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**BASS BASIN
"GEOLOGICAL EVALUATION"**

**Esso Standard Oil (Aust.) Ltd.,
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Bass Basin Geological Evaluation

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MEMORANDUM

September 11, 1967.

Geological Evaluation
Bass Basin.

Under terms of the May 5, 1967 Bass Basin Agreement between Esso and Hematite Petroleum, Esso agreed to evaluate certain geological information. This information is contained in the following reports -

AMDEL (1967); Core Sample Analysis of Seven Cores from Four Wells in Bass and Gippsland Basins. AMDEL Report MD 2848-67.

AMDEL (1967); Two Cylinders of Gas ex Esso Bass-3 Well 6740 feet. AMDEL Report AN 2662-67.

Esso Production Research Co. (1967); Summary of Organic Analysis of Samples from the Bass Basin.

Esso Production Research Co. (1967); Summary of Palynological Age Determination, Bass Basin.

State Laboratories Victoria (1967); Water from Esso Bass-3. Report 467, 477-67.

W.F. Threlfall (1967); Provenance of the Bass Basin Sandstones; Esso Standard Oil (Australia) Report AUST-67.

This memorandum summarizes the significance of these reports and reviews other aspects of basin exploration and potential.

Miocene

It cannot be determined, other than by drilling, whether the Miocene will form a trapping seal where the Lower Miocene oversteps the Oligocene along the margins of the basin. Lower Miocene fine grained sandstone, siltstone and marly siltstones lie on Permian basement at Wynyard in northwest Tasmania, indicating reduced seal potential in this area. The Middle Miocene in Bass-2 consists of soft sandstones and calcarenites, indicating coarser Miocene textures toward the Bassian Rise. Based on this evidence, as well as the increasing proportion of Oligocene and Eocene clastics toward the Bassian Rise and northeast Tasmania, the chance of Miocene clastics on basement (and subsequent loss of seal) along the eastern and northeastern flank of the basin is very likely.

Oligocene

- (1) Clastics in Section. The Bass-2 encountered 350 feet of soft, fine to medium grained, marine sandstone overlying the Upper Eocene Demons Bluff. This sandstone is 62 feet thick in Bass-1 and is absent in Bass-3. Siltstones and mudstones replace sandstones westerly across the basin. Oligocene sandstones were probably derived from granites along the Bassian Rise and northeast Tasmania and will be widespread in the east half of the basin.
- (2) Seal. The Oligocene probably does not seal the underlying Upper Eocene Demons Bluff along the east and northeast margin of the basin due to the presence of basal sandstone. The Oligocene on the western and northern margin of the basin is probably finer grained and may seal.
- (3) Source Potential. Esso Production Research Co. concludes the Bass Oligocene has "poor to fair" source potential when related to the Lakes Entrance in Gippsland or the

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Eocene-Paleocene shales in both basins. AMDEL points out that Bass Oligocene shale densities average 2.00, while those in Gippsland (at approximate equivalent depths) average 2.23. Bass Oligocene shales contain silt sized quartz and heavy minerals which are absent in Gippsland. As a result, Lakes Entrance shales in Gippsland have compressed more, because of the lower quartz content, than the Oligocene in Bass. This added reduction of porosity might be an important factor related to the migration of oil or gas from Oligocene in both basins.

Eocene-Paleocene

- (1) Stratigraphic Relations. Palynological age dates, prepared by Esso Production Research Co., suggest non-marine "Eocene" sandstones on the margin of the basin (Bass-2) intertongue with marine Demons Bluff carbonaceous siltstone and shales in the centre of the basin (Bass-1). Seismic correlations from Bass-1 to Bass-2 tie the top of the "Eocene" sandstone in both wells, suggesting these reflectors may follow lithologic, and not time, horizons. There is probably no "Eocene" unconformity in Bass-1 and Bass-3. There is no significant lithologic change occurring in the section where this unconformity has been proposed. The palynologic evidence (particularly in Bass-3) supports continuous sedimentation across the "seismic unconformity" horizon in these two wells. There is good evidence for an unconformity in Bass-2 at 4500 feet, however, because the Middle Eocene is probably absent.

Threlfall reports a dipmeter character change at about the same horizon and cuttings samples change from coarse grained sandstone to fine grained dolomitic cemented chips. The "Eocene unconformity" as seen on seismic records probably represents areas of rapid downwarp toward the centre of the basin during Middle Eocene time, followed by a transgression of Upper Eocene sedimentation toward the margin of the basin. The entire Eocene-Paleocene section is probably conformable over most of the central portion of the basin.

- (2) Sandstones. Threlfall conclusively demonstrates the source of Bass clastics was primarily mixed granites and metamorphics in northeast Tasmania and on the Bassian Rise. The Pre-Cambrian metasediment basement of northwestern Tasmania and King Island was not a significant source for early Tertiary clastics.

Early Tertiary sandstones are poor by Gippsland standards. The majority of permeability measurements we have made on Bass cores are less than 50 md, several are in the hundreds and the highest is 328 md. Porosities average 20 to 25%. The poor quality is due to immaturity of the sandstones as noted by large volumes of detrital clay and poor sorting. Threlfall did not observe any significant grading of clastics down section or across the basin, but suggests that sand quality may improve seaward or westerly or northwesterly. We might similarly conclude, however, that this evidence points to low-energy and thus poorer sandstones (by Gippsland standards) over the entire Bass Basin. In any event, it seems unreasonable to expect a thick or expansive section of "Latrobe-like" sands.

- (3) Seal. Our palynological correlations indicate sandstone climb section from Bass-1 and Bass-2. Threlfall indicates a similar sand source direction. Consequently, it is reasonable to expect the entire Upper Eocene section to be represented by sandstone along the east and northeast margin of the basin. Conversely, we do not expect a late Eocene (Demons Bluff) shale transgression or seal in this portion of the basin.
- (4) Source. Esso Production Research Co. reports both the marine Demons Bluff carbonaceous siltstone and underlying non-marine thin shale beds "represent strata with good potential for oil and gas". The Company analyzed four cores in the Demons Bluff, three cores in underlying non-marine shales, as well as canned cuttings from Bass-1 and Bass-2. The amount of total organic matter in the cores examined is above 2%, suggesting good source potential for oil and/or gas, and because the C15+ hydrocarbon yield exceeded more than 0.5% of the total organic matter, liquid, as well as gaseous hydrocarbons, were generated. The C8 - C14 values are not as conclusive. Analysis of canned cuttings show that Bass-1 and Bass-2 gave up considerably less wet gas than Marlin B-1 in Gippsland, for whatever this is worth.

The free wet gas recovered from a wireline formation test at 6740 feet does indicate that the non-marine Paleocene carbonaceous shales did at least generate some hydrocarbons. It does seem, however, that the prospects in this portion of the section will be limited by the amount of shale present. Bass-3 has the thickest non-marine shale section (300 feet, more or less), suggesting that better deep plays might be located on the west or north flanks of the basin. The interbedded relations between sand and shale suggest an anticlinal structure would be essential to a deep (or older section) play.

Cretaceous

The Bass-3 encountered about 650 feet of Upper Cretaceous, tight lithic sandstones which Threlfall shows was derived from the metamorphics of northwestern Tasmania. There is probably an unconformity between the Cretaceous and Tertiary in this well because of the change in source areas and because the Paleocene section appears shortened in this well. The Upper Cretaceous is non-marine and is probably distributed at the base of several graben or half graben wedges on the western margin of the Bass Basin. These Cretaceous rocks have a low exploration potential in our present evaluation.

Evaluation

- (1) Deep prospects, or plays, to test the Paleocene non-marine, will have to be anticlinal unless these rocks can be found unconformably sealed by shales at a structurally favourable location on the flanks of the basin.
- (2) The interplay of the potentially oil-gas source Demons Bluff and intertonguing non-marine sandstone is, stratigraphically, the most attractive portion of the section.
- (3) Lower Tertiary sandstones will not have the outstanding reservoir characteristics possessed by equivalent aged sands in Gippsland. On the basis of our experience so far, permeabilities in Bass might

average about 50 md and porosities between 20 and 25%.

- (4) The "Eocene" sand wedge plays described toward the Bassian Rise are marginal because -
- a) They do not occur on noses or arches.
 - b) Lateral closure is dependant on subtle change in direction of pinchout edge which is extremely difficult to detail from geophysical data.
 - c) The entire Upper Eocene is probably sandstone and the basinal Demons Bluff facies does not overlap sand.
 - d) The basal Oligocene is also probably sandstone and, consequently, may not seal.

The key factors relating to the profitability of a pinchout play in this portion of the basin are -

- a) The shallow objective - 1500 to 2000 feet.
 - b) The deep water - 250⁺ feet.
 - c) Interference from producing wells.
 - d) Suspect low permeabilities.
- (5) The potential of the basin is not "high" because the best prospects were drilled dry and, except for the one undrilled closed structure, no "interesting" structural features remain. Yet, seismic coverage is good enough to provide a reasonably detailed structural interpretation of the basin at least down to the Upper Eocene.
- (6) The northwest margin of the basin may have more potential than elsewhere, because -
- a) The section is expected to be more marine in this direction.
 - b) One of the major basin arches (the Mornington-King Island uplift) is in the area where locally Eocene shales might roll over and close underlying sandstone.
 - c) This region has the only major fault which strikes across the basin. A regional trap may be provided.

For these reasons exploration emphasis should be directed in the northwest margin of the basin.

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