BHP PETROLEUM PTY. LTD
A.C.N. 006 918 832

EPP SA-1

OFFSHORE OTWAY BASIN SOUTH AUSTRALIA

EVALUATION REPORT

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TABLE OF CONTENTS

		Page
1	SUMMARY	1
2	INTRODUCTION	2
3	EXPLORATION HISTORY	3
4	GEOLOGY	4
4.1	Regional Geology	4
4.2	Well Results	5
5	GEOCHEMISTRY	9
5.1	Source Rocks	9
5.2	Source Maturation and Hydrocarbon Migration	10
6	GEOPHYSICS	12
6.1	Recent Surveys and Reprocessing	12
6.2	Seismic Interpretation	12
7	PLAY TYPES AND LEADS	14
7.1	Play Types	14
7.2	Leads	16
8	CONCLUSIONS	18
9	REFERENCES	19

1 SUMMARY

Permit EPP SA-1, Otway Basin South Australia, was awarded on 15th November, 1990 to BHP Petroleum (Victoria) Pty Ltd and Cultus Petroleum (Australia) NL. The Operator for the permit is BHP Petroleum Pty Ltd. EPP SA-1 covers the three nautical mile territorial waters between the coastline and the eastern boundaries of offshore permits EPP 24 and the relinquished EPP 23 and was essentially acquired as protection acreage for these permits. The first three year work program involved seismic data acquisition and processing, reprocessing of seismic data and office studies. Based on the seismic data acquired in the work program a detailed evaluation of the permit and surrounding area has been carried out by members of the Otway Basin Team.

This report summarises this work. The conclusions are that there are no drillable prospects identified in the permit and all identified leads have high structural risk due to limited seismic coverage, plus high seal risk and high gas risk. All leads require additional seismic control for possible upgrade to prospect status.

2 INTRODUCTION

The Otway Basin stretches 500 km along the South Australian and Victorian coastline from Robe in South Australia to Cape Otway in Victoria. The basin originated as an intra-cratonic rift in the Late Jurassic and evolved into a passive margin during the Late Cretaceous.

EPP SA-1 covers the three nautical mile territorial waters between the coastline and the eastern boundaries of offshore permits EPP 24 and the relinquished EPP 23. It extends from north of the township of Robe to immediately west of Douglas Point where it joins permit EPP SA2 (figure 1). The total area of EPP SA-1 is approximately 750km^2.

Water depths in the area are shallow, up to a maximum of 30 metres. The southern portion of the area west of Douglas Point and south of Lake Bonney has very shallow water depths, averaging between only 6 and 10 metres (Enclosure 1).

EPP SA-1 was issued by the Minister for Mines and Energy on 15th November, 1990. The Operator for the permit has been BHP Petroleum Pty Ltd with interests held by BHP Petroleum (Victoria) Pty Ltd (70%) and Cultus Petroleum (Australia) NL (30%). The permit commitments are summarised in Table 1.

3 EXPLORATION HISTORY

There are no wells in EPP SA-1, but there are several nearby onshore and offshore wells drilled since 1961 from which correlations have been made.

The first seismic program in the permit was conducted by Western Geophysical for Esso Standard Oil in 1968 using an Aquapulse source for 4 second records. The six 6-fold lines totalled 83 km and were of poor quality. These lines were reprocessed in 1981 by Western Geophysical for Ultramar Australia with some improvement in data quality. They were again reprocessed in 1991 by Tensor Pacific for BHP Petroleum as part of the permit commitment. Quality improved marginally from the 1981 sections with most improvement coming from a more appropriate display scale.

A few lines from the 073A Seismic Survey are located at the northern end of EPP SA-1. These lines have not been used in the present evaluation.

Two lines totalling 73.4 km were acquired by Western Geophysical for BHP Petroleum in 1991. The 6 second/60-fold lines were processed by Tensor Pacific and are of excellent quality. These lines are designated OH91C-601 and OH91C-602.

The tail ends of seismic surveys from deeper water permits recorded in 1982, 1985, 1986, 1990 and 1993 lie in the permit and have been invaluable for mapping and obtaining well ties.

Aeromagnetic surveys over the area were flown in 1961-62 for Haematite Explorations (BHP) and in ~~1993 for SADME~~ 1992 for AGSO.

4 GEOLOGY

4.1 Regional Geology

Three main depositional periods dominate the stratigraphic record of the Otway Basin and are represented by the Early Cretaceous Otway Group, the Late Cretaceous Sherbrook Group and the Tertiary Wangerrip/Nirranda/ Heytesbury Groups (Figure 2).

The Otway Group was deposited during the Early Cretaceous and represents the onset of rifting. Up to 7000m of sediments were deposited in this first period. The second main period spans the Late Cretaceous and may have been the result of an additional rifting phase. A maximum of 5000m of Sherbrook Group sediments were deposited in this period. The last depositional period took place during passive margin subsidence in the Tertiary and up to 2500m of sediments were deposited.

The Early Cretaceous Otway Group forms the focus of this report because these rocks were assessed to be the most prospective in EPP SA-1. Most of the permit is dominated by these sediments with the remainder of the permit covered by thick Late Cretaceous and Tertiary age units under which the prospectivity and distribution of the Otway Group is unknown.

The members of the Otway Group are best described in a rifting setting. Syn-rift deposition is represented by continentally-derived fluvio-lacustrine sandstones, siltstones, mudstones and coals of the Crayfish Subgroup. These sediments infilled a complex system of half graben in which the upper portion of the hanging wall has generally been rotated and partially eroded prior to the cessation of rifting. In contrast, the flat lying sediments of the post-rift Eumeralla Formation are more lacustrine in character and comprise fine grained clastics and coals which lie with angular unconformity on top of the Crayfish Subgroup.

EPP SA-1 provides a cross-section of the major onshore and offshore tectonic elements. Most of the permit covers the "Crayfish Platform", an area dominated by the Early Cretaceous Otway Group. The tectonic style is that of generally east-west trending rotated half graben filled with Crayfish Subgroup sediments and overlain with angular unconformity by the Eumeralla Formation. The Crayfish Platform is bounded to the northwest by the Padthaway Horst which forms the basin margin. The various horst and graben structures within the Crayfish Platform have been well documented from early onshore work eg Robe Trough, Lake Eliza High etc. A previously unnamed feature has been called the "Rivoli Trough" (Enclosure 5).

In the very south of the permit lies the "Voluta Trough". The tectonic style within the Voluta Trough is dominated by intensive down to the basin faulting over which the Late Cretaceous and Tertiary sections rapidly thicken. For this report, in EPP SA-1 the "Tartwaup Fault" is assumed to be the boundary between the Crayfish Platform and Voluta Trough.

Most fault movement occurred during Crayfish Subgroup deposition along graben-bounding growth faults and prior to Eumeralla deposition along these, reactivated basement and new faults. The Beachport Horst was growing (in a relative sense) during Crayfish time and the thin veneer of Crayfish sediments over this feature may represent a condensed/highly reworked section or a terminal section. Syn- and post-depositional faulting occurred during Eumeralla time as evidenced by the in places highly faulted internal structure of this formation. Most of the Eumeralla age faults do not penetrate the Crayfish Subgroup unconformity. Some faults reactivated prior to Tertiary deposition and many exhibit evidence of movement during the Tertiary to Holocene period and may still be active today.

A recent compressional event has partially inverted the 'Rivoli Trough' and apparently reactivated existing normal faults into a number of small reverse faults over and to the south of the Beachport Horst within and to the west of EPP SA-1. The amount of inversion increases onshore where reversal of the southern Beachport Horst fault has occurred. This compression may still be in progress today. No such features are seen on the northern side of the Beachport Horst and so it seems that this feature is shielding these areas from the compressive stress. There appears no obvious mechanism for this compression.

4.2 Well Results

Onshore

Robe-1 was drilled in 1915 by South Australian Oil Wells on a fossil backshore beach dune which was mistaken for anticlinal structure. The well was the deepest for its day in the basin and reached a TD of 1373 m. It disclosed for the first time the presence of coal-bearing Early Cretaceous sediments below the widespread Tertiary limestones (Sprigg, 1985) but failed to encounter any hydrocarbon. recovered gas and water.

Beachport-1 was drilled in 1961 by South east Oil Syndicate to test anticlinal drape of deep sediments over a strong gravity and magnetic high expected to be an igneous plug or a basement high at approximately 1220 m (Beachport High). Drilling terminated at 1208 m due to mechanical difficulties while still in Eumeralla Formation equivalent (Douglas, 1988). Minor gas shows occurred in the Eumeralla Formation.

With attention drawn by strandings of fresh bitumen/heavy oil in the area, the Beach Petroleum-operated **Geltwood Beach-1** was spudded in 1963. The well tested an anticlinal structure at Tertiary level expected to reach down to Cretaceous level. Nine shallow holes were drilled to verify the structure at the Tertiary level and confirmed an anticline plunging south east, 3.2 km wide & 9.7 km long with slight reversal in the north west and probable closure at depth. The Eumeralla Formation produced some significant gas shows, however no shallow petroliferous reservoirs were found. Crayfish Subgroup sandstones were still not reached at the TD of 3749 m. This remains the deepest onshore well in the Otway Basin.

Lake George-1, drilled in 1969 by Esso, was designed to test Crayfish Subgroup sandstones (Pretty Hill Sandstone) on a large anticlinal closure on the Beachport High basement horst. Original seismic interpretation suggested a prospect of area 363 km^2 with 853 m of vertical closure existed on the crest of the structure. Probably due to non-deposition, the structure was bald of Crayfish sandstones and the 1369 m well drilled straight from Otway Group mudstones into metasedimentary basement. No shows were recorded.

Lake Eliza-1, was also drilled by Esso in 1969 as a test of Crayfish Subgroup sandstones. It terminated at 1473 m in basement after drilling about ?400 m of Crayfish section. One DST flowed gas at RTSTM. Core porosity is in the range 20-25% but permeability is generally less than 15md and averages 3md.

General Exploration drilled **Lake Eliza-2** in 1973 to test draping of Crayfish Subgroup sandstones over a large positive gravity anomaly. Eumeralla Formation mudstones were expected to seal a trap of areal closure 155 square km and vertical closure 244 m. The well drilled to 1158 m and terminated in basement with a only a minor gas show recorded in the Crayfish section (about 100 m drilled). Visual and log porosity are described as good with assumed good permeability but a DST recovered only gas cut fluids.

Beachport East-1 was drilled by the John Henry company in 1973 and reached a TD of 1428 m in pre-Cretaceous basement. Some 47 m of fair to good quality Crayfish Subgroup was encountered but they were not tested.

Following a detailed photogeological study of the area south of Mount Gambier, a surface-expressed anticline was chosen as a test of the basal Tertiary Pebble Point Formation (Sprigg, 1985). **Douglas Point-1** was drilled by General Exploration in 1973 and terminated at 1206 m in Late Cretaceous 'Paaratte Formation' without encountering any hydrocarbon.

Lake Hawdon-1 was drilled by Hartogen in November 1988 and reached a TD of 2803 m. Numerous good reservoir sandstones were encountered in the Crayfish Subgroup (drilled 1589 m) but none were tested.

Hatherleigh-1 was drilled by SAGASCO in October 1990 and reached a TD of 1908 m. The proposed target was Crayfish sandstones onlapping a basement high but the well drilled from Eumeralla Formation into Devonian basalt thus missing the onlap edge.

St Clair-1 was drilled in April 1993 by a Gas & Fuel Exploration operated joint venture. The well TD'd at 3284 m within the Crayfish Subgroup without reaching expected good quality sandstones. The proposed "good quality sandstones" may occur deeper in the section (R. Hoare, Cultus Petroleum, pers. comm. 7/93).

Offshore

The offshore Esso well **Crayfish-A1** was drilled in September 1967 on the interpreted crest of a north east - south west trending anticline (Lake Eliza High) and reached a TD of 3200 m after drilling 1603 m of Crayfish Subgroup. It was mapped on what was thought to be a "Pre-Early Cretaceous unconformity" which actually was the top of the Crayfish Subgroup. With apparently adequate Eumeralla seal and reservoir sands of good porosity (18-24% average) and variable permeability (0-600md; clay choking dependent), only minor dissolved gas in an entirely water saturated sand section was discovered. A non-commercial dry gas flow was tested in the Crayfish Subgroup sandstones (FIT rec. 0.15 cu. ft. gas) and fluorescence and hydrocarbon cuts in cores and cuttings in the deeper Crayfish section are considered attributable to the presence of scattered asphalt-like material (Esso, Morum WCR, 1975). Following post drilling seismic interpretation, it was decided that a down-faulted block on the anticline crest had destroyed closure.

Esso drilled **Argonaut-1** in 1968 on the high side of a tilted fault block in a heavily faulted section (Sprigg, 1985). The well reached a TD of 3708 m in early Late Cretaceous 'Waarre Sandstone'. No shows were recorded. The Late Cretaceous section was sandier than expected and may not have provided cross-fault seals.

Neptune-1 was drilled in 1973 by Esso to test a high side fault closure along the offshore extension of the Lake Eliza High. The well TD'd at 2437 m within the Crayfish Subgroup (1015 m drilled). It was expected that the overlying Eumeralla would act as the seal and source to Crayfish reservoir sands but despite an apparently robust closure and adequate overlying and interbedded seals, no shows were recorded. Only one core

was cut in a Crayfish sandstone which was of poor porosity and permeability. However it was decided from logs that this core was not representative of the Crayfish sandstones as a whole.

6 GEOPHYSICS

6.1 Recent Surveys and Reprocessing

The two seismic lines recorded in 1991 (OH91C survey) represent the only useable structural dip lines in this permit for mapping events below the top Crayfish Subgroup unconformity. Line tails from out of the permit provide valuable well and interpretation correlations and are the only reliable source of structural strike line information in the permit.

Lines from several open file and traded onshore surveys have been used for fault and structural extrapolations in the absence of data in EPP SA-1. The quality of these lines is variable and in most cases inferior to the recent offshore lines. Surface conditions obviously have a major impact on the quality of onshore data.

The onshore lines have also been useful for 'locating' onshore wells within a similar structural/stratigraphic setting in EPP SA-1 to allow the results of these wells to contribute to the offshore interpretation.

As previously mentioned, six EU68 seismic lines totalling 82.9km were reprocessed by Tensor Pacific in 1991. Of this 59.2km are within the boundaries of EPP SA-1 and the remainder lie in EPP 24 and PEL 40. Considerable difficulties were encountered in reading the field tapes or copies of them. HGS in Sydney were eventually able to transcribe the original field tapes into SEG-Y format, albeit with only three seconds of the original four seconds of data. Due to the erratic shotpoint spacing of this survey much time was spent on establishing the correct geometries prior to processing. This was achieved by adopting binning techniques used for 3D seismic processing with shotpoint labels added in the appropriate places subsequent to processing. The final product shows an irregular shotpoint spacing to match the original acquisition.

6.2 Seismic Interpretation

Principal events mapped from EPP 24 into EPP SA-1 are :

Base Tertiary : Tied to Neptune-1 and Crayfish-A1 and followed as a high amplitude package generally a half to one cycle above true Base Tertiary. The Tertiary and Late Cretaceous sections have little exploration potential for most of EPP SA-1 and cannot be mapped in the southern part of the permit due to lack of data. No structure map has been produced for the Base Tertiary.

Top Eumeralla : Tied to Neptune-1 and followed as a high amplitude package. There is occasional angularity at this unconformity, but in general it gives a very good indication of intra-Eumeralla structure. The southern end of line OH91C-602 is 6.0km from the onshore well Geltwood Beach-1 which intersected the Eumeralla at 1231mSS. This depth roughly equates to 1150ms TWT and has been used to constrain the interpretation of the Top Eumeralla and Base Tertiary (543mSS/560ms) events in the southern area of EPP SA-1.

Top Crayfish Subgroup Unconformity : Tied to Neptune-1 and Crayfish-A1 and an easily identified regional event generally showing obvious erosional truncation. There was some difficulty identifying this event with certainty south of the Tartwaup Fault on line OH91C-602 due to poor data quality. Geltwood Beach-1 TD'd at 3750mSS within the Eumeralla Formation. In the absence of a seismic line tie or any well seismic data, the time-depth curves of various deep wells in the area were used to calculate an approximate TWT of 2500ms for this depth. A 'possible' Top Crayfish event was interpreted below the well TD.

Intra-Crayfish Subgroup : Two events were originally picked on line OC91C-601 for interpreting throughout the permit with only the most reliable to be mapped. There were some problems correlating these events either side of the Lake Eliza High and across large faults because of rapid changes in seismic character. In all cases, true dip information has been preserved to allow lead identification even if the correlation is not obvious. Events either side of the Beachport Horst cannot be directly correlated and so a reliable event at a similar level was selected for mapping on the southern side.

Basement : Basement cannot be directly tied to any offshore wells but its position can be interpreted with confidence through most of the permit, particularly where it is shallow. This event has been a useful lower constraint for the interpretation of the intra-Crayfish events and has provided valuable information on the structural history of the permit and surrounding area.

7 PLAY TYPES AND LEADS

7.1 Play Types

Several play types exist within the western portion of the Otway Basin, most of which are represented in EPP SA-1. The Crayfish Group forms the primary reservoir target for most leads mapped in the permit. Crayfish-A1 and Neptune-1 intersected good quality Crayfish Subgroup reservoirs to the west of EPP SA-1. A regional porosity versus depth curve is shown in Figure 3 and illustrates good reservoir quality at the depths required for EPP SA-1 plays. The earliest play in the permit involves Crayfish Subgroup reservoirs sealed vertically by intraformational claystones deposited in overbank and lacustrine settings. The potential for intraformational sealing is illustrated in Neptune-1 and Crayfish-A1 which demonstrate development of common 20-50 m thick and occasional 100 m thick claystone intervals within the Crayfish Subgroup. Net to gross of the Crayfish Subgroup in these wells is around 40-50%.

During deposition of the Crayfish Subgroup section, both normal and listric rollover faults provided mechanisms for the formation of traps. Rollovers were evident in the northern halfgraben as early as the ?Valanginian, during deposition of the middle of the Crayfish Subgroup. Tilted fault blocks were also developed at this time, although continued fault movement may have breached the vertical seal of these structures. These traps still retain closure integrity and are mapped as leads on newly acquired seismic. Crayfish Subgroup and possibly Casterton sediments deposited in the deeper parts of the half-graben became mature for hydrocarbon generation as early as the ?Valanginian. Updip migration to rollover structures and tilted fault blocks in shallower parts of the hangingwall provides an easy mechanism for hydrocarbon charging of the structures during their formation. Subsequent deposition of the Eumeralla Formation has pushed the source sediments through the gas window, with the potential for generation of large volumes of gas. The Intra-Crayfish structures must therefore be considered as gas targets only.

The second play utilises the base of the Eumeralla Formation as a seal rock draped over existing highs, and overlying and juxtaposed across tilted fault blocks of the Crayfish Subgroup. The Eumeralla Formation is considered to have fair to good seal potential, predominantly comprising claystones and coals at the base. Minor sandstones are often associated with the coal bearing sequences in the Lower Eumeralla but are more likely to behave as secondary reservoirs to the Crayfish Subgroup rather than acting as a breach of the seal. The basal Eumeralla has been proven as a seal for underlying Crayfish Subgroup in several discoveries in the basin.

Drape structures are interpreted as having been created at the time of deposition of the Eumeralla Group over regional highs. Tilted fault blocks at the top of the Crayfish group were formed prior to and during deposition of the Eumeralla Formation, many having been reactivated through time. Similar to the intraformational plays, Top Crayfish Subgroup reservoirs could be sourced from either mature ?Casterton and/or Crayfish Subgroup sediments from within half-graben. Overmaturity of these sources during deposition of the Eumeralla suggests that these must also be considered as gas plays. A thicker section of Eumeralla, Sherbrook and Tertiary sediments in the southern part of the permit pushes the base of the Eumeralla Formation into the oil window. This unit may act to source both liquids and gas to Top Crayfish reservoirs, but the large volumes of gas potentially generated by underlying Crayfish sediments is likely to have displaced any liquids migrating to the structures.

The third play involves Intra-Eumeralla reservoirs and seals. Sandstones of the Eumeralla Formation are of fair quality as shown by the regional porosity versus depth trend in Figure 3. Adequate porosity has been intersected in wells near the permit (such as Crayfish-A1) at depths similar to those proposed for leads in EPP SA-1. However permeability of the reservoirs is often very low due to diagenesis of the mainly volcaniclastic section. The best potential for fair quality reservoirs exists at the base of the Eumeralla Formation (Windemere Sandstone) often associated with coals, the Middle of the Eumeralla Formation (Heathfield Sandstone), and the upper section of the Eumeralla Formation which becomes more proximal in nature towards the top. The remainder of the Eumeralla Formation is considered to have fair potential to seal the Intra-Eumeralla reservoirs. Potential sources for an Eumeralla play comprises gas mature Crayfish Subgroup sediments in the northern part of the permit, and liquids/gas prone Eumeralla (particularly Lower Eumeralla) in the middle part. The southern area is considered too deep to be economically prospective. A Eumeralla play is considered to be of fairly poor prospectivity, with no analogs discovered in the basin.

The fourth and youngest play proposed for the permit is only viable in the southern part of the permit where Late Cretaceous sediments thicken across several down-to-the-basin faults. Argonaut-1 is located near the southern extent of EPP SA-1 and reached total depth at 3708 mRT in Late Cretaceous sediments of Coniacian to Early Santonian age ('Waarre Sandstone'). The well intersected fairly well developed sandstones below 500 m of well developed claystone, with sandstone porosities in the order of 8-15% and permeabilities ranging from nil to 25 md. This play is viewed as fairly prospective elsewhere in the basin and has been demonstrated successfully in the Eastern Otway Basin. However depth of burial of the reservoir section in EPP SA-1 is typically too great to preserve reasonable porosity and overmature Eumeralla Formation implies a primarily gas prone

source. Lack of seismic data in this portion of the permit implies that at the current stage prospectivity of Late Cretaceous plays is low.

7.2 Leads

A number of leads have been identified at the Top Crayfish and Intra-Crayfish levels. All are poorly defined seismically, generally by only one or two lines, and none can be considered as prospects with existing data. The Intra-Crayfish leads have serious cross-fault and fault seal risks due to the generally sandy section and the Top Crayfish leads have serious fault seal risks. Summaries of sizes, possible hydrocarbon volumes and lead risks are contained in Tables 2,3 & 4. The location of these leads is shown on the enclosed structure maps and seismic sections.

Top Crayfish Leads

Lead CR1 A possible lowside fault play on the northern side of the Beachport Horst. It occurs in the gap between the two OH91C lines and is seen only on line EU68-1. Closure is more 'model-driven' than observed. Hydrocarbons would be generated within the Crayfish Subgroup in the St Clair Trough and migrate south updip into this lead. A trap, if present, would have existed since the early Aptian.

Lead CR2 A lead comprising two bumps overlying the Beachport Horst. One bump appears formed by drape over a basement feature, the other has been formed recently and is bounded to the south by a small reverse fault. The latter had some closure prior to the recent structuring as evidenced by thinning of the Eumeralla (approx 15ms). This lead is defined by one modern and four old/end lines and is moderately constrained. True closure is unconstrained shoreward. Actual Crayfish thickness is difficult to prove, but appears to be in the order of 70 to 100ms (100-150m). Reservoir quality is unknown. Hydrocarbons would be generated within the Crayfish Subgroup in the St Clair Trough to the north and west of this lead. Trap timing is complicated by the recent movements; about half of the mapped closure has existed since the early Aptian (drape), the remainder having been formed in the Late Tertiary - Holocene.

Lead CR3 A very encouraging lead on line OH91C-602 but which is not supported by parallel lines to the southwest. If real, the formation of this pinnacle structure is difficult to explain as it seems too large for footwall rebound and also predates the 'Rivoli Trough' inversion. Apparent onlap of the basal Eumeralla lends support to real structure however a component of its apparent structure may be due to over-migration. Hydrocarbon charge would come from the Crayfish Subgroup and possibly the basal Eumeralla within the 'Rivoli' and Voluta Troughs. Any trap would have existed since the early Aptian.

A lowside fault lead below CR3 is possible but has not been mapped due to poor quality data and uncertainty in the position of the Crayfish Subgroup.

Intra-Crayfish Leads

Lead IC1 An intra-Crayfish rollover into a fault defined by two lines and several end lines. True closure is unconstrained shoreward. Fault-independent closure is small and cross-fault seal cannot be demonstrated. Reservoir and intra-formational seals are expected to be adequate, as evidenced by the nearby wells. Hydrocarbon charge would come from the Crayfish Subgroup/Casterton section within the Robe Trough. Any trap may have existed since the ?Valanginian-Barremian but end Barremian fault movement provided the bulk of apparent closure.

Lead IC2 A poorly defined lead based on two seismic lines. Closure is unconstrained shoreward and is thus mostly 'model-driven'. The greatest risk with this lead is cross-fault seal as is it uncertain whether it requires basement of the Beachport Horst or Crayfish Subgroup sediments for seal. The former would be preferable but is the least likely of the two options. Hydrocarbon charge would come from the Crayfish Subgroup/Casterton section within the 'Rivoli' Trough and any trap may have existed since the ?Valanginian-Barremian.

To allow upgrade to prospect status all leads require more seismic, particularly normal to the coast for structural strike information. In the order of 70 to 150km of seismic would be required, depending on the leads and number to be defined.

8 CONCLUSIONS

At this stage the prospectivity of EPP SA-1 can be summarised to be primarily gas-prone plays within the Crayfish Subgroup with high trap risks due to sparse seismic coverage and fault seal requirements.

There are no leads identified in the adjoining EPP 24 which are likely to extend into EPP SA-1. This has two implications: the necessity for EPP SA-1 as protection acreage to EPP 24 is no longer valid (EPP 23 has already been relinquished) and any prospects proven in EPP SA-1 must stand on their own merits. The latter point makes the likelihood of discovering a stand-alone economic field in such a small area somewhat remote, particularly in the case of gas.

9 REFERENCES

ALLIANCE OIL DEVELOPMENT AUSTRALIA NL; 1978
Farmout Proposal, Petroleum Exploration Licence No 8 , State of South Australia. BHP Petroleum Code 12/3/003

BEACH PETROLEUM NL; 1965
Geltwood Beach No. 1 Summary of Data & Results. Published BMR. BHP Petroleum Code 12/1/Geltwood Beach 1/001

BHP PETROLEUM PTY LTD; 1990
Application For Offshore Area SA1 Otway Basin, South Australia. BHP Petroleum file ED.82.SA1.

BHP PETROLEUM PTY LTD; 1991
Evaluation Report, EPP 23 Otway Basin, South Australia
BHP Petroleum Code 12/3/166

BHP PETROLEUM PTY LTD; 1991
EPP SA-1 First Year Annual Report (unpublished).
BHP Petroleum file ED.82.SA1

BHP PETROLEUM PTY LTD; 1992
EPP SA-1 Second Year Annual Report (unpublished)
BHP Petroleum file ED.82.SA1

ESSO EXPLORATION & PRODUCTION INC; 1969
Lake Eliza-1 Well completion Report (unpublished).
BHP Petroleum Code 12/1/Lake Eliza 1/001

ESSO EXPLORATION & PRODUCTION INC; 1975
Neptune-1 Well Completion Report (unpublished)
BHP Petroleum Code 12/1/Neptune-1/001

ESSO EXPLORATION & PRODUCTION INC; 1970
Lake George-1 Well Completion Report (unpublished)
BHP Petroleum Code 12/1/Lake George-1/001

FELTON, A.E. and JACKSON, K.S.; 1987
Hydrocarbon Generation Potential in the Otway Basin, Australia. BMR Journal of Australian Geology & Geophysics, 10, pp 213-24.

GEOSURVEYS OF AUSTRALIA LTD for BEACH PETROLEUM N.L.; 1964
Geltwood Beach-1 Draft Report. BHP Petroleum Code

12/1/Geltwood Beach-1/003

JOHNSTON, J.J.; 1993
Permit EPP SA-1 Otway Basin, South Australia - Evaluation Report. Unpublished. BHP Petroleum Code OTW/3/183

KOPSEN, E. and SCHOLEFIELD, T.; 1990
Prospectivity of the Otway Supergroup in the Central and Western Otway Basin. APEA Journal, 30, pp 263-79.

LAING, S., DEE, C.N. & BEST, P.W.; 1989
The Otway Basin. APEA JOURNAL, p 417 - 429

PARKER, K.A.; 1992
The Exploration & Appraisal History of the Katnook & Ladbroke Grove Gas Fields, Onshore Otway. APEA JOURNAL, p 67-85

SOUTH EAST OIL SYNDICATE; 1962
Beachport-1 Well Completion Report (unpublished). BHP Petroleum Code 12/1/Beachport-1/001

SPRIGG, R.C.; 1986
A History of the Search for Commercial Hydrocarbons in the Otway Basin Complex. Second South-Eastern Australia Oil Exploration Symposium, Glenie. R.C. (ed) p 173 - 199

VICTORIAN DIVISION GEOLOGICAL SOCIETY OF AUSTRALIA INC.; 1988
Geology of Victoria. Chapter 7 by J.G. Douglas et al p 213 - 228 BHP PET/ER 55(ER) GEO.

BHP Petroleum

OTWAY BASIN

EPP SA-1 - LOCATION MAP & LEADS

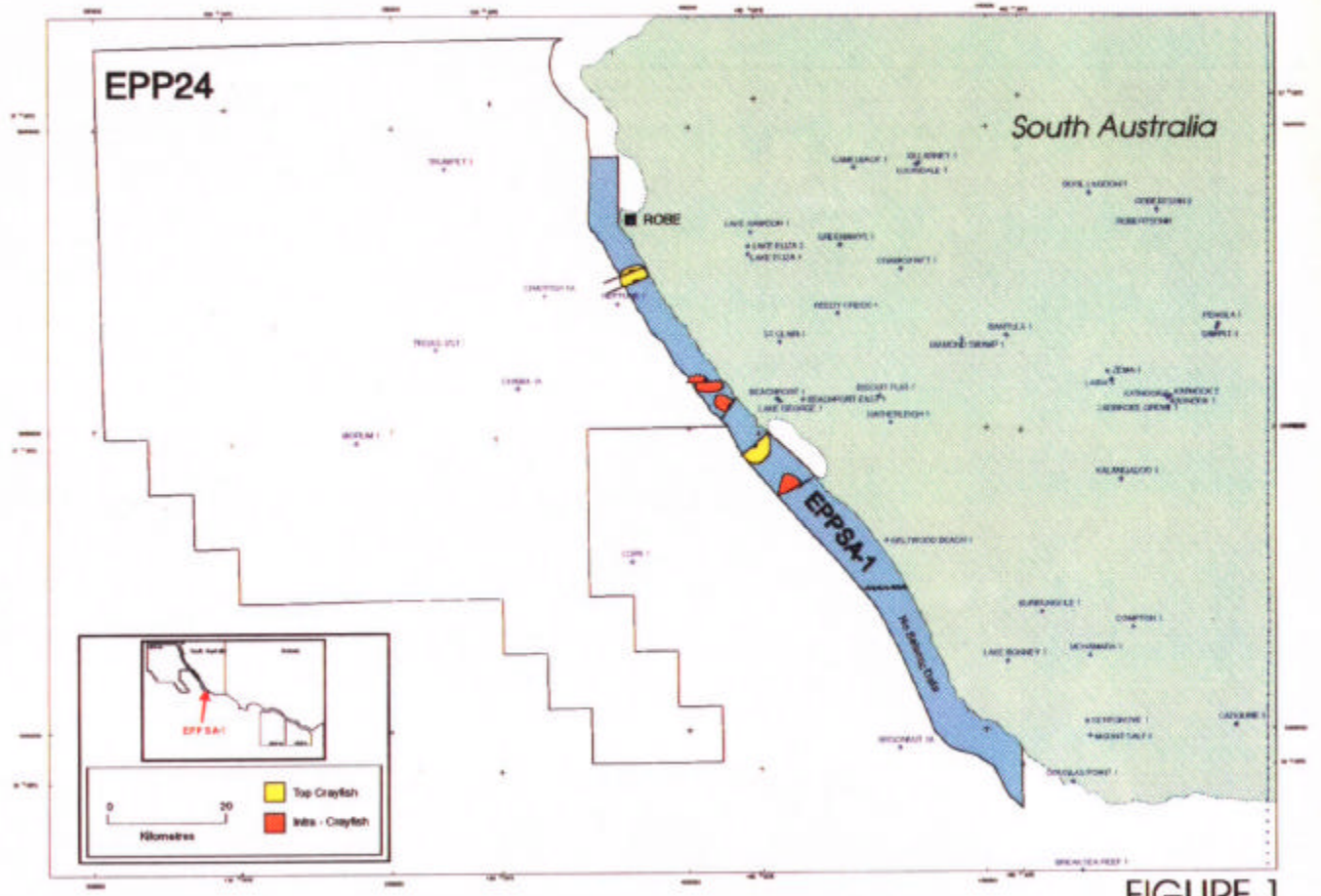
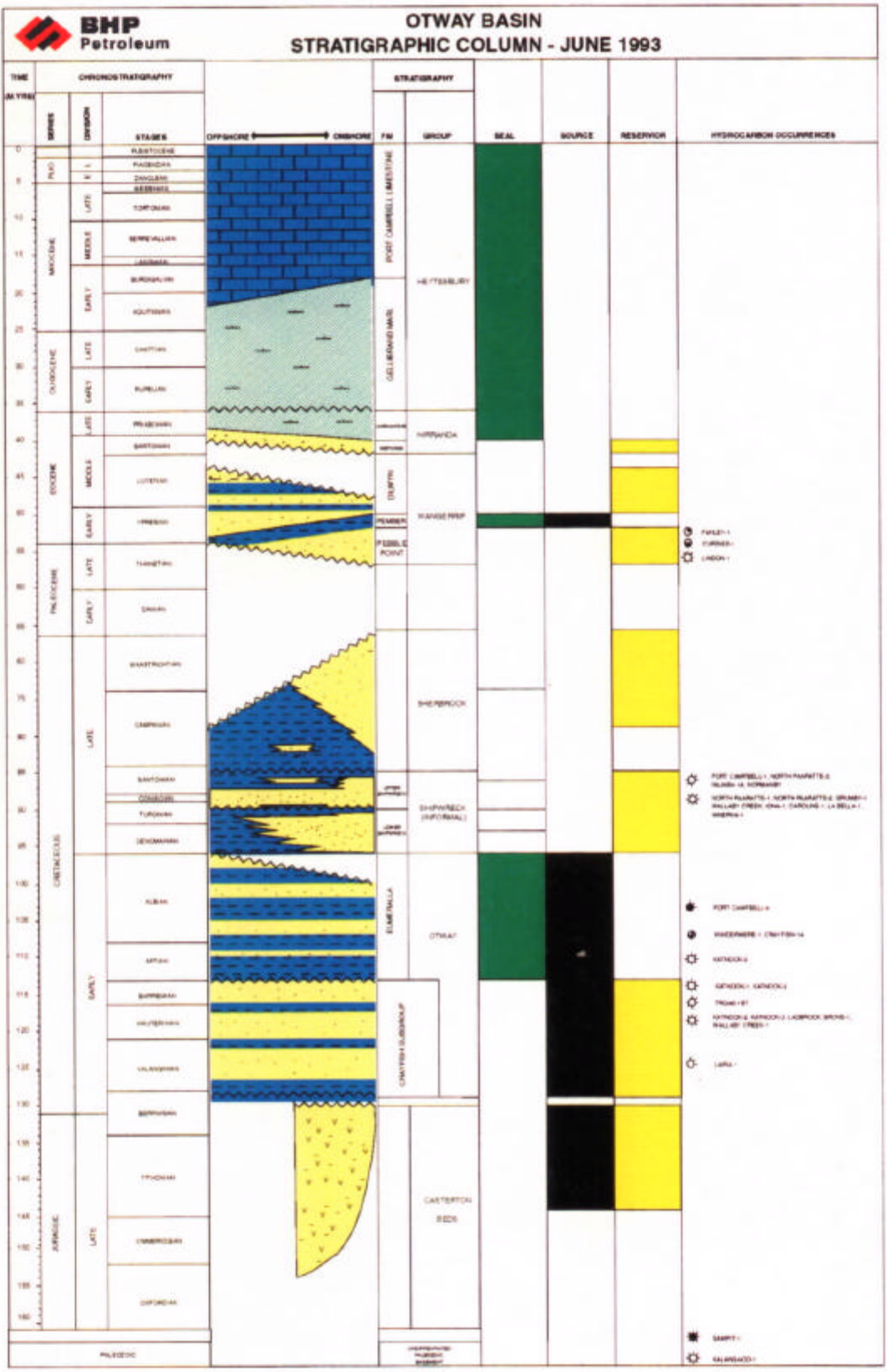


FIGURE 1

002_CDR_TD


BHP Petroleum
OTWAY BASIN
STRATIGRAPHIC COLUMN - JUNE 1993
TIME (M.YRS)
CHRONOSTRATIGRAPHY
SERIES
DIVISION
STAGES
OFFSHORE
ONSHORE
STRATIGRAPHY
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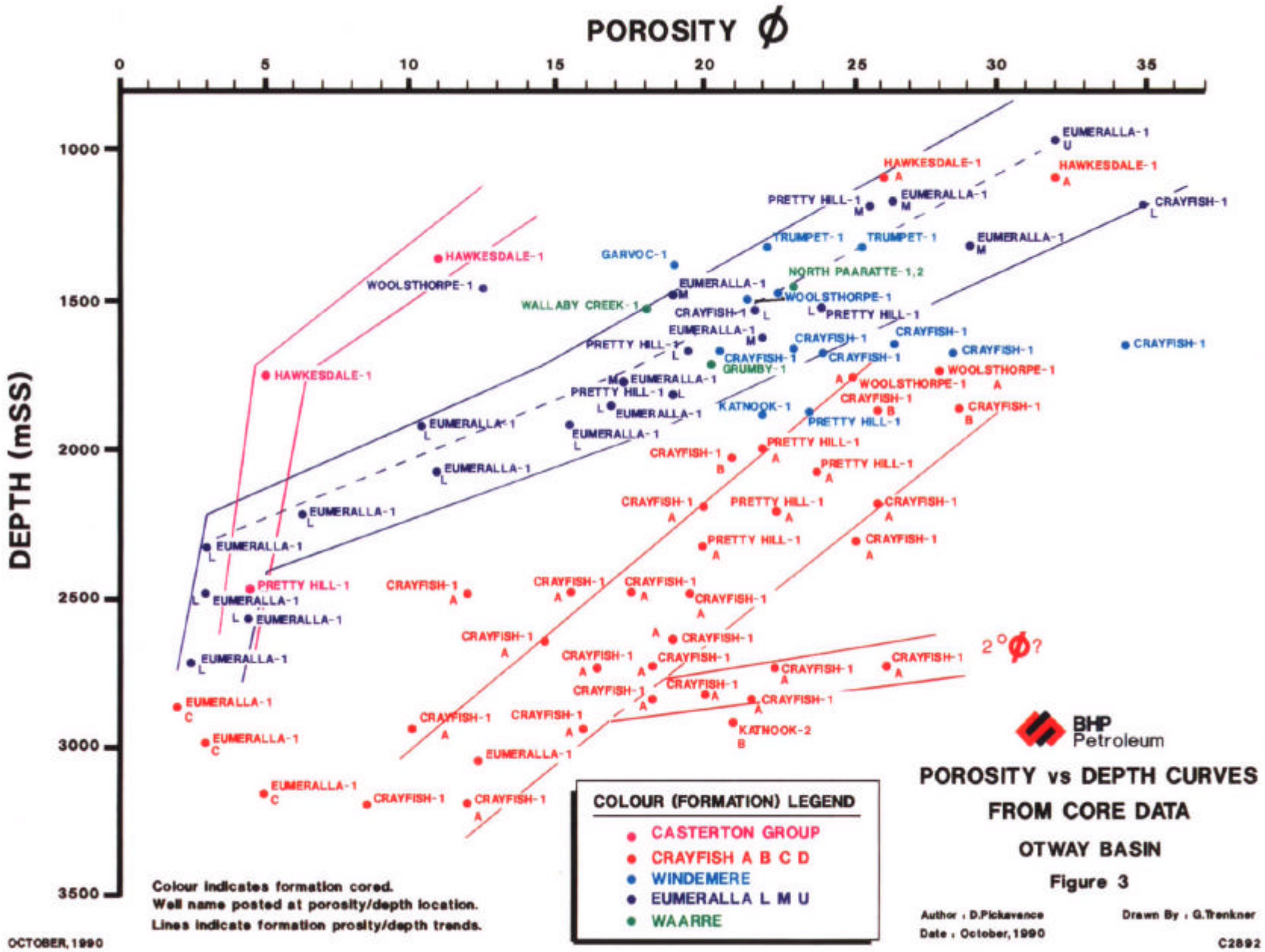
GROUP
SEAL
SOURCE
RESERVOIR
HYDROCARBON OCCURRENCES
PLEISTOCENE
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
CRETACEOUS
JURASSIC
PALEOZOIC
PORT CAMPBELL LIMESTONE
GELLIBRAND MARL
HEYTESBURY
NIRRANDA
DILWYN
PEMBER
FOSSIL POINT
WANGERRIP
SHERBROOK
SHIPWRECK (INFORMAL)
ELIMINATELLA
OTWAY
CRAYFISH SUBGROUP
CASTERTON BEDS

Figure 2


POROSITY ϕ
0
5
10
15
20
25
30
35
DEPTH (mSS)
1000
1500
2000
2500
3000
3500
HAWKESDALE-1
WOOLSTHORPE-1
WALLABY CREEK-1
GARVOC-1
TRUMPET-1
NORTH PAARATTE-1,2
EUMERALLA-1
CRAYFISH-1
PRETTY HILL-1
GRUMBY-1
KATNOOK-1
KATNOOK-2
2°ϕ?
COLOUR (FORMATION) LEGEND
CASTERTON GROUP
CRAYFISH A B C D
WINDEMERE
EUMERALLA L M U
WAARRE
Colour indicates formation cored.
Well name posted at porosity/depth location.
Lines indicate formation prosity/depth trends.
OCTOBER, 1990
BHP Petroleum
POROSITY vs DEPTH CURVES
FROM CORE DATA
OTWAY BASIN
Figure 3
Author : D.Pickavance
Date : October, 1990
Drawn By : G.Trenkner
C2892

BHP Petroleum

OTWAY BASIN

EPP SA1 WORK PROGRAM

PERMIT YEAR	MINIMUM WORK REQUIREMENTS	Estimated/ [Actual Expenditure] A$
FIRST 15/11/90 - 14/11/91	Reprocess, interpret and map at least 59.2 km of available seismic data (amended from 62.0 km) **Actual: 82.9 km reprocessing** (59.2 km in EPP SA1) **+ 73.4 km acquisition**	60 000 **[122 009]**
SECOND 15/11/91- 14/11/92	Acquire, process and interpret at least 70 km of seismic data **Actual: 73.4 km recorded in YEAR 1**	100 000 **[13 452]**
THIRD 15/11/92- 14/11/93	Review data *** in progress ***	50 000
FOURTH 15/11/93 - 14/11/94	Acquire, process and interpret at least 70 km of seismic data	800 000 - 1 000 000
FIFTH 15/11/94 - 14/11/95	Drill one exploratory well to at least 2500 m	6 000 000
SIXTH 15/11/96 14/11/97	Review data	100 000 **TABLE 1**

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EPP SA-1 LEAD RESERVOIR PARAMETERS

E1...3 - EUMERALLA RESERVOIRED PLAYS

CR1...3 - TOP CRAYFISH RESERVOIRED PLAYS

IC1, IC2 - INTRA-CRAYFISH RESERVOIRED PLAYS

	E1	E2	E3	CR1	CR2	CR3	IC1	IC2
GRV (MMm3)	101	130	172	339	628	500	646	2030
Net to Gross	0.3	0.3	0.3	0.25	0.25	0.25	0.5	0.5
Porosity	0.3	0.3	0.3	0.3	0.3	0.3	0.24	0.17
HC Saturation	0.85	0.85	0.85	0.85	0.85	0.85	0.8	0.8
Fm Vol Factor Oil	1.1	1.1	1.1	1.25	1.2	1.2	1.4	1.45
Expans Factor Gas	65	67	62	154	141	158	191	216

Table 2

EPP SA-1 PERMIT EVALUATION

SCOPING RESERVES - OIL CASE

LEAD	OIP (MMBBLS)	RESERVES (MMBBLS)	RISK
E1	44	13	0.003
E2	57	17	0.003
E3	75	23	0.003
CR1	109	38	0.002
CR2	210	63	0.006
CR3	167	50	0.004
IC1	279	98	0.0007
IC2	599	180	0.0001

SCOPING RESERVES - GAS CASE

LEAD	GIP (TCF)	RESERVES (TCF)	RISK
E1	0.018	-	0.012
E2	0.024	-	0.012
E3	0.029	-	0.012
CR1	0.118	0.07	0.005
CR2	0.200	0.12	0.016
CR3	0.178	0.11	0.011
IC1	0.419	0.25	0.014
IC2	1.06	0.63	0.002

* From Otway Scoping Economics

Table 3

EPP SA-1 PERMIT EVALUATION

LEADS RISK SUMMARY

	E1	E2	E3	CR1	CR2	CR3	IC1	IC2
Trap	0.4	0.4	0.4	0.1	0.3	0.2	0.25	0.25
Source/Migration	0.4	0.4	0.4	0.3	0.3	0.3	0.5	0.25
Seal	0.3	0.3	0.3	0.5	0.5	0.5	0.4	0.1
Reservoir	0.3	0.3	0.3	0.5	0.5	0.5	0.3	0.3
Preservation	0.9	0.9	0.9	.095	0.95	0.95	0.95	0.95
Oil	0.2	0.2	0.2	0.3	0.3	0.3	0.05	0.05
Oil Chance	0.003	0.003	0.003	0.002	0.006	0.0040	0.0007	0.0001
Gas Chance	0.012	0.012	0.012	0.005	0.016	0.011	0.014	0.002

Table 4