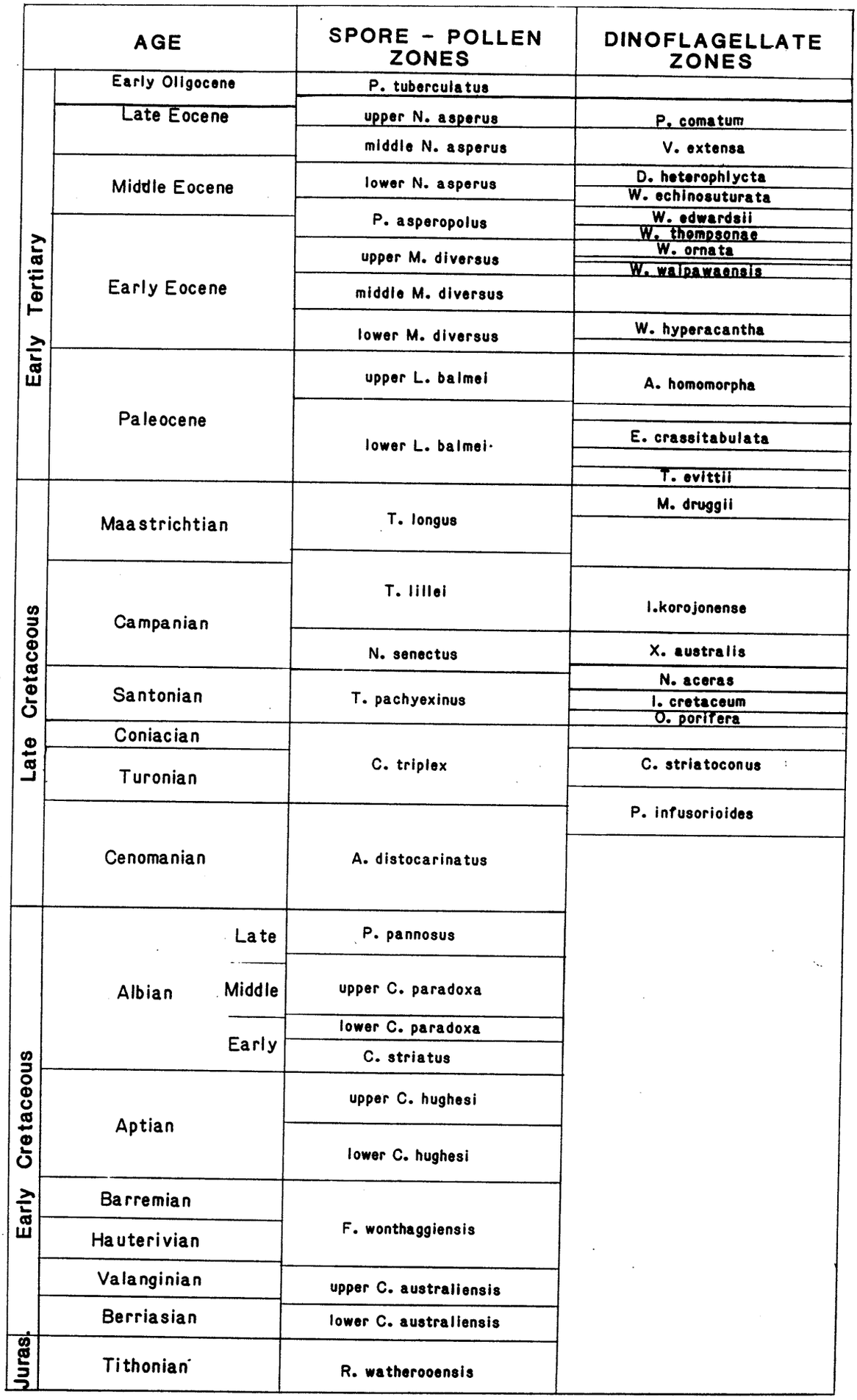


FIGURE 1 ZONATION FRAMEWORK

III PALYNOSTRATIGRAPHY

A. 1106 ft. (swc) : middle N. asperus Zone

Assignment to the middle Nothofagidites asperus Zone is indicated at the base by oldest Triorites magnificus, supported by oldest Aglaoreidia qualamus and Riccia "boxatus". At the top, assignment is indicated by youngest Triorites magnificus, supported by youngest Beaupreadites elegansiformis, Periporopollenites demarcatus, Proteacidites crassus, P. leightonii, P. incurvatus, Santalumidites cainozoicus, Tricolpites thomasii and consistent Proteacidites pachypolus.

Slightly brackish environments are suggest by the presence of a single dinoflagellate amongst diverse and abundant spore-pollen.

This zone is normally associated with the topmost Dilwyn Formation or lowermost Nirranda Group. In such restricted marine environments, the Dilwyn Formation is indicated.

Yellow spore colours indicate immaturity for hydrocarbon generation.

B. lower N. asperus to C. striatus Zones not seen

None of the late Eocene to early Albian zones were seen, and are probably largely absent by hiatus at 1252 ft. (log evidence).

C. 1965 ft. (swc) - 3600 ft. (swc) : upper C. hughesi Zone

Assignment to the upper Cyclosporites hughesi Zone is indicated at the top by the absence of the younger indicator Crybelosporites striatus and at the base by the absence of the older indicator Cooksonites variabilis. The presence of consistent Pilosisporites spp. and Cyclosporites hughesi confirm the assignment. Foraminisporis asymmetricus occurs down to the base of the interval but not beyond it. A single specimen of Crybelosporites stylosus occurs at 1965 ft. only.

Non-marine environments are indicated by the abundant and diverse spores and pollen and lack of brackish or marine indicators. Freshwater algal indicators include Botryococcus and Schizosporis spp. and suggest lacustrine influence.

This zone is usually associated with the lower part of the Eumeralla Formation, and often with coaly facies developments.

Spore colours of light brown at the top, grading to light-mid brown at 3600 ft. indicate marginal maturity for oil in the interval 1965-2940 ft., and early maturity for oil at 3600 ft. For gas/condensate, the interval is immature to 2940 ft., and marginally mature at 3600 ft.

D. 3885 ft. (swc) : lower C. hughesi Zone

Assignment to the lower Cyclosporites hughesi Zone is indicated at the top by youngest Cooksonites variabilis and at the base by oldest Pilosisporites notensis and P. parvispinosus. This interval is approximately equivalent to the middle C. hughesi Zone of Dettmann and Douglas (1976).

Non-marine, possibly lacustrine environments are indicated by the abundant and diverse spores and pollen, and presence of algal acritarchs (Schizosporis spp.).

This zone is usually associated with the basal Eumeralla Formation or uppermost Pretty Hill Formation.

Spore colours of mid to light brown indicate early maturity for oil, and marginal maturity for gas/condensate.

E. 4014 ft. (swc) : F. wonthaggiensis Zone

Assignment to the Foraminisporis wonthaggiensis Zone is indicated at the top by the absence of the younger indicator P. notensis, and confirmed by youngest Murospora florida in this sample. At the base, assignment is indicated by oldest Dictyotosporites speciosus, and confirmed by oldest Foraminisporis wonthaggiensis. Cicatricosisporites spp. are present but very rare. This interval is approximately equivalent to the lower C. hughesi Zone of Dettmann and Douglas (1976).

Non-marine lacustrine environments are indicated by abundant cuticle, common and diverse spores and pollen, and rare presence of the algal acritarch Microfasta evansii.

These features are normally seen in the topmost Pretty Hill Formation.

Mid brown spore colours indicate early maturity for oil, and marginal maturity for gas/condensate.

IV CONCLUSIONS

A. The log picks show good agreement with the regional geological framework.

The Pretty Hill Formation is here associated with the F. wonthaggiensis and lower C. hughesi Zones (log top at 3610 ft.). This is seen elsewhere although the lithological boundary can also coincide with the F. wonthaggiensis/C. hughesi boundary. The actual erosional event producing the angular unconformity probably occurs within the lower C. hughesi Zone, but, if sufficient erosion occurs, may remove all of the underlying lower C. hughesi Zone, so that the unconformity lies at the top, or is eroded down into, the F. wonthaggiensis Zone. The top good sand (4027 ft.) is well below the top Pretty Hill Formation, again consistent with the regional pattern of the best sand being located in the middle part of the Formation.

The Eumeralla Formation is Aptian at the base, as is usual. The upper 500 ft. is undated however, as no samples were studied from that interval. The age extent of erosional truncation of the Eumeralla is therefore unknown.

The logs suggest the absence of the late Cretaceous on an unconformity at 1252 ft., but no palynological control exists.

The logs suggest a Pebble Point Formation at 1209-1252 ft., and so imply the presence of at least part of the Paleocene. No palynology samples were studied in the interval.

The Dilwyn Formation is identified from logs at 1101-1209 ft.

Usually, the lower Eocene (M. diversus Zone) and late Eocene (N. asperus) intervals are the most laterally persistent. The single sample studied confirms a late Eocene top, but the age extent of the rest of the Formation is unknown.

B. Environmental data are consistent with the regional picture. The Pretty Hill and Eumeralla intervals are non-marine with lacustrine influence. Very rare brackish influence seen in some other localities was not seen here. The Dilwyn Formation is seen to be slightly brackish, although elsewhere the formation top is often rather more marine.

C. Maturity data indicate that the base of the section, although only early mature, could have sourced some hydrocarbons. Deeper burial offstructure could have taken the section to peak maturity and produced much more liquid hydrocarbons. However, burial to depths of about 7000 ft. would be necessary.

V REFERENCES

Dettmann, M.E. and Douglas, J.G. (1976) Mesozoic Palaeontology In Geology of Victoria Ed Douglas, J.G. and Ferguson, J.A. Geol. Soc. Austr. Spec. Publs. 5 164-169

Helby, R.J., Morgan, R.P. and Partridge, A.D. (1987) A Palynolgical Zonation of the Australian Mesozoic Australas. Assoc. Palaeot., Mem. 4

Partridge, A.D. (1976) The geological expression of eustacy in the Early Tertiary of the Gippsland Basin Aust. Pet. Explor. Assoc. J., 16 : 73-79

Stover, L.E. and Evans, P.R. (1973) Upper Cretaceous-Eocene spore-pollen zonation, offshore Gippsland Basin, Australia Spec. Publ. geol. Soc. Austr. 4 : 55-72

Stover, L.E. and Partridge, A.D. (1973) Tertiary and Late Cretaceous spores and pollen from the Gippsland Basin, South-eastern Australia Proc. R. Soc. Vict., 85 : 237-286

APPENDIX 8

SOURCE ROCK ANALYSIS

SOURCE ROCK EVALUATION, TIRRENGOWA-1
PEP-100, OTWAY BASIN

Hartogen Energy Limited

F3/1001/0-F6830/87 June 1987

amdel
technology and enterprise
Amdel Limited - Inc. in S.A.

Amdel
31 Flemington Street,
Frewville, S.A. 5063

Telephone: (08) 372 2700

Address all correspondence to:
P.O. Box 114,
Eastwood, S.A. 5063

Telex: AA82520
Facsimile: (08) 79 6623

30 June 1987

F 3/1001/0
F 6830/87

Hartogen Energy Limited
15 Young Street
SYDNEY NSW 2000

Attention: W.K. Morrison

REPORT F 6830/87

YOUR REFERENCE:	Phone call from W.K. Morrison, 10 June 1987
TITLE:	Source rock evaluation, Tirrengowa-1, PEP-100, Otway Basin
MATERIAL:	Sidewall cores
LOCALITY:	TIRRENGOWA-1
IDENTIFICATION:	As in Table 1 of report
DATE RECEIVED:	11 June 1987
WORK REQUIRED:	TOC and Rock-Eval pyrolysis. Vitrinite reflectance. Organic petrology. Interpretation.

Investigation and Report by: Dr David M. McKirdy and Brian L. Watson

Manager-Petroleum Services Section: Dr Brian G. Steveson

for Dr William G. Spencer
General Manager
Applied Sciences Group

cap

1. INTRODUCTION

Three sidewall cores from Tirrengowa-1 (Table 1) were received for source rock evaluation.

The aims of the investigation were to assess the hydrocarbon source potential (maturity, organic richness, kerogen type) of Otway Group shale and siltstones penetrated by the Tirrengowa-1 well.

Preliminary results were facsimiled to Hartogen's Sydney office on 26 June 1987.

2. RESULTS

Analytical data are summarised and presented herein as follows:

	Table	Figure	Appendix
TOC, Rock-Eval pyrolysis	2	1	-
Vitrinite reflectance	3	2	1
Dispersed organic matter (DOM)	4-6	-	2

3. DISCUSSION

3.1 Maturity

Vitrinite reflectance data (Fig. 2) indicate that sediments above 2570 feet depth in Tirrengowa-1 are thermally immature (VR <0.5%). The lower half of the Eumeralla Formation and the upper 340 feet of the underlying Pretty Hill Sandstone are marginally mature for oil generation from terrestrial organic matter (VR = 0.5-0.7%).

There is good agreement between measured vitrinite reflectance and Rock-Eval Tmax for two of the samples analysed (Fig. 1). However, Tmax for SWC 19 (1965 feet) is anomalously high (452°C) with respect to its vitrinite reflectance value (VR = 0.49%). The reason for this discrepancy is not clear but may be related to the highly inertinitic character of the DOM (Table 4).

Production index, another maturation-dependent parameter, increases with increasing depth in the sequence (Table 2) as would be expected.

3.2 Organic Richness

Total organic carbon contents of these fine-grained clastics are fair to good (TOC = 0.60-1.07%), although considerably less than the worldwide average for shale source rocks (TOC = 2.0%).

Source richness is *poor* as indicated by low potential hydrocarbon yields (S_1+S_2 <2 kg/tonne).

3.3 Source Quality and Kerogen Type

Siltstones from the Pretty Hill Sandstone (SWC 8) and the base of the Eumeralla Formation (SWC 11) have low hydrogen indices (HI = 113-159 mg S_2/g TOC) characteristic of poor quality Type III kerogen (Fig. 1).

Optical microscopy confirms the presence of terrestrial organic matter rich in inertinite (I = 90% of DOM : Table 4). The associated exinite (5% of DOM) is moderately to strongly oxidised. Such organic matter is a potential source of dry gas only.

Although containing similarly inertinitic DOM, shale from 1965 feet depth in the Eumeralla Formation (SWC 19) has an appreciably higher hydrogen index (HI = 252 mg S_2/g TOC). There is no obvious reason why this should be so.

4. CONCLUSIONS

1. Early Cretaceous sediments of the Otway Group below 2570 feet depth in Tirrengowa-1 are marginally mature (VR = 0.5-0.7%).

2. Such maturities are adequate for the initial phase of oil generation from terrestrial organic matter.

3. Representative shale and siltstones from the Eumeralla Formation and Pretty Hill Sandstone contain only moderate amounts of poor quality, oxidised, terrestrial organic matter at this well locality. Such organic matter is not capable of generating significant quantities of liquid hydrocarbons.

TABLE 1: SIDEWALL CORES SUBMITTED FOR SOURCE ROCK ANALYSIS, TIRRENGOWA-1

SWC	Depth ft	Formation	Rock Type
19	1965	Eumeralla	Shale
11	3600	Eumeralla	Siltstone
8	3885	Pretty Hill	Siltstone

TABLE 2

AMDEL

ROCK-EVAL PYROLYSIS 24/06/87

Client HARTOGEN ENERGY LTD

Well TIRRENGOWA-1

SWC No.	DEPTH (ft)	T MAX	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
19	1965	452	0.07	1.51	0.62	1.58	0.04	2.43	0.13	0.60	252	103
11	3600	442	0.21	1.45	2.14	1.66	0.13	0.67	0.13	0.91	159	235
8	3885	442	0.19	1.21	1.99	1.40	0.14	0.60	0.11	1.07	113	186

KEY TO ROCK-EVAL PYROLYSIS DATA SHEET

PARAMETER		SPECIFICITY
T max	position of S_2 peak in temperature program (°C)	Maturity/Kerogen type
S_1	kg hydrocarbons (extractable)/tonne rock	Kerogen type/Maturity/Migrated oil
S_2	kg hydrocarbons (kerogen pyrolysate)/tonne rock	Kerogen type/Maturity
S_3	kg CO_2 (organic)/tonne rock	Kerogen type/Maturity*
S_1+S_2	Potential Yield	Organic richness/Kerogen type
PI	Production Index ($S_1/S_1 + S_2$)	Maturity/Migrated oil
PC	Pyrolysable Carbon (wt. percent)	Organic richness/Kerogen type/Maturity
TOC	Total Organic Carbon (wt. percent)	Organic richness
HI	Hydrogen Index (mg h'c (S_2)/g TOC)	Kerogen type/Maturity
OI	Oxygen Index (mg CO_2(S_3)/g TOC)	Kerogen type/Maturity*

*Also subject to interference by CO_2 from decomposition of carbonate minerals.

TABLE 3: SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS, TIRRENGOWA-1

Depth (ft)	Mean Maximum Reflectance (%)	Standard Deviation	Range	Number of Determinations
1965	0.49	0.05	0.42-0.56	4
3600	0.57	0.09	0.40-0.74	25
3885	0.72	0.08	0.59-0.86	6

TABLE 4: PERCENTAGE OF VITRINITE, INERTINITE AND EXINITE IN DISPERSED ORGANIC MATTER, TIRRENGOWA-1

Depth (ft)	Percentage of		
	Vitrinite	Inertinite	Exinite
1965	<5	90	5*
3600	5	90	<5*
3885	<5	90	5*

*Exinite is moderately to strongly oxidised.

TABLE 5: ORGANIC MATTER TYPE AND ABUNDANCE, TIRRENGOWA-1

Depth (ft)	Relative Maceral Group Proportions	Estimated Volume of DOM	Exinites	Exinite Macerals
1965	I>>E>V	1-2	Ra	phyto,spo,?oil
3600	I>>V>E	≈1	Vr	lipto,phyto,spo
3885	I>>E>V	1-2	Vr	?oil,phyto,spo

TABLE 6: EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS, TIRRENGOWA-1

Depth (ft)	Exinite Macerals	Lithology/Comments
1965	phyto(Ra;m0-nofl),spo(Vr;m0-nofl),?oil(Tr;iY)	Shale; exinite is moderately to strongly oxidised. ?Oil is associated with the larger mineral grains and is likely to have migrated to this location.
3600	lipto(Vr;m0-d0),phyto(Vr;d0-nofl),spo(Tr;d0-nofl)	Siltstone; exinite is strongly oxidised.
3885	?oil(Vr;iY-i0),phyto(Vr;d0-nofl),spo(Vr;d0-nofl)	Siltstone; exinite as above. ?Oil is generally associated with the larger mineral grains and is likely to have migrated into this unit. Two distinct fluorescence colours indicate the possibility of two families of oil.

KEY TO DISPERSED ORGANIC MATTER DESCRIPTIONS

MACERAL GROUPS

V	Vitrinite
I	Inertinite
E	Exinite

EXINITE MACERALS

spo	Sporinite
cut	Cutinite
res	Resinite
sub	Suberinite
lipto	Liptodetrinite
fluor	Fluorinite
terp	Terpenite
exs	Exsudatinite
phyto	Phytoplankton
tela	Telalginite
lama	Lamalginite
bmite	Bituminite
bmen	Bitumen
thuc	Thucholite

ABUNDANCE (by vol.)

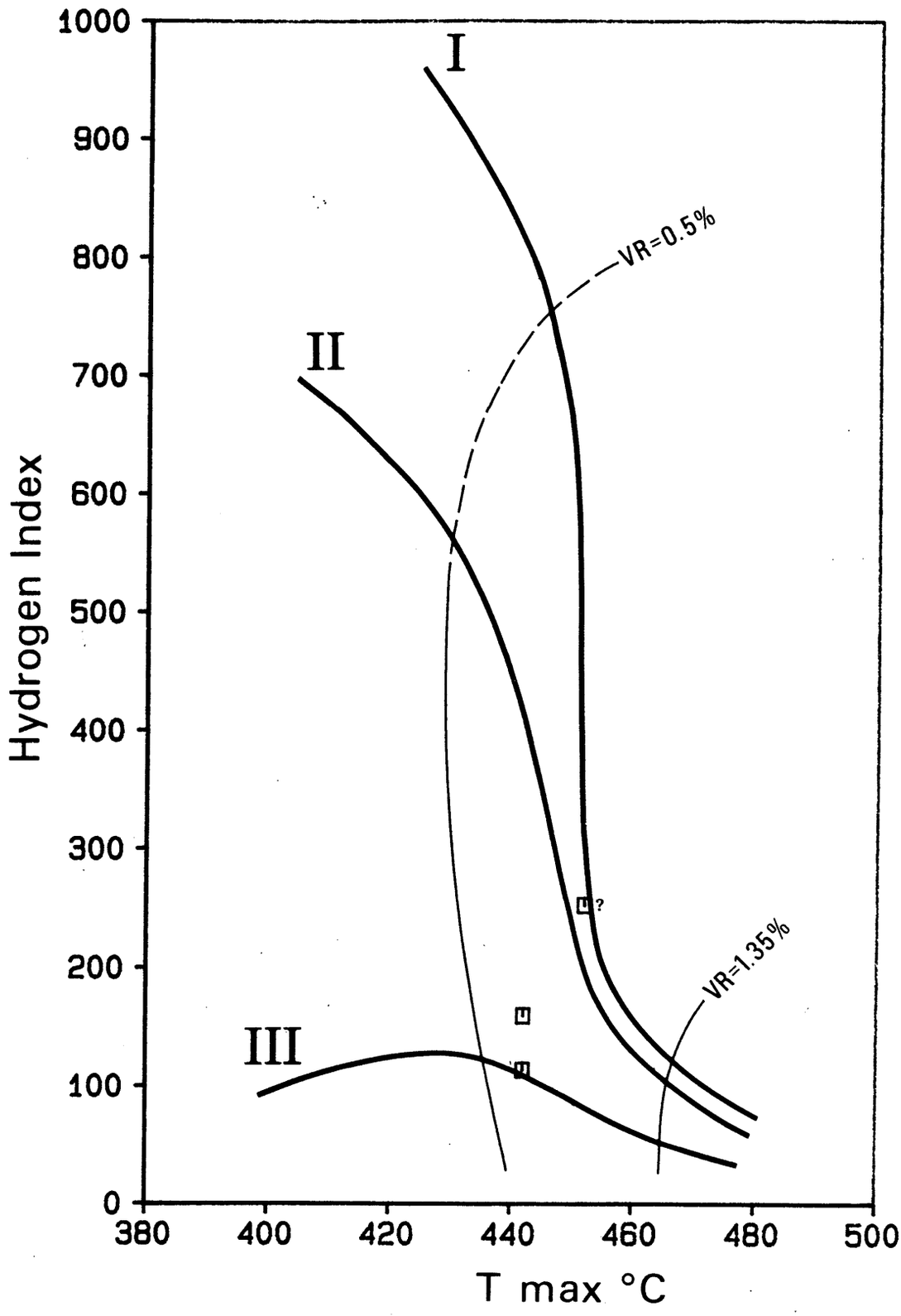
Ma	Major	>15%
Ab	Abundant	2-15%
Co	Common	1-2%
Sp	Sparse	0.5-1%
Ra	Rare	0.1-0.5%
Vr	Very Rare	≈0.1%
Tr	Trace	<0.1

FLUORESCENCE COLOUR AND INTENSITY

G	Green
Y	Yellow
O	Orange
B	Brown

i	Intense
m	Moderate
d	Dull
nofl	No Visible Fluorescence

Client : HARTOGEN ENERGY
Well name : TIRRENGOWA-1



TIRRENGOWA #1

DESCRIPTION:

ALL SAMPLE DEPTHS ARE IN FEET
* INDICATES NON SPORE POLLEN
PALYNOLOGICAL INTERPRETATION DONE BY ROGER MORGAN - JUNE 1987

CHECKLIST OF GRAPHIC ABUNDANCE BY LOWEST APPEARANCE

= Abundant
= Common
= Few
= Rare
= Very Rare
? = Questionably Present
. = Not Present

		1106.0 SWC	1965.0 SWC	2350.0 SWC	2940.0 SWC	3600.0 SWC	3885.0 SWC	4014.0 SWC
1	* BATIACASPHAERA MACROGRANULATA *	.	.	.	.	.	.	?
2	* MICROFASTA EVANSII *	.	.	.	.	.	.	-
3	AEQUITRIRADITES SPINULOSUS	.	-	.	-	-	-	-
4	ARAUCARIACITES AUSTRALIS	.	-	.	.	-	-	-
5	BIRETRISPORITES SPECTABILIS	.	.	.	.	.	.	-
6	CALLIALASPORITES DAMPIERI	.	-	.	-	-	-	-
7	CALLIALASPORITES TURBATUS	.	.	.	.	.	.	-
8	CICATRICOSISPORITES AUSTRALIENSIS	.	-	.	□	□	□	-
9	CICATRICOSISPORITES LUDBROOKIAE	.	.	.	.	.	.	-
10	CINGUTRILETES CLAVUS	.	.	.	.	.	.	-
11	COROLLINA TOROSUS	.	-	-	-	-	-	-
12	COUPERISPORITES TABULATUS	.	.	.	?	.	.	-
13	CYATHIDITES AUSTRALIS	.	▓	▓	▓	▓	▓	▓
14	CYATHIDITES MINOR	.	▓	▓	▓	▓	▓	-
15	CYCADOPITES FOLLICULARIS	.	-	-	-	-	-	-
16	DICTYOTOSPORITES SPECIOSUS	.	-	-	▓	-	-	-
17	FALCISPORITES GRANDIS	.	▓	-	▥	.	.	-
18	FALCISPORITES SIMILIS	.	▓	-	▥	-	-	▓
19	FORAMINISPORIS DAILYI	.	-	.	.	-	-	-
20	FORAMINISPORIS WONTHAGGIENSIS	.	-	-	□	-	-	▥
21	ISCHYOSPORITES PUNCTATUS	.	-	.	-	.	.	-
22	JANUASPORITES SPINULOSUS	.	-	.	.	.	.	-
23	LEPTOLEPIDITES MAJOR	.	-	-	-	-	-	-
24	LEPTOLEPIDITES VERRUCATUS	.	-	-	-	.	.	-
25	MICROCACHRYIDITES ANTARCTICUS	.	-	.	-	-	-	-
26	MUROSPORA FLORIDA	.	-	.	.	.	.	-
27	NEORAISTRICKIA TRUNCATA	.	-	.	-	-	-	-
28	NEVESISPORITES VALLATUS	.	-	.	.	.	.	-
29	OSMUNDACIDITES WELLMANII	.	▓	-	▓	-	-	-
30	RETITRILETES AUSTROCLAVATIDITES	.	-	-	-	-	-	-
31	RETITRILETES CIRCOLUMENUS	.	□	□	.	.	.	-
32	RETITRILETES EMINULUS	.	-	.	-	-	-	-
33	RETITRILETES FACETUS	.	-	-	-	-	-	-
34	RETITRILETES WATHERDOENSIS	.	-	-	.	.	.	-
35	TRILOBOSPORITES PURVERULENTUS	.	-	.	.	.	.	-
36	VELOSPORITES TRIQUETRUS	.	-	.	-	-	-	-
37	* SCHIZOSPORIS PSILATA *	.	.	-	.	.	.	-
38	AEQUITRIRADITES VERRUCOSUS	.	-	.	-	.	-	-
39	CERATOSPORITES EQUALIS	.	-	-	-	-	-	-
40	CONTIGNISPORITES COOKSONIAE	.	-	-	.	.	.	-
41	COOKSONITES VARIABILIS	.	-	.	.	.	.	-
42	CYCLOSPORITES HUGHESI	.	-	-	-	-	-	-
43	DICTYOTOSPORITES COMPLEX	.	-	-	-	-	-	▓
44	FORAMINISPORIS CAELATUS	.	-	.	.	.	.	-
45	GLEICHENIIDITES	.	-	-	-	.	-	-
46	KLUKISPORITES SCABERIS	.	-	.	-	-	-	-
47	LYCOPODIACIDITES ASPERATUS	.	-	.	.	.	.	-
48	MATONISPORITES COOKSONIAE	.	-	.	.	.	.	-
49	PILOSISPORITES NOTENSIS	.	-	-	□	▥	▥	-
50	PILOSISPORITES PARVISPINOSUS	.	-	-	-	□	□	-
51	RETITRILETES NODOSUS	.	-	.	-	.	.	-
52	STEREISPORITES ANTIQUASPORITES	.	-	.	-	.	-	-
53	VITREISPORITES PALLIDUS	.	-	.	.	-	-	-
54	* SUBTILOSPHAERA SP. *	.	.	-	.	.	.	-
55	FORAMINISPORIS ASYMMETRICUS	.	.	-	-	-	-	-
56	NEORAISTRICKIA TAYLORI	.	.	-	.	.	.	-
57	PEROTRILETES WHITFADENSIS	.	.	-	.	.	.	-
58	* BOTRYOCOCCUS *	.	.	.	-	.	.	-
59	CRYBELOSPORITES BERBEROIDES	.	.	.	-	.	.	-
60	FOVEOTRILETAS PARVIRETUS	.	.	.	-	.	.	-
61	POLYCINGULATISPORITES CRENULATUS	.	.	.	-	.	.	-
62	ROGALSKISPORITES CICATRICOSUS	.	.	.	-	.	.	-
63	* SCHIZOSPORIS RETICULATA *	.	.	.	.	-	.	-
64	DICTYOTOSPORITES FILOSUS	.	.	.	.	-	.	-
65	ANNULISPORITES FOLLICULOSA	.	.	.	.	.	-	-
66	CRYBELOSPORITES STYLOSUS	.	.	.	.	.	-	-
67	RETICULATISPORITES PUDENS	.	.	.	.	.	-	-
68	* SPINIFERITES RAMOSUS *	.	.	.	.	.	.	-
69	AGLAOREIDIA QUALUMIS	.	.	.	.	.	.	-
70	BEAUPREAIDITES ELEGANSIFORMIS	.	.	.	.	.	.	-
71	CUPANIEIDITES ORTHOTEICHUS	.	.	.	.	.	.	-
72	DACRYCARPITES AUSTRALIENSIS	.	.	.	.	.	.	-
73	ERICIPITES SCABRATUS	.	.	.	.	.	.	-
74	HALORAGACIDITES HARRISII	.	.	.	.	.	.	-
75	ISCHYOSPORITES GREMIUS	.	.	.	.	.	.	-
76	KUYLISPORITES WATERBOLKII	.	.	.	.	.	.	-
77	LILIACIDITES LANCEOLATUS	.	.	.	.	.	.	-
78	LYGISTEPOLLENITES FLORINII	.	.	.	.	.	.	-
79	MALVACIPOLLIS SUBTILIS	.	.	.	.	.	.	-
80	MILFORDIA HOMEOPUNCTA	.	.	.	.	.	.	-
81	NOTHOFAGIDITES ASPERUS	.	.	.	.	.	.	-
82	NOTHOFAGIDITES BRACHYSPINULOSUS	.	.	.	.	.	.	▓
83	NOTHOFAGIDITES EMARCIDUS	.	.	.	.	.	.	▓
84	NOTHOFAGIDITES FALCATUS	.	.	.	.	.	.	▥
85	NOTHOFAGIDITES FLEMINGII	.	.	.	.	.	.	-
86	NOTHOFAGIDITES HOCHSTETTERI	.	.	.	.	.	.	-

SPECIES LOCATION INDEX

Index numbers are the columns in which species appear.

INDEX NUMBER	SPECIES
1	* BATIACASPHAERA MACROGRANULATA *
58	* BOTRYOCOCCUS *
2	* MICROFASTA EVANSII *
37	* SCHIZOSPORIS PSILATA *
63	* SCHIZOSPORIS RETICULATA *
68	* SPINIFERITES RAMOSUS *
54	* SUBTILOSPHAERA SP. *
3	AEQUITRIRADITES SPINULOSUS
38	AEQUITRIRADITES VERRUCOSUS
69	AGLAOREIDIA QUALUMIS
65	ANNULISPORITES FOLLICULOSA
4	ARAUCARIACITES AUSTRALIS
70	BEAUFREAIDITES ELEGANSIFORMIS
5	BIRETRISPORITES SPECTABILIS
6	CALLIALASPORITES DAMPIERI
7	CALLIALASPORITES TURBATUS
39	CERATOSPORITES EQUALIS
8	CICATRICOSISPORITES AUSTRALIENSIS
9	CICATRICOSISPORITES LUDBROOKIAE
10	CINGUTRILETES CLAVUS
40	CONTIGNISPORITES COOKSONIAE
41	COOKSONITES VARIABILIS
11	COROLLINA TOROSUS
12	COUPERISPORITES TABULATUS
59	CRYBELOSPORITES BERBEROIDES
66	CRYBELOSPORITES STYLOSUS
71	CUPANIEIDITES ORTHOTEICHUS
13	CYATHIDITES AUSTRALIS
14	CYATHIDITES MINOR
15	CYCADOPITES FOLLICULARIS
42	CYCLOSPORITES HUGHESI
72	DACRYCARPITES AUSTRALIENSIS
43	DICTYOTOSPORITES COMPLEX
64	DICTYOTOSPORITES FILOSUS
16	DICTYOTOSPORITES SPECIOSUS
73	ERICIPITES SCABRATUS
17	FALCISPORITES GRANDIS
18	FALCISPORITES SIMILIS
55	FORAMINISPORIS ASYMMETRICUS
44	FORAMINISPORIS CAELATUS
19	FORAMINISPORIS DAILYI
20	FORAMINISPORIS WONTHAGGIENSIS
60	FOVEOTRILETAS PARVIRETUS
45	GLEICHENIIDITES
74	HALORAGACIDITES HARRISII
75	ISCHYOSPORITES GREMIUS
21	ISCHYOSPORITES PUNCTATUS
22	JANUASPORITES SPINULOSUS

46 KLUKISPORITES SCABERIS
76 KUYLISPORITES WATERBOLKII
23 LEPTOLEPIDITES MAJOR
24 LEPTOLEPIDITES VERRUCATUS
77 LILIACIDITES LANCEOLATUS
47 LYCOPODIACIDITES ASPERATUS
78 LYGISTEPOLLENITES FLORINII
79 MALVACIPOLLIS SUBTILIS
48 MATONISPORITES COOKSONIAE
25 MICROCACHRYIDITES ANTARCTICUS
80 MILFORDIA HOMEOPUNCTA
26 MUROSPORA FLORIDA
56 NEORAISTRICKIA TAYLORI
27 NEORAISTRICKIA TRUNCATA
28 NEVESISPORITES VALLATUS
81 NOTHOFAGIDITES ASPERUS
82 NOTHOFAGIDITES BRACHYSPINULOSUS
83 NOTHOFAGIDITES EMARCIDUS
84 NOTHOFAGIDITES FALCATUS
85 NOTHOFAGIDITES FLEMINGII
86 NOTHOFAGIDITES VANSTEENISII
29 OSMUNDACIDITES WELLMANII
87 PERIPOROPOLLENITES DEMARCATUS
88 PERIPOROPOLLENITES VESICUS
57 PEROTRILETES WHITFADENSIS
89 PHYLOCLADIDITES MAWSONII
49 PILOSISPORITES NOTENSIS
50 PILOSISPORITES PARVISPINOSUS
90 PODOSPORITES MICROSACCATUS
61 POLYCINGULATISPORITES CRENULATUS
91 PROTEACIDITES ANNULARIS
92 PROTEACIDITES CRASSUS
93 PROTEACIDITES GRANDIS
94 PROTEACIDITES INCURVATUS
95 PROTEACIDITES LEIGHTONII
96 PROTEACIDITES PACHYPOLUS
67 RETICULATISPORITES PUDENS
30 RETITRILETES AUSTROCLAVATIDITES
31 RETITRILETES CIRCOLUMENUS
32 RETITRILETES EMINULUS
33 RETITRILETES FACETUS
51 RETITRILETES NODOSUS
34 RETITRILETES WATHEROOENSIS
97 RICCIA BOXATUS
62 ROGALSKISPORITES CICATRICOSUS
98 SANTALUMIDITES CAINOZOICUS
52 STEREISPORITES ANTIQUASPORITES
99 TRICOLPITES PHILLIPSII
100 TRICOLPITES THOMASII
35 TRILOBOSPORITES PURVERULENTUS
101 TRIORITES MAGNIFICUS
36 VELOSPORITES TRIQUETRUS
102 VERRUCOSISPORITES KOPUKUENSIS
53 VITREISPORITES PALLIDUS

APPENDIX 1

HISTOGRAM PLOTS OF VITRINITE REFLECTANCE MEASUREMENTS, TIRRENGOWA-1

TIRRENGOWA—1

1965 FT ; SWC 19

SORTED LIST
.42 .45 .51 .56
Number of values= 4

MEAN OF VALUES .485
STD DEVIATION .054

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

42 - 46 |▒▒
47 - 51 |▒
52 - 56 |▒

TIRRENGOWA—1

3600 FT ; SWC 11

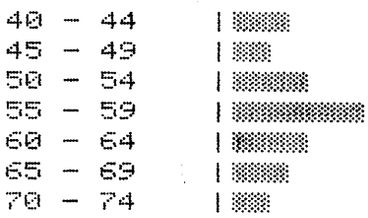
SORTED LIST

.4 .42 .43 .46 .48 .5 .5 .54 .54 .56
.57 .58 .58 .58 .58 .59 .62 .62 .64 .64
.66 .67 .69 .7 .74

Number of values= 25

MEAN OF VALUES .572
STD DEVIATION .089

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100



TIRRENGOWA—1

3885 FT ; SWC 8

SORTED LIST
.59 .68 .72 .72 .72 .86
Number of values= 6

MEAN OF VALUES .715
STD DEVIATION .08

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

```
59 - 63    |▒
64 - 68    |▒
69 - 73    |▒▒▒▒
74 - 78    |
79 - 83    |
84 - 88    |▒
```

APPENDIX 2

PHOTOMICROGRAPHS OF DISPERSED ORGANIC MATTER, TIRRENGOWA-1, OTWAY BASIN

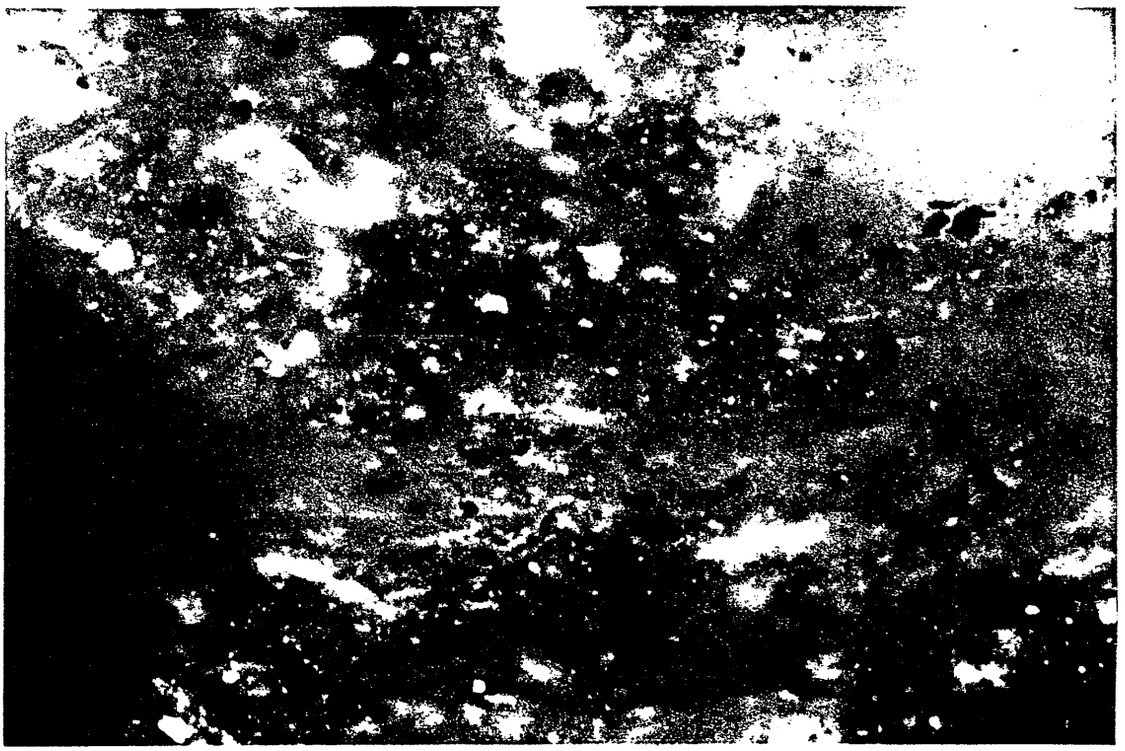


PLATE 1: SWC 19, 1965 ft, Eumeralla Fm. Reflected Light
Inertinite occurs in this shale with liptodetrinite (brown; centre left) and trace ?oil.
Field Dimensions 0.26 x 0.18 mm.

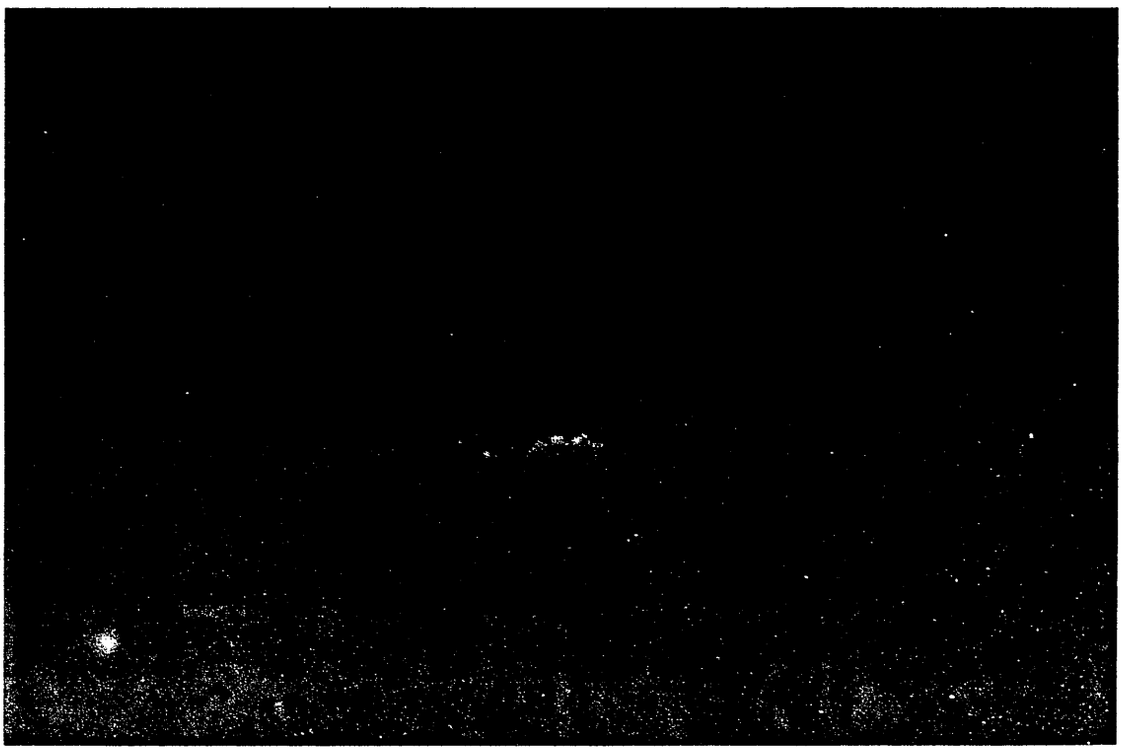


PLATE 2: Same field of view as above. Fluorescence Mode
The ?oil has an intense yellow fluorescence whereas the liptodetrinite is dull orange.

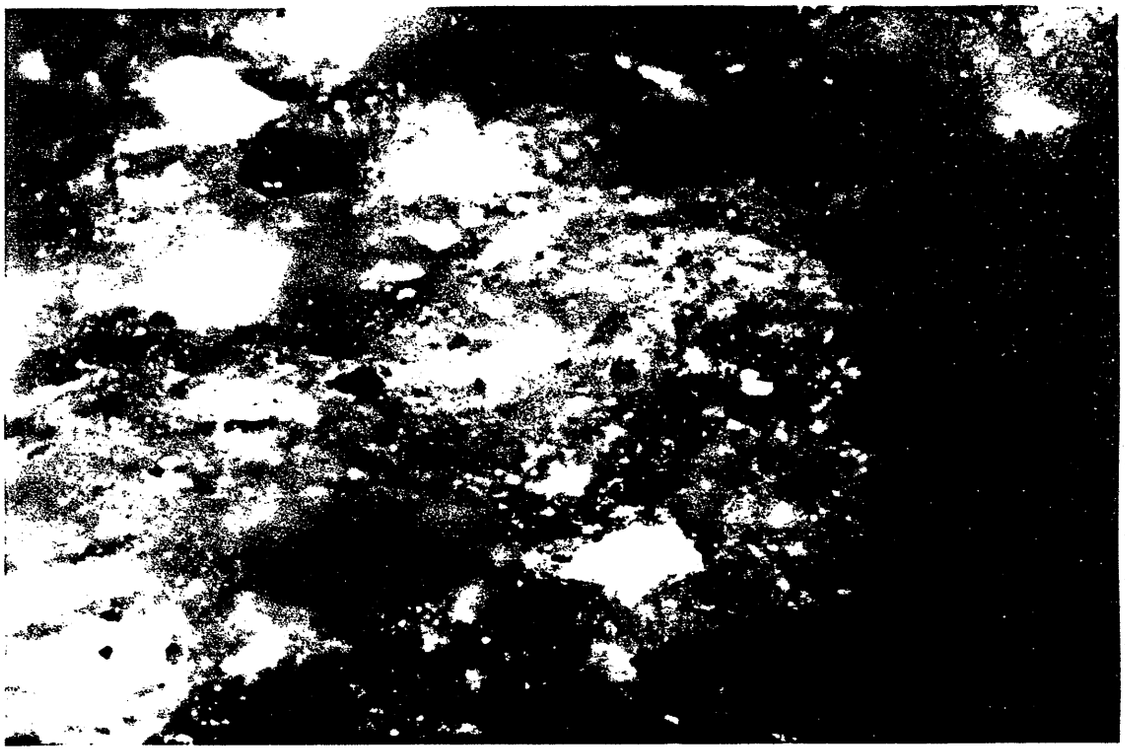


PLATE 3: SWC 8, 3885 ft, Pretty Hill Sst. Reflected Light
Siltstone containing inertinite and trace ?oil.
Field Dimensions 0.26 x 0.18 mm.

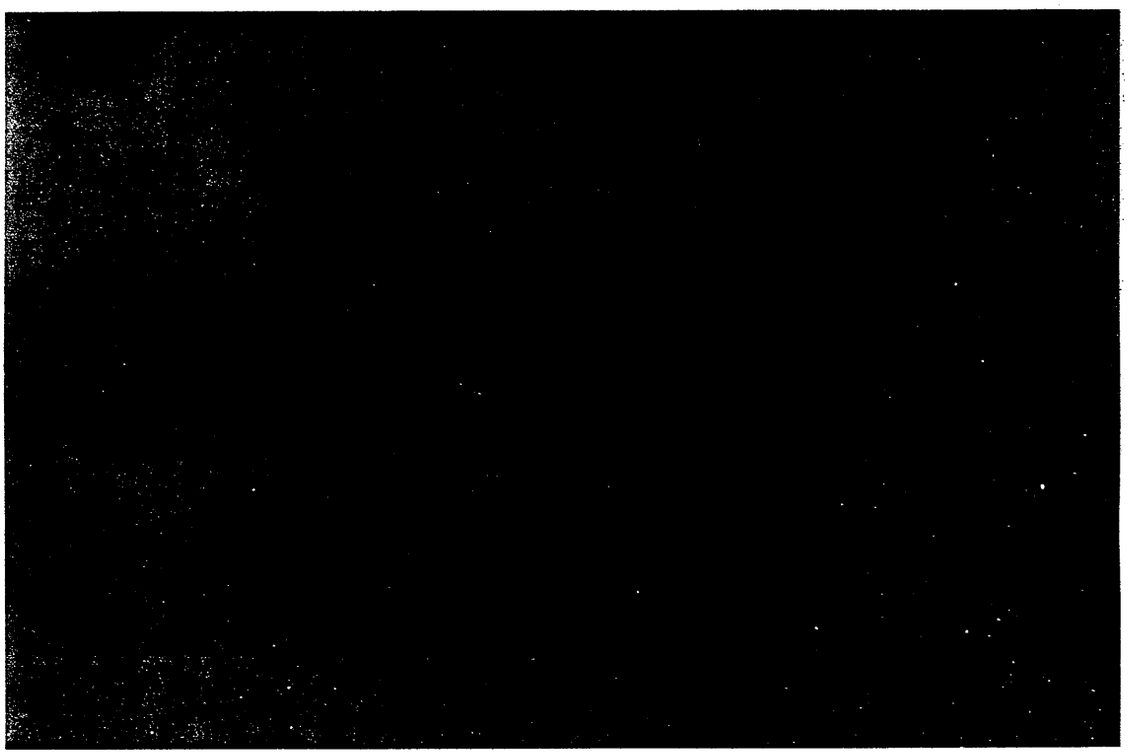


PLATE 4: Same field of view as above. Fluorescence Mode
The ?oil has an intense yellow fluorescence.

APPENDIX 9

WELL VELOCITY SURVEY

APPENDIX 9

WELL VELOCITY SURVEY

TIRRENGOWA NO. 1

VELOCITY SURVEY

A VELOCITY SURVEY WAS RUN ON THIS WELL BY SCHLUMBERGER,
A COPY OF WHICH HAS ALREADY BEEN FORWARDED.

PE601095

This is an enclosure indicator page.
The enclosure PE601095 is enclosed within the container PE902223 at this location in this document.

The enclosure PE601095 has the following characteristics:

ITEM_BARCODE	= PE601095
CONTAINER_BARCODE	= PE902223
NAME	= Exlog Formation Evaluation Log
BASIN	= OTWAY
PERMIT	= PEP/100
TYPE	= WELL
SUBTYPE	= MUD_LOG
DESCRIPTION	= Exlog Formation Evaluation Log (enclosure from WCR) for Tirrengowa-1
REMARKS	=
DATE_CREATED	= 22/03/87
DATE_RECEIVED	= 10/08/87
W_NO	= W954
WELL_NAME	= Tirrengowa-1
CONTRACTOR	= EXLOG
CLIENT_OP_CO	= HARTOGEN ENERGY LTD

(Inserted by DNRE - Vic Govt Mines Dept)

PE601096

This is an enclosure indicator page.
The enclosure PE601096 is enclosed within the container PE902223 at this location in this document.

The enclosure PE601096 has the following characteristics:

ITEM_BARCODE	= PE601096
CONTAINER_BARCODE	= PE902223
NAME	= Composite Well Log
BASIN	= OTWAY
PERMIT	= PEP/100
TYPE	= WELL
SUBTYPE	= COMPOSITE_LOG
DESCRIPTION	= Composite Well Log (enclosure from WCR) fro Tirrengowa-1
REMARKS	=
DATE_CREATED	= 24/03/87
DATE_RECEIVED	= 10/08/87
W_NO	= W954
WELL_NAME	= Tirrengowa-1
CONTRACTOR	= HARTOGEN ENERGY LTD
CLIENT_OP_CO	= HARTOGEN ENERGY LTD

(Inserted by DNRE - Vic Govt Mines Dept)