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EXPLORATION LICENCE 37/79

STYX RIVER, TASMANIA

REPORT FOR THE SIX MONTHS ENDED 1st NOVEMBER, 1981

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SUMMARY

In July, 1981 two holes of 57 metres and 210 metres respectively were drilled in the Permian Woody Island Siltstone of the Styx River valley within E.L. 37/79, to test the possibility of oil shales occurring within that unit.

Although thin bands of high-yielding oil shale occur in correlated sediments in northern Tasmania, the maximum oil yield obtained from any part of the Woody Island Siltstone drilled in the present programme was only seven litres/tonne. Thin bands of low oil-yielding siltstone near the bottom of the Woody Island Siltstone appear to contain minor Tasmanites algae, correlating those bands with the tasmanite oil shales of Northern Tasmania.

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1. GENERAL

Exploration Licence 37/79 of 280 square kilometres was granted to The Broken Hill Proprietary Company Limited on 1st May, 1981. An application for renewal from 1st November, 1981 has been submitted. The licence area consists of two parts, one an area of 205 square kilometres including part of the Styx River valley, and the other of 75 square kilometres, covering an area east of the Snowy Range. The bulk of the area originally applied for (figure 1) lies within the South-west Conservation area, title to which has not yet been granted.

2. EXPLORATION PHILOSOPHY

Following the discovery of shales with a strong petroliferous odour in the Styx River valley near Maydena, an area covering most of the known Lower Permian exposure in south-eastern Tasmania was applied for. Oil shale, oil and coal are the principal exploration targets. Fischer analysis of outcrop samples in the discovery area returned oil yields varying from 0.5 to 4.1 litres per tonne depending on the degree of weathering of each sample. Two drillholes were sited to test the Lower Permian Strata within the licence area and to obtain fresh samples for analysis.

Two main possibilities were considered:

1) the possibility that the Lower Permian strata may contain oil shales (Kerogen rich sediments) of economic grade; and

2) the possibility that the Lower Permian strata may constitute an oil source rock and that oil accumulations may be present in the fracture zones.

3. OTHER OCCURRENCES OF PERMIAN OIL SHALE IN TASMANIA

In the early part of this century, a number of operations existed mining a Permian oil shale bed in the Mersey district of northern Tasmania. The oil shale averages 1.57 metres in thickness and is a variety of oil shale called tasmanite. This is a marine oil shale characterised by the presence of flattened disc-shaped remains of the algae Tasmanites. The oil shale has yielded up to 156-205 litres/tonne of oil (Raphael and Saxby 1980). The tasmanite oil shale is known from near the base of the Quamby Mudstone at Quamby Brook, near the base of the Spreyton Beds at Latrobe and near the base of the Inglis Siltstone in the Hellyer Gorge, as well as several other localities in northern and north-western Tasmania (Clarke and Banks, 1975). These formations are all found immediately above the Wynyard

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Tillite, and are all correlated with the Woody Island Siltstone of southern Tasmania. The tasmanite oil shale of northern Tasmania is thought to have formed marginal to basement ridges in a restricted basinal environment (Clarke and Banks, 1975). In places the tasmanite oil shale passes laterally into coal as if a coal-forming swamp ran out into the shallow marine oil shale environment (Yen and Chilingarian, 1976, p 54).

4. SUMMARY OF WORK COMPLETED

1. Literature survey and review of available data.

2. 1:50,000 scale reconnaissance mapping.

3. Drilling, sampling and downhole logging of two diamond holes in the Styx River area near Maydena (267 metres).

5. RESULTS

5.1 Physiography/Access

The Styx River portion of the licence area is a densely wooded mountainous area with relief varying by up to 600 metres. Access is afforded by private forest roads from the town of Maydena to the north.

5.2 Geological Mapping

The area was previously mapped by Jago in 1972 and the present work has largely confirmed his findings (Figure 2).

Precambrian Quartzites and Dolomites

A major angular unconformity which separates the Precambrian rocks (exposed to the west of the Styx River area) from the overlying Phanerozoic rocks is exposed at a number of locations a few kilometres north and west of the Maydena Range.

The Precambrian rocks include quartzites, dolomites (extensively developed further south-west in the Weld Valley) and a dark brown ferruginous sandstone and siltstone interbedded (?) with quartzite at the northern end of the Styx Road.

Cambrian Serpentinites

Serpentinites have been reported in the Styx River, upstream of the Styx Road bridge. However, ultrabasic rocks were not located during the present mapping exercise.

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Permo-Carboniferous Sediments

The Permo-Carboniferous sequence, (the "Lower Parmeener Super Group" of Banks, 1973) in the Styx area comprises:

a) Wynyard Tillite - The basal unit of the sequence is a tillite which lies on an uneven Precambrian surface and thus varies considerably in thickness. It reaches 250 metres in thickness on the north-west side of the Maydena Range, and is thought to be of Permo-Carboniferous age. The remainder of the Lower Parmeener Super Group is thought to be of Permian age.

b) Woody Island Siltstone - This unit directly overlies the Wynyard Tillite, and is the unit of interest in the present investigation. The thickness of the unit varies from 137 metres on the northern side of the Maydena Range (Jago, 1972) up to 200 metres in the Styx Valley. This is as thick a development of the Woody Island Siltstone (W.I.S.) as is known anywhere in Tasmania.

The Woody Island Siltstone generally is a massive uniform dark grey to black siltstone with minor pyrite and yellow limonite pseudomorphs after pyrite. Glendonites (carbonate crystal pseudomorphs) occur, and rare marine and terrestial (leaf) fossils were found in the drillholes. Dropstones are found throughout the formation, although they are very sparse except in the upper and lowermost parts. In the upper 40 metres, dropstones, fossils and sandstone bands become common. The unit commonly has a slightly oily appearance and has a petroliferous smell when broken.

In a number of places on the south side of the Styx Valley, the Woody Island Siltstone apparently exhibits rapid vertical and lateral facies variations (over a few centimetres to a few metres) to a pale grey/yellow or yellow/brown massive unfossiliferous siltstone. Similar facies variants have not been found in the present drilling.

The Woody Island Siltstone characteristically weathers by rapidly disintegrating into flaky masses, giving rise to prominent horizontally oriented ellipsoid bodies up to two metres long by a form of concentric weathering similar to "onion skin" weathering of granites. The ellipsoid masses are generally bounded by vertical fractures up to one metre apart.

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c) Fossiliferous Siltstone and Darlington Limestone - Jago (1972) describes a 9.2 metre thick richly fossiliferous grey siltstone overlying the Woody Island Siltstone, which he refers to as the "Fossiliferous Siltstone". Overlying this on the north side of the Styx River is the 3.7 metre thick Darlington Limestone, characterised by its grey colour and an abundance of fossils and dropstones. The limestone unit may be absent south of the Styx River, since it did not crop out where expected near drillhole S2 site.

d) Bundella Mudstone - Overlying the Darlington Lime-Stone, north of the Styx River, and possibly directly overlying the Woody Island Siltstone south of the river, the Bundella Mudstone consists of grey/green to pale pink mudstones, sandstones and sub-grey-wackes containing common pebbles and fossils, particularly bryozoans and strophamenid brachiopods. Jago (1972) assigned a thickness of 32 metres to the Bundella Mudstone in the Maydena area.

e) Mersey Group - Overlying the Bundella Mudstone is the distinctive Mersey Group, which reaches 52 metres in the Maydena area. The Mersey Group comprises grey carbonaceous mudstones and white-grey terrestial sandstones, characterised by an absence of marine fossils and an abundance of mica flakes and black carbonaceous partings. Oil shales are known in Mersey Group sediments in northern Tasmania.

f) Upper Permian Sediments - The Mersey Group at Maydena is overlain by Permian sediments of the Cascades Group, the Malbina Siltstone and Sandstone, the Risdon Sandstone, the Ferntree Mudstone and the Cygnet Coal Measures.

Structure of the Permian Sediments - The Permian sediments are gently warped on a scale of a few tens or hundreds of metres, although their overall structure in the Styx River area is that of a gentle east-west trending anticline/syncline system plunging eastwards at about two degrees. Whereas the axis of the syncline is approximately co-incident with the crest of the Maydena Range, the axis of the anticline approximately co-incides with the Styx River south of the Maydena Range.

The only major fault known to affect the Woody Island Siltstone at the Styx River is the Pillinger fault (see Figure 2) which truncates the siltstone to the east.

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Post Permian Rocks

Triassic sediments are found east of the Pillinger Fault, and Jurassic dolerite intrusions form the top of the Snowy Range, and cap other mountains surrounding the Maydena area.

Unconsolidated Quaternary sediments of possible periglacial origin were observed at a number of locations on the Maydena range. These sediments comprise flaky and platy mudstone clasts with bedding formed by an alignment of the clasts.

5.3 Drilling

5.3.1 General

Two vertical drillholes (S1 and S2) were drilled in the Styx River area between 7th and 26th July, 1981. The holes were sited on the basis of observations made during reconnaissance mapping of the area in the Woody Island Siltstone, a member of the Lower Permian Succession.

Core was logged, photographed and split. Samples were taken at regular intervals through each two metre section in prospective rocks.

5.3.2 Drilling Results

Holes S1 of 57.2 metres and S2 of 209.74 metres were drilled in the Styx River Valley, at the locations indicated on Figure 2. Drill logs are in Appendix 1, graphic and geophysical logs are on Figures 3 and 4, and oil yield assay results are in Appendix 2.

a) Hole S1

This hole was drilled immediately north of the Styx River bridge, at the site of the original observation of petroliferous smelling siltstones. A thickness of 52.72 metres of siltstone, probably representing the lower quarter of the Woody Island Siltstone, was intersected before the drill passed into the underlying Wynyard Tillite.

The siltstone is dark grey/black, uniformly fine grained and massive, with common pyrite, rare sandy bands and irregularly distributed dropstones. The sediment is intensely fractured between 15.0 and 27.5 metres depth, possibly representing a fault breccia zone.

Oil yields are low, the highest value being 7 litres/tonne near the top of the drill hole. Gas plus loss values range up to 20kg/tonne. Between 33.0 and 37.8 metres (within 20 metres of the

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Woody Island Siltstone base), are present a number of bands of dark black to brown tinged siltstone having tiny (less than 1mm diameter) circular impressions on broken horizontal surfaces. This sediment is very similar to tasmanite oil shale and it is possible that the bands are correlates of the tasmanite oil shales found in Lower Permian units in northern Tasmania.

b) Hole S2

This hole was drilled south of the Styx River, adjacent to one of the lowermost Bundella Mudstone outcrops, in order to drill a complete section through the Woody Island Siltstone.

Approximately 195 metres of Woody Island Siltstone were drilled before the Wynyard Tillite was intersected at 208.63 metre depth. The siltstone is lithologically similar to that in S1. Minor pyrite is present throughout. Minor dropstones and rare sand bands also occur throughout, although they are more common in the upper half of the unit, above 105 metres. Rare leaf fossils are present, and minor brachipod, bryozoan and gastropod fossils occur in a few sandy and pebbly bands. No major fractured zones were encountered.

As in S1, a band of possible tasmanite shale occurs near the base of the Woody Island Siltstone, at 203.58 - 203.95 metres. The section assayed returned oil yield values in the range 0 to 6 litres/tonne and gas plus loss values in the range 2 to 40 kg/tonne.

6. CONCLUSIONS

Low oil yields, up to 7 litres/tonne, were obtained from samples of the Woody Island Siltstone intersected in the two boreholes. Bands of probable tasmanite oil shale were found near the base of the Woody Island Siltstone in a similar stratigraphic position to the higher yielding tasmanite shales of northern Tasmania.

It is considered unlikely that thick high grade oil shales are to be found in the Woody Island Siltstone of south-eastern Tasmania. However, the observed small oil content of the siltstone indicates that it could have served as an oil source rock in the past. The degree of uplift and erosion of the Permian rocks in the upper Styx River area is not particularly favourable with regard to the existence of oil traps in the area. However, the possible existence of fractured oil reservoirs has not yet been tested.

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The apparent absence of high yielding oil shale beds in the Woody Island Siltstone in the Styx River area may be related to the fact that it was deposited in a relatively deep marine trough in south-east Tasmania. The high yielding oil shales of northern Tasmania appear to have formed in shallow marine conditions adjacent to subaerially exposed basement ridges.

7. SUMMARY OF WORK IN PROGRESS

1. Evaluation of analytical and down hole logging data;

2. Petrological examination of core samples.

8. PROPOSED WORK

Evaluation of the potential of the Woody Island Siltstone as a petroleum source rock.

This report is submitted to the Mines Department as required by Schedule A of Exploration Licence 37/79.

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APPENDIX 1

Drill Logs

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HOLE NO: Styx No. 1 (S1)
LOCATION: Styx Road, 100m north of Styx River Bridge
DATE COMMENCED: 7.7.1981.
DATE COMPLETED: 9.7.1981.

DRILLED BY: Stacpoole Drillers
DRILLER: C. Jacobson

LOGGED BY: Chris Sharples

CO-ORDS 146°37'02"E 42°49'08"S

CASING: Collar (Steel)
DEPRESSION: Vertical
BEARING: -
RIG: Foxmobile Diamond Drill rig 8-40L

COLLAR R.L: 330m A.S.L.

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
0	3.0	3.0	SOIL/WEATHERED SEDIMENT - No recovery, but probably thin recent soil and weathered siltstone as below. Outcropping Siltstone beds are near horizontal.	Open holed
3.0	5.81	2.81	BLACK SILTSTONE - dark grey to nearly black massive finegrained well sorted siltstone. Glinting grains indicate minor (<5%?) mica (on pyrite?) content. No marked cleavage, but core generally breaks along flat to slightly uneven/hackly horizontal planes. Some breaks are at 45° to horizontal, however. Sediment strong, unfractured. Core broken at approx 0.18 - 0.7m intervals for the most part. Pyrite blebs up to 1.5mm diameter and stringers 1 - 10mm wide, of varying length and often parallel to bedding, consisting of fine dissemminated pyrite grains, make up 1 - 5% of the sediment. At 5.11 to 5.19m, 1-3mm black siltstone layers are interbedded with 3-10mm fine grey-white somewhat friable quartzose sandstone. Differential compaction has produced pronounced up-arching domal forms (approx 10mm diameter and 5-10mm amplitude) in both the siltstone and sandstone layers.	Coring from 3.0m down Pyrite
5.81	6.0	0.19	Core loss	
6.0	11.92	5.92	BLACK SILTSTONE - as at 3-5.81m. Pyrite minor (<1%). Rare well-rounded grey-white quartz pebbles 3-20mm diameter make up less than 1% of sediment. Minor black ?organic bodies (<1mm thick, 2-5mm long) dispersed through sediment (<5%).	Glacial dropstones
11.92	11.94	0.02	Core Loss	
11.94	15.0	3.06	BLACK SILTSTONE - as at 6-11.92m. Pyrite minor except for a few (<2% of total sediment) irregular to rounded pyrite nodules ~10mm diameter, and an unusual band at 14.33-14.42m, which consists of 80% finegrained pyrite with 20% wavy upwards-doming bands and lenses of siltstone 1-20mm thick. At 14.22 a slickenslide-like surface coated with a black shiny (carbonaceous?) brittle substance occurs. The grooves are not quite parallel, so perhaps this is a fossil?	Pyrite
15.0	20.0	5.0	BLACK SILTSTONE - As at 11.94-15.0m, with minor dropstones (quartz and ?quartzite) and minor pyrite nodules (<2%).	

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917015

HOLE NO: S1

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
			Fracturing becoming evident:- Siltstone breaks into smaller core lengths, commonly only 10-50mm lengths. Long subvertical breaks occur in 15-18m interval. At 17.15 - 17.45m, the siltstone is intensely fractured by sub-horizontal cracks 1 - 10mm apart vertically. Cracks are often lined with off-white ?carbonate material. Subvertical ?carbonate-lined fracture at 19.0 - 19.3m.	Fracturing (often sub-vertical) Intense fracture zone
20.0	20.75	0.75	BLACK SILTSTONE - siltstone as at 15-20m, with minor dropstones (often indicated by rounded holes in core) and pyrite rare to absent. Intensely fractured-core broken up into chips and lengths <100mm long. White ?carbonate material often lines cracks.	Intense fracture zone
20.75	21.0	0.25	Core loss	
21.0	24.0	3.0	BLACK SILTSTONE - As at 20.0 - 20.75m. Fractures run in all directions but notably get vertically oriented fractures up to 20 - 30mm wide containing breccia of angular to subangular siltstone fragments up to 30mm diameter, with finer fragments and off-white carbonate coatings.	
24.0	27.58	3.58	BLACK SILTSTONE - As at 20.0 - 20.75m, with rare (<1%) pyrite nodules up to 5mm diameter. Fracturing less intense - commonly get 200 - 400mm sections of unbroken core. Major sub-vertical fracture extends from 24.3 - 25.55m - thin with ?carbonate infilling and ?brecciated pyrite nodules in places. Intense fracturing at 26.3 - 26.37m and at 27.03 - 27.24m.	Fracturing (often subvertical)
27.58	33.0	5.42	BLACK SILTSTONE - As at 20.0 - 20.75m, fracturing minor to absent, pyrite minor to absent, subrounded dropstones 1mm to approx 40mm diameter present (~2-5%). Dropstones mainly white-grey quartzites (some pyritic). Some banding becoming evident in the siltstones (lighter & darker dark grey layers.) Bands usually 1-10mm thick, "wispy" and lensing, often indistinct. Some bands in 30 - 32m interval have a brownish tinge - more carbonaceous rich? At 32.33 - 32.36m, band containing 70% white and pale green subrounded quartzite dropstones up to 20mm diameter.	Indistinct Banding Pebble band
33.0	37.8	4.8	BLACK/BROWN SILTSTONE - dark grey/black (tinge of brown) finegrained siltstone, pyrite very minor (<1%), white quartzite dropstones minor (1-2%). Indistinct lenses 10-20mm thick of grey/black siltstone without brown tinge make up approx 5% of unit, plus a band at approx 34.8 - 36.4m. Brown tinge due to increased carbonaceous content? Indistinct circular impressions <1mm diameter on horizontal broken surfaces - Tasmanites algae fossils?	Core loss at 35.09 - 36.0m Organic rich siltstone?
37.8	41.67	3.87	BLACK SILTSTONE - dark grey/black finegrained siltstone with 2-5% subrounded - rounded white/grey quartzite dropstones 1-30mm diameter. Pyrite trace only. No apparent	Indistinct Transition

HOLE NO: S1

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
			banding or layering, unit unfractured except for one long subvertical fracture from 37.3 - 38.78m (partly in previous unit) At 40.81 - 40.85m get horizontal interlaminae (60% of sediment) of white quartzose fine to medium sandstone with horizontal lenses up to 6mm thick of pyrite (10% of interval).	
41.67	52.72	11.05	PEBBLY BLACK SILTSTONE - dark grey/black finegrained massive siltstone with 10-20% subrounded to rounded white and grey/green quartzite dropstones 1-100mm diameter. Pyrite present (<5%) as small nodules <5mm diameter, and as concentric growths around dropstone Nuclei. (Good example at 44.38m) Minor pale grey/brown siltstone beds at 50.35m and 51.28 - 51.37m. Bottom 0.3m of unit has <2% dropstones, but shows indistinct subhorizontal banding (caused by 2-10mm bands containing pale sandsize clasts) and has approx. 2% lenticular pale brown siltstone pods (~1x4mm) elongated along bedding	Core less at 44.93-45.0m Woody Island Siltstone
			Sharp Transition	
52.72	57.21	4.49	TILLITE - dark grey/black siltstone matrix with 40% angular to rounded dropstones 0.5 - 100mmdiameter. (Open frame fabric). Dropstones mostly fine/medium grained grey/white quartzites. Minor shales, granites(?), Conglomerates also present. Pyrite trace or absent, no fracturing.	Wynyard Tillite
57.21			END OF HOLE	
			Hole flowing significant quantity of water, probably mostly from fracture zone at 20 metres.	

CONTENTS

FIGURES

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HOLE NO:	Styx No. 2 (S2)	CO-ORDS	146°37'29"E 42°50'33"S
LOCATION:	Waterfall Creek Road, South side of Styx R. Valley	CASING:	Steel 0-27m
DATE COMMENCED:	10.7.1981	DEPRESSION:	Vertical
DATE COMPLETED:	26.7.1981.	BEARING:	-
		RIG:	Foxmobile B40L Diamond Drill
DRILLED BY:	Stacpoole Drillers		
DRILLER:	C. Jacobson	COLLAR R.L:	520m A.S.L.
LOGGED BY:	Chris Sharples		

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
			Outcrops of Bundella Mudstone at the drillsite dip 3° towards the north-northeast.	
0	27.0	27.0	Open Hole drilled. No samples retained, but material drilled was weathered yellow-brown and grey fossiliferous sands and muds. Probably this interval represents the Bundella Mudstone and the top of the Woody Island Siltstone. Previous field work suggests the "Fossiliferous Siltstone" and "Darlington Limestone" may be absent at this locality.	
27.0	35.45	8.45	PEBBLY FOSSILIFEROUS SILTSTONE - dark grey finegrained siltstone with approx 5% fine mica specs and 5-20% small 0.5-2mm diameter rounded quartz clasts (dropstones?) Large Spiriferid Brachiopods and minor bryozoans constitute approx 2-5% of the unit, commonly being slightly concentrated in bands 200-300mm thick. In several cases, cavities with yellow limonite stained surfaces have been weathered out of fossiliferous bands. Rounded - subrounded grey/white quartzite pebbles 2-30mm diameter constitute 5% of the unit, also being most common in a few 100-200mm thick bands (not the same bands that fossils are common in). Bedding is not evident and the rock is unfractured, apart from 3 tight fractures at 60° to the horizontal, at 32.5, 33.3 and 34.5m.	NEARLY A GREYWACKE IN PLACES
35.45	50.97	15.52	PEBBLY SILTSTONE - Similar to above unit, but fossils rare. - dark grey-black fine siltstone with approx 5% fine mica specs and generally 5-10% sandsize quartz clasts (except at 36.38 - 37.0m, 43.1 - 43.34, 46.28 - 46.43, where poorly sorted rounded - subangular quartz sand-size clasts constitute 40-50% of sediment, making it a greywacke). Rounded-subrounded dropstones (usually grey/white quartzite, minor pale green or black shaly dropstones) up to 40mm diameter (usually approx 10-20mm diameter) occur dispersed in unit, or concentrated in bands up to 100mm thick (44.47 - 44.57m, 48.7 - 48.9m, 48.94m, 49.12m, 50.15m) Dropstones = 2-5% of unit. Rare dispersed Brachipod fragments present, and trace pyrite stringers. At bottom 100mm of unit, get white (clay or fine sand?) blebs and stringers elongated at approx 40° to horizontal - too steep to be bedding.	GREYWACKE BANDS

HOLE NO: S2

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
			Bottom of unit marked by white carbonate coated slickenslide parallel to above stringers.	
50.97	51.4	0.43	PEBBLY GREYWACKE - dark grey-black siltstone with 2-5% fine mica and 10-20% subrounded-subangular quartz grains 0.5-4mm diameter. Minor Brachiopod and Bryozoan fossils, and 10-20% rounded dropstone pebbles 10-30mm diameter (mainly quartzite, also shales and medium/coarse ?gra-nites) Thin anastomosing fractures occur, at about 60° to the horizontal. Minor irregular black-organic? - stringers. Sediment grades down into next unit:-	MINOR FRACTURES
51.4	59.9	8.5	BLACK SILTSTONE - dark grey-black finegrained massive siltstone with minor fine mica specs and 0-2% rounded sandsize quartz clasts. Fossils trace only usually fragments. Rounded grey-white and pale green quartzite dropstones 10-20mm (rarely approx 50mm) diameter present:- usually dispersed, constituting approx 2% of unit, but concentrated in bands at 51.75 - 51.85m, 53.58 - 53.66m, 54.76 - 54.79m 54.99 - 55.04m. Overall pebble content decreasing downwards.	PEBBLE CONTENT MINOR AND DECREASING DOWN.
			Occasional clean calcite-filled (~1mm thick) fractures present:- at approx 30° to horizontal at 54.32m, and at 60-70° to horizontal at 51.5 - 51.6m, 55.96-56.15m, 56.21 - 56.6m, 56.9 - 57.035m and 60.38 - 60.65m (in next unit)	MINOR FRACTURES
			Horizontally broken surfaces flat to slightly rough, sometimes with vague suggestions of circular bodies <1mm diameter -? Tasmanites alga?	??TASMANITES?
59.9	62.8	2.9	PYRITIC FOSSILIFEROUS BLACK SILTSTONE - Most of unit is grey-black siltstone as at 51.4 - 59.9, with only trace pebbles or sand-size clasts, and no fossils. However 3 bands (59.9 - 60.24m, 62.5 - 62.66m, 62.75 - 62.80m) contain 10-15% fossils (Brachiopods, Fenestella, other Bryozoans), 5-10% rounded quartzite dropstones up to 10mm diameter, and 10% Blebs and stringers up to 10mm thick of pyrite.	FOSSIL PYRITE
62.8	83.0	20.2	BLACK SILTSTONE - dark grey-black finegrained massive siltstone with <5% fine mica. Sandsize grains trace or absent, dropstones minor (<2%), fossils trace or absent, fractures absent. Common pyrite blebs and nodules up to 15x30mm, oriented sub-horizontally. (2-5% of sediment, less common below 67m, but often large where present, eg, 40mm diameter at 77m) Minor sand and 10% dropstones at 67.7 - 68m, and minor sand at 73 - 73.25m. At 78.09 - 78.11, thin dropstone band, with sand for 100mm above that (ie, fining up dropstone band) One pyrite-pseudomorphed Brachiopod shell at 76.09m and one Fenestella fossil at 82.8m.	PYRITE RARE FOSSILS
83.0	93.0	10.0	BLACK SILTSTONE - dark grey/black siltstone as at 62.8 - 83.0m, with trace only dropstones, and pyrite rare or absent.	NO VISIBLE BOUNDARY
			Sandy (greywacke) bands with quartzite pebbles (approx	

HOLE NO: S2

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
			10mm diameter) at 85.23 - 85.34m (including shell fossil), 89.13 - 89.37m (including 50mm grey/pale green moderately well sorted fine to medium sand band), and 91.9-92.1m	GREYWACKE BANDS
93.0	98.0	5.0	BLACK SILTSTONE - Siltstone as at 83-93m, with minor (~ <1%) Pyrite nodules up to 10mm diameter. Dropstones present (1-2%), scattered throughout, mainly quartzite, some shale and ?granite. One brachiopod fossil at 95.73m.	NO VISIBLE BOUNDARY PYRITE
			Fine/medium moderately sorted grey quartzose sand band with 5-10% fossils (mostly gastropods) at 97.77 - 97.85m. Tight calcite and pyrite - lined fractures angled approx 70% to horizontal, at 97.3 - 97.4m and 97.64 - 97.76m.	FOSSIL-IFEROUS SAND BAND
98.0	123.0	25.0	BLACK SILTSTONE - As at 93 - 98.0, except no pyrite visible. Approx 110mm diameter subrounded dropstone of intensely vien-fractured ?Dolomite at 99.83 - 99.94m.	NO VISIBLE BOUNDARY
			Band with minor sand content (and 10-20% dropstones in bottom part) at 102.8 - 102.98m. Unidentified finely ribbed sheet-like fossil present in this interval. (Leaf-Gangomopteris?). 1-2% dropstones elsewhere in unit.	LEAF FOSSIL
			Approx 50 % of the dropstones are subangular to sub-rounded pale to dark-brown medium grained crystalline ?igneous? (Ultrabasic or carbonate?) rocks?) Clasts up to 80mm diameter. The remaining dropstones are the usual grey/white quartzites.	?ULTRABASIC DROPSTONES (or carbonate?)
			Dropstones <1% of unit below 103.5m. At 114.73 - 114.84m, angular to rounded holes 1-2mm diameter indicate weathering out of soluble mineral (dropstone grains?)	
			Subvertical fracture at 119.2 - 119.67m. ?Leaf fossil occurs at 121.24m, in otherwise featureless siltstone. Fossil is well preserved, unbroken, shows branching veins on leaf surface. Petroliferous smell when broken at this horizon.	LEAF FOSSIL GANGAMO-PTERIS?
123.0	170.0	47.0	BLACK SILTSTONE - dark grey-black massive siltstone as at 98-123m, with <1% dropstones. Minor (<1-5%) pyrite present as thin stringers and nodules. Large (~80mm diameter) pyrite nodule at 125.38 - 125.46m, broken by fine ?quartz veins. Pyrite has grown as a rim around grey oolitic limestone clast (broken by fine veins) at 130.25m.	NO VISIBLE BOUNDARY DISTINCT PETROLI-FEROUS SMELL FROM BROKEN SURFACES
			One shell fossil fragment at 129.82m	
			Thin fractures (~60-70° to horizontal) at 128.1 - 128.3m, and at 129.26 - 129.6m, 135.75 - 135.95m, 153.5 - 153.66m.	
			Greywacke band (no pebbles) at 133.88 - 133.92m. Small pebble band at 139.97m.	DRILLING BECOMING VERY HARD BELOW 150 METRES.
			Tight near-vertical fracture at 159.15 - 159.42m. Pyrite content up to approx 5% at 160 - 170m, minor content of yellow/copper coloured metallic mineral (pyrite or chalcopyrite?).	
170.0	194.0	24.0	BLACK SILTSTONE - siltstone as at 123 - 170m. Dropstones	

HOLE NO: S2

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	DESCRIPTION	COMMENTS
			rare:- <1%. Pyrite rare, except for a couple of large bands and nodules up to 30mm diameter. At 193.75, an angular irregular body up to 40mm long and 10mm thick of white (poorly sorted, coarse, subrounded) sandstone occurs.	DRILLING WITH OILS BELOW 171m. CORE LOSSES AT:- 185.16 - 186.0m 187.56 - 189.00m 191.76 - 192.0m
194.0	203.2	9.2	BLACK SILTSTONE - Siltstone as at 170 - 194. Pyrite content minor (<1%, as small 5-10mm diameter nodules). Dropstones (sizes from sand grade up to 40mm diameter pebbles, mainly white quartzite) present, content increasing down from approx 2% at 194m to 5-10% at 203.2m. Dropstones well rounded.	
203.2	208.63	5.43	PEBBLY BLACK SILTSTONE - siltstone as at 194-203.2m, with 5-40% sand-pebble size dropstones dispersed throughout (rounded, mainly quartzite, with minor granite and shale seen). Sometimes pebbles occur in bands 50-100mm thick.	DROPSTONES COMMON
			At 203.58 - 203.95m, get a brown band with abundant ~1mm diameter circular impressions on broken surfaces - Tasmanites algae? Broken surfaces in this band often have shiny black vitrinite - like appearance.	TASMANITES? BAND
			At 204.21 - 204.34m, 70% of unit is pale grey sandy siltstone laminae showing contorted bedding. Minor pyrite - mainly as small irregular nodules - is present.	CONTORTED SANDY BED.
208.63	209.74	1.11	PEBBLY BLACK SILTSTONE/TILLITE - As at 203.2 - 208.63mm with 10 - 60% dropstones. Academic question as to whether this is top of Wynyard Tillite or bottom of *Woody Island Siltstone*.	
209.74			END OF HOLE.	

APPENDIX 2

Oil Yield Assay Results

APPENDIX TWO

Oil Yield Assay Results

Analysis was performed by Australian Laboratory Services Pty. Ltd. (Woolloongabba, Queensland) using a modified Fischer Technique (ASTM D 3904 Modified).

Samples are specified in terms of drill-hole and depth interval (metres). Oil and water yields are quoted in litres/tonne, while gas + loss and residue are quoted in kilograms/tonne. Specific gravity of the oil obtained is given.

The accuracy of Fischer Analysis on such low oil-yielding rocks is clearly not high as is indicated by the oil yields from samples S1 21.0 - 23.1m A and B; although both samples came from throughout the same two metre interval, their reported oil yields differ by four litres/tonne - a significant figure when the higher of the two yields is only six litres/tonne!

SAMPLE NO.	OIL YIELD l/tonne	OIL S.G.	WATER YIELD l/tonne	GAS + LOSS kg/tonne	RESIDUE kg/tonne
S1 3.0-4.95m	7	.920	15	10	969
S1 4.95-7.0m	3	.920	13	16	969
S1 7.0-9.0m	2	.920	12	8	979
S1 9.0-10.97m	4	.920	16	13	968
S1 10.97-13.04m	3	.920	17	12	969
S1 13.04-15.0m	3	.920	17	10	971
S1 15.0-17.02m	4	.920	18	10	969
S1 17.02-19.0m	2	.920	28	9	962
S1 19.0-21.0m	2	.920	20	12	967
S1 21.0-23.1m A	6	.920	25	14	956
S1 21.0-23.1m B	2	.920	27	14	958
S1 23.1-25.0m	0	.920	23	11	966
S1 25.0-27.03m	0	.920	20	14	966
S1 27.03-29.03m	2	.920	12	14	973
S1 29.03-31.01m	2	.920	15	9	975
S1 31.01-32.99m	4	.920	11	11	975
S1 32.99-35.09m	6	.920	12	20	963
S1 35.09-37.0m	5	.920	11	8	977
S1 37.0-39.06m	2	.920	15	6	978
S1 39.06-41.09m	0	.920	15	7	978
S1 41.09-42.97m	1	.920	12	11	977
S1 42.97-45.0m	1	.920	8	9	983
S1 45.0-47.0m	1	.920	10	10	980
S1 47.0-48.88m	2	.920	8	12	979
S1 48.88-51.09m	1	.920	8	11	981
S1 51.09-53.05m	3	.920	7	18	973
S1 53.05-55.03m	2	.920	7	7	985
S1 55.03-57.21m	2	.920	6	13	980
S2 27.0-29.0	3	.920	7	18	973
S2 29.0-31.0	1	.920	8	15	977
S2 31.0-33.0	2	.920	13	23	963
S2 33.0-35.0	1	.920	10	27	963
S2 35.0-37.0	0	.920	13	15	972
S2 37.0-39.0	2	.920	10	10	979
S2 39.0-41.0	0	.920	10	9	981
S2 41.0-43.0	2	.920	10	5	984
S2 43.0-45.0	2	.920	10	6	983
S2 45.0-47.0	3	.920	8	16	974
S2 47.0-49.0	1	.920	10	9	981
S2 49.0-51.0	1	.920	10	11	979
S2 51.0-53.0	2	.920	8	7	984
S2 53.0-55.0	2	.920	7	16	976
S2 55.0-57.0	0	.920	8	14	978
S2 57.0-59.0	0	.920	10	15	975
S2 59.0-61.0	4	.920	10	14	973
S2 61.0-63.0	1	.920	7	38	955
S2 63.0-65.0	0	.920	7	6	987
S2 65.0-67.0	1	.920	7	13	980
S2 67.0-69.0	2	.920	7	24	968
S2 69.0-71.0	0	.920	10	2	988
S2 71.0-73.0	0	.920	10	12	978

k - Kilograms
l - Litres
m - Metres

SAMPLE NO.	OIL YIELD l/tonne	OIL S.G.	WATER YIELD l/tonne	GAS + LOSS kg/tonne	RESIDUE kg/tonne
S2 73.0-75.0	1	.920	7	10	983
S2 75.0-77.0	2	.920	8	9	982
S2 77.0-79.0	1	.920	7	7	986
S2 79.0-81.0	3	.920	8	10	980
S2 81.0-83.0	4	.920	8	4	985
S2 83.0-85.0	1	.920	7	8	985
S2 85.0-87.0	0	.920	10	11	979
S2 87.0-89.0	3	.920	8	8	982
S2 89.0-91.0	3	.920	7	14	977
S2 91.0-93.0	2	.920	8	10	981
S2 93.0-95.0	1	.920	10	4	986
S2 95.0-97.0	5	.920	7	4	985
S2 97.0-99.0	3	.920	8	7	983
S2 99.0-101.0	2	.920	8	7	984
S2 101.0-103.0	2	.920	10	7	982
S2 103.0-105.0	0	.920	8	4	988
S2 105.0-107.0	6	.920	8	4	983
S2 107.0-109.0	2	.920	6	6	987
S2 109.0-111.0	1	.920	7	11	982
S2 111.0-113.0	2	.920	7	15	977
S2 113.0-115.0	2	.920	8	15	976
S2 115.0-117.0	0	.920	8	14	978
S2 117.0-119.0	3	.920	6	11	981
S2 119.0-121.0	1	.920	8	17	975
S2 121.0-123.0	1	.920	7	28	965
S2 123.0-125.0	0	.920	7	8	985
S2 125.0-127.0	0	.920	6	19	975
S2 127.0-129.0	0	.920	6	37	957
S2 129.0-131.0	1	.920	6	22	972
S2 131.0-133.0	0	.920	7	20	973
S2 133.0-135.0	2	.920	7	40	952
S2 135.0-137.0	3	.920	6	35	957
S2 137.0-139.0	5	.920	6	30	960
S2 139.0-141.0	1	.920	7	18	975
S2 141.0-143.0	3	.920	8	7	983
S2 143.0-145.0	1	.920	8	16	976
S2 145.0-147.0	1	.920	7	12	981
S2 147.0-149.0	1	.920	7	12	981
S2 149.0-151.0	2	.920	7	24	968
S2 151.0-153.0	3	.920	8	10	980
S2 153.0-155.0	2	.920	11	8	980
S2 155.0-157.0	1	.920	8	19	973
S2 157.0-159.0	1	.920	16	6	978
S2 159.0-161.0	2	.920	8	9	982
S2 161.0-163.0	1	.920	7	10	983
S2 163.0-165.0	0	.920	7	16	977
S2 165.0-167.0	2	.920	7	20	972
S2 167.0-169.0	3	.920	8	12	978
S2 169.0-171.0	2	.920	8	10	981
S2 171.0-173.0	1	.920	8	14	978
S2 173.0-175.0	2	.920	6	11	982
S2 175.0-177.0	1	.920	10	15	975

SAMPLE NO.	OIL YIELD l/tonne	OIL S.G.	WATER YIELD l/tonne	GAS + LOSS kg/tonne	RESIDUE kg/tonne
S2 177.0-179.0	2	.920	7	9	983
S2 179.0-181.0	1	.920	6	8	986
S2 181.0-183.0	1	.920	5	5	990
S2 183.0-185.0	0	.920	6	7	987
S2 185.0-187.0	2	.920	7	5	987
S2 187.0-189.0	0	.920	7	3	990
S2 189.0-191.0	0	.920	7	3	990
S2 191.0-193.0	2	.920	8	4	987
S2 193.0-195.0	1	.920	8	2	990
S2 195.0-197.0	0	.920	7	15	978
S2 197.0-199.0	1	.920	8	5	987
S2 199.0-201.0	1	.920	7	2	991
S2 201.0-203.0	3	.920	6	2	990
S2 203.0-205.0	2	.920	7	5	987
S2 205.0-207.0	1	.920	7	3	990
S2 207.0-209.0	1	.920	7	2	991
S2 209.0-211.0	0	.920	7	6	987

028

917027

Australian Laboratory Services PTY. LTD.

CONSULTING CHEMISTS & ANALYSTS

OIL SHALE ASSAY REPORT

OFFICE & LABORATORY
44 BALACLAVA ST.,
WOOLLOONGABBA 4102
Phone (07) 391 6799 A/H 355 0776
TELEX ALSEV42344

BATCH No.: S120-79 CLIENT: B.H.P. CO. LTD.

ORDER No.: 000606 AREA: TASMANIA DATE REC'D: 20.11.79

SAMPLE TYPE: ROCK No.: 7 DATE COMP'D: 22.11.79

ATTENTION: DR. R. HINE

SAMPLE NO.	OIL YIELD gal/ton	OIL S.G.	WATER YIELD gal/ton	GAS + LOSS lbs/ton	RESIDUE lbs/ton		V_2O_5 Wt. %
051	0.7		3.1		1968		
052	0.8		2.8		1974		
053	0.7		3.3		1972		
054	0.4		3.3		1968		
055	0.2		3.3		1978		
056	0.1		3.2		1968		
057	0.9		2.3		1972		

1 gal = 4.55 l

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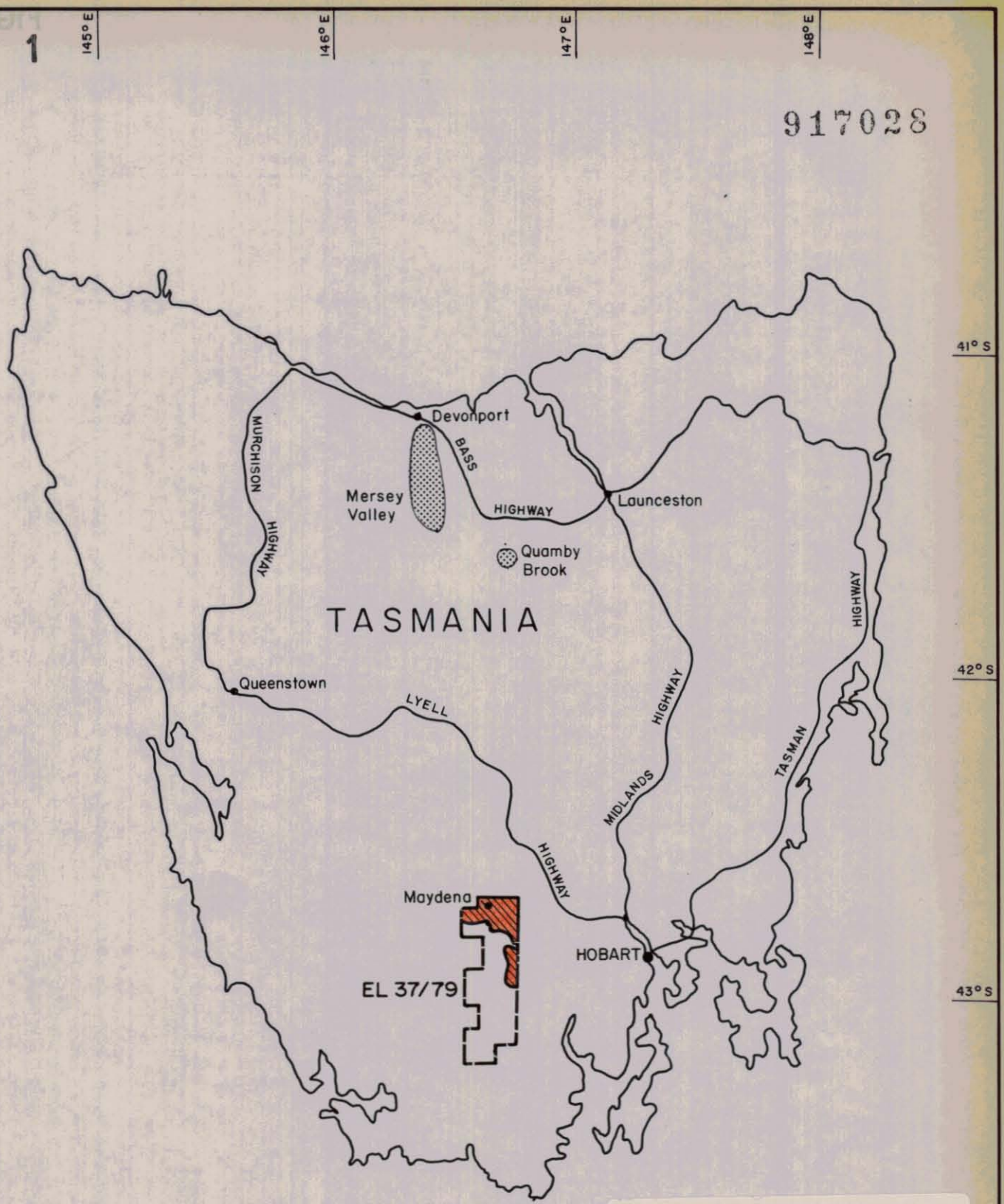
METHODS: U.S. BUREAU OF MINES: ISO 647-1974.

Signatory G. Lawn

003

FIG. 1

917028



Centre: Melbourne	THE BROKEN HILL PROPRIETARY CO. LTD. EL 37/79, STYX RIVER AREA S.W. TASMANIA LOCALITY MAP	Drawing No: A4-2264
Date: OCT 1981		Project Plan No: C 360-2

E.L. 37/79

146° 30'E.

146° 50'E.

42° 45'S

43° 00'S

52 60 000 m N

52 50 000 m N

52 40 000 m N

52 30 000 m N

52 20 000 m N

470 000 m E

LOCALITY MAP

E.L. 37/79

STYX RIVER AREA

0 20 40 60 80 100 Kms

Devonport

Launceston

Queenstown

Maydena

HOBART

41°

42°

43°S

LEGEND

pCq	PreCambrian Quartzite
pCd	PreCambrian Dolomite
?pCf	PreCambrian ferruginous sandstone and siltstone
Ogl	Ordovician Gordon Limestone
Pt	Permo - Carboniferous Wynyard Tillite
Pw	Permian Woody Island Siltstone
Ps,Pd	Permian "Fossiliferous Siltstone" and Darlington Limestone
Pb	Permian Bundella Mudstone
Pm	Permian Mersey Group
Pc	Permian Cascades Group
Pml	Permian Malbina Sandstone and Siltstone
Pf	Permian Ferntree Mudstone
Pu	Permian undifferentiated
Puu	Upper Permian undifferentiated (Pc, Pml, Pf)
Ru	Triassic undifferentiated
Jdl	Jurassic dolerite
Qdl	Quaternary dolerite talus

Stratigraphic and Intrusive Contacts

Boundary or unconformity

- located or inferred from closely spaced outcrops
- based on air photo interpretation
- inferred
- guessed only
- based on Jago (1972)

Attitude of beds

+ ↘ Dips measured during present work ; horizontal , dipping and striking as indicated

Faulting

- Fault inferred from outcrops
- Fault based on air photo interpretation
- Fault based on Jago (1972)
- Normal fault , downthrown block indicated
- Reverse or thrust fault, upper plate indicated
- Transverse movement on fault , sense of movement

S2. Diamond drill hole.

EL 37/79 Application area

EL 37/79 area granted

Scale 1:100 000

0 1 2 3 4 5 6 Km

5 cm

THE BROKEN HILL PROPRIETARY Co Ltd
EXPLORATION DEPARTMENT

EL 37/79, STYX RIVER AREA
S.W. TASMANIA

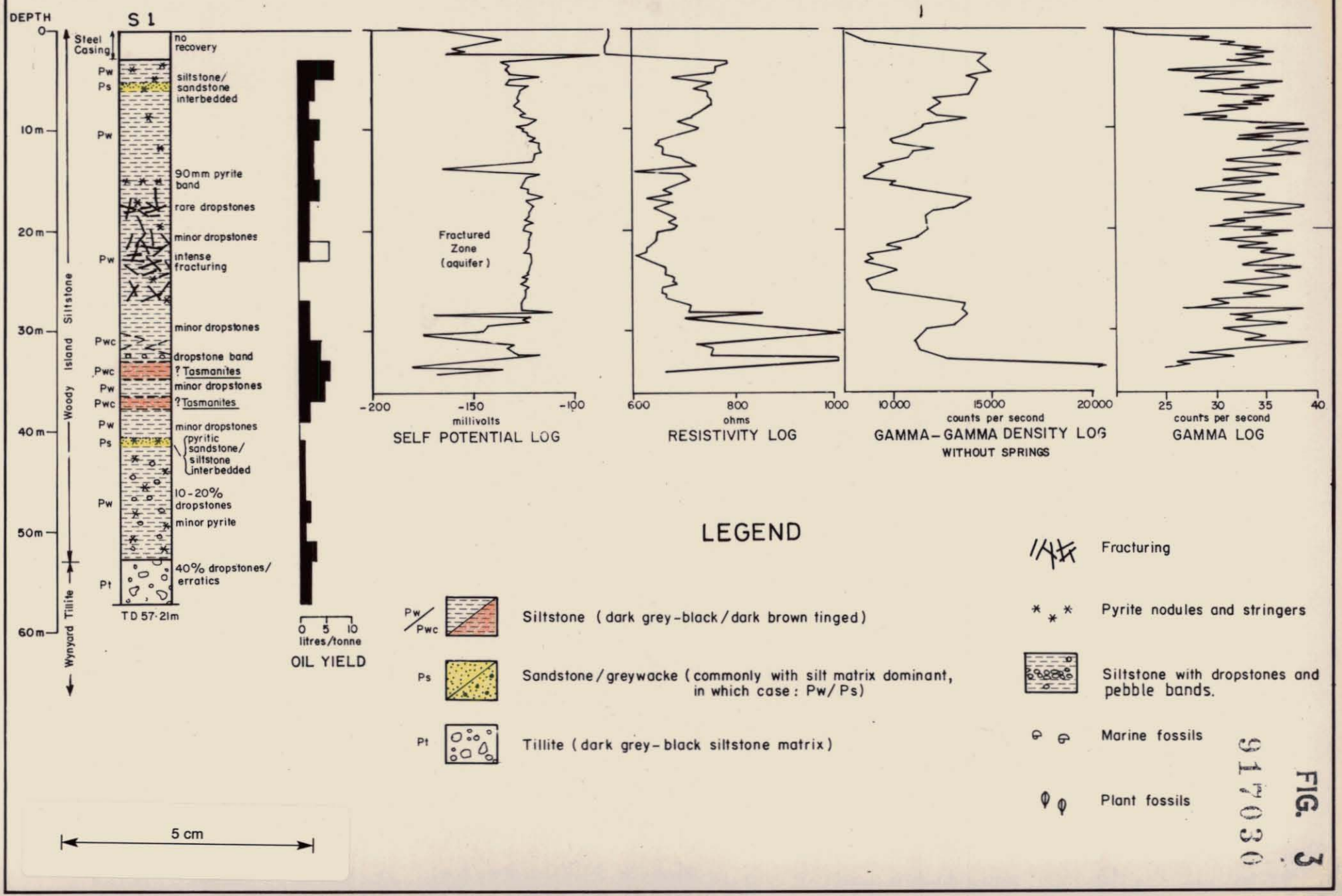
GEOLOGY AND DRILLING

Scale 1:50000 | Date OCT 1981 | Centre Melbourne
Drawing No. A2-1393 | Project Prior No. C360-5
Drawn
Checked
O.I.C.

81-1657. FIGURE 2.

3032

9117029



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EL 37/79, STYX RIVER AREA

S.W. TASMANIA

GRAPHIC AND GEOPHYSICAL LOG - S1

FIG. 3

Centre: Melbourne

Date: OCT 1981

Drawing No: A4-2266

Project Plan No: C 360-3

S 2

DEPTH

Steel Casing

no recovery

fossils, pebble bands weathering evident minor fracturing

trace fossils and trace pyrite

minor fracturing

? Tasmanites algae ?

3 bands containing dropstones (Brachiopods, Bryozoans) and pyrite

pyrite nodules

minor pyrite and dropstones

minor fractures

Gastropods

minor dropstones

leaf fossil

trace dropstones only

fracture

leaf fossil

minor fractures

minor pyrite

0·04m Greywacke band

fracture

Pebble band

minor pyrite

fracture

fracture

common pyrite

pyrite rare

minor pyrite

dropstones increasing downwards

? Tasmanites band

sandy band

TD 209·74m

Woody Island Silstone

Wynyard Tillite

OIL YIELD litres/tonne

GAMMA LOG counts per second

SELF POTENTIAL LOG millivolts

GAMMA–GAMMA DENSITY LOG counts per second x 1000

Logged without springs

DENSITY LOG INTERPRETATION

BUNDELLA MUDSTONE

? FOSSILIFEROUS SILTSTONE ?

WOODY ISLAND SILTSTONE ?

SANDY SILTSTONE

NON-SANDY SILTSTONE

LEGEND

- Pw / Pwc — Siltstone (dark grey-black / dark brown tinged)
- Ps — Sandstone / greywacke (commonly with silt matrix dominant, in which case: Pw/Ps)
- Pt — Tillite (dark grey-black siltstone matrix)
- Fracturing
- Pyrite nodules and stringers
- Siltstone with dropstones and pebble bands.
- Marine fossils
- Plant fossils

5 cm

THE BROKEN HILL PROPRIETARY Co Ltd
EXPLORATION DEPARTMENT

EL 37/79, STYX RIVER AREA
S.W. TASMANIA
GRAPHIC AND GEOPHYSICAL LOG - S2

Scale. As shown | Date. OCT 1981 | Centre. Melbourne
Drawn. C.S.
Checked.
O.I.C.
Drawing No A2-1392
Project Plan No C 360-4

81-1657

3033

9170311

FIG. 4