# LAKES OIL N.L.

(A.C.N. 004 247 214)

## GEOLOGICAL AND GEOPHYSICAL REVIEW OF PEP 158 ONSHORE GIPPSLAND BASIN VICTORIA



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## INTRODUCTION

A thorough review of both the well and seismic data base of PEP 158 was conducted during 2002/2003. Coal exploration well bore data was also incorporated into this study. Several wells in the permit have encountered residual oil columns hence a hydrocarbon charge has passed through portion of the block. Several prospects have been identified from seismic and sub-surface data. Infill seismic acquisition is required to evaluate these prospects and leads. The outcome is this work has been to highlight two areas of the permit for further work, namely the southeast and north of the permit.

## THE RESULTS OF DRILLING WITHIN PEP 158

A total of 18 wells have been drilled for the purposes of petroleum exploration in the onshore sector of the Gippsland Basin in PEP 158. Four of these wells were really scout wells. Reports of minor oil shows are recorded from several of these wells, particularly the wells drilled by Woodside in the Woodside area. These wells are listed in Table 1.

### Darriman-1 well

The first well drilled in the permit was **Darriman-1** which was spudded by the Frome-Lakes consortium in 1955 in the Darriman area approximately 17 kms southwest of the Seaspray township. The well was sited on the regional Darriman Anticline by gravity work and a rudimentary seismic survey.

The objective of the well was to test the oil possibilities of the marine Tertiary and Upper Jurassic. The oil source for the play was the postulated marine Devonian rocks, which are present in outcrop in the Victorian Alps but have never been intersected by drilling in the Gippsland Basin. No reports of hydrocarbons are noted and no tests were conducted. Subsequent seismic mapping by Crusader shows that the well, whilst high on the structure, is off the absolute crest of the Darriman Anticline. Crusader later tested another, but structurally lower, culmination of Darriman Anticline with the **Wonga Binda-1** well, which will be discussed later.

The well was drilled to a total depth of 1445.5 metres into the Strzelecki Formation after penetrating through some 1290.8 metres of Tertiary section, of which 775.7 metres was Latrobe Group, and the remaining 149.7 metres was Strzelecki Group.

The Darriman Anticline, the northern edge of which is bound by the high angle reversed Darriman Fault, forms the southern truncation edge of the Seaspray Depression and the southern boundary of a potentially large stratigraphic trap in the Golden Beach Group, within the Seaspray Depression. It is important to not that no Golden Beach Group section is present at Darriman-1.

**Woodside-1 Well**

The first of the Woodside's wells drilled in the onshore Gippsland Basin was **Woodside-1** which was spudded in September 1955 in the foreshore of the Ninety Mile Beach at Woodside, approximately 20 kilometres south of **Darriman-1**. The well was located without seismic surveying.

Many reports of minor hydrocarbon shows are noted in this well ranging from the Gippsland Limestone, Giffard Sandstone and Latrobe Group to the Strzelecki Group. Gas shows were recorded from the Strzelecki Group section as well as from the Gippsland Limestone and Giffard Sandstone. Many reports of oil shows including minor recoveries of oil scums are reported from the Latrobe Group and to a lesser extent from the Strzelecki Group. Subsequent mapping of seismic data acquired by Crusader show that the well did not test a structural trap.

Woodside-1 was drilled to a total depth of 1831.5 metres in the Strzelecki Group after passing through some 1199.4 metres Tertiary section of which 128.6 metres consisted of the Latrobe Group. The Latrobe Group thins rapidly, south of the Darriman Anticline on the Southern Strzelecki Terrace and Southern Platform of the basin.

**Woddside-2**

Woodside followed this well up with **Woodside-2** another well on the foreshore of the Ninety Mile Beach some 5 kilometres southwest of Woodside-1. This well like its immediate predecessor is reported to have encountered many hydrocarbon shows, right through the section.

Oil and oil staining with occasional gas shows are reported from the Gippsland Limestone, the Giffard Sandstone Member of the Lakes Entrance Formation, from the Latrobe Group and the Strzelecki Group. An oil sample from the Strzelecki Group was analysed by the Victorian Government Analyst. The well does not appear to have been tested and was left cased and suspended at a depth of 1861.7 metres whilst Woodside drilled the twin well **Woodside-3** at the request of the Victorian Department of Minerals and Energy to follow up these shows. Woodside did not test the well after it reached its final depth because during the hiatus whilst **Woodside-3** was being drilled and before **Woodside-2** reached its final total depth of 2701.1 metres "water entered the formations". Lighter pipe was used in the second phase of drilling of **Woodside-2** to reach the deeper final depth.

**Woodside-2** was drilled without seismic surveying and the mapping of subsequently acquired seismic data shows that the well did not test a structural trap.

**Woodside-3**

The third well drilled by Woodside was also spudded in 1956 when Woodside at the request of the Victorian Department of Minerals and Energy spudded **Woodside-3** as a twin of Woodside-2 to follow up the encouraging hydrocarbon, particularly oil shows in **Woodside-2**.

No hydrocarbon shows are reported in this well which reached a total depth of 1824.2 metres in the Strzelecki Group, after drilling through some 1064.6 metres of Tertiary section and some 759.6 metres of Strzelecki Group. The Top of the Latrobe Group was encountered at an unknown depth in this well of which little data is available, however Latrobe Group section is present. In a similar vein to the previous well **Woodside-3** did not test a structural trap.

**Woodside-4**

Woodside's fourth well **Woodside-4** was also spudded in late 1956 but was plugged and abandoned in 1957. It was drilled on a island extension of the Ninety Mile Beach east of Port Albert some 6.5 kilometres southwest of the **Woodside-2 and 3** cluster of wells. No hydrocarbons are reported from this well which was also drilled without seismic surveying. The well reached a total depth of 821.1 metres probably in the Latrobe Group the top of which occurred at 702.3 metres. Little data is available for this well.

**Gippsland-1/1A**

The Frome-Lakes group also conducted another scout drilling program in the Woodside area and in the Bairnsdale area north of the permit in 1956/1957. The first of these wells **Gippsland-1/1A** was spudded in Balloong Parish, 5.6 kilometres southeast of Woodside. The well, located without seismic surveying reached a total depth of 596.8 metres in the Upper Latrobe Group sequence, the top of which was encountered at 590.4 metres. No indications of hydrocarbons are reported.

**Gippsland-2**

The same group spudded Gippsland-2 in November 1956 in the Parish of Tarra some 4.0 kilometres east of Tarraville. This scout well which was located without seismic surveying reached its total depth of 477.6 metres in the Upper Latrobe Group sequence, the top of which was encountered at 476.1 metres. No indications of hydrocarbons are noted.

**Gippsland-3**

The third scout well drilled by this group was **Gippsland-3** which Frome-Lakes drilled in the Parish of Balloong 6.4 kilometres west of **Gippsland-1**, just east of Yarram. This scout well reached a total depth of 572.0 metres in the Upper Latrobe Group sequence, the top of which was intersected at a depth of 568.5 metres. No indications of hydrocarbons are recorded. Little is known of the well which like all others in this program appears to have been aimed at the Cunninghame Greensand, the oil saturated section at the Lakes Entrance Oil Field further north east. The thin Lakes Entrance Formation section and the absence of the oil saturated greensand resulted in Frome-Lakes abandoning the search in the Yarram-Woodside area. The Gippsland scout wells were all sited on gravity anomalies.

**Darriman-4**

The **Darriman-4** scout well was also drilled in 1957. This shallow well was drilled on another culmination of the regional Darriman Anticline in a location on the foreshore of the Ninety Mile Beach. Little is known of this well which reached a total depth of 381.0 metres probably in the Gippsland Limestone. The well was drilled by Frome-Lakes group and is located 6.5 kilometres east of **Darriman-1**.

**Yarram-1**

During 1957 two petroleum exploration wells were drilled in the Yarram area. The first was **Yarram-1**, spudded by Westralian Oil Limited some 16 kilometres northwest of Frome-Lake's **Gippsland-2** on the regional Yarram Structure. The well, which was sited without seismic surveying, reached a total depth of 351.7 metres in the Strzelecki Group. Not much data has been uncovered for the well but it is believed that a thin veneer of Latrobe Group section overlies the Strzelecki Group at the well location near the pinchout edge of the Latrobe Group. No indications of hydrocarbons are recorded.

**Hedley-1**

Woodside spudded **Hedley-1** well on the Hedley Dome some 19.5 kilometres west of **Gippsland-2** and 13 kilometres southwest of **Yarram-1** in May 1957. This well was also sited without seismic surveying. The well reached a total depth of 1223.2 metres in the Strzelecki Group. Information on the well is scarce but like **Yarram-1** the well is believed to have intersected a thin veneer of Latrobe Group as the well is sited near the Latrobe Group zero edge. As for all other wells sited on the Southern Strzelecki Platform and Southern Platform no Golden Beach Group section was present. No hydrocarbon indications are reported.

**Woodside South-1**

These two wells were followed in 1965 by the **Woodside South-1** well which was sited without seismic surveying near the Frome-Lakes **Gippsland-1A** well some 3.2 kilometres northwest of **Woodside-1**. Little data appears to be available on this well which reached a total depth of 1773.6 metres in the Strzelecki Group after drilling through some 958.6 metres of Tertiary section including some 353.6 metres of Latrobe Group and finally some 815.0 metres of Strzelecki Group.

There are no reports of hydrocarbon shows in the well but some 11 drillstem tests were conducted. The first four were conducted on intervals of the Latrobe Group shilst the remaining seven were tests of the Strzelecki Group. No flows, nor recoveries of the hydrocarbons are reported. The tests of the Strzelecki Group. No flows, nor recoveries of hydrocarbons are reported. The tests of the Strzelecki Group invariably led to recoveries of mud from that unit of low permeability and porosity. The drillstem tests of the latrobe Group produced recoveries of various amounts of 'fresh water'.

Mapping of seismic data acquired subsequently by Crusader in the late 1980's shows that Woodside South-1 is a near crestal test of the lowest of the two structural culminations of the Woodside South Structure. The structure does not warrant redrilling.

**Sunday Island-1**

The Woodside led group drilled an additional two wells south of PEP 157 during late 1965 and early 1966. The first **Sunday Island-1** was spudded in November 1965 on Sunday Island, between Port Albert and Port Welshpool, approximately 15.5 kilometres southwest of **Woodside-4**. The well which, was located without seismic surveying, reached a total depth of 1829.7 metres in the Strzelecki Group. Granitic basement which was predicted at 1447.8 metres was not reached. The objective of the well was a stratigraphic test of the thinning, onto granitic basement of the Bassian Ridge, of sands of the Latrobe Group which are productive

offshore. Similar geometry exists for sandstones within the Strzelecki Group which have exhibited oil shows in many onshore wells, particularly Woodside-1 and 2. The well drilled some 507.2 metres of Tertiary section of which 108.8 metres was Latrobe Group and the rest, some 1322.5 metres was Strzelecki Group, in which the well reached total depth.

Significant hydrocarbon indications were encountered throughout the tertiary section and a drillstem test of the Latrobe was conducted which produced slightly oil cut mud and fresh water. It is though that 67 metres residual oil column is present in the lower Latrobe Group which rests on Strzelecki Group section. It would appear that a significant oil charge has passed through this location. The sand grains were coated with tar.

**St Margaret Island-1**

Woodside's next well **St Margaret Island-1** spudded on January 1966 on St Margaret Island some 10 kilometres southwest of **Woodside-1**. Like many of the Woodside wells of this vintage the well was sited without seismic surveying. It was drilled to a total depth of 1422.0 metres and bottomed in Strzelecki Group section. A total of 926.4 metres of Tertiary section including some 321.9 metres of the Latrobe Group and finally some 495.6 metres of the Strzelecki Group was drilled. No indications of hydrocarbons are reported however five drillstem tests were conducted, two in the Latrobe Group both of which exhibited recoveries of sand and water resulting from the unconsolidated nature of the Latrobe Group sands. The three tests of the tighter Strzelecki Group resulted in small recoveries of mud and some water. Like most of the wells drilled south of PEP 157 this well was really a stratigraphic test.

**Salt Lake-1**

Woodside spudded **Salt Lake-1** in 1970 on the regional Darriman Anticline one kilometre back from the Ninety Mile Beach. This well was also sited with sparse seismic surveying. Some very minor hydrocarbon indications in the coals and sands at the Top of the Latrobe Group were recorded as was some slight fluorescence from cores from the Lower Latrobe Group. Log analysis indicated that the shows were residual. Very minor indications of gas were noted in the Latrobe Group section.

Some minor fluorescence was also noted in the tight Strzelecki Group section. No drillstem tests were conducted. The well drilled through 1588.0 metres of Tertiary section of which 810.8 metres was Latrobe Group and some 56.4 metres of Strzelecki Group in which total depth of 1644.4 metres was reached.

Subsequent seismic mapping by Crusader of old 1960's analogue and modern 1980's multi-fold seismic data show that Salt Lake-1 did not test a closed culmination on the Darriman Anticline. The Darriman-4 well, previously discussed, located on the foreshore of the Ninety Mile Beach, 1.1 kilometres to the east, is a better test as it is crestal. No significant untested potential exists on the Darriman Anticline.

**Wonga Binda-1**

Two modern petroleum wells were drilled by Crusader in this permit. The first of these was Wonga Binda-1 which was located on modern multi-fold vibroseis data. The well which is sited on a culmination of the regional Darriman Anticline was targeted at Top Latrobe Group closure which coincided with a 'barrier sand' build up.

No significant indications of hydrocarbons were noted however two drillstem tests of the Top of the Latrobe were conducted, both failed due to the ubiquitous tool plugging problem related to the unconsolidated sands at the Top of the Latrobe Group. Several RFT's were attempted, unsuccessfully. It is the view of the author that this well failed for several reasons, the first is that the structural closure on the Upper Latrobe Group coals, is not reflected on the Intra-Latrobe Group horizons. The Top Latrobe Group horizon is an unconformity surface. The second is that the sand mound and a target of the well, immediately above that level, post dates the cutting of the major unconformity. This suggests that the trap at the Wonga Binda Structure may have been too young to entrap migrating hydrocarbons. The third reason is that the sand mound at the Top Latrobe Group was overlain by sands of the Giffard Sandstone which show only nebulous closure at that level. Hence the Wonga Binda Structure may not have been a competent trap and sealing is problematical.

**Wonga Binda-1** was drilled to a total depth of 1394.0 metres in April 1988 in the Strzelecki Group. The well penetrated 1344.0 metres of Tertiary section of which 738.5 metres was Latrobe Group and the remaining 50 metres was Strzelecki Group section. The well is located 3 kilometres east of **Darriman-1** and 4 kilometres west of **Salt Lake-1**.

**Stringy Bark-1**

Crusader's second well was Stringy Bark-1 drilled in 19990. This well was located by modern multi-fold seismic data from the GCR87B (Kangaroo Swamp) and 1989 GCR98C (Stringy Bark) Seismic Surveys in the Woodside area.

The objectives of the well were two large potential stratigraphic traps, the first at the Top of the Latrobe Group which is also just inside structural closure. The second stratigraphic trap was believed to be within the Latrobe Group. Crusader believed that they needed a permeability barrier to the west to seal the 'stratigraphic' trap. The well was sited as a compromise to test both traps. Given the need for permeability barriers, the trapping geometry on the target reservoirs at both levels was problematic.

No significant hydrocarbon shows were recorded however in spite of this a drillstem test of the Top of the Latrobe Group was conducted. The reasons given for this was firstly that hydrocarbon shows would be hard to see in the very porous and permeable sandstones of the Upper Latrobe Group. Secondly that the 'fresh artesian formation waters with their high resistivities would make the detection of hydrocarbons on electric logs difficult.'

The final reason was that poor hole conditions mandated an off bottom test rather than a straddle test after logging. The result of the drillstem test was the recovery of 1.18 bbls of formation water following the almost immediate plugging of the tool with sand.

**The Stringy Bark-1** well, which is located approximately 6.0 kilometres north of Woodside South-1, was drilled to a total depth of 1050 metres in the Strzelecki Group. The well drilled through 1018.0 metres of Tertiary section of which 634.5 metres was Latrobe Group and finally some 32 metres of Strzelecki Group.

It is the author's view that the compromise nature of the well location and the fact that the Top of the Latrobe Group sand pile was overlaid by the sands of the Giffard Sandstone, which made sealing problematic, were the reasons for the failure of this prospect. The structure is also fault

bound and the faults in the Woodside are often normal and tensional and perhaps leaky. This is another possible reason for failure of the well.

### York-1

The last petroleum well drilled in PEP 158 was **York-1** drill by Lakes Oil in 2002 on a seismically defined dome approximately 15 kilometres east of Yarram and some 5 kilometres west of Woodside South-1. No significant hydrocarbon indications are reported from this well which reached a total depth of 1200 metres in the Strzelecki Group section and drilled some 964.5 metres of Tertiary of which 352 metres was Latrobe Group along with 80.5 metres of weathered basalt overlying 235.5 metres of Strzelecki Group.

The structure appears to have several faults near its crest, the probable reason for failure.

| WELL | OPERATOR | FORMATION AT TOTAL DEPTH | TOTAL DEPTH (metres) (RKB) | YEAR |
|---|---|---|---|---|
| Darriman-1 | Frome-Lakes | Strzelecki Group | 1440.5 | 1955 |
| Woodside-1 | Woodside | Strzelecki Group | 1831.2 | 1955 |
| Woodside-2 | Woodside | Strzelecki Group | 2701.1 | 1956 |
| Woodside-3 | Woodside | Strzelecki Group | 1824.2 | 1956 |
| Woodside-4 | Woodside | Latrobe Group | 1821.1 | 1956 |
| Gippsland-1 | Frome-Lakes | Basal Lakes Entrance Formation | 598.0 | 1956 |
| Gippsland-2 | Frome-Lakes | Basal Lakes Entrance Formation | 473.0 | 1956 |
| Gippsland-3 | Frome-Lakes | Basal Lakes Entrance Formation | 572.0 | 1956 |
| Darriman-4 | Frome-Lakes | Gippsland Limestone? | 381.0 | 1957 |
| Yarram-1 | Westralian Oil Limited | Strzelecki Group | 551.7 | 1957 |
| Hedley-1 | Woodside | Strzelecki Group | 1223.2 | 1957 |
| Woodside South-1 | Woodside | Strzelecki Group | 1773.6 | 1965 |
| Sunday Island | Woodside | Strzelecki Group | 1829.7 | 1966 |
| St Margaret Island | Woodside | Strzelecki Group | 1422.0 | 1966 |
| Salt Lake-1 | Woodside | Strzelecki Group | 1644.4 | 1970 |
| Wonga Binda-1 | Crusader | Strzelecki Group | 1394.0 | 1988 |
| Stringy Bark-1 | Crusader | Strzelecki Group | 1050 | 1990 |
| York-1 | Lakes Oil N.L. | Strzelecki Group | 1200 | 2002 |

*Table 1*

## OTHER DRILLING

There has been much stratigraphic and coal exploration drilling by the former State Electricity Commission of Victoria particularly in the Yarram/Alberton/Gelliondale area. Some of this drilling has encountered black sands stained with what is believed to be residual oil. Lakes Oil recently drilled the Alberton-1 Scout Hole to investigate these sands. We are awaiting analysis of samples of these black sands.

## SEISMIC SURVEYING

Several seismic surveys or parts thereof have been acquired in PEP 158. The first by the BMR in 1954 to define a location on the Darriman Structure which had earlier been found by gravity surveying. Portions of three seismic surveys conducted by Woodside are located within the permit. These are shown below in Table 2 below.

The first modern seismic acquisition was done by Crusader in the late 1980's and has resulted in a good regional grid over the eastern half of the permit.

Lakes Oil acquired the last seismic recorded in 2000 when the Yarram Seismic Survey was recorded to detail the York Prospect prior to its drilling.

| SURVEY | YEAR | OPERATOR | FOLD | AREA |
|---|---|---|---|---|
| GBMR54 (Darriman) | 1954 | BMR | 100% | Darriman |
| GWS62A (Sale extended) | 1962 | Arco-Woodside | 100% | Regional |
| GWS65A (Woodside - Seaspray) | 1965 | Woodside | 600% | Regional |
| GWS65B (Paynesville) | 1965 | Crusader | 1000% | Regional |
| GCR87A (Monkey Creek) | 1987 | Crusader | 6000% | Stradbroke-Darriman |
| GCR87B (Kangaroo Swamp) | 1987 | Crusader | 6000% | Woodside-Yarram |
| GCR87A (Seaspray) | 1987 | Crusader | 9000% | Seaspray-Darriman |
| GCR89A (Stringy Bark) | 1989 | Crusader | 6000% | Woodside |
| GLO00A (Yarram) | 2000 | Lakes Oil | 9000% | Yarram |

*Table 2*

The quality of the data from these surveys varies as would be expected from the variation in redundancy. The post 1987 surveys are of very good quality above and within the Latrobe Group. The underlying Strzelecki Group section is poorly imagined due to the following reasons:

1) The almost total reflection of energy by the Latrobe Group coals resulting in very little penetration of energy into the Strzelecki Group.
2) The lack of large acoustic impedance contrasts within the Strzelecki Group.

## PROSPECTS AND LEADS

A total of nine leads and 1 prospect have been identified with PEP 158. Work will continue to rank and high grade these leads. It is expected seismic delineation of the most attractive lead will then follow.