W1016

ESSO EXPLORATION AND PRODUCTION
AUSTRALIA INC.

WELL COMPLETION REPORT
ADMIRAL-1
VOLUME-2
INTERPRETED DATA

VIC/P19
GIPPSLAND BASIN

ESSO AUSTRALIA RESOURCES LIMITED

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C O N T E N T S

F I G U R E S

A P P E N D I C E S

E N C L O S U R E S

GEOLOGICAL AND GEOPHYSICAL ANALYSIS

1. SUMMARY OF WELL RESULTS

Formation/Horizon	Pre-drill Depth (mSS)	Post Drill Depth (mSS)
Gippsland Limestone (seafloor)	-99	-101
Top of Latrobe Group	-1215	-1215
Intra T. lilliei Marker (Top of Volcanics)	-1510	-1471
Base of Volcanics	-1540	-1482
Top of Strzelecki Group	-1810	Not Penetrated
TD	-1850	-2141

2. INTRODUCTION

Admiral-1 was drilled to test a fault-dependent closure of N. senectus to T. apoxyexinus sandstones top sealed by volcanics and juxtaposed against impermeable Strzelecki Group by a normal fault in a situation analogous to the Kipper Discovery. The well was predicted to reach total depth in Strzelecki Group sediments.

Admiral-1 encountered a substantially thinner section of poorly developed volcanics 39m high to prediction. The prognosed reservoir section was present but dry, though it is dated as older P. mawsonii section. The well also encountered a substantially thicker section of early Latrobe Group, (P. mawsonii), which was not predicted. The most likely reason for the failure of the Admiral prospect is the lack of top seal, the volcanics failing to extend to the north bounding fault.

Admiral-1 represented the Year 2 commitment well for the VIC/P19 permit.

3. STRATIGRAPHY

Admiral-1 encountered the top of Latrobe Group at -1215mSS, as predicted, after penetrating 1114m of calcareous siltstone and limestones of the Gippsland Limestone and Lakes Entrance Formation. Thirty one metres of Lower N. asperus to P. asperopolis or Upper

<u>M</u>. <u>diversus</u> shales and siltstones equivalent to the Gurnard and Flounder Formations overlie the "Coarse Clastics". The base of the Gurnard/top of the Flounder Formation is interpreted at -1221mSS from electric logs.

The top of the "Coarse Clastics" is interpreted at 1248mSS, just above the first coal. One hundred and fifteen metres of coastal plain coals, shales and sandstones of <u>L</u>. <u>balmei</u> age overlie a Lower <u>L</u>. <u>balmei</u> package of marginal marine sediments. A coal identified elsewhere as the Mid Palaeocene Marker occurs at the base of the coastal plain section at -1364mSS.

A marine package consists of upper shoreface sands to offshore shales occurs below the coastal plain section. The marine dinoflagellate <u>T</u>. <u>evittii</u> is identified at -1409mSS confirming the basal Lower <u>L</u>. <u>balmei</u> age. Approximately 60m of <u>T</u>. <u>longus</u> aged coastal plain sediments below the Lower <u>L</u>. <u>balmei</u> marine package.

The top of the volcanics, interpreted to be the top seal on the primary target occurs at -1471mSS. They are poorly developed being just 11m thick. The character of the gamma-ray log suggests the incorporation of other clastic material, being more irregular and having a higher base line than the volcanics seen at Kipper. This may suggest proximity to the edge of a flow.

Well developed sandstones, siltstones and shales occur below the volcanics. Sandstones are well developed up to 10m thick and with porosities of up to 24%. The overall net-to-gross is 85%. This section is older than the reservoir section at Kipper, being dated as <u>P</u>. <u>mawsonii</u>. Eighty metres of massive shale occurs from -1579mSS and is dated as <u>P</u>. <u>mawsonii</u>. Below this approximately 500m of low net-to-gross early Latrobe Group siltstones, sandstones, shales and rare coals occur. These sediments are now dated as <u>P</u>. <u>mawsonii</u>. All of this shaly section is equivalent to the "Kipper Shale". At -2097mSS a massive shaley sandstone of very low porosity is encountered. This unit was previously interpreted as Strzelecki Group, now it appears to be earliest Latrobe Group, (Fission Track Analysis, Appendix 4).

4. STRUCTURE

Admiral-1 confirmed the pre-drill structural interpretation. The structure is a low side fault dependant closure against the Northern Bounding Fault System. Faulting is non-continuous at the top of Volcanics, (top of seal) however the faults are seen to be through going just below the intra *T. lilliei* unconformity. Seismic resolution below the level of the volcanics, (intra *T. lilliei* unconformity), remains very poor. The dipmeter run in Admiral-1 suggests structural dip of 10 to 12° to the west below the volcanics compared to a gentle 3° dip to the south in the younger Latrobe section. This confirms the intra *T. lilliei* unconformity as a major structural event. It also suggests that considerable structuring of the early Latrobe Group had taken place prior to the intra *T. lilliei* break up unconformity. The structural relationship between these early Latrobe Group sediments and the older Strzelecki Group remains unknown.

5. GEOPHYSICAL DISCUSSION

Seismic coverage of the Admiral prospect was provided by data from 3 surveys providing a north-south line spacing of 500m. Twenty six of these lines were reprocessed to provide improved resolution of faulting and to attempt to improve data quality below the intra *T. lilliei* unconformity. The depth structure map to the top of Latrobe Group remains unchanged post drill. (Enclosure 2).

The error in depth prediction for the intra *T. lilliei* unconformity (Enclosure 3) was 39m and may be partly accounted for by the two-way-time to the horizon being picked 12msec too low. In addition, velocity errors contributed to the difference in pre-drill and post-drill depths. Initially, an average velocity of 2465m/sec was used for depth conversion at the well location. The correct velocity from the well was 2424m/sec.

6. DISCUSSION

The geometry of the trap tested by the Admiral-1 well was found to be correct. The lack of reservoired hydrocarbons can most likely be ascribed to two reasons. Firstly, the volcanics prognosed to form the top seal may not extend as far as the north bounding fault, thus failing to seal the trap. Secondly, the identification of a thick section of lower Latrobe Group below the intra T. lilliei unconformity, rather than the prognosed Strzelecki Group suggests that perhaps lower Latrobe Group occurs on the highside of the bounding fault and that Strzelecki Group seal is not juxtaposed against the potential reservoir. However the older Latrobe Group is very shaley so than fault seal would be expected with very little movement along the northern fault.

The demonstrated occurrence of reservoir section below the volcanics suggests that similar prospects may be successful in situations where the volcanics can be demonstrated to extend to a bounding fault. Improved seismic data quality in the older Latrobe section will be critical to the definition of such traps.

FIGURES

ADMIRAL-1
Locality Map

Scale 1: 250 000

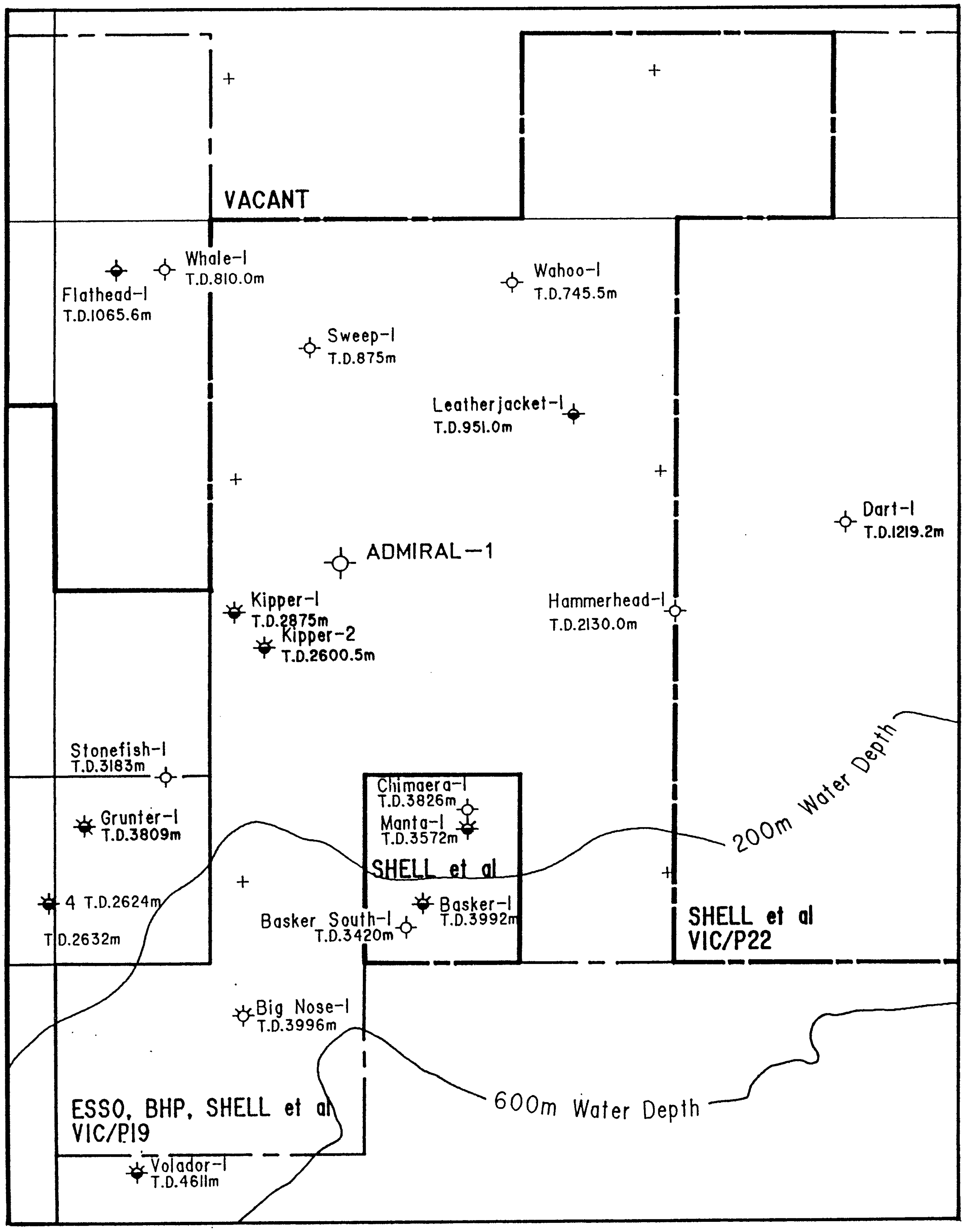

Fig. 1

Dwg.2455/OP/

APPENDIX
1

APPENDIX 1

APPENDIX-1

PALYNOLOGICAL ANALYSIS OF ADMIRAL-1
GIPPSLAND BASIN.

by

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INTERPRETED DATA

INTRODUCTION

Sixty-three samples comprising 47 sidewall core samples and 16 cuttings samples were processed from Admiral-1 and examined for spores, pollen and microplankton. Oxidized organic residue yields were mostly moderate to high except for the few samples from the marine Flounder and Gurnard Formations at the top of the Latrobe Group and the single sample from the overlying Seaspray Group which gave only very low to moderate yields. Palynomorph concentrations on the strew slides however were more variable but were mostly moderate to low. Preservation of palynomorphs overall was fair to good, and occasionally exceptional.

Analysis of the sequence in Admiral-1 can be divided between an "Upper" Latrobe Group section which was given routine examination and a "Lower" Latrobe Group section which was examined in more detail and partially quantitatively analysed with selective counting of samples.

Sixteen samples (including 14 SWCs) were analysed from the Maastrichtian to Eocene "Upper" Latrobe and Oligocene/Miocene Seaspray Group. Average spore-pollen diversity was 23.8 species per sample, with a maximum diversity of 63+ species. Microplankton, principally dinoflagellates cysts were present in 80% of the samples and exhibited their highest diversity in the marine Eocene samples.

The "Lower" Latrobe sequence below 1503m is Turonian to possibly Coniacian in age. Forty-seven samples (including 33 SWCs) were examined from this unit, and these had an average spore-pollen diversity of 18.7 species per sample, with a maximum diversity of 34+ species. Microplankton, which are chiefly represented by fresh water algae, including fresh water dinoflagellate cysts were recorded from nearly 90% of the samples. Diversity is very low ranging from 1 to 6+ species. Twelve of the sidewall cores were also counted and the results of this quantitative analysis is presented in Table-3.

Lithological units and palynological zones from base of the Seaspray Group to T.D. are given in the following summary. Interpretative data with identification of zones and confidence ratings are recorded in Table-1 and basic data on residue yields, preservation and diversity are recorded in Table-2. All species which can be identified with binomial names are tabulated on the two accompanying range charts.

PALYNOLOGICAL SUMMARY OF ADMIRAL-1

AGE	UNIT/FACIES	SPORE-POLLEN ZONES (Microplankton Zones)	DEPTH RANGE (mKB)
Oligocene-Early Miocene	Seaspray Group	*P. tuberculatus*	1234.5
UNCONFORMITY	1236.0m		
Middle Eocene	Gurnard Formation	Lower *N. asperus* (*A. australicum*)	1238.0-1241.4 (1241.4)
Early Eocene		*P. asperopolus*	1254.1
	1255.0m		
Early Eocene	Flounder Formation	*P. asperopolus* to Upper *M. diversus*	1268.7
UNCONFORMITY	1269.0m		
Paleocene	Upper Latrobe Group (coarse clastics)	Upper *L. balmei* (*A. homomorphum*)	1275.0-1285.8 (1275.0-1285.8)
Paleocene		Lower *L. balmei* (*T. evittii*)	1314.0-1430.8 (1427.0-1430.8)
Maastrichtian		Upper *T. longus*	1437.0-1477.5
	1492.0m		
Senonian	Unnamed Volcanics		
UNCONFORMITY	1503.0m		
Santonian?-Turonian	Lower Latrobe Gp. (Unnamed unit)	*P. mawsonii*	1518.3-1580.5
	1600.0m		
Santonian?-Turonian	Kipper Formation	*P. mawsonii* (*R. kipperii*)	1606.2-2071.3 (1606.2-2036.0)
	2073.0m		
Santonian?-Turonian	Lower Latrobe Gp. (Unnamed unit)	*P. mawsonii*	2103.5
	2117.0m		
Turonian?-Cenomanian?	Lower Latrobe Gp. (Arkosic sst.)	Not datable with palynology.	
	T.D. 2162.0m		

GEOLOGICAL COMMENTS

1. Admiral-1 was predicted to drill a 270 metres thick "Upper" Latrobe Group section of *T. apoxyexinus* to *N. senectus* Zones in age sandwiched between volcanics above (the seal) and Strzelecki Group sediments below (economic basement). Instead it found a 614 metres thick section of well dated *P. mawsonii* Zone age sediments referable to the "Lower" Latrobe Group, and then drilled 45 metres of indurated arkosic coarse grained sandstone to conglomerate before being plugged and abandoned.

2) The basal unit in Admiral-1 from 2117-2162m T.D. is not lithologically typical of the Strzelecki Group based on the petrographic description and fission track analysis (FTA) performed by Duddy *et al.* (1990). The most favoured interpretation is that at T.D. the well was still within the "Lower" Latrobe Group. The unit is nevertheless distinct from the overlying *P. mawsonii* Zone section, as it is much harder, based on slower drilling rate, higher sonic velocity and higher density. This is exemplified by the fact that although seven sidewall cores were programmed in this unit none were successfully recovered. SWC-2 at 2151.1m which was composed of floating rock fragments in a mud matrix was interpreted to be entirely downhole contamination and was not processed for palynology.

3) Palynological analysis of the cuttings sample at 2160m gave an assemblage grossly similar to those from the overlying *P. mawsonii* Zone and is therefore considered to be composed mostly of caved fossils. The only distinguishing feature of the assemblage is an increase in abundance of *Cyathidites australis s.l.* However this change is considered more likely to reflect a difference in environment of deposition rather than being a reliable indicator of a significant age difference.

4) The *P. mawsonii* Zone in Admiral-1 is one of the best sections of this age penetrated in the Gippsland Basin. The samples examined are in general characterised by better preserved and slightly more diverse palynomorph assemblages compared with other wells. The large number and good recovery of sidewall cores and the presence of a variety of depositional environments within the zone allowed the spore-pollen and microplankton assemblages to be better and more fully recorded. As a result a number of new spore-pollen species are recognised as stratigraphically significant and a better understanding of the effects of environment of deposition on assemblage composition was developed.

5) The 614 metres thick section referred to the *P. mawsonii* Zone between 1503-2117m can be lithologically subdivided into three units:-

UNIT	TOP	THICKNESS
"Upper unnamed unit"	1503m	197m
Kipper Formation	1600m	473m
"Lower unnamed unit"	2073m	44m

6) The most distinctive unit is the Kipper Formation which was first proposed as a discrete formation in the Kipper-1 well completion report (Marshall & Partridge, 1986). The environment of deposition of the bulk of the Kipper Formation is interpreted to be a large, and at times deep, fresh water lake. Evidence for this interpretation is derived from both lithology and palynology.

7) The Kipper Formation in Admiral-1 is dominantly a fine grained clastic unit composed of >85% siltstone to claystone with minor <15% fine to very fine grained sandstone and very minor <1% coal or carbonaceous beds which are all less than 1 metre thick. In Admiral-1 the cuttings descriptions suggest that the unit is predominantly siltstone but at least a third of the sidewall cores recovered from the unit are claystone and most of these are typically homogeneous. It is suggested that a lot of this clay has been washed out of the cuttings. This is supported by the palynological data which shows differences in the composition of assemblages comparing the cuttings and sidewall core preparations. On the electric logs the Kipper Formation is best characterised by a broad and consistent separation between the curves for the neutron porosity and bulk density logs. All logs suggest relatively thick homogeneous beds through the bulk of the unit and this implies a constant depositional environment, or rapid deposition, or both. Note for example, the thick beds at the top and bottom of the Kipper Formation at 1600-1681m and 2030-2073m. In contrast in the "Upper unnamed unit", and more especially in the Upper Latrobe Group, although there may be equivalent separation on some beds between neutron porosity/bulk density logs the bedding thickness is less (typically 1-5 metres) suggesting more frequent environmental changes (or slower average depositional rate?). Overall the dominance of fine grained clastics in the Kipper Formation suggests a more distal or offshore environment of deposition.

8) Another feature is the moderate but consistent carbonate content of the Kipper Formation which was determined as part of the geochemical analysis (Burns 1990, Table-1). The 27 SWC's analysed averaged 14%

CO_3 with a range of 2-36%. In contrast the "Upper unnamed unit" averaged 4% CO_3 with a range of 2-9%; and the Upper Latrobe Group averaged 3% with a range of 1-4%. The values below 5% can probably be mostly discounted allowing for some analytical error and diagenetic carbonate.

The higher carbonate content of the Kipper Formation suggested the possibility of biogenic carbonate so four SWCs were processed for microfossils. These were at 1789m (19% CO_3), 1843m (21%), 1873.2m (36%) and 1912m (21%). Except for a few obvious downhole contaminants from the drilling mud no calcareous microfossils were found.

The washed and sieved residues were also undistinguished except for the sample with the highest carbonate content at 1873.5m. The coarse sieved fraction of this sample was dominated by spheroidal grains which are either **oolites** or some type of **faecal pellets**. In case the idea of oolites is somewhat bizarre it is pointed out that oolitic limestone is recorded in trace amounts in the cuttings decription between 7930-40ft in Sunfish-1 over an interval now interpreted as Kipper Formation.

9) Traces of coal are recorded in the cuttings descriptions through the Kipper Formation at 1740-45m, 1815-20m, 1885-90m and 1985-90m. These confirm thin coals identified at 1883.5-84.5m and 1986-87m from the density log. Other possible coals identified on the density log such as at 1868-68.5m and 1901.5-02m, were not manifest in the cuttings descriptions. None of these coals are clearly expressed on the sonic log. Separation and palynological analysis of these coals are needed to determine their nature and perhaps their environment of deposition.

10) Low diversity assemblage of fresh water algae and microplankton are common throughout the *P. mawsonii* Zone and indicate that lacustrine environments are a characteristic feature of this time interval.

Algal and/or microplankton were recorded in 29 out of 33 (or 87%) of sidewall cores analysed from the *P. mawsonii* Zone. Diversity of these palynomorphs is typically 1 or 2 species in most samples but range to a high of 6+ species in the sample at 1606.2m from the top of the Kipper Formation (Table-2). This sample also had maximum algal and microplankton abundance of 29.7% (Table-3). Total diversity for entire zone is 19+ species.

The Kipper Formation contains most of the more diverse and abundant assemblages, and from this unit the *Rimosicysta kipperii* Microplankton Association (informally named in Partridge, 1990), has been identified between 1606.2-2036m. This association is based on the work of Marshall (1989) who described a highly unusual and mostly endemic group of algal cysts, from the Kipper Formation in Kipper-1, Sunfish-1 and from dredge samples from outcropping Latrobe Group sediments in the Bass Canyon.

11) The *R. kipperii* Association although widespread in the Gippsland Basin has not been recorded from known marine sections of equivalent age elsewhere around Australia. Conversely known marine dinoflagellate cyst of this age are not recorded from the Gippsland Basin. On this evidence, until demonstrated otherwise, the *R. kipperii* Association is interpreted as an exclusively lacustrine environmental association without evidence of esturine or marine environments originally suggested as possibilities by Marshall (1989, p.25).

12) The abundance of floral components within the spore-pollen assemblages also support an interpretation that the predominant environment of the Kipper Formation in Admiral-1 is the distal portion of a large lake or lake system.

The breakdown of the counts on the spore-pollen assemblages (Table-3) show an unusual dominance of gymnosperm pollen (51%-84%; average 65%). In particular there is a dominance of bisaccate pollen broadly referred to *Aliosporites/Podocarpidites* and the alete *Araucariacites/Dilwynites* groups. The dominance of these types is interpreted to be a manifestation of the "Neves effect", which is the tendency, for bisaccate pollen, certain buoyant spores, and other pollen with "comparatively great transportability" to have greater relative abundance the further offshore you go in any depositional basin (Traverse, 1988; p.413). As the "Neves effect" is characteristic of majority of samples through the Kipper Formation it suggests stability of environment through a considerable period of geological time and this is a prerequisite only fulfilled by a large lake.

13) The "Neves effect" is also manifest in samples at 1518.3m and 1580.5m from above the Kipper Formation. However these, and the other samples from the "Upper unnamed unit", contain few algae of the *R. kipperii* Association and the counts show greater swings or changes in dominance of different species or groups (eg. note dominance of

Podosporites microsaccatus at 1518.3m). It is suggested that while lacustrine environments predominate through this unit the "lake system" is no longer as stable or persistent.

14) Another feature of assemblage from the *P. mawsonii* Zone is the consistent occurrence of reworked spores and pollen. In order of prominence most of the reworking is from Triassic sediments, then Permian and least frequent is Early Cretaceous (Strzelecki Group) reworking. In the counts the reworking reaches a maximum of 6% but this is probably a conservative value because of the problems of being able to confidently identify all reworked specimens. As an example of this problem many reworked specimens of the dominant Triassic bisaccate *Falcisporites australis* have probably been included in the counts under the broad category *Aliosporites/Podocarpidites* because of problems of confident identification of the former species when poorly preserved. The greater frequency of the Triassic species of *Aratrisporites* spp. on the range chart compared to *Falcisporites australis* is clear evidence that the latter species, which is orders of magnitude more abundant in the Triassic than *Aratrisporites* spp., is under-represented in the counts.

15) Reworking is notably more abundant in the Lower compared to the Upper Latrobe Group. This characteristic of the Lower part of the group may reflect a more extensive exposure of sediments of Permian and Triassic age to erosion, which subsequently have been either removed or buried. In general however, reworking tends to be a feature of distal rather than proximal environments. For example it tends to be ubiquitous in oceanic sediments sampled by the Deep Sea Drilling Projects. In deltaic or coastal plain sedimentary sequences the presence or absence and abundance of reworking tends to correlate to provenance of sediments being deposited.

    The prominence of reworking in the Kipper Formation, relative to its near absence in the Upper Latrobe Group is here interpreted to support a more distal environment for the Kipper Formation and lends support to the large lake hypothesis.

16) In summary evidence that the Kipper Formation can be interpreted as a large lake is:-

    i) Dominance of fine clastics.
    ii) Mild to significant calcareous component of sediments.
    iii) Rarity of coals or clean sands.

iv) Common fresh-water algae and microplankton.
v) "Neves effect" displayed by spore-pollen.
vi) Common occurrence of reworked Triassic, Permian and Early Cretaceous spores and pollen.

This Turonian to Senonian lake is considered to extend about 100 km east-west by 50 km north-south based on the known distribution of the algal cysts of the *Rimosicysta kipperii* Association (ie. from Sweetlips-1 to Kipper-1 to dredge sample in Bass Canyon examined by Marshall, 1989). Assuming, based on comparison to modern lakes, a conservative average water depth of 100 metres the lake would have a volume of 500 km^3. A lake of this size would rank 18th on the list of the largest modern lakes of the world by volume, and therefore could justifiably be called a large lake (see Herdendorf, 1982, table-8).

17) Only one sidewall core and a single cuttings sample were analysed from the "Lower unnamed unit" between 2073-2117m. A similar assemblage to the overlying Kipper Formation was recorded except for the absence of the key index species of the *R. kipperii* Association. However, in the counts on the sidewall core at 2103.5m water-transported elements in the assemblage, represented by both the total spores at 62.4% and reworked category at 5.6%, are significantly higher than the gymnosperm pollen category at 36.9% which is (at least initially) wind transported. It therefore may be argued that this "Lower unnamed unit" has a higher "fluviatile component" to its assemblages relative to samples from the overlying Kipper Formation.

18) The palynomorph assemblages from the "Upper unnamed unit" show the greatest variation in assemblage composition and abundances within the *P. mawsonii* Zone. This is interpreted to reflect variations from "lacustrine" to more "deltaic" or "fluviatile" environments.

Notable features are absence of significant counts of the algae *Amosopollis cruciformis* and high angiosperm pollen abundances (see Table-3). The spores *Crybelosporites brenneri*, *Cyathidites minor* and *Foraminisporis asymmetricus* and megaspores are conspicuous in most samples and also have their highest abundances in this unit. The algae and microplankton diversity is also significantly less than from the underlying Kipper Formation.

19) Definition of the *P. mawsonii* Zone and its correlation to the geological time scale is based on the synthesis of Helby *et al.* (1987). Analysis of the assemblages in Admiral-1 have highlighted

the lack of documentation of the complete spore-pollen assemblages in the zone in all sequences across Australia. At present the Admiral-1 assemblages cannot be compared readily with any other sequence of the same age outside of the Gippsland Basin. Further, it is likely that the complete zone has not yet been penetrated in the Gippsland Basin. Both Admiral-1 and Kipper-1 are still within the zone at the base of their dated sequences, while the top of the zone is definitely an unconformity in Admiral-1 and there is suspected to be a break at the top of the zone in Kipper-1. According to Helby *et al.* (1987) the *P. mawsonii* Zone extends from the base of the Turonian to just into the base of the Santonian, which is a time interval of 4 million years on the geochronometric scales of both Harland *et al.* (1982) and Haq *et al.* (1987, 1988). A rate of deposition greater than 154 m/m.y. (metres/million years) is therefore calculated for the sequence in Admiral-1. This rate is near the top of the range of maximum depositional rates for latest Cretaceous sections in the Gippsland Basin. For example, the thick Maastrichtian in Hermes-1 has a depositional rate of 207+ m/m.y. and in Volador-1 the equivalent section the rate is 168 m/m.y. In the Tertiary part of the Upper Latrobe Group depositional rates are typically lower. For example in the thickest Paleocene section located below the Marlin field the maximum depositional rate is about 75 m/m.y.

Considering the above deposition rates it is likely that the *P. mawsonii* Zone in Admiral-1 represents a considerable proportion of the time interval of the zone and probably represents a significant part of both the Turonian and Coniacian Stages.

20) The top of the Lower Latrobe Group in Admiral-1 is marked by the Late Cretaceous erosive unconformity described by Lowry (1987, 1988). For simplicity the unconformity is picked at 1503m at the base of the volcanics unit. It is noted however that the sidewall core recovered at 1508.1m is a conglomerate with quartz and lithic pebbles and was considered unsuitable for palynological age dating. As this lithology is quite distinct from all other sidewall cores recovered from the *P. mawsonii* Zone it is suggested the major unconformity may lie at 1509m immediately below the conglomerate and not directly at the base of the volcanic unit. Therefore there could be 6 metres of section of *T. apoxyexinus* or *N. senectus* Zone age below the volcanic unit. Because of severe cavings problems, at this level in the well, it would not be possible to confirm this interpretation by analysis of cuttings.

21) In the Upper Latrobe Group the sequence thins significantly from 570 metres in Kipper-1 to 267 metres in Admiral-1. All units thin and there is a loss of zones or parts of zones in Admiral-1 relative to Kipper-1.

22) Of particular interest and most difficult to explain is absence of the *M. druggii* Dinoflagellate Zone at the base of the marine shale and condensed section between 1423-1432m in Admiral-1 compared to its presence in the equivalent unit in Kipper-1 between 1723-1735m. The log character and thickness of this condensed section is very similar between the two wells.

23) The top of the Latrobe Group coarse clastic section in Admiral-1 is of Upper *L. balmei* Zone age. In Kipper-1 there is an additional 35+ metres of section referred to the Lower *M. diversus* Zone with the key *A. hyperacanthum* Dinoflagellate Zone occurring at the base of the section. It is considered these latter zones have been removed by erosion in Admiral-1 prior to deposition of the Flounder Formation. The unconformity is correlated to one of the erosive events which cut the Tuna-Flounder Channel.

24) The top of Flounder Formation between 1255-1268m is also considered to be an unconformity, this time correlated with the erosive event which cut the Marlin Channel. The presence of the *P. asperopolus* Zone at the base of the overlying Gurnard Formation is consistent with age dating of the Marlin Channel discussed in Marshall & Partridge (1988).

25) In both Admiral-1 and Kipper-1 the Gurnard Formation has not been demonstrated to contain section younger than the Lower *N. asperus* Zone. Elsewhere in the basin the Gurnard Formation frequently extends into the Middle *N. asperus* Zone and rarely into the Upper *N. asperus* Zone. The absence of these latter zones and the sharp log break at the Gurnard Formation in both wells suggest the top of the Latrobe Group is possibly an erosive unconformity. The consistent thickness of the Gurnard Formation between Admiral-1 and Kipper-1 would not however indicate the loss of any significant section.

BIOSTRATIGRAPHY

Zone and age-determinations have been made using criteria proposed by Stover & Partridge (1973), Helby *et al.* (1987) and unpublished observations made on Gippsland Basin wells drilled by Esso Australia Ltd. The description of the zones identified is presented in the order of oldest to youngest as in the formal definitions of the zones the first appearances of species are considered to be the most reliable criteria.

Author citations for most spore-pollen species can be sourced from Stover & Partridge (1973, 1982), Helby *et al.* (1987) and Dettmann & Jarzen (1988) or other references cited herein. Author citations for dinoflagellates can be found in Lentin & Williams (1985, 1989). Principal reference for other microplankton and algal cysts are Marshall (1989), Marshall & Partridge (1988) and Srivastava (1984). Species names followed by "ms" are unpublished manuscript names.

Phyllocladidites mawsonii **Zone: 1518.3-2103.5 metres Santonian?-Turonian**

This zone is identified on the rare and infrequent presence of *Phyllocladidites mawsonii* and the absence of index species for the overlying *T. apoxyexinus* Zone or younger zones.

Phyllocladidites mawsonii was recorded in 17 out of the 33 sidewall cores examined which represents 52% of the samples. The species was also recorded from a majority of the cutting samples but these records are unreliable because of the probability of some down hole contamination. In the samples counted *P. mawsonii* abundance ranges from zero, or not recorded in count to a maximum of 1.8% (Table-3). As a comparison *P. mawsonii* in the *L. balmei* and *T. longus* Zones in Sweetlips-1 from which 18 samples were counted has an abundance range of 0 to 56.7% and an average abundance of 9.8% (Partridge, 1990; table-3).

The assemblages in Admiral-1 show several of the other key species shown as diagnostic or ranging through the zone on the range chart of Helby *et al.* (1987, fig.33). There is however almost an equal number of species which were either not recorded or found only extremely rarely. A third group consists of new or previously unrecorded species.

Diagnostic species recorded and their range in Admiral-1 are:-

Amosopollis cruciformis	Abundant	1518.3m-2160m*
Appendicisporites distocarinatus	Frequent	1518.3m-2160m*
Crybelosporites striatus	Rare	1555.6m-2056.0m
Cyatheacidites tectifera	Frequent	1640m*-2105m*
Foraminisporis asymmetricus	Frequent	1518.3m-1912.0m
Foraminisporis wonthaggiensis	Rare	1563.9m-1850m*
Interulobites intraverrucatus	Very Rare	1700m*-2056.0m

* Cuttings

Species considered diagnostic by Helby *et al*. (1987) either not recorded or recorded only extremely rarely in Admiral-1 are:-

Aequitriradites spinulosus	Not recorded.
Australopollis obscurus	Only caved specimens recorded.
Clavifera triplex	Single specimens at 1563.9m and 2103.5m
Contignisporites spp.	All specimens considered reworked.
Lygistepollenites florinii	Not recorded.
Phimopollenites pannosus	Not confidently recorded.
Trilobosporites trioreticulosus	Not recorded.

Previously described species either recorded for the first time in the *P. mawsonii* Zone in the Gippsland Basin or considered to have enhanced biostratigraphic significance because of their documentation in Admiral-1:-

Arcellites sp. cf. *A. disciformis* Miner 1935	1518.3m-1831.0m
Balmeisporites holodictyus Cookson & Dettmann 1958	1518.3m-2056.0m
Crybelosporites brenneri Playford 1971	1518.3m-2056.0m
Foveotricolpites robustus Singh 1983	1518.3m-1912.0m
Liliacidites peroreticulatus (Brenner)	1555.6m-1563.9m
Senectotetradites varireticulatus Dettmann 1973	1750m*-1930m*
Striatopollis paraneus (Norris)	1750m*-1930m*

* Cuttings

New species identified in Admiral-1 with considerable future potential for zone identification and subdivision are:-

Coptospora pileolus n.sp.	1555.6m-1930m*
Densoisporites muratus n.sp.	1620.1m-2060m*
Dilwynites echinatus n.sp.	1728.5m-2016.1m

Hoegisporis trinalis n.sp.	1912.0m-2103.5m
Laevigatosporites musa n.sp.	1563.9m-2056.0m
Phyllocladidites eunuchus n.sp.	1972.5m-2056.0m
Rugulatisporites admirabilis n.sp.	1518.3m-2160m*

* Cuttings

Assemblage counts sufficient for determination of meaningful percentages were made on about a quarter of the samples in the zone and these are given on Table-3. Partial counts were made on some other samples, but these counts were insufficient (<100 specimens) for calculation of meaningful percentages, but they are consistent with broad generalizations.

The counts show the *P. mawsonii* Zone spore-pollen assemblages are dominated by gymnosperm pollen (av. 60%) with secondary spores (av. 37%) and rare angiosperm pollen (<3%). The most characteristic aspect of the gymnosperm pollen is the dominance of a small sized variety of *Dilwynites granulatus*. This form probably needs a new specific epithet as its size range is significantly different from "topotypic" populations of *D. granulatus* from the Paleocene. Bisaccate gymnosperm pollen referred to the broad category *Aliosporites/Podocarpidites* are the next most abundant. Unfortunately no diagnostic species to be recognised in this broad group. The comparative rarity of angiosperm pollen is somewhat of a surprise. Most conspicuous is virtual absence of triporate grains particularly *Proteacidites* spp. Thus, the assemblages on initial impressions do not obviously belong to the *Proteacidites* Superzone of Helby *et al*. (1987, p.55).

Average spore-pollen diversity is 18+ species per sample through the zone. Range chart-2 which is solely for the *P. mawsonii* Zone shows a total *in situ* spore-pollen diversity of 63 species and about a third of these can be regarded as common species. In addition another 30 species of reworked spores and pollen were recorded, although this diversity is probably a gross under-estimation because only the common or highly distinctive reworked species were consistently recorded.

The relative high diversity through the zone and number of new species recorded suggests that there is significant potential for subdivision of and more detailed correlation within the *P. mawsonii* Zone. However to be able to do this it would be necessary to re-examine other sections of the *P. mawsonii* Zone in the Gippsland Basin. For example the thick section of the zone in Kipper-1 needs to be re-examined to either find or confirm the absence of the new and previously unrecorded species documented in Admiral-1.

Rimosicysta kipperii **Microplankton Zone: 1606.2-2036.0 metres.**

Algal microfossils including dinoflagellates are present in 30 out of 33 sidewall cores (91% of samples) in the *P. mawsonii* Zone interval. Total species diversity is moderate with 19 types identified. Most species recognised have been documented in Marshall (1989). Significant exceptions are small smooth or finely spinose spheres assigned respectively to *Sigmopollis carbonis* and *S. hispidus*. The description and environmental distribution of these species are best summarised in Srivastava (1984). The most consistently present form and overall most abundant is however *Amosopollis cruciformis*. Although originally described as a possible angiosperm pollen it's observed environmental distribution suggests strongly that it is some type of algae.

Species of *Rimosicysta* and *Wuroia* are distributed sporadically through the Kipper Formation. They are probably commoner than suggested by their occurrences on the range chart, because confident species identification is difficult where preservation is poor. This overall microplankton association is named the *Rimosicysta kipperii* Microplankton Zone or Association after the morphologically simplest species. A noted feature of the assemblages is the absence of the morphologically distinctive species *Limbicysta pediformis, L. guttularis, Rimosicysta cucullata* and *Tetrachacysta? keenei*. Their absence suggests that the complete time interval for the *P. mawsonii* Zone is probably not represented in Admiral-1.

Upper *Tricolpites longus* **Zone: 1437.0-1477.5 metres** **Maastrichtian**

The two sidewall cores samples are assigned to the zone with high confidence on the presence in both samples of *Stereisporites (Tripunctisporis)* spp. and common *Gambierina rudata*. The shallower sample also has the LADs of the important species *Quadraplanus brossus* and *Tricolporites lilliei*, while the deeper sample is characterised by common *Peninsulapollis gillii* and *Triporopollenites sectilis*.

The cuttings sample at 1495m from the volcanics interval referred to undifferentiated *T. longus* Zone is considered likely to contain only caved palynomorphs and is unlikely to be indicative of the age of the volcanics.

Lower *Lygistepollenites balmei* Zone: 1314.0-1430.8 metres Paleocene.
and
Trithyrodinium evittii Zone: 1427.0-1430.8 metres Paleocene.

This zone is represented by three sidewall cores from the condensed marine interval between 1423-1432m and two sidewall cores from the coastal plain facies above 1388m. The three lower samples contain mixed assemblages of both *T. longus* and *L. balmei* Zone spore-pollen species, but because of the frequent to abundant occurrence of the key dinoflagellate *Trithyrodinium evittii* assignment to the Lower *L. balmei* Zone is preferred. The following *T. longus* Zone index species are considered reworked: *Beaupreaidites orbiculatus* at 1430.8m, *Proteacidites clinei* at 1427.0m and 1430.8m; *P. reticuloconcavus* ms at 1430.8m, and *Triporopollenites sectilis* at 1427.0m and 1430.8m. Most of these records represent only single specimen occurrences. The only pollen species restricted to the Lower *L. balmei* Zone in the samples is *Proteacidites angulatus* at 1427.0m and 1428.9m. Of the two shallower samples, the lower at 1359.6m gave a limited assemblage but clearly belongs to the broader *L. balmei* Zone. Important oldest occurrences in the sample are *Australopollis obscurus* and *Milfordia homeopunctatus*. The higher sample at 1314.0m yielded a high diversity assemblage with presence of *Integricorpus antipodus* and FADs for *Haloragacidites harrisii* and *Myrtaceidites parvus/mesonesus*. The algae *Amosopollis cruciformis* is common in the sample which suggests a lacustrine environment, while the bed thickness (<3 metres) suggests the lake was ephemeral.

The *T. evittii* Zone is recognised in Admiral-1 on the acme of the eponymous species in accordance with the original definition of Helby *et al.* (1987). The associated microplankton although slightly more diverse than in other wells are all long ranging species and therefore are not very diagnostic.

Upper *Lygistepollenites balmei* Zone: 1275.0-1285.8 metres Paleocene.
and
Apectodinium homomorphum Zone: 1275.0-1285.8 metres Paleocene.

The two samples in this interval are both confidently assigned to the Upper *L. balmei* Zone on the FADs for *Proteacidites annularis* at 1285.8m, and *Cupanieidites orthoteichus* and *Cyathidites gigantis* at 1275.0m. Aside from *Lygistepollenites balmei* species with diagnostic LADs for the zone are rare. However, supporting the spore-pollen evidence for this age is the occurrence of the dinoflagellate *Apectodinium homomorphum* (short spined variety), which is abundant in the deeper sample and rare in the shallower.

Upper *Malvacipollis diversus* Zone
to
Proteacidites asperopolus Zone: 1268.7 metres Early Eocene.

Only a single sidewall core was recovered from the interval assigned to the Flounder Formation. Unfortunately the glauconitic sandstone from this core only gave an extremely meager residue. The palynomorph assemblage is dominated by the dinoflagellate cyst *Paralecaniella indentata* which has no zone significance. Other dinoflagellates and the spores-pollen are rare and not particularly diagnostic. An age no older than the Upper *M. diversus* Zone is suggested solely on the presence of the dinoflagellate cyst *Apectodinium longispinosum*. The lithology and electric log character support this age assignment as the marine glauconitic facies is more consistent with assignment to the Flounder Formation rather than being related to the lower coastal plains environment of the underlying Upper *L. balmei* Zone.

Proteacidites asperopolus Zone: 1254.1 metres Early Eocene.

This sample is assigned to the *P. asperopolus* Zone on the association of frequent *Conbaculites apiculatus* with *Proteacidites asperopolus* and the absence of any noticeable abundance of *brassii* type *Nothofagidites* pollen. *Nothofagidites flemingii* however is common, but this species is referred to the *fusca* group *of Nothofagidites* pollen and it can occur in some abundance in this zone. This sample also has the highest recorded spore-pollen diversity (63+ species) of all samples in Admiral-1. Whilst high diversity is also "typical" of samples from the *P. asperopolus* Zone it is noted that *Myrtaceidites tenuis* was not recorded. The LAD of this species is considered the most important criteria for picking the the top the *P. asperopolus* Zone and its absence (or extreme rarity?) suggest this assemblage is near the top of the zone. Because of this uncertainty only a Confidence Rating of 2 is given to the zone pick. The microplankton recorded from the sample are not diagnostic.

Lower *Nothofagidites asperus* Zone: 1238.0-1241.4 metres Middle Eocene.
and
Areosphaeridium australicum Zone: 1241.4 metres Middle Eocene.

The two samples are assigned to this zone on the common occurrence of *Nothofagidites* spp. of the *brassii* group. Key spore-pollen index species are rare but include the FAD for *Nothofagidites falcatus* and the LAD for

Proteacidites asperopolus both in the shallower sample at 1238.0m. The latter datum is indicative of an age no younger than the Lower subzone, although in the offshore marine environment represented in Admiral-1 it is possible that *P. asperopolus* could be reworked. A more definitive age is obtained by the microplankton in the deepest sample. The key species are the dinoflagellate *Areosphaeridium australicum* ms (= *Areosphaeridium* sp. cf. *A. diktyoplokus* of Marshall & Partridge 1988) and the acritarch *Tritonites tricornus* Marshall & Partridge 1988.

Proteacidites tuberculatus Zone: **1234.5 metres** **Miocene-Oligocene**.

This very low yield sample is assigned to the *P. tuberculatus* Zone on its microplankton content as the associated spores and pollen whilst supportive are not diagnostic. The key dinoflagellate species is *Protoellipsodinium simplex* ms which is abundant in the sample. Abundant occurrences of this species are typical of the younger part of this spore-pollen zone in the marine section in the offshore Gippsland Basin. An Early Miocene rather than Oligocene age is therefore favoured for the base of the marine Seaspray Group in Admiral-1. Equivalent ages are documented in Tuna field wells and in Sweep-1, while Hammerhead-1 has a thin section (<8 metres) of the Early Oligocene Zonule J-1 recorded immediately overlying the Latrobe Group. Other nearby well lack micropalaeontological data.

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PALYNOLOGY DATA SHEET

BASIN: Gippsland **ELEVATION:** KB: +21 m GL: -101 m

WELL NAME: Admiral-1 **TOTAL DEPTH:** 2162 m

AGE	PALYNOLOGICAL ZONES	HIGHEST DATA				LOWEST DATA			
		Preferred Depth	Rtg	Alternate Depth	Rtg	Alternate Depth	Rtg	Preferred Depth	Rtg
NEOGENE	*T. pleistocenicus*								
	M. lipsis								
	C. bifurcatus								
	T. bellus								
	P. tuberculatus							1234.5	2
PALEOGENE	Upper *N. asperus*								
	Middle *N. asperus*								
	Lower *N. asperus*	1238	2					1241.4	0
	P. asperopolus							1254.1	2
	Upper *M. diversus*								
	Middle *M. diversus*								
	Lower *M. diversus*								
	Upper *L. balmei*	1275	0					1285.8	0
	Lower *L. balmei*	1314	2	1427	0	1428.9	0	1430.8	2
LATE CRETACEOUS	Upper *T. longus*	1437	1					1477.5	1
	Lower *T. longus*								
	T. lilliei								
	N. senectus								
	T. apoxyexinus								
	P. mawsonii	1518.3	2	1580.5	1	2071.3	1	2103.5	2
	A. distocarinatus								
EARLY CRET.	*P. pannosus*								
	C. paradoxa								
	C. striatus								
	C. hughesii								
	F. wonthaggiensis								
	C. australiensis								

COMMENTS: All depths in metres.

Dinoflagellate Zones: *A. australicum* 1241.4; *A. homomorphum* 1275-1285.8 m; *T. evittii* 1427-1430.8 m.

CONFIDENCE RATING:

0: SWC or Core, Excellent Confidence, assemblage with zone species of spores, pollen and microplankton.
1: SWC or Core, Good Confidence, assemblage with zone species of spores andpollen or microplankton.
2: SWC or Core, Poor Confidence, assemblage with non-diagnostic spores, pollenand/or microplankton.
3: Cuttings, Fair Confidence, assemblage with zone species of either spores and pollen and/or microplankton.
4: Cuttings, No Confidence, assemblage with non-diagnostic spores, pollen and/or microplankton.

NOTE:
If an entry is given a 3 or 4 confidence rating, an alternative depth with abetter confidence rating should be entered, if possible. If a sample cannot be assigned to one particular zone,then no entry should be made, unless a range of zones is given where the highest possible limit will appear in one zone and the lowest possible limit in another.

DATA RECORDED BY: A.D. Partridge **DATE:** June 1990

DATA REVISED BY: **DATE:**

TABLE-1: INTERPRETATIVE PALYNOLOGICAL DATA ADMIRAL-1, GIPPSLAND BASIN

Sheet 1 of 3

SAMPLE TYPE	DEPTH (metres)	SPORE-POLLEN ZONE	DINOFLAGELLATE ZONE (OR ASSOCIATION)	CONFIDENCE RATING	COMMENT
SWC 60	1234.5	*P. tuberculatus*	*(P. simplex)*	2	Age based on dinoflagellates.
SWC 59	1238.0	Lower *N. asperus*		2	*Proteacidites asperopolus* present.
SWC 58	1241.4	Lower *N. asperus*	*A. australicum*	0	*Tritonites tricornus* present.
SWC 57	1254.1	*P. asperopolus*		2	*H. harrisii* > *Nothofagidites* spp.
SWC 56	1268.7	No older than Upper *M. diversus*	*(A. longispinosum)*	-	Dominated by *Paralecaniella indentata*.
SWC 55	1275.0	Upper *L. balmei*	*A. homomorphum*	0	FAD *Cyathidites gigantis*.
SWC 54	1285.8	Upper *L. balmei*	*A. homomorphum*	0	
SWC 53	1314.0	Lower *L. balmei*		2	Common *Amosopollis cruciformis*
SWC 52	1359.6	*L. balmei*		2	
SWC 51	1427.0	Lower *L. balmei*	*T. evittii*	0	
SWC 50	1428.9	Lower *L. balmei*	*T. evittii*	0	
SWC 49	1430.8	Lower *L. balmei*	*T. evittii*	2	
SWC 48	1437.0	Upper *T. longus*		1	LAD *Quadraplanus brossus*.
Cuttings	1445	*L. balmei/Upper T. longus*		3	Most palynomorphs caved.
SWC 47	1477.5	Upper *T. longus*		1	FAD *Stereisporites (Tripunctisporis)* spp.
Cuttings	1495	*T. longus*		3	Palynomorphs all caved.
SWC 45	1518.3	*P. mawsonii*		2	LADs for number of species.
Cuttings	1540	Indeterminate			Dominated by caved palynomorphs.
Cuttings	1545	Indeterminate			Dominated by caved palynomorphs.
SWC 43	1555.5	*P. mawsonii*		2	Dominated by fines.
SWC 42	1563.9	*P. mawsonii*		2	Rich assemblage, common megaspores.
SWC 41	1580.5	*P. mawsonii*		1	Dominated by gymnosperm pollen.
SWC 39	1606.2	*P. mawsonii*	*(R. kipperii)*	0	Abundant microplankton.
SWC 38	1620.1	*P. mawsonii*		2	
Cuttings	1640	*P. mawsonii*	*(R. kipperii)*	3	
SWC 37	1648.5	Indeterminate			
SWC 36	1680.5	*P. mawsonii*	*(R. kipperii)*	2	
SWC 35	1697.5	*P. mawsonii*	*(R. kipperii)*	1	*Amosopollis cruciformis* >18%

TABLE-1: INTERPRETATIVE PALYNOLOGICAL DATA ADMIRAL-1, GIPPSLAND BASIN

Sheet 2 of 3

SAMPLE TYPE	DEPTH (metres)	SPORE-POLLEN ZONE	DINOFLAGELLATE ZONE (OR ASSOCIATION)	CONFIDENCE RATING	COMMENT
Cuttings	1700	*P. mawsonii*	*(R. kipperii)*	3	LAD *Cyatheacidites tectifera.*
SWC 34	1728.4	Indeterminate	*(R. kipperii)*		*Wuroia corrugata* present.
SWC 33	1749.5	*P. mawsonii*		1	
Cuttings	1750	*P. mawsonii*		2	LAD *Senectotetradites varireticulatus.*
SWC 32	1768.8	*P. mawsonii*	*(R. kipperii)*	0	
SWC 31	1789.0	*P. mawsonii*	*(R. kipperii)*	0	*Amosopollis cruciformis* >20%
Cuttings	1790	Indeterminate			
SWC 30	1796.0	*P. mawsonii*		2	
SWC 29	1806.6	*P. mawsonii*		2	
SWC 28	1816.6	*P. mawsonii*		2	
SWC 27	1831.0	*P. mawsonii*		1	
SWC 26	1843.1	*P. mawsonii*	*(R. kipperii)*	2	*Amosopollis cruciformis* abundant >28%
Cuttings	1850	*P. mawsonii*	*(R. kipperii)*	3	
SWC 25	1858.1	Indeterminate			
Cuttings	1870	*P. mawsonii*		3	
SWC 24	1873.2	*P. mawsonii*		1	Abundant reworking.
SWC 23	1899.0	*P. mawsonii*	*(R. kipperii)*	2	FAD *Wuroia corrugata.*
Cuttings	1910	*P. mawsonii*		3	
SWC 22	1912.0	*P. mawsonii*		1	FAD *Coptospora pileolus* ms.
Cuttings	1930	*P. mawsonii*		3	*Coptospora pileolus* frequent.
SWC 21	1936.0	*P. mawsonii*		1	
SWC 20	1961.1	Indeterminate			
SWC 19	1972.5	*P. mawsonii*		1	
SWC 18	1988.0	*P. mawsonii*		2	
Cuttings	2010	Indeterminate			No older than *A. distocarinatus* Zone.
SWC 17	2016.1	*P. mawsonii*	*(R. kipperii)*	1	
SWC 16	2036.0	*P. mawsonii*	*(R. kipperii)*	2	FAD *Rimosicysta* spp.
SWC 15	2048.9	Indeterminate			
Cuttings	2060	Indeterminate			No older than *A. distocarinatus* Zone.
SWC 14	2056.0	*P. mawsonii*		1	FAD *Balmeisporites holodictyus.*

TABLE-1: INTERPRETATIVE PALYNOLOGICAL DATA ADMIRAL-1, GIPPSLAND BASIN

Sheet 3 of 3

SAMPLE TYPE	DEPTH (metres)	SPORE-POLLEN ZONE	DINOFLAGELLATE ZONE (OR ASSOCIATION)	CONFIDENCE RATING	COMMENT
SWC 13	2061.5	*P. mawsonii*		1	
SWC 12	2071.3	*P. mawsonii*		1	FAD *Phyllocladidites mawsonii.*
SWC 9	2103.5	*P. mawsonii*		2	FAD *Cyatheacidites tectifera.*
Cuttings	2105	Indeterminate			No older than *A. distocarinatus* Zone.
Cuttings	2160	Indeterminate			

LAD = Last Appearance Datum
FAD = First Appearance Datum

Range chart missing

BASIC DATA

TABLE-2: BASIC DATA

TABLE-3: PALYNOMORPH PERCENTAGES FOR

P. MAWSONII ZONE.

RANGE CHART FOR SAMPLES BETWEEN

1234.5m - 1495m

AND

1518.3m - 2160m

TABLE-2: BASIC PALYNOLOGICAL DATA ADMIRAL-1, GIPPSLAND BASIN

SP|P Dino Sheet 1 of 3

SAMPLE TYPE	DEPTH (metres)	LAB. NO.	LITHOLOGY	RESIDUE YIELD	PALYNOMORPH CONCENTRATION	PRESERVATION	NO. OF S-P SPECIES*	MICROPLANKTON ABUNDANCE	NO. SPECIES*
SWC 60	1234.5	78290 H	Calcareous claystone	Very Low	Low	Fair-good	12+	High	7+
SWC 59	1238.0	78290 G	Brown glauconitic sandstone	Moderate	Moderate	Poor	22+	Low	4+
SWC 58	1241.4	78290 F	Brown glaucontic siltstone	Moderate	High	Low	41+	High	10+
SWC 57	1254.1	78290 E	Siltstone (trace glauconite)	Low	High	Good	63+	Moderate	9+
SWC 56	1268.7	78290 D	Glauconitic sandstone	Very Low	Low	Poor-fair	11+	High	5+
SWC 55	1275.0	78290 C	Homogeneous siltstone	High	Low	Fair	21+	Low	2
SWC 54	1285.8	78290 B	Claystone	High	High	Fair	21+	High	3
SWC 53	1314.0	78290 A	Claystone	High	High	Fair	31+	Low	2
SWC 52	1359.6	78289 Z	Claystone	Moderate	Low	Good	11+	Low	1
SWC 51	1427.0	78289 Y	Carbonaceous siltstone	Moderate	Moderate	Fair-good	22+	High	7+
SWC 50	1428.9	78289 X	Glauconitic sandstone/siltstone	Moderate	Low	Fair	15+	Low	3+
SWC 49	1430.8	78289 W	Glauconitic sandstone	Moderate	Low	Poor-good	23+	Low	5+
SWC 48	1437.0	78289 V	Carbonaceous siltstone	Moderate	Low	Poor-fair	22+		
Cuttings	1445	78281 J		Moderate	Moderate	Fair-good	15+	Low	1
SWC 47	1477.5	78289 U	Homogeneous claystone	High	High	Good	26+	Very Low	1
Cuttings	1495	78281 K	(Volcanic interval)	Moderate	Moderate	Fair-good	22+	Very Low	1
SWC 45	1518.3	78289 S	Homogeneous claystone	High	Low	Poor-fair	24+	Low	4
Cuttings	1540	78281 L		Moderate	Low	Poor-good	13+		
Cuttings	1545	78281 S		Very Low	Low	Poor-good	4+		
SWC 43	1555.5	78289 Q	Claystone	High	High	Poor-good	24+	Low-High	2
SWC 42	1563.9	78289 P	Homogeneous claystone	High	High	Good	29+	Low	4
SWC 41	1580.5	78289 O	Mottled siltstone	High	Moderate	Fair	33+	Low	3
SWC 39	1606.2	78289 M	Homogeneous claystone	High	Moderate	Fair	21+	High	6+
SWC 38	1620.1	78289 L	Siltstone	High	Moderate	Fair	23+	Low	5
Cuttings	1640	78281 N		High	Moderate	Good	13+	Low	2+
SWC 37	1648.5	78289 K	Siltstone	High	Low	Fair	12+	Low	1
SWC 36	1680.5	78289 J	Homogeneous claystone	High	Low	Fair	13+	Low	3
SWC 35	1697.5	78289 I	Homogeneous siltstone	High	Low	Fair	15+	Low	2

TABLE-2: BASIC PALYNOLOGICAL DATA ADMIRAL-1, GIPPSLAND BASIN

Sheet 2 of 3

SAMPLE TYPE	DEPTH (metres)	LAB. NO.	LITHOLOGY	RESIDUE YIELD	PALYNOMORPH CONCENTRATION	PRESERVATION	NO. OF S-P SPECIES*	MICROPLANKTON** ABUNDANCE	NO. SPECIES*
Cuttings	1700	78281 O		High	Moderate	Good	14+	Low	2
SWC 34	1728.4	78289 H	Siltstone with sandy laminae	High	Low	Fair	14+	Low	5+
SWC 33	1749.5	78289 G	Sandy siltstone	High	Low	Fair	16+	Low	3
Cuttings	1750	78281 P		High	High	Good	23+	Low	4+
SWC 32	1768.8	78289 F	Claystone with silty laminae	High	High	Good	28+	Low	4
SWC 31	1789.0	78289 E	Laminated siltstone	High	Moderate	Fair-good	24+	Low	3
Cuttings	1790	78281 Q		Moderate	Low	Good	11+	Low	1
SWC 30	1796.0	78289 D	Homogeneous claystone	High	Moderate	Fair	21+	Low	2
SWC 29	1806.5	78289 C	Homogeneous claystone	Moderate	High	Fair-good	9+	Low	3+
SWC 28	1816.6	78289 B	Homogeneous claystone	High	Low	Fair	7+	Low	2
SWC 27	1831.0	78289 A	Siltstone	High	High	Fair-good	29+	Low	2
SWC 26	1843.1	78288 Z	Laminated siltstone	High	Low	Fair	19+	High	2
Cuttings	1850	78281 R		High	Moderate	Fair-good	19+	Low	2
SWC 25	1858.1	78288 Y	Homogeneous claystone	High	Low	Fair	13+	Low	3
Cuttings	1870	78281 S		High	High	Fair	21+	Low	3
SWC 24	1873.2	78288 X	Homogeneous claystone	Low	Moderate	Poor-good	22+		
SWC 23	1899.0	78288 W	Siltstone	Moderate	Low	Fair-good	16+	Low	4
Cuttings	1910	78281 T		Moderate	High	Fair-good	20+	Low	4
SWC 22	1912.0	78288 V	Siltstone	High	High	Poor-good	34+	Low	3
Cuttings	1930	78281 U		High	High	Fair-good	19+	Low	2
SWC 21	1936.0	78288 U	Interlaminated claystone/sltst.	High	High	Good	29+	Low	4
SWC 20	1961.1	78288 T	Homogeneous siltstone	Moderate	Very Low	Poor	7+	Low	1
SWC 19	1972.5	78288 S	Carbonaceous siltstone	High	Low	Poor-fair	31+	Low	3
SWC 18	1988.0	78288 R	Sst/carbonaceous claystone	High	Low	Fair	16+	Low	1
Cuttings	2010	78281 V		Moderate	Low	Poor	7+	Low	1
SWC 17	2016.1	78288 Q	Carbonaceous siltstone	High	Low	Fair-good	30+	Low	4
SWC 16	2036.0	78288 P	Siltst. grading to claystone	Moderate	Low	Fair-good	17+	Low	2
SWC 15	2048.9	78288 O	Laminated carbonaceous siltstone	High	Low	Fair	11+	Low	2
Cuttings	2060	78281 W		Moderate	Very Low	Fair-good	10+	Low	2
SWC 14	2056.0	78288 N	Siltstone	High	Low	Fair	31+	Low	4

TABLE-2: BASIC PALYNOLOGICAL DATA ADMIRAL-1, GIPPSLAND BASIN

Sheet 3 of 3

SAMPLE TYPE	DEPTH (metres)	LAB. NO.	LITHOLOGY	RESIDUE YIELD	PALYNOMORPH CONCENTRATION	PRESERVATION	NO. OF S-P SPECIES*	MICROPLANKTON ABUNDANCE	NO. SPECIES*
SWC 13	2061.5	78288 M	Sandy siltstone	High	Very Low	Fair	14+		
SWC 12	2071.3	78288 L	Homogeneous siltstone	Low	Low	Fair	21+		
SWC 9	2103.5	78288 I	Homogeneous siltstone	High	Low	Fair	30+	Low	3
Cuttings	2105	78281 X		Moderate	Low	Poor-fair	13+	Low	1
Cuttings	2160	78281 Y	Arkosic sandstone	Moderate	Low	Fair	11+	Low	1

* Diversity:
- Very Low = 1- 5 species
- Low = 6-10 species
- Moderate = 11-25 species
- High = 26-74 species
- Very High = 75+ species

** Note: Algal cysts including *Amosopollis cruciformis* included under Microplankton category.

TABLE 3: PALYNOMORPH PERCENTAGES FOR P. mawsonii Zone					Page 1 of 2	
	1518.3m SWC 45	1555.5m SWC 43	1563.9m SWC 42	1580.5m SWC 41	1606.2m SWC 39	1620.1m SWC 38
TRILETE SPORES undiff.	1.8%	2.7%	3.0%	6.1%	1.9%	3.8%
Appendicisporites spp.		1.6%				
Cicitricosisporites spp.	1.8%		0.5%			
Crybelosporites spp.	3.7%	2.2%	6.5%			
Cyatheacidites tectifera						
Cyathidites/Biretisporites (large)			0.3%	4.0%		0.3%
Cyathidites (small)	12.8%	14.6%	21.4%	1.4%	3.9%	1.9%
Dictyophyllidites spp.	0.9%					
Gleicheniidites spp.		3.2%	1.4%	1.4%		1.9%
Foraminisporis asymmetricus		9.7%	3.0%			1.3%
Osmundacidites/Baculatisporites spp.	2.7%	0.5%	0.8%	4.0%	2.9%	1.3%
Rugulatisporites spp.				4.0%		
Stereisporites antiquisporites		1.1%	0.5%	1.4%	1.9%	3.8%
MONOLETE SPORES						
Laevigatosporites spp.	5.5%	3.2%		1.4%	4.9%	4.4%
Marattisporites scabratus				0.7%		1.3%
HILATE SPORES						
Coptospora pileolus ms		0.5%	2.4%			
Triporoletes spp.		3.2%	3.5%		0.9%	0.3%
MEGASPORES	0.9%	0.5%	1.4%	0.7%		
TOTAL SPORES %	30.0%	48.6%	44.6%	25.0%	16.5%	20.6%
GYMNOSPERM POLLEN						
Aliosporites/Podocarpidites	17.4%	18.9%	11.1%	28.4%	16.5%	16.3%
Araucariacites australis	2.7%	2.2%	1.4%	6.1%	6.8%	6.9%
Cycadopites spp.			6.5%	0.7%		
Dilwynites spp.	21.1%	8.1%	19.5%	33.8%	57.3%	46.9%
Microcachryidites antarcticus	0.9%	5.4%	11.9%	4.0%	1.9%	2.4%
Phyllocladidites mawsonii				1.4%	0.9%	0.6%
Podosporites microsaccatus	23.8%	3.8%				4.4%
TOTAL GYMNOSPERM POLLEN %	65.5%	38.4%	50.3%	74.3%	83.5%	77.5%
ANGIOSPERM POLLEN						
"Monolete"		1.1%	1.9%			
"Tricolpates"	3.6%	11.4%	3.2%	0.7%		0.6%
"Triorates"	0.9%	0.5%				1.3%
TOTAL ANGIOSPERM POLLEN %	4.5%	13.0%	5.1%	0.7%	0.0%	1.9%
TOTAL SPORES & POLLEN COUNT	110	185	370	148	103	160
PERCENTAGES OF MAJOR CATEGORIES						
TOTAL SPORES & POLLEN %	86.6%	85.6%	94.6%	92.5%	67.8%	90.9%
FUNGAL SPORES & HYPHAE %	3.9%		0.5%	1.9%	2.6%	1.1%
REWORKED SPORES & POLLEN %		0.5%		5.6%		
TOTAL ALGAE & MICROPLANKTON	9.5%	13.9%	4.8%	0.6%	29.7%	8.0%
ALGAE & MICROPLANKTON Subcategories						
Amosopollis cruciformis					0.7%	4.5%
Circulisporites parvus	9.5%					0.6%
Micrhystridium spp.				0.6%		
Rimosicysta spp.					14.5%	1.1%
Sigmopollis carbonis		10.2%	1.0%		3.3%	1.7%
Sigmopollis hispidus		3.7%	3.8%			
Wuroia spp.					11.2%	
TOTAL COUNT	127	216	391	160	152	176

TABLE 3: PALYNOMORPH PERCENTAGES FOR P. mawsonii Zone					Page 2 of 2	
	1768.8m SWC 32	1831.0m SWC 27	1912.0m SWC 22	1972.5m SWC 19	2016.1m SWC 17	2103.5m SWC 9
TRILETE SPORES undiff.	3.0%	3.6%	2.5%	6.2%	5.9%	13.4%
Appendicisporites spp.		0.5%		0.9%		
Cicitricosisporites spp.	0.5%	0.9%	2.5%	0.9%	1.0%	
Crybelosporites spp.	0.5%	4.6%	2.5%		0.5%	
Cyatheacidites tectifera	0.5%	0.5%		0.9%		2.0%
Cyathidites/Biretisporites (large)	1.0%	4.1%	2.5%	0.9%	2.5%	
Cyathidites (small)	4.0%	9.6%	1.6%	4.0%	3.0%	12.8%
Dictyophyllidites spp.	0.5%	0.5%		5.8%	1.0%	0.7%
Gleicheniidites spp.	4.5%	1.8%	1.6%	9.3%	4.9%	4.7%
Foraminisporis asymmetricus			0.8%			
Osmundacidites/Baculatisporites spp.	1.5%	1.4%	4.1%	3.6%	3.9%	10.7%
Rugulatisporites spp.	0.5%	1.8%	4.9%	4.4%	6.9%	3.4%
Stereisporites antiquisporites	1.0%	0.9%	1.6%	3.6%	1.5%	8.7%
MONOLETE SPORES						
Laevigatosporites spp.	3.0%	2.3%	1.6%	3.1%	4.4%	5.4%
Marattisporites scabratus	1.5%			2.2%	0.5%	
HILATE SPORES						
Coptospora pileolus ms	1.5%	2.8%				
Triporoletes spp.	8.1%	8.7%	0.8%	0.4%	8.4%	0.7%
MEGASPORES	0.5%	3.2%		0.4%	1.0%	
TOTAL SPORES %	32.3%	47.2%	27.0%	46.7%	45.3%	62.4%
GYMNOSPERM POLLEN						
Aliosporites/Podocarpidites	14.1%	15.6%	45.1%	24.0%	23.6%	22.1%
Araucariacites australis	1.5%	4.1%	8.2%	3.1%	7.4%	6.0%
Cycadopites spp.	0.5%					
Dilwynites spp.	31.8%	27.5%	13.9%	14.6%	10.3%	4.7%
Microcachryidites antarcticus	16.7%	2.8%	2.5%	8.0%	9.8%	2.7%
Phyllocladidites mawsonii		0.5%		1.8%	0.5%	
Podosporites microsaccatus	2.5%	0.9%	0.8%	0.9%	1.5%	0.7%
TOTAL GYMNOSPERM POLLEN %	67.2%	51.4%	70.5%	52.4%	53.2%	36.9%
ANGIOSPERM POLLEN						
"Monolete"						
"Tricolpates"	0.5%	1.4%		0.4%	1.5%	0.7%
"Triorates"			2.5%	0.4%		
TOTAL ANGIOSPERM POLLEN %	0.5%	1.4%	2.5%	0.9%	1.5%	0.7%
TOTAL SPORES & POLLEN COUNT	198	218	122	225	203	149
PERCENTAGES OF MAJOR CATEGORIES						
TOTAL SPORES & POLLEN %	89.2%	90.5%	85.3%	94.9%	88.3%	92.0%
FUNGAL SPORES & HYPHAE %	0.9%			0.4%		0.6%
REWORKED SPORES & POLLEN %	1.4%	1.2%	0.7%	0.8%	4.8%	5.6%
TOTAL ALGAE & MICROPLANKTON	8.6%	8.3%	14.0%	3.8%	6.9%	1.9%
ALGAE & MICROPLANKTON Subcategories						
Amosopollis cruciformis	3.2%	7.1%	11.9%	3.0%	3.5%	0.6%
Circulisporites parvus						
Micrhystridium spp.			1.4%	0.4%	0.4%	1.2%
Rimosicysta spp.	0.9%				3.0%	
Sigmopollis carbonis	3.6%		0.7%	0.4%		
Sigmopollis hispidus	0.9%	1.2%				
Wuroia spp.						
TOTAL COUNT	222	241	143	237	230	162

PE900765

This is an enclosure indicator page.
The enclosure PE900765 is enclosed within the container PE902122 at this location in this document.

The enclosure PE900765 has the following characteristics:

ITEM_BARCODE = PE900765
CONTAINER_BARCODE = PE902122
NAME = Admiral 1 palynological range chart (1 of 2)
BASIN = GIPPSLAND
PERMIT = VIC/P19
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Admiral 1 Palynological Range Chart (1 of 2). Enclosure from appendix 1, Vol 2 of WCR.
REMARKS =
DATE_CREATED = 30/09/90
DATE_RECEIVED = 26/07/90
W_NO = W1016
WELL_NAME = Admiral-1
CONTRACTOR =
CLIENT_OP_CO = Esso Australia Ltd

(Inserted by DNRE - Vic Govt Mines Dept)

PE900766

This is an enclosure indicator page.
The enclosure PE900766 is enclosed within the container PE902122 at this location in this document.

The enclosure PE900766 has the following characteristics:

ITEM_BARCODE = PE900766
CONTAINER_BARCODE = PE902122
NAME = Admiral 1 palynological range chart (2 of 2)
BASIN = GIPPSLAND
PERMIT = VIC/P19
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Admiral 1 Palynological Range Chart (2 of 2). Enclosure from appendix 1, Vol 2 of WCR.
REMARKS =
DATE_CREATED = 30/09/90
DATE_RECEIVED = 26/07/90
W_NO = W1016
WELL_NAME = Admiral-1
CONTRACTOR =
CLIENT_OP_CO = Esso Australia Ltd

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX
2

APPENDIX 2

APPENDIX 2

ADMIRAL-1

QUANTITATIVE LOG ANALYSIS

Interval: 1238-2145m MDKB
Analyst : A.P. CLARE.
Date : March, 1990.

ADMIRAL-1

QUANTITATIVE LOG ANALYSIS

CONTENTS

ADMIRAL-1
QUANTITATIVE LOG ANALYSIS

Wireline log data from the Admiral-1 well have been quantitatively analysed over the interval 1238-2145m MDKB for effective porosity and effective water saturation. Results are presented in the form of the accompanying tabular listings and depth plots and are summarised and discussed below. Admiral-1 failed to intersect any significant hydrocarbon bearing reserviors.

The primary objectives of the Admiral-1 well were the N.Senectus to T.apoxyexinus aged sediments top sealed by volcanics and fault sealed against the Strzelecki Group. These sands had an average ϕe of 17.6% and an Swe of 100%. All other sands within the section also proved water wet.

LOGS USED

CALI (caliper)
GR (gamma ray - cased hole)
LLD (deep laterolog)
RHOB (bulk density)
NPHI (neutron porosity)

DATA QUALITY

No curves showed any anomalous data values for the entire log interval. The only curve reflecting a loss of quality was the caliper which revealed a highly rugose hole in places. Numerous sections of hole are significantly washed out resulting in anomalous readings for the MSFL, NPHI and RHOB. The DRHO and SONIC curves were subsequently utilised as an aid to clearly defining coaly and carbonaceous intervals over the sections of bad hole. Apart from the hole conditions, data quality remained high for the whole interval analysed.

DISCUSSION

Admiral-1 failed to encounter any significant hydrocarbons. All sands proved water wet from logs. The primary objective (1503.8mKB) was encountered below the volcanics and contained 38m of water bearing reservior quality sandstones in a 93m gross section. As a result of this no RFT's were deemed necessary.

<u>ADMIRAL-1</u>
<u>QUANTITATIVE LOG ANALYSIS</u>

ANALYSIS METHODOLOGY

Apparent total porosity and shale volume was calculated using density-neutron crossplot algorithms.

Water saturations were determined from the dual water relationship. Effective porosities and water saturations were derived from the apparent total porosity and water saturation, calculated shale volume and apparent shale porosity.

ANALYSIS PARAMETERS

Esso Australia Logic Model	: K12 (option 1)		
Tortuosity "a"	: 1.00		
Cementation factor "m"	: 2.00		
Saturation exponent "n"	: 2.00		
Fluid density (rhof)	: 1.00		

	from 1238	to 2161mKB	
Gamma Ray value in clean formation (grmin)	: 30	30	gapi
Gamma Ray value in shale (grmax)	: 105	70	gapi
Shale Resistivity (Rsh)	: 10	10	ohmm
Apparent bulk density of shale (RHOBSH)	: 2.50	2.56	g/cc
Apparent neutron porosity of shale (PHINSH)	: 0.30	0.35	frac
Salinity	: 70,000	30,000	ppm

Hydrocarbon density (RHOH)	: 1.00
Lower limit of grain density	: 2.645 g/cc
Upper limit of grain density	: 2.675 g/cc
Measured Rmf	: 0.2 ohmm
Temperature at which Rmf measured	: 20.0°C
SXO from RXO?	: No
z	: 0.3
AMS used?	: No
Total Depth	: 2162 m
BHT	: 72°C
Sea bed/Surface temperature	: 10°C
Water depth/GL	: 101 m
KB height	: 21 m
Irreducible water saturation	: 0.025
Vsh upper limit for effective porosity	: 0.65
Phie minimum for hydrocarbons	: 0.03

(03900231)

ADMIRAL_1

ANALYSIS SUMMARY.

Net porosity cut-off.........: 0.100 volume per volume
Net water saturation cut-off..: 0.500 volume per volume

Net Porous Interval based on Porosity cut-off only.
Both Porosity and Sw cut-offs invoked when generating Hydrocarbon-Metres.

	GROSS INTERVAL (metres) (top) -(base)	Gross Metres	NET POROUS INTERVAL Net Metres	Net to Gross	Mean Vsh	(Std.) (Dev.)	Mean Porosity	(Std.) (Dev.)	Mean Sw	(Std.) (Dev.)	HYDROCARBON METRES
MDKB	1254.8-1269.2	14.4	7.2	50 %	0.357	(0.060)	0.156	(0.031)	1.000	(0.393)	0.000
MDKB	1275.6-1283.6	8.0	7.2	90 %	0.192	(0.149)	0.224	(0.048)	1.000	(0.233)	0.000
MDKB	1286.0-1289.8	3.8	3.0	79 %	0.175	(0.116)	0.249	(0.040)	1.000	(0.243)	0.000
MDKB	1290.2-1292.4	2.2	1.0	45 %	0.273	(0.126)	0.233	(0.025)	1.000	(0.000)	0.000
MDKB	1296.0-1301.8	5.8	5.6	97 %	0.094	(0.127)	0.240	(0.034)	1.000	(0.213)	0.000
MDKB	1305.0-1312.0	7.0	4.6	66 %	0.232	(0.150)	0.205	(0.057)	0.997	(0.015)	0.000
MDKB	1316.0-1317.4	1.4	1.0	71 %	0.221	(0.050)	0.208	(0.025)	1.000	(0.000)	0.000
MDKB	1319.0-1322.4	3.4	2.4	71 %	0.320	(0.126)	0.155	(0.040)	1.000	(0.216)	0.000
MDKB	1323.4-1325.8	2.4	2.2	92 %	0.167	(0.092)	0.224	(0.027)	0.985	(0.027)	0.000
MDKB	1327.2-1328.4	1.2	1.0	83 %	0.141	(0.191)	0.255	(0.058)	0.968	(0.023)	0.000
MDKB	1329.0-1338.0	9.0	6.4	71 %	0.264	(0.150)	0.158	(0.036)	1.000	(0.307)	0.000
MDKB	1339.0-1348.6	9.6	9.2	96 %	0.148	(0.090)	0.234	(0.035)	0.996	(0.012)	0.000
MDKB	1350.6-1352.0	1.4	0.4	29 %	0.497	(0.019)	0.112	(0.011)	1.000	(0.000)	0.000
MDKB	1353.2-1354.2	1.0	0.2	20 %	0.476	(0.000)	0.132	(0.000)	1.000	(0.000)	0.000
MDKB	1355.6-1356.4	0.8	0.6	75 %	0.388	(0.099)	0.200	(0.039)	1.000	(0.000)	0.000
MDKB	1360.2-1365.0	4.8	4.4	92 %	0.251	(0.099)	0.197	(0.027)	1.000	(0.165)	0.000
MDKB	1370.2-1373.6	3.4	3.4	100 %	0.127	(0.145)	0.253	(0.066)	1.000	(0.203)	0.000
MDKB	1377.0-1380.6	3.6	3.2	89 %	0.153	(0.059)	0.217	(0.030)	1.000	(0.092)	0.000
MDKB	1386.2-1426.4	40.2	39.0	97 %	0.132	(0.092)	0.241	(0.034)	1.000	(0.198)	0.000
MDKB	1430.6-1436.6	6.0	5.6	93 %	0.239	(0.131)	0.174	(0.039)	1.000	(0.282)	0.000
MDKB	1440.8-1442.2	1.4	0.4	29 %	0.370	(0.057)	0.156	(0.016)	1.000	(0.000)	0.000
MDKB	1445.4-1447.2	1.8	1.6	89 %	0.077	(0.071)	0.253	(0.030)	1.000	(0.000)	0.000
MDKB	1452.8-1462.6	9.8	7.8	80 %	0.285	(0.143)	0.187	(0.050)	1.000	(0.209)	0.000
MDKB	1463.6-1472.4	8.8	4.4	50 %	0.303	(0.119)	0.173	(0.049)	0.998	(0.007)	0.000
MDKB	1473.6-1491.4	17.8	10.8	61 %	0.209	(0.144)	0.194	(0.048)	1.000	(0.235)	0.000
MDKB	1503.8-1517.8	14.0	8.8	63 %	0.239	(0.132)	0.176	(0.034)	1.000	(0.172)	0.000
MDKB	1518.6-1547.2	28.6	19.0	66 %	0.276	(0.121)	0.176	(0.029)	1.000	(0.205)	0.000
MDKB	1556.0-1560.8	4.8	4.4	92 %	0.142	(0.127)	0.214	(0.032)	1.000	(0.282)	0.000
MDKB	1566.6-1577.8	11.2	10.8	96 %	0.127	(0.094)	0.238	(0.025)	1.000	(0.123)	0.000
MDKB	1581.4-1600.6	19.2	17.6	92 %	0.186	(0.113)	0.202	(0.038)	1.000	(0.410)	0.000
MDKB	1608.2-1615.0	6.8	3.0	44 %	0.352	(0.062)	0.158	(0.020)	1.000	(0.421)	0.000
MDKB	1681.4-1690.4	9.0	2.4	27 %	0.339	(0.100)	0.167	(0.043)	1.000	(0.161)	0.000
MDKB	1730.4-1748.2	17.8	6.4	36 %	0.325	(0.118)	0.151	(0.036)	1.000	(0.363)	0.000
MDKB	1753.4-1756.4	3.0	1.4	47 %	0.323	(0.071)	0.136	(0.019)	1.000	(0.396)	0.000
MDKB	1765.2-1767.6	2.4	2.0	83 %	0.133	(0.128)	0.206	(0.036)	1.000	(0.416)	0.000
MDKB	1769.6-1783.0	13.4	9.2	69 %	0.276	(0.139)	0.173	(0.045)	1.000	(0.387)	0.000
MDKB	1799.2-1801.4	2.2	1.2	55 %	0.136	(0.116)	0.155	(0.034)	1.000	(0.458)	0.000
MDKB	1809.0-1812.4	3.4	0.6	18 %	0.402	(0.058)	0.136	(0.024)	0.982	(0.026)	0.000
MDKB	1859.0-1863.0	4.0	1.8	45 %	0.252	(0.070)	0.128	(0.016)	1.000	(0.262)	0.000
MDKB	1904.0-1905.6	1.6	0.8	50 %	0.361	(0.103)	0.122	(0.020)	1.000	(0.000)	0.000
MDKB	1919.4-1933.2	13.8	7.6	55 %	0.363	(0.083)	0.125	(0.016)	1.000	(0.240)	0.000
MDKB	1944.4-1957.6	13.2	10.4	79 %	0.278	(0.103)	0.141	(0.029)	1.000	(0.318)	0.000
MDKB	1962.4-1970.4	8.0	3.2	40 %	0.369	(0.050)	0.120	(0.012)	1.000	(0.249)	0.000
MDKB	1984.6-1987.6	3.0	1.8	60 %	0.210	(0.057)	0.127	(0.010)	1.000	(0.000)	0.000
MDKB	1991.2-1993.4	2.2	0.6	27 %	0.454	(0.012)	0.124	(0.014)	1.000	(0.000)	0.000
MDKB	2001.4-2004.6	3.2	2.2	69 %	0.317	(0.052)	0.122	(0.012)	1.000	(0.000)	0.000
MDKB	2008.2-2014.6	6.4	4.6	72 %	0.192	(0.100)	0.157	(0.035)	1.000	(0.373)	0.000
MDKB	2018.8-2023.4	4.6	2.6	57 %	0.252	(0.080)	0.120	(0.013)	1.000	(0.388)	0.000
MDKB	2029.4-2033.8	4.4	1.4	32 %	0.270	(0.105)	0.154	(0.035)	1.000	(0.000)	0.000
MDKB	2072.0-2102.6	30.6	4.0	13 %	0.320	(0.055)	0.114	(0.007)	0.999	(0.003)	0.000
MDKB	2105.2-2117.4	12.2	2.6	21 %	0.338	(0.074)	0.112	(0.009)	1.000	(0.000)	0.000

APPENDIX 1
ALGORITHMS & LOGIC USED IN THE QUANTITATIVE ANALYSIS

Initial Total Porosity and Shale Volume was calculated from the bulk density and neutron porosity log responses as follows:

```
    vsh = ((nphi+0.04) - ((2.65-rhob)/(2.65-rhof)))/
          ((phinsh+0.04) - ((2.65-rhobsh)/(2.65-rhof)))
    vsh = min(1,(max(0,vsh)))


    h = (2.71-rhob) + (nphi*(rhof-2.71))
      if (h>=0)
        rhoma=2.71-(0.5*h)
      else
        rhoma=2.71-(0.64*h)
    phit = max(0.001,(min(1,((rhoma-rhob)/(rhoma-rhof)))))
```

The Apparent Salinity profile was derived from aRw back-calculated in clean sands from Archie's equation, assuming 100% Sw.

Swt (total Water Saturation) was calculated using the dual water relationship

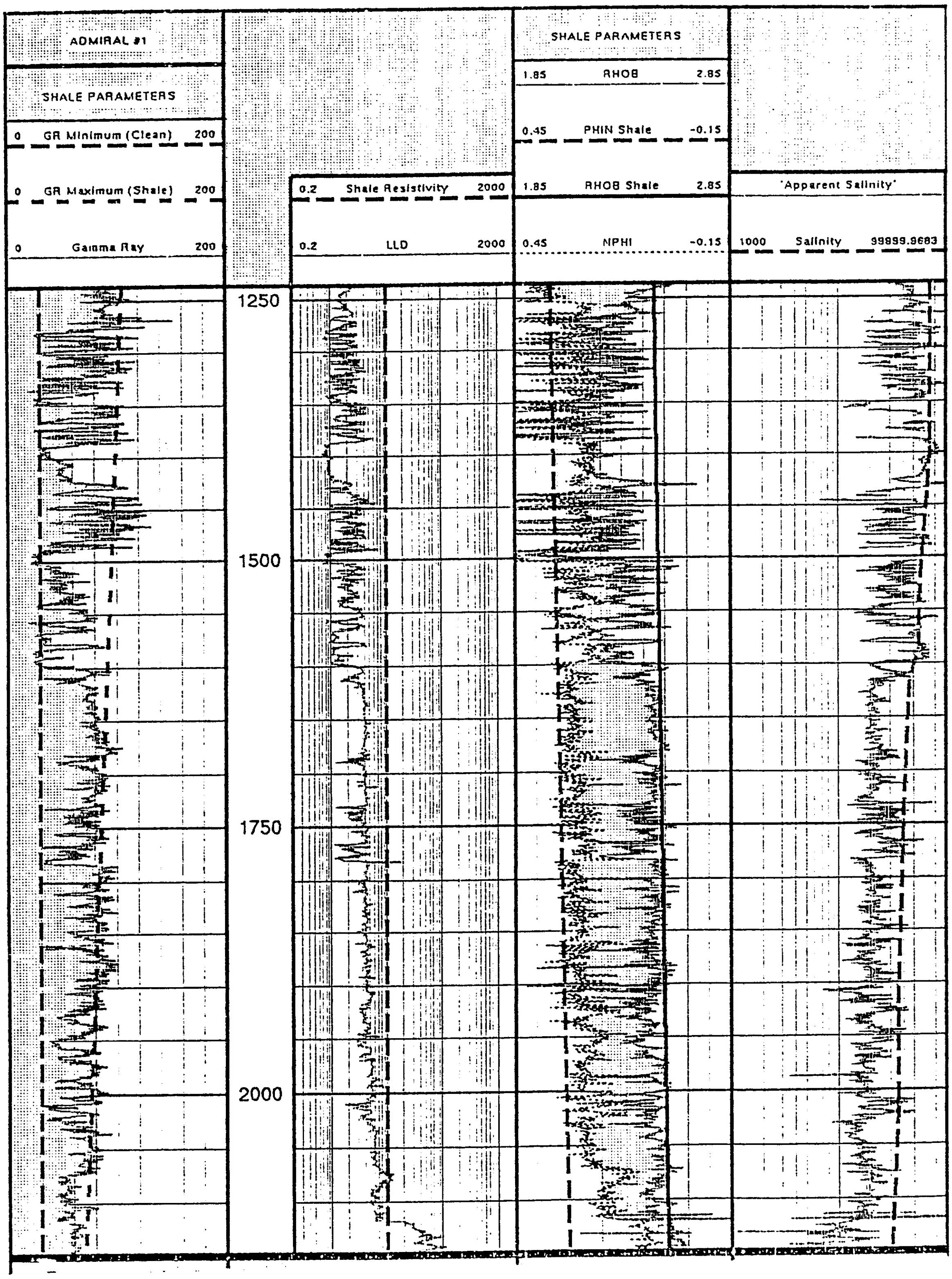
```
1/rt = (swt**n)*(phit**m)/(a*rw)+swt**(n-1)*(swb*(phit**m)/a)*((1/rwb)-(1/rw))
```

This is solved for Sw by Newtons solution:

```
     exsw=0
     sw  =0.9
     aa  =((phit**m)/(a*rw))
     bb  =((swb*(phit**m)/a)*((1/rwb)-(1/rw)))
         repeat
           fx1=(aa*(sw**n))+(bb*(sw**(n-1)))-(1/rt)
           fx2=(n*aa*(sw**(n-1)))+((n-1)*bb*(sw**(n-2)))
              if((abs(fx2)) < 0.0001)
               fx2=0.0001
           swp=sw
           sw =swp-(fx1/fx2)
           exsw=exsw+1
         until (exsw > 4 or (abs(sw-swp)) <= 0.01)
     swt=sw
```

Effective Porosity and Water Saturation were derived as follows:

```
  if (vsh > vshco){
   swt  = 1
   swe  = 1
   phie = 0
  }
  else {
    phie= max(0.0,(phit-(vsh*phish)))
    swe = max(swirr,( 1 - ((phit/phie)*(1-swt))))
    if (vsh > (vshco-0.2)){
       phie= phie*((vshco-vsh)/0.2)
       swe = 1-((1-swe)*((vshco-vsh)/0.2))
    }
  }
 where vshco = 0.65
```


ADMIRAL #1
SHALE PARAMETERS
0 GR Minimum (Clean) 200
0 GR Maximum (Shale) 200
0 Gamma Ray 200
0.2 Shale Resistivity 2000
0.2 LLD 2000
SHALE PARAMETERS
1.85 RHOB 2.85
0.45 PHIN Shale -0.15
1.85 RHOB Shale 2.85
0.45 NPHI -0.15
'Apparent Salinity'
1000 Salinity 99999.9683
1250
1500
1750
2000

PE600975

This is an enclosure indicator page.
The enclosure PE600975 is enclosed within the container PE902122 at this location in this document.

The enclosure PE600975 has the following characteristics:

ITEM_BARCODE = PE600975
CONTAINER_BARCODE = PE902122
NAME = Computer Generated Log
BASIN = GIPPSLAND
PERMIT = VIC/P19
TYPE = WELL
SUBTYPE = WELL_LOG
DESCRIPTION = Admiral-1 Computer Generated Log. From appendix 2 (Quantitative Log Analysis) of WCR volume 2.
REMARKS =
DATE_CREATED = 09/03/1990
DATE_RECEIVED = 26/07/1990
W_NO = W1016
WELL_NAME = Admiral-1
CONTRACTOR = ESSO
CLIENT_OP_CO = ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 3

APPENDIX 3

APPENDIX 3

GEOCHEMICAL REPORT

ON

ADMIRAL 1 WELL

GIPPSLAND BASIN

BY

B.J.BURNS

JUNE 1990

Analyses by
Dr M.J.Hannah
H. Schiller

LIST OF TABLES AND FIGURES

INTRODUCTION

Admiral 1 was drilled approx. 5 km north-east of the Kipper 1 well along the northern margin of the basin and penetrated over 900 meters of Paleocene and Upper Cretaceous Latrobe Group sediments, including a thick sequence of lacustrine beds of the *P. mawsonii* Zone. Forty SWCs over the interval from 1234.5m to 2151.1m were examined for routine TOC and Rockeval measurements. The *L. balmei* and *T. longus* Zones consisted of sands, shales, siltstones and minor thin coals while the *P. mawsonii* Zone was comprised of more massive medium-brown siltstones and claystones which is believed to represent deposition in a true deep-water lacustrine environment (Partridge 1990).

Twenty representative sidewall core samples were selected over the interval from 1275 - 2103.5m for palynological separation of the organic concentrate which was then analysed by our palynologist, Dr. M.J. Hannah, for kerogen and fluorescence determinations.

A suite of twelve SWC's was sent to Keiraville Konsultants for vitrinite reflectance measurements.

RESULTS

The TOC and Rockeval results are presented in Tables 1 and 2 and Figure 1. The calcareous Oligocene Lakes Entrance sample at 1234.5m had very low TOC content (0.14%) and was considered as non-source. The four *L. balmei* samples were light-grey to medium-browm claystones and siltstone with TOC's varying from a "very poor" 0.27% to "very good" 4.26% The two *T. longus* samples had "fair" TOC's of just over 1% The remaining 33 samples were from the *P. mawsonii* lacustrine interval from 1518.3m to 2151.1 (TD=2162m) and typically exhibit more uniform TOC values from 1.0-2.5% (av. 1.66%), a feature that has been observed in other wells in the basin (eg Kipper 1, Sweetlips 1).
The corresponding Rockeval results (Table 2) are particularily dissapointing for the *P. mawsonii* lacustrine interval with only seven of the thirty three samples even having a "fair" source richness rating based

on S2 yields of between 2 and 6mg/g (S_2 levels above 6 mg/kg are rated as "good" source rocks). The remainder are rated as being "poor" or non-source. Only one sample (1518.3m) has a Hydrogen Index greater than 250 which would rate it as a gas-plus-oil source (Fig 2). For the remaining samples the expected product would only be gas. Overall, the *P. mawsonii* shales appear to have only limited source potential for gas.

Tmax values are low (<437) throughout the whole well (Table 2, Fig 1) indicating that the the section penetrated is still immature and this is supported by the Vitrinite Reflectance data (Table 3, Fig 1) and Thermal Alteration Indices (Table 4). The vitrinite data indicate a maximum maturity of Rv = 0.55% at the Total Depth (2162m) of the well.

Kerogen organic matter descriptions and fluorescence characteristics are set out in Tables 4 & 5 and Figures 3 & 4. The *P. mawsonii* kerogen types are generally dominated by gas-prone material such as the Cellular and Semi-opaque varieties. The virtual absence of the Biodegraded Terrestrial category from these lacustrine samples makes them notably different from typical younger Latrobe kerogens and contributes to their lower "oil-prone" rating. The percentage of fluorescing kerogen is also generally low (three exceptions at 1518.3m, 1806.5m and 1936m) and is generally confined to the Cellular material. Some of the fluorescence colours are "gold" which suggests a more mature rating than previously indicated but the consistancy of the vitrinite and Tmax data makes them the more reliable maturity parameters.

DEPOSITIONAL ENVIRONMENT

The lacustrine *P. mawsonii* sediments in Admiral 1 are rated as very poor source rocks. They are remarkably uniform in their physical appearance and chemical properties, a feature which is believed to be related to the development of a more stable environment in a large fresh-brackish lake (Partridge 1990, this report). The low Rockeval HI values indicate that these lacustrine sediments have been well oxygenated, at least around the northern margins of the basin. The quantity and quality of equivalent sediments in the central areas of the ancient lake remain untested.

Increased oxygenation of these lake deposits may be the result of a relatively cool climate at the time of deposition. Annual cooling of the lake surface, and subsequent turn-over of these denser layers, would carry oxygenated water to the sediment/water interface with the resulting decrease in the quantity and "oil-proneness" of the accumulating kerogen.

SUMMARY

1. The lacustrine *P. mawsonii* sediments are uniform in their organic content but at this location are rated as fair source rocks for gas only.

REFERENCES

BURNS, B.J., Geochemical Report on Sweetlips 1, Gippsland Basin. Well Completion Report, Feb. 1990.

PARTRIDGE, A.D., Palynological analysis of Sweetlips 1, Gippsland Basin. *Esso Australia Ltd. Palaeo. Rept. 1990/3*, 1-22.

PARTRIDGE, A.D., Palynological analysis of Admiral 1, Gippsland Basin. *Esso Australia Ltd. Palaeo. Rept. 1990/4*.

(BJB157)

TABLE 1 TOTAL ORGANIC CARBON

WELL: ADMIRAL 1

SAMPLE No.	DEPTH (m)	TYPE	AGE	ZONE	TOC %	CO3 %	DESCRIPTION
78290 H	1234.5	CRSW	Oligocene	Lakes Entr	0.14	71.84	CLYST LT GY,BLOCKY,FIRM
78290 C	1275.0	CRSW	Paleocene	L.balmei	4.26	3.19	SLTST M BRN,TR CARB FLKS
78290 B	1285.8	CRSW	" "	L.balmei	3.39	3.53	CLYST M BRN,BLOCKY,FIRM
78290 A	1314.0	CRSW	" "	L.balmei	1.88	2.78	CLYST M BRN,FIRM-SOFT
78289 Z	1359.6	CRSW	" "	L.balmei	0.27	1.28	CLYST LT GY,SLTY,BLOCKY
78289 V	1437.0	CRSW	Upper Cret	U.T.longus	1.13	3.86	SLTST M GY,BLOCKY,FIRM
78289 U	1477.5	CRSW	" "	U.T.longus	1.34	2.18	CLYST M GY,SL SLTY,FIRM
78289 S	1518.3	CRSW	" "	P.mawsonii	2.21	2.35	CLYST M BRN,TR CARB FLKS
78289 Q	1555.6	CRSW	" "	P.mawsonii	0.74	1.67	CLYST M GY-BRN,BLOCKY
78289 P	1563.9	CRSW	" "	P.mawsonii	2.17	3.66	CLYST M GY-BRN,CARB FLKS
78289 O	1580.5	CRSW	" "	P.mawsonii	1.61	8.98	SLTST M GY,ABT CARB FRGS
78289 M	1606.2	CRSW	" "	P.mawsonii	0.95	4.00	CLYST M BRN,BLOCKY,FIRM
78289 L	1620.1	CRSW	" "	P.mawsonii	1.25	7.05	SLTST M GY,BLOCKY,FIRM
78289 K	1648.5	CRSW	" "	P.mawsonii	1.97	7.76	SLTST M GY,BLOCKY,FIRM
78289 J	1680.5	CRSW	" "	P.mawsonii	0.69	9.24	CLYST MGY,SL SLTY,BLOCKY
78289 I	1697.5	CRSW	" "	P.mawsonii	1.57	13.13	SLTST M GY-M BRN,BLOCKY
78289 H	1728.4	CRSW	" "	P.mawsonii	2.56	14.63	SLTST M GY,ABT CARB FLKS
78289 G	1749.5	CRSW	" "	P.mawsonii	1.17	2.32	SLTST M BRN,BLOCKY,FIRM
78289 F	1768.8	CRSW	" "	P.mawsonii	1.57	8.59	CLYST M GY,SLTY,BLOCKY
78289 E	1787.0	CRSW	" "	P.mawsonii	1.93	18.96	SLTST M BRN,BLOCKY,FIRM
78289 D	1796.0	CRSW	" "	P.mawsonii	1.55	8.98	CLYST M BRN,SL SLTY,FIRM
78289 C	1806.5	CRSW	" "	P.mawsonii	2.00	7.61	CLYST M BRN,BLOCKY,FIRM
78289 B	1816.6	CRSW	" "	P.mawsonii	1.69	16.36	CLYST M BRN,BLOCKY,FIRM
78289 A	1831.0	CRSW	" "	P.mawsonii	1.10	17.19	SLTST M GY,BLOCKY,FIRM
78288 Z	1843.1	CRSW	" "	P.mawsonii	1.56	21.21	SLTST M BRN,CARB,FLKS
78288 Y	1858.1	CRSW	" "	P.mawsonii	2.45	10.91	CLYST M BRN,SLTY
78288 X	1873.2	CRSW	" "	P.mawsonii	0.59	35.55	CLYST M GY-M BRN,QTZ
78288 W	1899.0	CRSW	" "	P.mawsonii	1.78	13.95	SLTST M GY,TR CARB FLKS
78288 V	1912.0	CRSW	" "	P.mawsonii	1.25	21.04	SLTST M GY,CALC
78288 U	1936.0	CRSW	" "	P.mawsonii	2.28	17.30	SLTST M GY,CALC
78288 T	1961.1	CRSW	" "	P.mawsonii	2.30	13.15	SLTST M GY,SLTY CLYST
78288 S	1972.5	CRSW	" "	P.mawsonii	1.64	14.33	SLTST M GY,CARB FRGS
78288 R	1988.0	CRSW	" "	P.mawsonii	1.21	18.06	SST WH-CREAM,CLYST M BRN
78288 Q	2016.1	CRSW	" "	P.mawsonii	1.02	14.35	SLTST LT-M GY,CARB FRGS
78288 P	2036.0	CRSW	" "	P.mawsonii	2.08	17.44	SLTST M GY,CLYST,CALC
78288 O	2048.9	CRSW	" "	P.mawsonii	2.19	13.32	SLTST M GY,CALC
78288 N	2056.0	CRSW	" "	P.mawsonii	2.06	22.55	SLTST M GY-MOTTLED,CALC
78288 L	2071.3	CRSW	" "	P.mawsonii	1.19	4.55	SLTST M GY,COM CARB FLKS
78288 I	2103.6	CRSW	" "	P.mawsonii	1.76	11.44	SLTST M GY,COM CARB FLKS
78288 B	2151.1	CRSW	" "	P.mawsonii	2.72	36.48	SLTST M GY,SST LT BRN

TABLE 2 ROCKEVAL REPORT

WELL: ADMIRAL 1

SAMPLE NO.	DEPTH (m)	TYPE	TOC %	Tmax	S1 mg/g	S2 mg/g	S3 mg/g	HI	OI	HI/OI	ENVIRONMENT
78290 C	1275.0	CRSW	4.26	416	0.23	4.14	0.46	97	11	9	L. Coastal Plain
78290 B	1285.8	CRSW	3.39	413	0.15	3.00	0.40	89	12	8	L. Coastal Plain
78290 A	1314.0	CRSW	1.88	413	0.26	2.83	0.25	150	13	11	U. Coastal Plain
78289 V	1437.0	CRSW	1.13	417	0.15	1.28	0.14	113	13	9	U. Coastal Plain
78289 U	1477.5	CRSW	1.34	423	0.22	1.71	0.19	128	14	9	U. Coastal Plain
78289 S	1518.3	CRSW	2.21	426	0.21	5.83	0.23	264	11	25	Lacustrine
78289 Q	1555.6	CRSW	0.74	427	0.07	0.64	0.09	86	12	7	Lacustrine
78289 P	1563.9	CRSW	2.17	422	0.24	4.06	0.22	187	10	18	Lacustrine
78289 O	1580.5	CRSW	1.61	426	0.07	0.70	0.22	44	14	3	Lacustrine
78289 M	1606.2	CRSW	0.95	424	0.10	0.79	0.16	83	17	5	Lacustrine
78289 L	1620.1	CRSW	1.25	426	0.07	0.43	0.13	34	10	3	Lacustrine
78289 K	1648.5	CRSW	1.97	434	0.06	0.89	0.21	45	11	4	Lacustrine
78289 J	1680.5	CRSW	0.69	416	0.06	0.34	0.06	50	9	5	Lacustrine
78289 I	1697.5	CRSW	1.57	420	0.06	0.65	0.17	41	11	4	Lacustrine
78289 H	1728.4	CRSW	2.56	435	0.07	1.20	0.24	47	9	5	Lacustrine
78289 G	1749.5	CRSW	1.17	425	0.07	1.10	0.14	94	12	8	Lacustrine
78289 F	1768.8	CRSW	1.57	425	0.07	0.51	0.21	33	13	2	Lacustrine
78289 E	1787.0	CRSW	1.93	427	0.11	1.35	0.20	70	10	7	Lacustrine
78289 D	1796.0	CRSW	1.55	423	0.07	0.74	0.16	48	11	5	Lacustrine
78289 C	1806.5	CRSW	2.00	426	0.14	2.88	0.20	144	10	14	Lacustrine
78289 B	1816.6	CRSW	1.69	425	0.12	2.03	0.18	120	11	11	Lacustrine
78289 A	1831.0	CRSW	1.10	429	0.07	0.61	0.10	56	9	6	Lacustrine
78288 Z	1843.1	CRSW	1.56	423	0.06	0.70	0.16	45	10	4	Lacustrine
78288 Y	1858.1	CRSW	2.45	424	0.12	1.68	0.21	69	9	8	Lacustrine
78288 X	1873.2	CRSW	0.59	417	0.06	0.13	0.10	22	17	1	Lacustrine
78288 W	1899.0	CRSW	1.78	431	0.14	2.05	0.11	115	6	18	Lacustrine
78288 V	1912.0	CRSW	1.25	429	0.08	0.83	0.08	66	6	10	Lacustrine
78288 U	1936.0	CRSW	2.28	433	0.14	2.60	0.15	114	7	17	Lacustrine
78288 T	1961.1	CRSW	2.30	433	0.12	2.05	0.10	89	4	21	Lacustrine
78288 S	1972.5	CRSW	1.64	434	0.07	0.93	0.05	57	3	18	Lacustrine
78288 R	1988.0	CRSW	1.21	433	0.08	0.80	0.19	66	16	4	Lacustrine
78288 Q	2016.1	CRSW	1.02	431	0.10	0.70	0.06	69	6	12	Lacustrine
78288 P	2036.0	CRSW	2.08	436	0.11	1.73	0.12	83	6	14	Lacustrine
78288 O	2048.9	CRSW	2.19	436	0.11	1.28	0.25	59	11	5	Lacustrine
78288 N	2056.0	CRSW	2.06	436	0.09	1.26	0.16	61	8	8	Lacustrine
78288 L	2071.3	CRSW	1.19	435	0.07	0.29	0.09	24	7	3	Lacustrine
78288 I	2103.6	CRSW	1.76	437	0.12	1.00	0.13	57	8	8	Lacustrine
78288 B	2151.1	CRSW	2.72	417	0.08	0.67	0.14	25	5	5	Alluvial Fan

TABLE 3 **VITRINITE REFLECTANCE REPORT**

WELL: ADMIRAL 1

SAMPLE NO.	DEPTH (m)	TYPE	Rv (max) Avg %	COUNTS	FLUORESCENCE COLOUR	MACERALS
78290 C	1275.0	CRSW	0.35	26	YEL-ORANGE	DOM ABUNDANT,V>I>>L
78290 B	1285.5	CRSW	0.36	28	YEL-ORANGE	DOM ABUNDANT,V>I>>L
78289 V	1437.0	CRSW	0.33	25	YEL-ORANGE	DOM ABUNDANT,I>L>V
78289 U	1477.5	CRSW	0.37	22	YEL-ORANGE	DOM ABUNDANT,I>L>V
78289 S	1518.3	CRSW	0.37	24	YEL-ORANGE	DOM ABUNDANT,I>L>V
78289 P	1563.9	CRSW	0.39	25	YEL-ORANGE	DOM ABUNDANT,I>L=V
78289 H	1728.5	CRSW	0.41	24	YEL-ORANGE	DOM ABUNDANT,V>I>>L
78289 C	1806.5	CRSW	0.48	25	YEL-DUL OR	DOM ABUNDANT,I>V>L
78288 U	1936.0	CRSW	0.46	25	YEL-ORANGE	RARE OIL DROPS,V>I>>L
78288 T	1961.0	CRSW	0.48	27	YEL-ORANGE	DOM ABUNDANT,V>I>L
78288 O	2048.8	CRSW	0.50	27	YEL-ORANGE	DOM ABUNDANT,V>I>L
78288 I	2103.5	CRSW	0.54	27	OR-DUL OR	DOM ABUNDANT,I>V>L

TABLE 4 **KEROGEN P.O.M.T REPORT**

WELL ADMIRAL 1

SAMPLE NO.	DEPTH (M)	Particulate Organic Matter Types (%) 1.1	1.2	2.1	2.2	3.0	4.0	5.1	5.2	5.3	6.1	6.2	7.0	TAI	% OIL PRONE	% FLUOR
78290 C	1275.0	35					5		30	20			10		40	15
78289 U	1477.5	20				10	10		45	15				2.1	40	50
78289 S	1518.3	30				15	10		25	20					55	70
78289 O	1580.5	20					5		35	40					25	15
78289 M	1606.2	55					10		15	15	5				65	40
78289 J	1680.5	5				5	15		30	45				2.1	25	40
78289 H	1728.5	15				5	5		35	40					25	20
78289 G	1749.5	25					5		50	20					30	30
78289 E	1787.0	15					10		60	15				2.1	25	50
78289 C	1806.5	40					10		35	15				2.1	50	60
78289 B	1816.5	20				10	5		45	20				2.1	35	15
78288 Z	1843.0	20					5		40	35					25	15
78288 Y	1858.0	15					5		50	30					20	20
78288 W	1899.0	40					1		39	20					41	40
78288 U	1936.0	30					1		34	30	5				31	60
78288 T	1961.1	25							15	45	10		5		25	5
78288 R	1988.0	25					1		20	44	10				26	5
78288 O	2048.8	20							35	40	5				20	5
78288 M	2061.5	15							45	30	10				15	5
78288 I	2103.5	35					1		39	15	5		5		36	20

LEGEND

1 = AMORPHOUS 1.1 – UNDIFFERENTIATED 1.2 – GREY
2 = STRUCTURED AQUEOUS 2.1 – ALGAE 2.2 – DINOFLAGELLATES/ACRITARCHS
3 = BIODEGRADED TERRESTRIAL
4 = SPORES/POLLEN
5 = STRUCTURED TERRESTRIAL 5.1 – LAMINAR 5.2 – CELLULAR 5.3 – SEMI-OPAQUE
6 = INERT 6.1 – OPAQUE 6.2 – META-OPAQUE
7 = INDETERMINATE FINES

TAI = THERMAL ALTERATION INDEX
OIL PRONE = SUM OF 1.1 THRU 4.0
FLUOR = PERCENT FLUORECSCENT MATERIAL

TABLE 5

KEROGEN FLUORESCENCE

WELL: ADMIRAL 1

SAMPLE NO	DEPTH (M)	TYPE	COLOUR	%	DESCRIPTOR	COMMENTS
78290 C	1275.0	CRSW	Bright Yellow	15	Cellular	IMMATURE.Amorphous shows dull fluor after prolonged excitation.
			TOTAL	15		
78289 U	1477.5	CRSW	Bright Yellow	50	Cellular, Biodeg Terrest, Amorph	IMMATURE. 'Pin-prick' fluoro in amorphous.
			TOTAL	50		
78289 S	1518.3	CRSW	Bright Yellow	70	Cellular, Biodeg Terrest, Amorph	IMMATURE. 'Pin-prick' fluoro in Amorph. More Biodeg visible under fluorescence
			TOTAL	70		
78289 O	1580.5	CRSW	Gold	15	Cellular, Spore/Pollen	?MATURE.
			TOTAL	15		
78289 M	1606.2	CRSW	White Yellow	40	Cellular, Amorph (see comments)	IMMATURE. Amorph appears non-fluoro but contains abund 'pin-prick'.
			TOTAL	40		
78289 L	1620.1	CRSW	Gold	20	Cellular	MARGINAL MATURE. All fluoro material light colour with hi birefringance.
			TOTAL	20		
78289 K	1648.5	CRSW	Bright Yellow	15	Fragments of Cellular	IMMATURE-MARGINALLY MATURE
			Gold	10	Cellular	
			TOTAL	25		
78289 J	1680.5	CRSW	Bright Yellow	15	Cellular, Spore/Pollen	IMMATURE
			Gold	10	Cellular	
			TOTAL	25		
78289 H	1728.5	CRSW	Bright Yellow	20	Cellular, Semi-Opaque	IMMATURE
			TOTAL	20		
78289 G	1749.5	CRSW	Bright Yellow	30	Cellular, Spore/Pollen	IMMATURE
			TOTAL	30		
78289 E	1787	CRSW	Gold	50	Cellular Frags, Spore/Pollen	MATURE
			TOTAL	50		
78289 C	1806.5	CRSW	Gold	60	Cellular Frags, Spore/Pollen	MATURE. Hi proportion of Cellular tied up within Amorphouus
			TOTAL	60		
78289 B	1816.5	CRSW	Gold	15	Cellular	MATURE
			TOTAL	15		
78288 Z	1843	CRSW	Gold	15	Cellular	MATURE
			TOTAL	15		
78288 Y	1858	CRSW	Gold	20	Cellular Frags, Spore/Pollen	MATURE
			TOTAL	20		

TABLE 5 (cont) **KEROGEN FLUORESCENCE**

WELL: ADMIRAL 1

SAMPLE NO	DEPTH (M)	TYPE	COLOUR	%	DESCRIPTOR	COMMENTS
78288 W	1899	CRSW	Gold	40	Cellular Fragments	MATURE. Amorph non-fluorescing
			TOTAL	40		
78288 U	1936	CRSW	Gold	20	Cellular Fragments	MATURE
			Bright Orange	40	Cellular, Amorph, Semi-Opaque	
			TOTAL	60		
78288 T	1961.1	CRSW	Bright Yellow	5	Cellular	IMMATURE
			TOTAL	5		
78288 R	1988	CRSW	Bright Yellow	5	Cellular	MATURE. Very little fluorescence
			TOTAL	5		
78288 O	2048.8	CRSW	Bright Yellow	5	Cellular	MATURE. ?Contaminants fluorescing
			TOTAL	5		
78288 M	2061	CRSW	Bright Orange	5	Cellular	MATURE. ?Contaminants fluorescing
			TOTAL	5		
78288 I	2103	CRSW	Bright Yellow	5	Cellular	MATURE. Amorph non-fluorescing.
			Gold	15	Cellular	?Contaminants fluor bright yellow
			TOTAL	20		

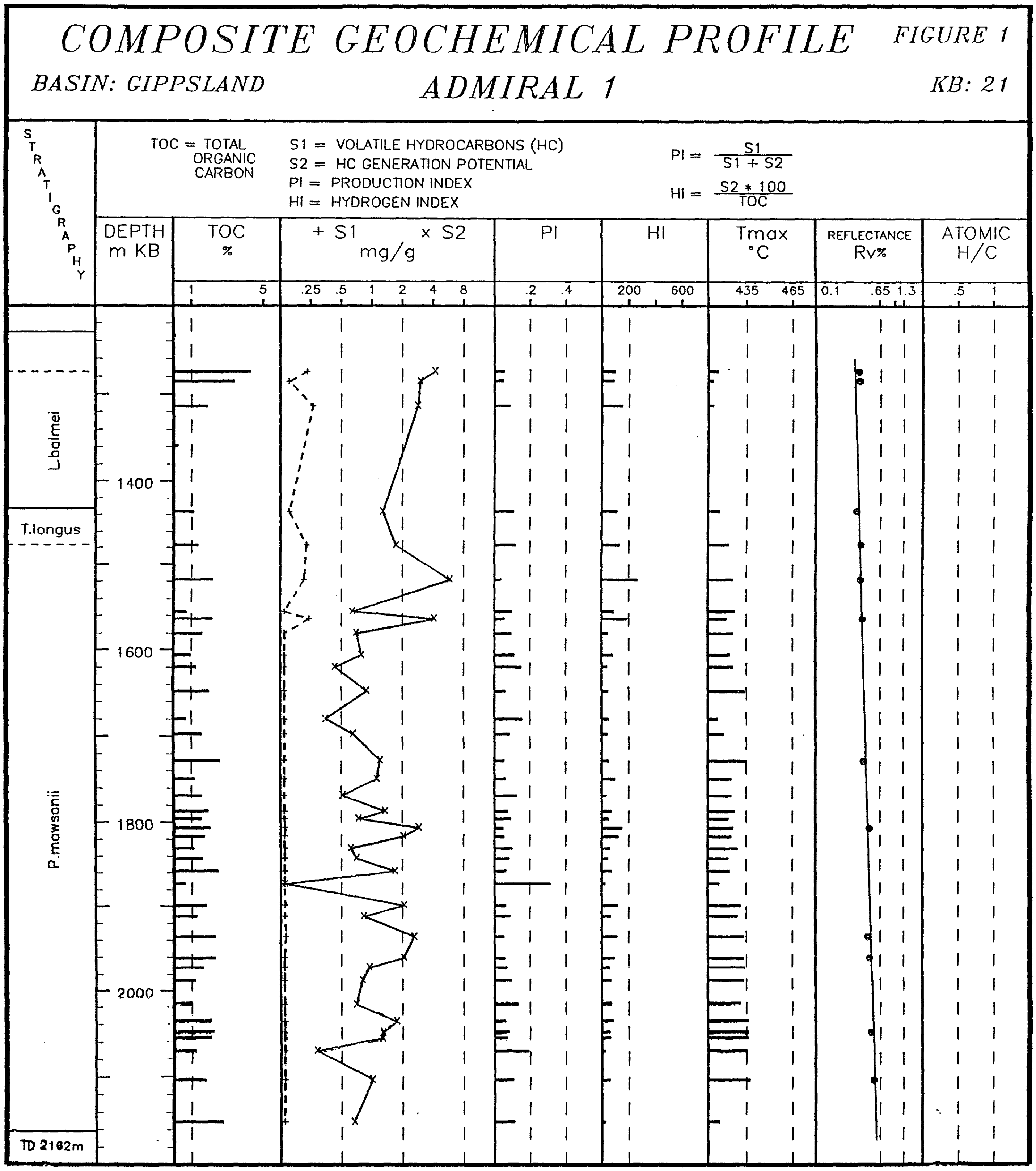

COMPOSITE GEOCHEMICAL PROFILE
FIGURE 1
BASIN: GIPPSLAND
ADMIRAL 1
KB: 21
STRATIGRAPHY
TOC = TOTAL ORGANIC CARBON
S1 = VOLATILE HYDROCARBONS (HC)
S2 = HC GENERATION POTENTIAL
PI = PRODUCTION INDEX
HI = HYDROGEN INDEX
PI = S1 / S1 + S2
HI = S2 * 100 / TOC
DEPTH m KB
TOC %
+ S1 x S2 mg/g
PI
HI
Tmax °C
REFLECTANCE Rv%
ATOMIC H/C
1 5
.25 .5 1 2 4 8
.2 .4
200 600
435 465
0.1 .65 1.3
.5 1
1400
1600
1800
2000
L.balmei
T.longus
P.mawsonii
TD 2162m

Figure 2

ROCKEVAL MATURATION PLOT

Admiral 1

Gippsland Basin

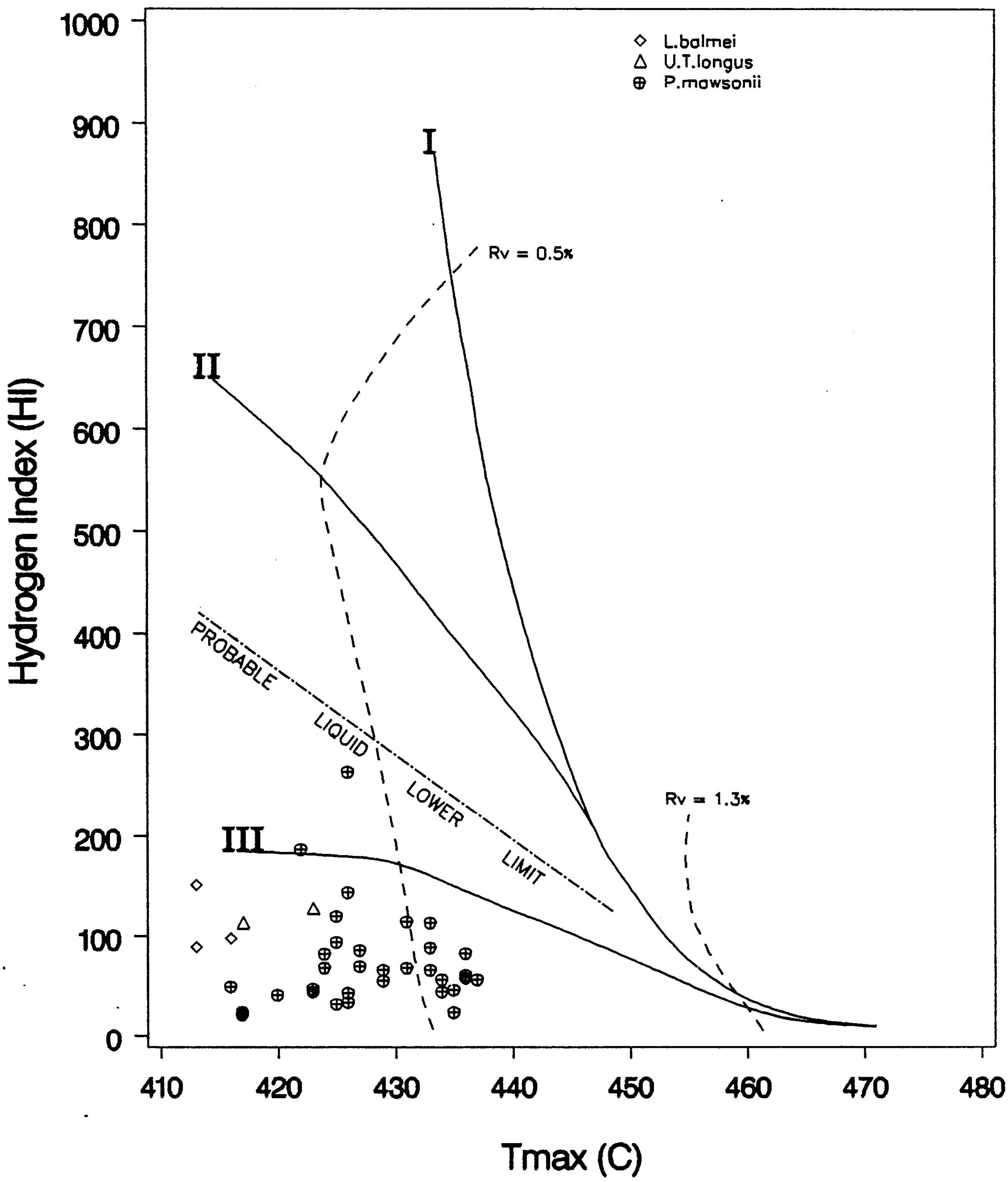
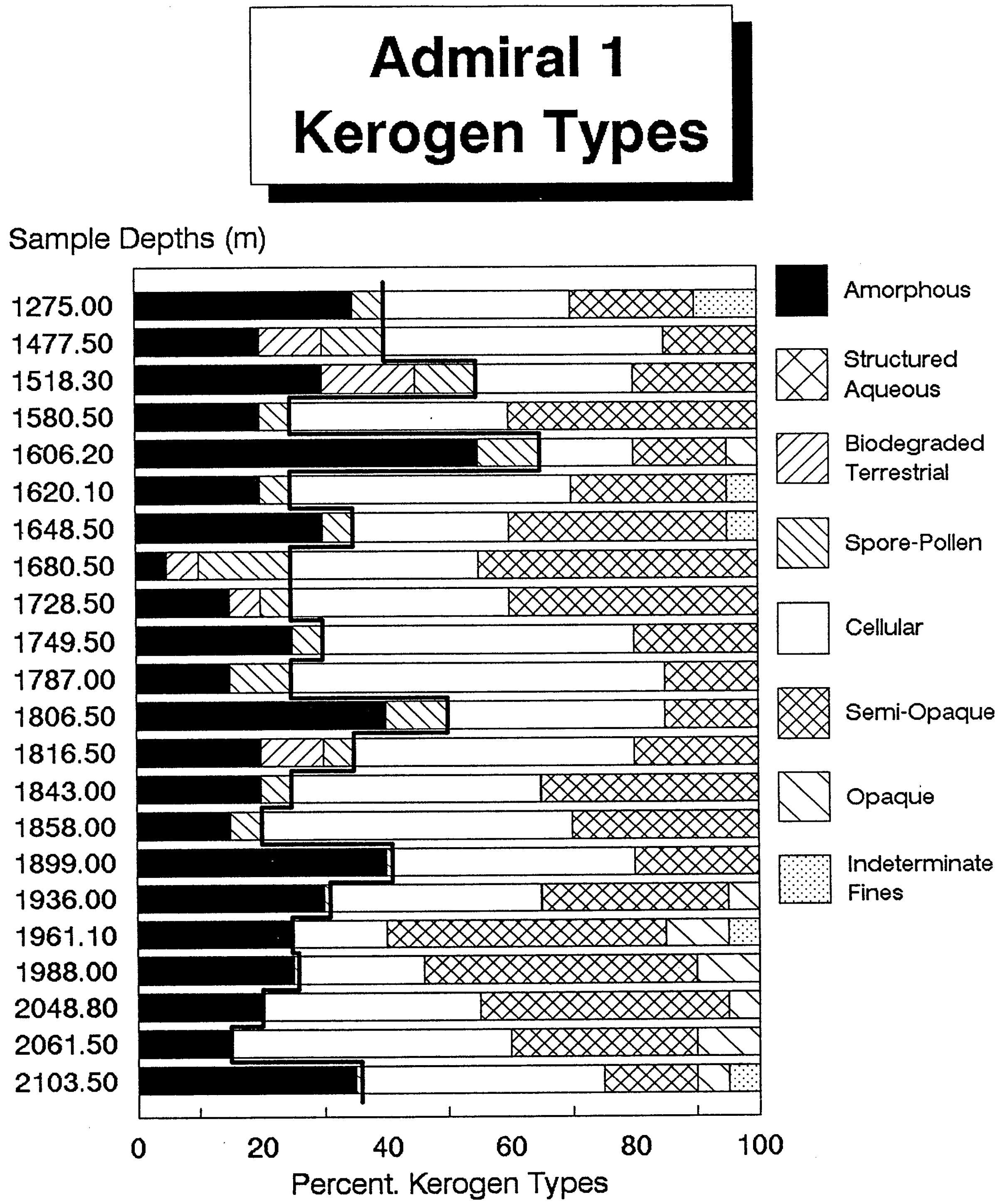
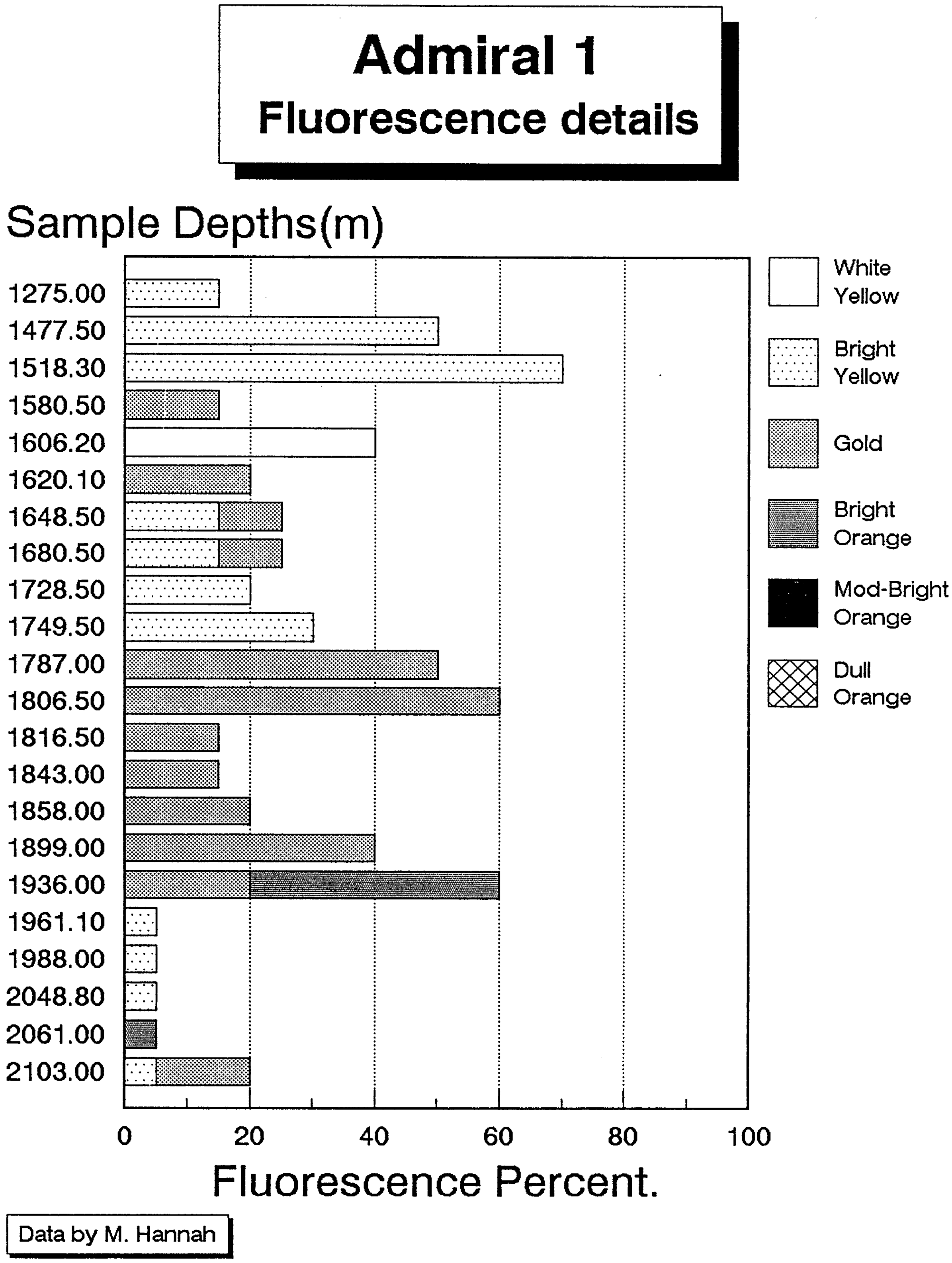


Figure 3



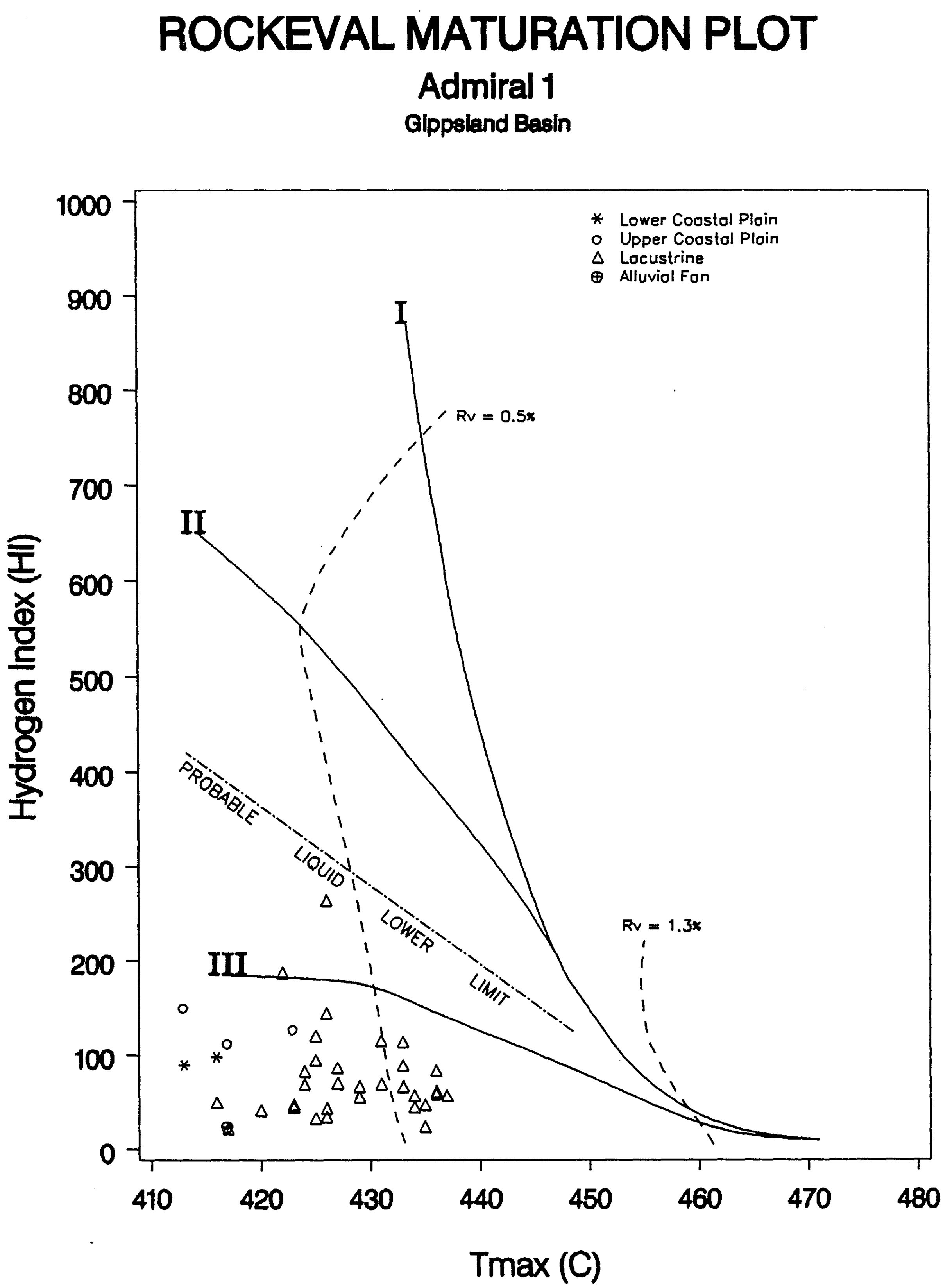
Oil prone types shown to the left of the heavy line.
Data by M. Hannah

Figure 4



Admiral 1
Fluorescence details
Sample Depths(m)
1275.00
1477.50
1518.30
1580.50
1606.20
1620.10
1648.50
1680.50
1728.50
1749.50
1787.00
1806.50
1816.50
1843.00
1858.00
1899.00
1936.00
1961.10
1988.00
2048.80
2061.00
2103.00
0
20
40
60
80
100
Fluorescence Percent.
White Yellow
Bright Yellow
Gold
Bright Orange
Mod-Bright Orange
Dull Orange
Data by M. Hannah

Figure 5


ROCKEVAL MATURATION PLOT
Admiral 1
Gippsland Basin
Lower Coastal Plain
Upper Coastal Plain
Lacustrine
Alluvial Fan
I
II
III
Rv = 0.5%
Rv = 1.3%
PROBABLE LIQUID LOWER LIMIT
Hydrogen Index (HI)
Tmax (C)
1000
900
800
700
600
500
400
300
200
100
0
410
420
430
440
450
460
470
480

APPENDIX 4

APPENDIX 4

GEOTRACK

APATITE AND ZIRCON FISSION TRACK ANALYSIS AND PETROGRAPHY OF POSSIBLE STRZELECKI GROUP, ADMIRAL-1, GIPPSLAND BASIN

A report prepared for the
Esso Australia Ltd
Sydney, Australia

Report prepared by:	I.R. Duddy
Fission track age determinations by:	P. O'Sullivan and P.F.Green
Track length measurements by:	P. O'Sullivan

May 1990

GEOTRACK REPORT #223

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APATITE AND ZIRCON FISSION TRACK ANALYSIS AND PETROGRAPHY OF POSSIBLE STRZELECKI GROUP, ADMIRAL-1, GIPPSLAND BASIN

CONTENTS

GEOTRACK REPORT #223

APATITE AND ZIRCON FISSION TRACK ANALYSIS AND PETROGRAPHY OF POSSIBLE STRZELECKI GROUP, ADMIRAL-1, GIPPSLAND BASIN

EXECUTIVE SUMMARY

1. The sample of possible Strzelecki Group from 2125-2162 m in Admiral-1 provided excellent yields of apatite and zircon suitable for fission track analysis. No sphene was recovered.

2. Petrographic data indicates that the unit intersected below 2117.0 m in Admiral-1 is not typical Strzelecki Group, and is most likely a unit equivalent in age to the basal Latrobe Group that contains some reworked Strzelecki Group detritus of volcanic origin.

3. Zircon fission track data suggests that the maximum stratigraphic age of the unit is early Cretaceous, consistent with the petrography and paleontological data from the overlying section.

4. The AFTA data provide clear evidence that the sample at TD is currently at its maximum temperature since deposition (~98°C).

5. The available data does not allow precise estimation of any time break at 2117 m level, but suggests that any such break is of small magnitude.

GEOTRACK REPORT #223

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Table i: Paleotemperature analysis summary - Admiral-1 well, Gippsland Basin (Geotrack Report #223)

Sample number	Average depth (m)	Fission track age (Ma)	Corrected age*1 (Ma)	Stratigraphic age (Ma)	Mean track length (μm)	l_p*1 (μm)	Present temperature (°C)	Estimated maximum paleotemperature*3 (°C)
GC217-1	2244	89.3 ± 15.4	127	~90-120*2	10.49 ± 0.83	10.1	~98	present

*1 For details of Corrected ages and l_p values see Appendix C.
*2 Based on zircon fission track and paleontological data - see text.
*3 Paleotemperature estimates based on apatite compositions with Cl varying from 0 to ~0.4 wt% - see Appendix D).

ADMIRAL-1

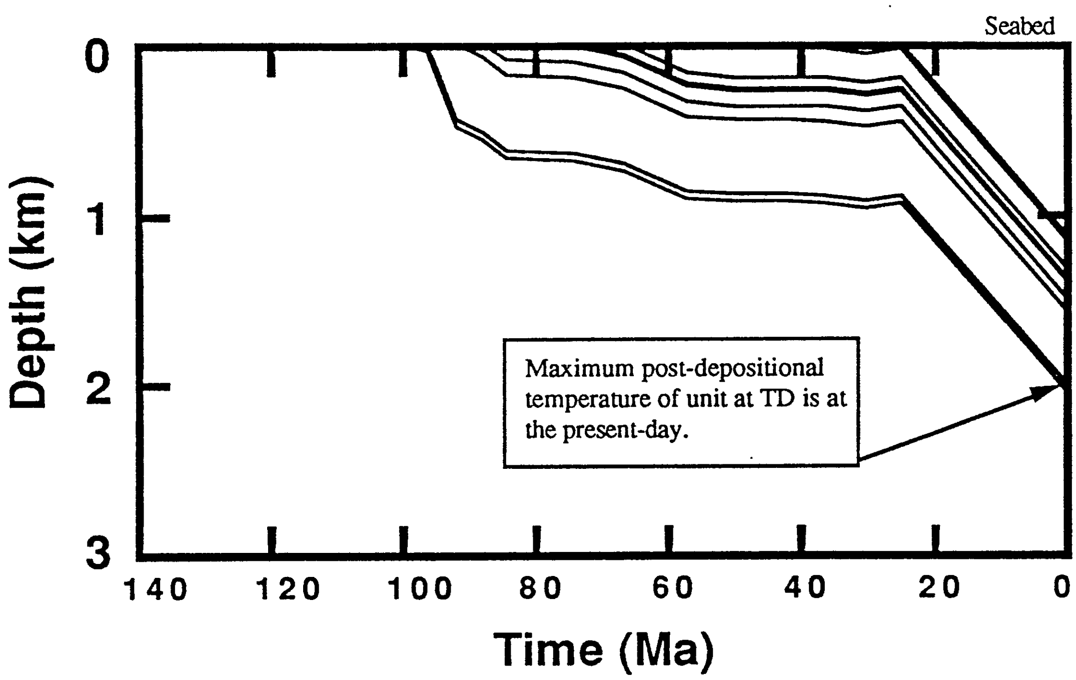

Figure i: Schematic illustration of preferred AFTA thermal history interpretation for **Admiral-1 well, Gippsland Basin.** The AFTA data indicate that the present temperatures experienced by the unit below 2117 m are the maximum temperatures since deposition - see text.

1. Introduction

This report describes results of a petrographic study on five samples plus an AFTA and zircon fission track study of one sample from the **Admiral-1 well,** Gippsland Basin, submitted for analysis by Esso Australia Ltd, Sydney. Sample details are summarised in Appendix A (including present temperature data), while sample preparation and experimental details etc are described in Appendix B. The data obtained from the samples are presented in the form of both Tables and Figures following the text and details of the data presentation are discussed in Appendix C. Appendix D outlines the principles employed in interpreting the AFTA and zircon fission track data in terms of thermal histories. Petrographic descriptions of the 5 samples are provided in Appendix E.

The main aim of the study was to determine if the petrography of the unit intersected at 2117 m in Admiral-1 is typical of the early Cretaceous Strzelecki Group.

Interpretation of the zircon fission track data and petrography suggests that the section intersected below 2117 m in **Admiral-1** is no older than early Cretaceous, and may either be a basal unit of the Latrobe Group containing some reworked Strzelecki Group volcanogenic detritus, or an atypical member of the Strzelecki Group containing abundant arkosic detritus.

Given that the unit is no older than early Cretaceous, AFTA data indicate that the unit intersected at TD is currently at its maximum post-depositional temperature. Figure i shows a schematic illustration of the main features of the thermal history interpretation derived from the AFTA and Table i summarises the interpretation, together with various AFTA parameters for the sample.

2. Petrography

Petrographic descriptions for each sample are presented in Appendix E. In particular, we were asked the following two questions pertaining to the petrography:

2.1 Does the petrography of the unit correspond to the Strzelecki Group ?

The petrography of the five samples analysed is clear in showing that the unit intersected below 2117.0 m in Admiral-1 is not typical Strzelecki Group.

Note that only the sandstone lithologies can give diagnostic information that enables typical Strzelecki Group to be identified. The major petrological characteristic of the Strzelecki Group sandstones *sensu stricto* (and its Otway Basin equivalent, the Otway Group) is the abundance of material derived from contemporaneous early Cretaceous volcanism (Duddy, 1983). Typically, Strzelecki Group has >50% volcanic rock fragments, plagioclase feldspars, a well developed chlorite clay coating grains and secondary zeolite cements. Importantly, quartz makes up less than 20% of the typical sandstone. The samples from the basal undifferentiated Latrobe Group (samples GC223-2 and 3) are of a very similar petrology to the samples from the section below 2117 m that have been assigned to the Strzelecki Group (samples GC223-1, 4 and 5). In particular, all samples show a dominance of granitic quartz, "chert", altered feldspar, and diagenetic carbonate and kaolinite. Rock fragments are common, but identifiable rock fragments are mostly of siltstones and mudstones. Nevertheless, fine-grained rock fragments are present which might have a volcanic origin. A single definite volcanic rock fragment was noted in sample GC223-5, and possible volcanic rock fragments were noted in one large sandstone cuttings fragment in sample GC223-1.

Thus on petrographic grounds, the unit below 2117 m cannot be regarded as typical Strzelecki Group.

2. **Does the unit contain detrital sphenes and apatites?**

Detrital apatite was recovered from sample GC223-1 and then subjected to AFTA. No sphene was recovered.

The AFTA data (see below) show that many grains are present with fission track ages greater than the age of the Strzelecki Group, consistent with a source from Paleozoic basement rocks. However, many grains are highly annealed, this due to the prevailing temperature of ~98°C, so that individual grains have ages which range from zero to ~230 Ma. Thus, this result is compatible with the petrography of the unit, suggesting that at least a large component of the unit is composed of basement granitic detritus, and not of contemporaneous volcanogenic detritus.

Note that the fission track data preclude post-depositional temperatures >~110°C associated with the opening of the Tasman Sea at ~80 Ma, as many grains exceed this age.

3. Thermal history and provenance interpretation

3.1 Zircon fission track data

The zircon fission track ages from the possible Strzelecki Group intersected in **Admiral-1 well** range from ~ 55 ± 10 Ma (1 sigma) to 469 ± 92 Ma, with the bulk of the single grains older than ~100 Ma (Appendix C and Figure 4). It seems likely the youngest grain is derived from cavings as the unit would appear to be at least Cenomanian in age on paleontological grounds, and caved material was noted in the petrographic analysis (Appendix E). The remaining nine grains are considered to belong to the indigenous population, and of these, five are consistent with an early Cretaceous age suggesting an upper limit for the age of the sediment, with the older grains consistent with derivation from a Paleozoic terrain. Thus we would place the stratigraphic age of the sample between ~90 and 120 Ma.

3.2 AFTA data

AFTA data from the one sample analysed from **Admiral-1 well** indicate that the sample is currently being subjected to its maximum temperature since deposition. Two lines of evidence lead to this conclusion:-

1) The mean fission track age is similar to, or slightly less than, a mid to early Cretaceous stratigraphic age (based on the zircon data), as shown in Figure 1, and the individual grains give fission track ages which spread from significantly less than, to significantly greater than, the stratigraphic age (Figure 2 and Appendix C). These data alone indicate that the sample could not have been subjected to a temperature greater than ~110°-120°C after deposition, the temperature at which all fission tracks would be erased.

2) The measured mean track length is similar to the value of $\mathbf{l_p}$ (Table i), which indicates that the majority of tracks in these samples are similar in length to those expected if they had formed at the prevailing temperature of ~98°C in the sample. Since the fission track age of the samples is close to, or less than the stratigraphic age, the similarity between the mean track length and $\mathbf{l_p}$ values can be explained simply if the present temperature is the maximum temperature experienced after deposition.

In summary, AFTA parameters in samples from the **Admiral-1 well** show a degree of annealing which is consistent with the burial and thermal history inferred from the preserved stratigraphy and the quoted present temperature. The corrected fission track ages for the sample (GC223-1; Table i) is greater than, or close to, the interpreted stratigraphic age, and it is clear that the sample has not been totally annealed since deposition.

Based on this thermal history interpretation we show in Figure 5 a profile of vitrinite reflectance predicted using the algorithm of Burnham and and Sweeney (1989), using the Basinmod software package of Platte River and Associates.

Figure i shows a schematic illustration of the main features of the thermal history interpretation derived from the AFTA data for the **Admiral-1 well**, and Table i summarises the interpretation, together with various AFTA parameters for each sample.

4. Concluding remarks

The combined petrology and zircon fission track and AFTA study shows that the unit of interest below 2117 m in Admiral-1 is not typical of the Strzelecki Group. The abundance of basement derived detritus might suggest that a lower-most Latrobe Group age could be more likely, with some minor reworked Strzelecki Group sediment being present (ie the few volcanic rock fragments). This would be consistent with the known tectonic development of the region, with major uplift and erosion at ~95-100 Ma.

Zircon fission track data indicates the presence of grains with early Cretaceous fission track ages, suggesting that unit can be older that early Cretaceous. Given that the section immediately above 2117 m is said to be no older than 96 Ma on paleontological grounds (Esso information), this information is consistent with the unit being of either basal Latrobe Group age, or that the unit is equivalent in age to the uppermost Strzelecki Group, but is of an atypical lithology. No precise information is available on the magnitude any time break between the section above 2117 m and that below, however, any such break is likely to be minor.

References

Burnham, A.K. and Sweeney, J.J., 1989, A chemical kinetic model of vitrinite reflectance maturation. *Geochim. et Cosmochim. Acta*, 53, 2649-2657.

Duddy, I.R., 1983, The geology, petrology and geochemistry of the Otway Formation volcanogenic sediments. PhD, University of Melbourne (Unpublished)

Table 1: Sample details and apatite and zircon yields - Admiral-1, Gippsland Basin (Geotrack Report #223)

Geotrack number	Depth (m)	Sample type	Stratigraphic sub-division	Stratigraphic age (Ma)	Present temperature (°C)	Raw weight (g)	Washed weight (g)	Apatite yield*1	Zircon yield*1	Sphene yield*1
GC223-1	2125-62	UW Cuttings	? Strzelecki	~97-144	~98	~800	450	Excellent	Excellent	None
GC223-2	2090-95	W Cuttings	Cenomanian	~90-97	~95	-	-	NA	NA	NA
GC223-3	2115.0	SWC	Cenomanian	~90-97	~96	-	-	NA	NA	NA
GC223-4	2130-35	W Cuttings	? Strzelecki	~97-144	~97	-	-	NA	NA	NA
GC223-5	2145-2150	W Cuttings	? Strzelecki	~97-144	~97	-	-	NA	NA	NA

*1 Yield based on quantity ofmineral suitable for age determination. Excellent: >20 grains (10 grains for zircon); Very good: ~20 grains; Good: 15-20 grains; Fair: 10-15 grains; Poor: 5-10 grains; Very poor: <5 grains.

NA : Not applicable - for petrographic description only.

Table 2: Apatite fission track analytical results - (Geotrack Report #223)

Geotrack number	Average Depth (m)	Number of grains	Standard track density ($x10^6 cm^{-2}$)	Fossil track density ($x10^6 cm^{-2}$)	Induced track density ($x10^6 cm^{-2}$)	Chi square probability (%)	Fission track age (Ma)	Uranium Content (ppm)	Mean track length (μm)	Standard deviation (μm)
GC223-1	2244	20	1.423 (2238)	0.586 (429)	1.956 (1433)	<0.1	74.7 ± 4.5 *89.3 ± 15.4**	18	10.74 ± 0.23 (100)	2.28

Brackets show number of tracks counted.
Standard and induced track densities measured on mica external detectors (g=0.5), and fossil track densities on internal mineral surfaces.
* Mean age, used where pooled data fail χ^2 test at 5%. Errors quoted at $\pm 1\sigma$.
Ages for samples calculated using ζ=352.7 (Analyst: P.O'Sullivan) for dosimeter glass SRM612 (Hurford and Green, 1983).
Track length measurements by P.O'Sullivan.

Table 3: Length distribution summary data: Admiral-1 (Geotrack Report #223)

Sample number	Average depth (m)	Mean track length (μm)	Std dev (μm)	Number of tracks (N)	Number of tracks in length interval (μm)																			
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
GC223-1	2244	10.74 ± 0.23	2.28	100	-	1	-	-	3	4	-	1	5	9	21	27	18	10	1	-	-	-	-	-

Track length measurements by P.O'Sullivan.

Table 4: Zircon fission track analytical results - (Geotrack Report #223)

Geotrack number	Average Depth (m)	Number of grains	Standard track density ($x10^6cm^{-2}$)	Fossil track density ($x10^6cm^{-2}$)	Induced track density ($x10^6cm^{-2}$)	Chi square probability (%)	Fission track age (Ma)	Uranium Content (ppm)
GC223-1	2244	10	1.128 (1774)	12.010 (429)	4.011 (621)	<0.1	146.4 ± 7.7 *187.9 ± 40.4**	190

Brackets show number of tracks counted.
Standard and induced track densities measured on mica external detectors (g=0.5), and fossil track densities on internal mineral surfaces.
* Mean age, used where pooled data fail χ^2 test at 5%. Errors quoted at $\pm 1\sigma$.
Ages for samples calculated using ζ=87.7 (Analyst: P.F. Green) for dosimeter glass SRM612 (Hurford and Green, 1983).

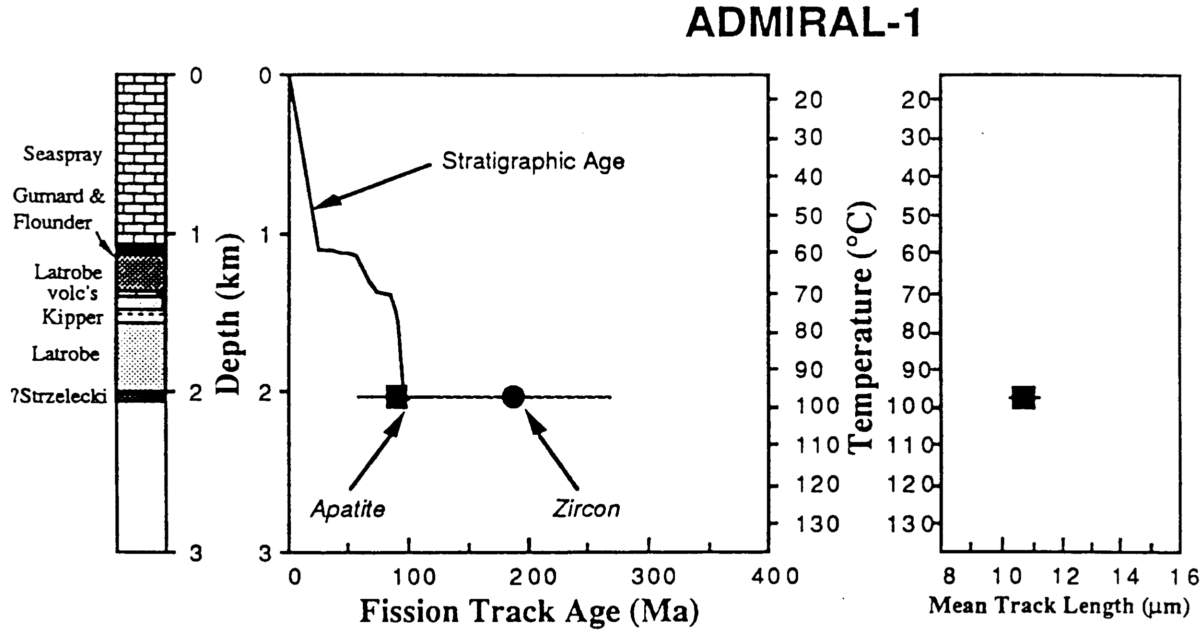

Figure 1: AFTA parameters plotted against sample depth and present temperature for samples from the **Admiral-1 well**. The variation of stratigraphic age with depth is also shown, as the solid line in the central panel.

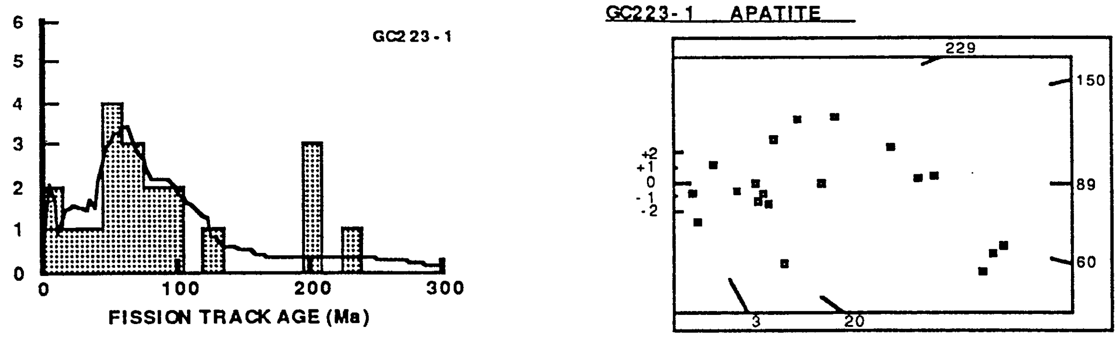

Figure 2: Single grain age distributions with smoothed cumulative age probability distributions (left) and radial plots of single grain age data (right) in apatites from **the Admiral-1 well, Gippsland Basin.** See Appendix C for details, including explanation of radial plots.

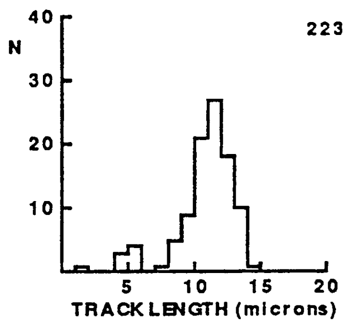

Figure 3: Distributions of confined track lengths in apatites from **the Admiral-1 well, Gippsland Basin.**

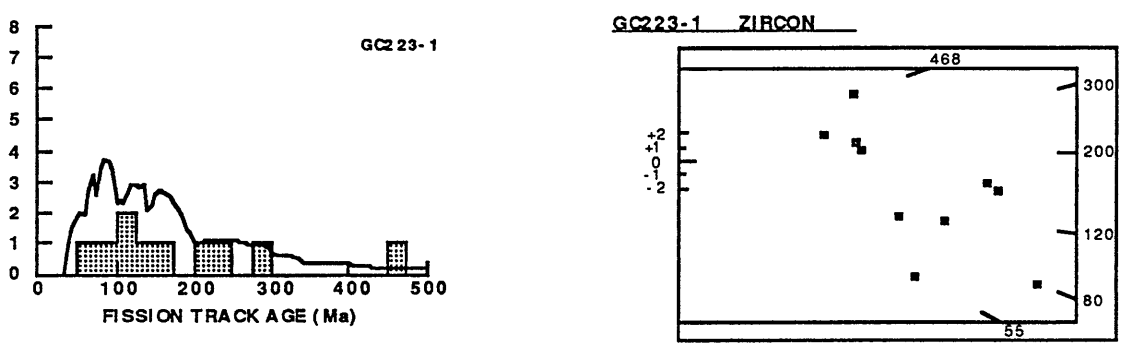

Figure 4: Single grain age distributions with smoothed cumulative age probability distributions (left) and radial plots of single grain age data (right) in zircons from **the Admiral-1 well, Gippsland Basin.** See Appendix C for details, including explanation of radial plots.

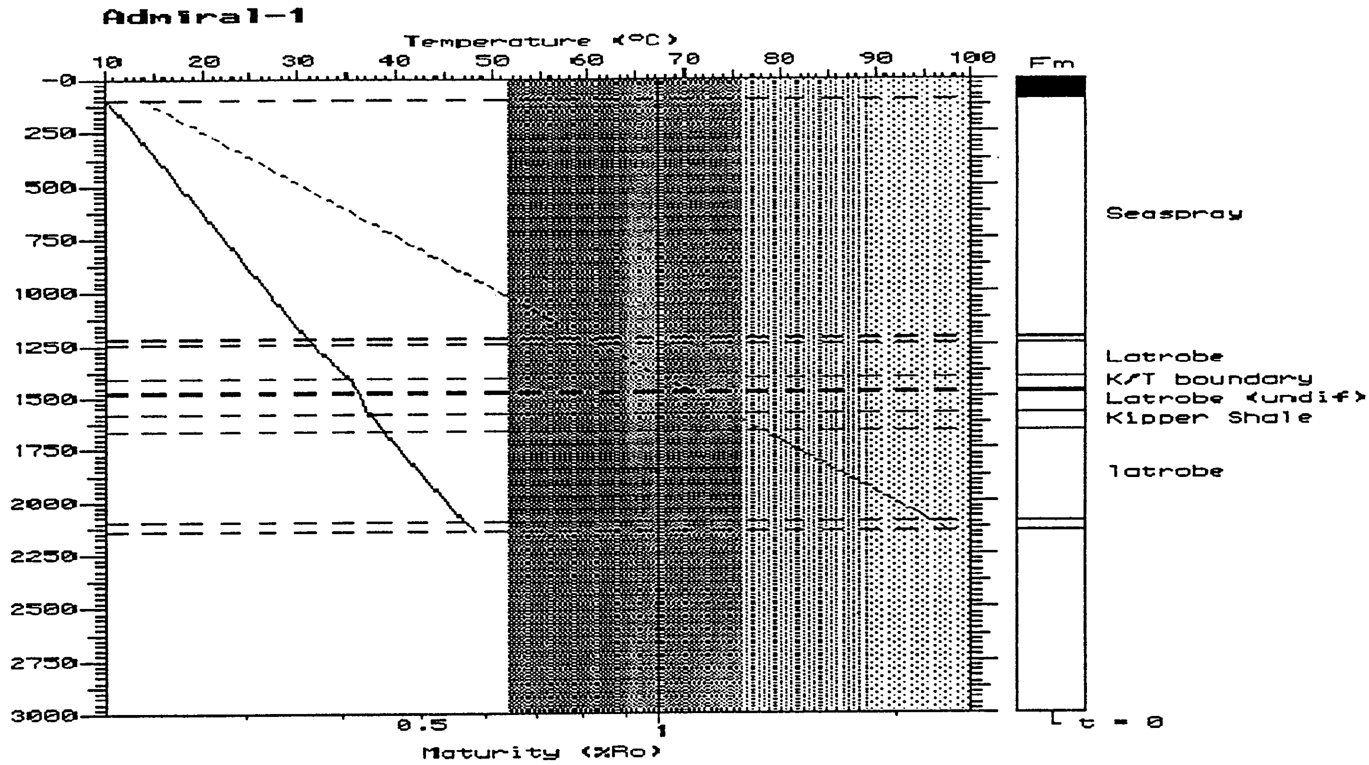

Figure 5: Predicted vitrinite reflectance (based on the distributed activation energy model of Burnham and Sweeney, 1989) for the **Admiral-1 well**, for the history shown in Figure i with maximum temperatures being experienced at the present day.

APPENDIX A

Sample Details

One sample from the **Admiral-1 well**, Gippsland Basin, was submitted by Esso Australia Ltd., for apatite and zircon fission track analysis, with a further 4 samples submitted for additional petrographic description. Sample details supplied by Esso Australia, are summarised in Table 1, together with the yields of detrital apatite and zircon obtained after mineral separation. No sphene was recovered. Numerical values for stratigraphic ages have been assigned using Harland et al. (1982). Present temperatures of each sample are based on a geothermal gradient of ~43°C/km and an average sea bed temperature of 14°C, as supplied by Esso.

Excellent yields of both apatite and zircon suitable for analysis were obtained and the overall quality of the data is regarded as excellent.

References

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APPENDIX B

Sample Preparation and Experimental Details

The cuttings sample was ground to sand size in the rotary disc mill. The ground material was washed to remove dust, dried and processed by conventional heavy liquid and magnetic separation techniques to recover heavy minerals. Petrographic sample preparation details are described in Appendix E.

Apatite fission track age and length measurements were made using techniques outlined by Green (1986). Apatites were mounted in epoxy resin on glass slides, polished and etched for 20 sec in 5M HNO_3 at 20°C to reveal the fossil fission tracks. Zircons were embedded in FEP Teflon between heated microscope slides on a hot plate. The zircon mount was then polished and etched for ~73 hours in a molten KOH:NaOH eutectic mixture at ~220°C (Gleadow et al., 1976). Fission track ages for apatite and zircon were determined by the external detector method or EDM (Gleadow, 1981) using an Autoscan™ microcomputer controlled automatic stage (Smith and Leigh Jones, 1985). The EDM has the advantage of allowing fission track ages to be determined on single grains. Wherever possible, tracks were counted over 20 grains in each apatite mount, and 10 grains in each zircon mount. In those samples where this number was not present, all available grains were counted, the actual number depending on the availability of suitably etched and oriented apatites. Only grains oriented with surfaces parallel to the crystallographic c-axis were analysed. Such grains can be identified on the basis of the etching characteristics, as well as from morphological evidence in euhedral grains. The grain mount was scanned sequentially, and the first 20 (or 10) suitably oriented grains identified were analysed. Track counting was carried out using a Zeiss(R) Axioplan microscope, with an overall linear magnification of 1068 x using dry objectives.

Neutron irradiations were carried out in a well thermalised flux (X-7 facility) in the Australian Atomic Energy Commission's HIFAR research reactor. Total neutron fluence was monitored by counting tracks in mica external detectors attached to two pieces of the NBS standard glass SRM612, in the case of apatite mount irradiations, included in the irradiation canister at each end of the sample stack. Corning Glass standard U3 was used to monitor total fluence during zircon mount irradiations. No flux gradient is usually found in the irradiation facility used over the length of the sample package and this was confirmed by the track counts over the two dosimeter glasses. The two values have been pooled to give the single values quoted in Tables 2 and 4.

For apatite track length studies, the full lengths of 'confined' fission tracks were measured. Confined tracks are those which do not intersect the polished surface but have been etched from other tracks or fractures, so that the whole length of the track is etched. Confined track lengths were measured using a digitising tablet connected to a microcomputer, superimposed on the microscope field of view via a projection tube. With this system, calibrated against a stage graticule ruled in 2 μm divisions, individual tracks can be measured to a precision of ± 0.2 μm. Tracks were measured only in prismatic grains, characterised by sharp polishing scratches with well etched tracks of narrow cone angle in all orientations, because of the anisotropy of annealing of fission tracks in apatite (as discussed by Green et al., 1986). Tracks were also measured following the recommendations of Laslett et al. (1982), the most important of which is that only horizontal tracks should be measured. One hundred tracks were measured whenever possible. In apatite samples with low track density, or in those samples in which only a small number of apatite grains were obtained, fewer confined tracks may be available, and in such cases, the whole mount was scanned to measure as many confined tracks as possible.

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Green, P.F. 1986, On The thermo-tectonic evolution of Northern England: evidence from fission track analysis. *Geol. Mag.*, 123, 493 - 506.

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APPENDIX C

Data Presentation

Full analytical data for the apatite and zircon fission track age determinations are given in Tables 2 and 4, respectively, together with the mean confined track length and the standard deviation of the distribution of confined track lengths in each apatite sample.

Fission track ages were calculated using the standard fission track age equation (Hurford and Green, 1982) and errors are quoted at the level of one standard deviation throughout. All constants used in derivation of the results are shown at the bottom of Tables 2 and 4 using the nomenclature of Hurford and Green (1982). The Zeta calibration factor has been determined empirically (Green, 1985) by direct comparison with K-Ar ages for a set of carefully chosen age standards, following the methods outlined by Hurford and Green (1983). The pooled or maximum probability age is determined from the ratio of the total spontaneous and induced track counts in all the analysed grains. Errors for the pooled age were calculated using the 'conventional' technique outlined by Green (1981), based on the total number of tracks counted for each track density measurement.

The variability of fission track ages between individual apatite grains within each sample can be assessed using a chi-squared (χ^2) statistic (Galbraith, 1981), the results of which are summarised for each sample in Tables 2 and 4. The probability of obtaining the observed χ^2 value, for ν degrees of freedom (where ν = number of crystals -1), which can be obtained from standard tables, indicates the probability that all the grains counted belong to a single age population. A probability of less than 5% denotes a significant spread of single grain ages, and suggests that real differences exist between the fission track ages of individual apatite grains. A significant spread in grain ages can result either from inheritance of detrital grains from mixed source areas, or from differential annealing in apatite grains of different composition, within a narrow range of temperature.

Calculation of the pooled age inherently assumes that only a single population of ages is present, and is thus not appropriate to samples containing a significant spread of fission track ages. In such cases the mean of the single grain fission track ages provides a useful measure and this parameter has been used for those samples in which $P(\chi^2)<5\%$. The error in the mean fission track age is taken as the standard deviation of the single grain ages.

Full details of the fission track age data for individual grains in each sample are given, together with the primary counting results and statistical data, on pages C.3 - C.4 for apatite and zircon respectively. Plots of the single grain age data in each sample are shown in Figures 2 and 4 for apatite and zircon, respectively. The distributions of single grain ages are shown in histogram form and also as smoothed probability functions. In constructing these functions, each grain is represented by a normal probability curve with mean equal to the single grain age, standard deviation given by the error on the single grain age, and the contributions from all grains analysed in each sample are summed to produce the plotted curve.

Single grain age data are also plotted on radial plot diagrams (Galbraith, 1988) in Figures 2 and 4. These plots display the variation of individual grain ages as a plot of $y = (z_i - z)/\sigma_i^2$ against $x = 1/\sigma_i^2$ where z_i is the fission track age of each grain, z is the mean age, and σ_i is the error in each age. In this plot, the slope of a straight line from the origin is equivalent to fission track age, and the value of x is a measure of the precision of each individual grain age. Therefore, precise individual grain ages fall to the right of the plot (high x), enabling precise, young grains to be identified. The age scale is shown radially around the perimeter of the plot (in Ma). If all grains belong to a single age population, all data should scatter between $y = +2$ and $y = -2$, equivalent to scatter within $\pm 2\sigma$. Scatter outside these boundaries shows a significant spread of individual grain ages, as also reflected in the Chi-square statistic in Tables 2 and 4.

Distributions of confined track lengths in each sample are shown in Figure 3 and have been normalised to 100 tracks for each sample to facilitate comparison. The number of tracks (N) measured for each sample is indicated in Table 2 and full details of the track length distributions are given in Table 3.

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GC223-1 APATITE

IRRADIATION 092
SLIDE NUMBER 13
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHO_s	RHO_i	F.T. AGE (Ma)
1	48	129	100	0.372	18.9	7.628E+05	2.050E+06	92.7 ± 15.8
2	4	5	20	0.800	3.7	3.178E+05	3.973E+05	197.6 ± 132.7
3	17	21	60	0.810	5.1	4.502E+05	5.562E+05	199.9 ± 65.4
4	19	54	28	0.352	28.2	1.078E+06	3.065E+06	87.7 ± 23.5
5	43	117	100	0.368	17.1	6.833E+05	1.859E+06	91.5 ± 16.5
6	54	220	60	0.245	53.7	1.430E+06	5.827E+06	61.3 ± 9.4
7	7	82	100	0.085	12.0	1.112E+05	1.303E+06	21.4 ± 8.4
8	43	89	20	0.483	65.1	3.416E+06	7.071E+06	120.1 ± 22.5
9	1	67	100	0.015	9.8	1.589E+04	1.065E+06	3.7 ± 3.8
10	8	29	70	0.276	6.1	1.816E+05	6.583E+05	68.8 ± 27.5
11	43	212	100	0.203	31.0	6.833E+05	3.369E+06	50.7 ± 8.6
12	1	8	50	0.125	2.3	3.178E+04	2.542E+05	31.3 ± 33.2
13	27	29	50	0.931	8.5	8.581E+05	9.217E+05	229.4 ± 61.6
14	49	212	60	0.231	51.7	1.298E+06	5.615E+06	57.7 ± 9.3
15	5	19	70	0.263	4.0	1.135E+05	4.313E+05	65.7 ± 33.1
16	37	46	24	0.804	28.0	2.450E+06	3.046E+06	198.7 ± 44.2
17	7	30	40	0.233	11.0	2.781E+05	1.192E+06	58.3 ± 24.5
18	8	35	32	0.229	16.0	3.973E+05	1.738E+06	57.1 ± 22.4
19	0	6	45	0.000	2.0	0.000E+00	2.119E+05	0.0 ± 0.0
20	8	23	35	0.348	9.6	3.632E+05	1.044E+06	86.7 ± 35.6
	429	1433			18.0	5.857E+05	1.956E+06	

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 107.142 with 19 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.819
Variance of SQR(Ns) = 5.43
Variance of SQR(Ni) = 15.94
Age Dispersion = 53.332 %

Ns/Ni = 0.299 ± 0.016
Mean Ratio = 0.323 ± 0.048

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 1.423E+06cm-2; ND = 2238

POOLED AGE = 74.7 ± 4.5 Ma
MEAN AGE = 89.3 ± 15.4 Ma
CENTRAL AGE = 80.6 ± 12.0 Ma

GC223-1 ZIRCON

IRRADIATION G100
SLIDE NUMBER 14
COUNTED BY: PFG

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	71	63	32	1.127	147.9	3.526E+06	3.128E+06	55.5 ± 9.7
2	126	21	20	6.000	78.9	1.001E+07	1.669E+06	290.0 ± 68.8
3	297	92	25	3.228	276.4	1.888E+07	5.848E+06	157.7 ± 19.2
4	158	72	16	2.194	338.0	1.569E+07	7.151E+06	107.6 ± 15.5
5	303	99	40	3.061	185.9	1.204E+07	3.933E+06	149.6 ± 17.7
6	214	130	30	1.646	325.5	1.134E+07	6.886E+06	80.9 ± 9.2
7	154	31	25	4.968	93.1	9.789E+06	1.970E+06	241.1 ± 47.8
8	146	33	16	4.424	154.9	1.450E+07	3.277E+06	215.1 ± 41.8
9	285	29	30	9.828	72.6	1.510E+07	1.536E+06	468.5 ± 92.1
10	106	51	12	2.078	319.2	1.404E+07	6.754E+06	102.0 ± 17.6
	1860	621			189.6	1.201E+07	4.011E+06	

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 135.951 with 9 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.419
Variance of SQR(Ns) = 9.65
Variance of SQR(Ni) = 5.18
Age Dispersion = 58.577 %

Ns/Ni = 2.995 ± 0.139
Mean Ratio = 3.148 ± 0.607

Ages calculated using a zeta of 87.7 ± .75 for U3 glass
Rho D = 1.128E+06cm-2; ND = 1774

POOLED AGE = 146.4 ± 7.7 Ma
MEAN AGE = 187.9 ± 40.4 Ma
CENTRAL AGE = 153.8 ± 29.9 Ma

APPENDIX D

Principles of Interpretation of AFTA Data in Sedimentary Basins

The following discussion details the principles of interpretation of the apatite and zircon fission track data. Of the two minerals, the annealing characteristics of fission tracks in apatite are more fully understood, mainly as this mineral is the more useful of the two in terms of thermal history analysis. Thermal history interpretation of fission track length and age data in apatite is based on study of the response of induced fission tracks to elevated temperatures in the laboratory (Green et al., 1986; Laslett et al., 1987; Duddy et al., 1988; Green et al., 1989b) and in geological situations (Green et al., 1989a), observations of the lengths of spontaneous tracks in apatites from a wide variety of geological environments (Gleadow et al., 1986), and the relationship between track length reduction and reduction in fission track age observed in controlled laboratory experiments (Green, 1988). The basis of the interpretation of apatite data may be summarised as follows.

Detrital apatite grains are incorporated into sedimentary rocks from three dominant sources - crystalline basement rocks, older sediments and from contemporaneous volcanism. Apatites derived from the first two sources will, in general, contain fission tracks when they are deposited, with AFTA parameters characteristic of the source regions. However apatites derived from contemporaneous volcanism, or from rapidly uplifted basement, will contain no tracks when they are deposited. For now, we will restrict discussion to this situation, and generalise at a later point to cover the case of apatites which contain tracks that have been inherited from source regions.

Fission tracks are trails of radiation damage, which are produced within apatite grains at a more or less constant rate through geological time, as a result of the spontaneous fission of ^{238}U impurity atoms. Therefore the number of fission events which occur within an apatite grain during a fixed time interval depends on the magnitude of the time interval and the uranium content of the grain. Each fission event leads to the formation of a single fission track and the proportion of tracks which can intersect a polished surface of an apatite grain depends on the length of the tracks. Therefore, the number of tracks that are etched in unit area of the surface of an apatite grain (the "spontaneous track density") depends on three factors - (i) the time over which tracks have been accumulating, (ii) the uranium content of the apatite grain, and (iii) the distribution of track lengths in the grain. In sedimentary rocks which have not been subjected to temperatures greater than ~50°C since deposition, spontaneous fission tracks have a characteristic distribution of confined track lengths, with a mean length in the range 14-15 μm, and a standard deviation of ~1 μm. In such samples, by measuring the spontaneous track density and the uranium content of a collection of apatite grains, a "fission track age" can be calculated which will be equal to the time over which tracks have been accumulating. The technique is calibrated against other isotopic systems using age standards which also have this type of length distribution (see Appendices B and C).

In samples which have been subject to temperatures greater than ~50°C after deposition, fission tracks are shortened because of the gradual repair of the radiation damage which constitutes the unetched tracks. In effect, the tracks shrink from each end, in a process which is known as fission track "annealing". The final length of each individual track is essentially determined by the maximum temperature that track has experienced. Time differences of orders of magnitude produce changes in fission track parameters that are equivalent to temperature changes of only ~10°C, so temperature is by far the dominant factor in determining the final fission track parameters. As temperature increases, all existing tracks rapidly shorten to a length determined by the prevailing temperature, regardless of when they were formed. After the temperature has subsequently cooled, all tracks formed prior to the thermal maximum are "frozen" at the degree of length reduction they attained at that time. Thus, the length of each track can be thought of as a maximum-reading thermometer, recording the maximum temperature to which it has been subjected.

In samples for which the present temperature is maximum, all tracks therefore have much the same length resulting in a narrow, symmetric distribution. The degree of shortening will depend on the temperature, with the mean track length falling progressively from ~14 μm at 50°C, to zero at around 110°-120°C, the actual value depending on the timescale of heating and the composition of the apatites present in the sample (see below). Values quoted here relate to times of the order of 10^7-10^8 years, and average apatite composition. If the effective timescale of heating is shorter than 10^7-10^8 years, then the temperature responsible for a given degree of track shortening will be higher, depending in detail on the kinetics of the annealing process (Green et al., 1986; Laslett et al., 1987; Duddy et al., 1988; Green et al., 1989b). Shortening of tracks produces an accompanying reduction in the fission track age, because of the reduced proportion of tracks which can intersect the polished surface. Therefore, the fission track age is also highly temperature dependent, falling to zero at around 120°C, due to total erasure of all tracks.

Complex thermal histories produce correspondingly complex length distributions and ages. Samples which have cooled from a thermal maximum (with peak temperature between ~50° and 120°C) at some time in the past will contain two populations of tracks. Those formed prior to the thermal maximum will all be shortened to more or less the same degree (the precise value depending on the peak temperature) while those formed during and after cooling will be longer due to the lower prevailing temperatures. The length distribution in such samples will be broader than in the simple case, and the fission track age will be a reflection of the amount of length reduction which has occurred. In some cases this kind of history produces a characteristic bimodal distribution of confined track lengths. If cooling is sufficiently rapid, and the final temperature is low enough (<~50°C), tracks formed subsequently will have lengths of 14-15 μm, and will contribute a fission track age component corresponding to the age of the cooling "event". If maximum temperatures exceed ~120°C, all pre-existing tracks will be erased, and all tracks now present will have formed during and subsequent to cooling. The fission track age in such samples therefore relates directly to the time of cooling.

Because temperature dominates the thermal response of tracks in apatite, no information is preserved on the approach to maximum temperature, and the only information available is the magnitude of the maximum temperature, the timing of cooling from that maximum, and some indication of the thermal history since cooling. Note that if temperature increases again, subsequent to the initial cooling, those tracks formed during this second heating phase will undergo greater shortening. If the temperature in the second heating phase reaches similar values to that reached in the original heating, the two generations of tracks will be identical and all information on the original heating phase will be lost. If the temperature during the second heating phase increases beyond that reached in the original heating phase, <u>all</u> tracks are shortened further.

Our understanding of the behaviour of the AFTA system during geological thermal histories is based on study of the response of fission tracks to elevated temperatures in the laboratory (Green et al., 1986; Laslett et al., 1987; Duddy et al., 1988; Green et al., 1989b) and in geological situations (Green et al., 1989a), observations of the lengths of spontaneous tracks in apatites from a wide variety of geological environments (Gleadow et al., 1986), and the relationship between track length reduction and reduction in fission track age observed in controlled laboratory experiments (Green, 1988).

Final interpretation is based on computer modelling of track shortening through likely thermal histories for an apatite of average composition (Green et al., 1989b). As explained by Green et al. (1989b), the uncertainty in estimates of maximum paleotemperature derived using this approach is thought to be ~10°C. Predictions from these modelling procedures agree well with observed AFTA parameters in apatites of the appropriate composition in samples from the Otway Basin reference wells (Gleadow and Duddy, 1981; Gleadow et al., 1983; Green et al., 1989a), providing support for the validity of extrapolation from laboratory to geological timescales.

The ratio of chlorine to fluorine in the apatite lattice exerts a compositional control on the degree of annealing, with apatites richer in fluorine being more easily annealed than those richer in chlorine. Our understanding of the kinetics of fission track annealing relates to apatite with Cl/Cl+F of ~0.1 (Durango apatite) on which most of our original experimental studies were carried out. Unpublished laboratory annealing studies on a range of different apatites, together with observations of annealing in apatites from the Otway Basin reference wells, which show a wide spread of compositions, afford a means of extending the model predictions to apatites of other compositions. The apatite grains analysed in this study have etching characteristics suggesting a restricted compositional range, from Cl/(Cl+F) of zero (pure fluorapatite) to ~0.1, the value in Durango apatite. Therefore, in our interpretation, paleotemperature estimates are based on this assumption. Experience with a wide variety of rock types from a variety of source terrains suggests that this assumption should be valid.

The basic principle involved in the interpretation of AFTA data in sedimentary basins is to ask whether the degree of annealing shown by tracks in apatite from a particular sample could have been produced by the thermal history suggested by the preserved sedimentary section and the prevailing geothermal gradient.

The degree of annealing is assessed in two ways - from fission track age and track length data. The stratigraphic age provides a basic reference point for the interpretation of fission track age, because reduction of the fission track age below the stratigraphic age unequivocally reveals that appreciable annealing has taken place after deposition of the host sediment. Large degrees of fission track age reduction, with the mean or pooled fission track age very much less than the stratigraphic age, indicate severe annealing, which requires paleotemperatures of at least ~100°C for any reasonable geological timescale of heating (>~10 Ma). Note that this applies even when apatites contain tracks inherited from source areas. More moderate degrees of annealing can be detected by inspection of the single grain age data, as the most sensitive (fluorine-rich) grains will begin to give fission track ages significantly less than the stratigraphic age before the mean or pooled age has been reduced sufficiently to give a noticeable signal. Note that this aspect of the single grain age data can also be used for apatites which have tracks inherited from source areas. If signs of moderate annealing (from single grain age reduction) or severe annealing (from the mean or pooled age) are seen in samples which are from present temperatures at which the observed degree of annealing would not be expected, then this suggests that the sample has been subjected to elevated temperatures at some time in the past.

Similarly, the present temperature from which a sample is taken, and the way this has been approached (as inferred from the preserved sedimentary section), forms a basic point of reference for track length data (as well as fission track age data). If observed track shortening cannot have been produced from the apparent burial to the present temperature, then this suggests higher paleotemperatures at some time in the past. Using the kinetic description of fission track annealing described in an earlier section, we can predict a value of mean length, $\mathbf{l_p}$, that would be expected in each sample, from the thermal history suggested by the burial history derived from the preserved stratigraphic section, and using the present thermal gradient, ie assuming there has been no uplift and erosion, and no changes in thermal gradient through time. These values of l_p are then compared with measured mean track lengths in assessing past variations in paleotemperature. Values of l_p for all samples analysed are shown in Table i.

The influence of track lengths inherited from source areas can readily be allowed for, by comparison of the fission track age with the stratigraphic age and inspection of the length distribution. If the mean track length is less than l_p then either the sample has been subjected to elevated paleotemperatures, sufficient to produce the observed degree of length reduction, or else the sample contains a large proportion of shorter tracks inherited from source areas. However in such a case, the sample should give a mean or pooled fission track age correspondingly older than the stratigraphic age, and the length distribution should contain a component of longer track lengths corresponding to the value of l_p. It is important in this regard that the length of a track depends primarily on the maximum temperature to which it has been subjected, whether in the source regions or after deposition in the sedimentary basin. Thus any lengths retaining a provenance signature will be towards the shorter end of the length distribution where track lengths will not have "equilibrated" with the prevailing temperature within the basin.

Timing of cooling from maximum paleotemperatures can be estimated from a number of lines of evidence. The most direct of these is "correction" of measured fission track ages for the observed degree of length reduction, which provides an estimate of the time over which tracks have been retained. Corrected ages, shown for each sample in Table i, are calculated using the relationship between length reduction and the reduction in fission track age during annealing reported by Green (1988). In samples which have been totally annealed prior to cooling, and have undergone a relatively simple history since cooling, the corrected age should directly indicate the time of cooling. Note that any complexity in the thermal history leads to these "corrected ages" underestimating this parameter, but this procedure can often yield useful results. However, corrected ages can be very misleading, particularly in samples which have only been partially annealed.

Inspection of the distribution of single grain ages in partially annealed samples can also often yield useful information on the time of cooling, as the most easily annealed grains (those richest in fluorine) may have been totally annealed prior to cooling. The form of the track length distribution can also provide information, from the relative proportions of tracks with different lengths. Normally, all of these aspects of the data are employed in reaching a consistent thermal history interpretation.

As mentioned above, the understanding of the annealing characteristics of fission tracks in zircon is less well developed than for apatite. From both laboratory and geological evidence, fission tracks in zircon are known to be less sensitive to annealing than fission tracks in apatite.

Zircon fission track ages are conventionally interpreted in terms of a closure temperature, defined as the nominal temperature below which a radiogenic product, in this case fission tracks, is effectively retained. Although the closure temperature in zircon is not well constrained, geological evidence suggests that temperatures of between 175-250°C are appropriate, with Hurford (1986) proposing a closure temperature of 240 ± 50°C. In contrast, tracks in apatite begin to be retained when the mineral cools below a temperature of the order of ~100-120°C. Where fission track ages are available for apatite and zircon, the cooling history of a sample can be assessed because of the differing thermal sensitivities of the tracks in the minerals. In samples which have cooled rapidly from high temperatures of >240°C to less than ~50°C the apatite and zircon fission track ages are usually concordant, as tracks in both minerals began to be retained at roughly the same time.

Because track length information is not usually available in zircon, the type of analysis presented for apatite data is not possible. This makes it difficult to determine whether a thermally affected zircon fission track age represents partial or total annealing, and thus whether the fission-track age can be interpreted in terms of a specific "event". Another problem with the interpretation of zircon data is posed by the lack of constraint on the temperatures required for a given degree of partial annealing. This and other aspects of the interpretation of zircon data are discussed where relevant in the following discussion.

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APPENDIX E

Petrographic descriptions

Brief petrographic descriptions are presented for four cuttings and one sidewall core sample from **Admiral-1** as detailed in Table 1. The descriptions were aimed specifically at deciding whether the samples could be classed as typical Strzelecki Group and were not intended to be a comprehensive petrographic analysis. The sandstone lithologies potentially provide the most diagnostic criteria for recognition of Strzelecki Group, particularly the abundance of rock fragments with volcanic textures, plagioclase, chlorite grain coatings, zeolites and the paucity of detrital quartz (Duddy, 1983).

GC223-1: 2125-12162 m, ?Strzelecki Group

Sample type and preparation: Bulk unwashed cuttings submitted for AFTA, washed to remove drilling mud and representative large chips selected for mounting.

Description: Most fragments of coarse grained ?arkosic sandstone, with altered feldspar and granitic quartz dominant, and with abundant fine-grained rock fragments of uncertain affinities, and patchy carbonate cement. Chert grains are also present and definite volcanic rocks fragments (VRF's) are present, but rare.
Other fragments include laminated fine sandstone/siltstone with abundant plant material, some cemented by carbonate, and coal fragments. One fragment was of a limestone/marl with obvious foraminifera and other fossil debris.

Conclusion: Not typical Strzelecki Group, but may be a variant where volcanogenic detritus is severely diluted by granitic detritus from marginal basement. More likely, perhaps, is that this sample represents a unit at the base of the Latrobe Group with some reworked Strzelecki Group detritus. The unidentified fine-grained rock fragments in the sandstones may be of volcanogenic origin. Some fragments (e.g. limestone/marl) clearly cavings.

GC223-2: 2090-95 m, Cenomanian, Latrobe Group

Sample type and preparation: Washed and sieved cuttings, most fragments only a few aggregated grains. Representative fragments mounted as a strewn slide.

Description: Multi-grain fragments are mostly "arkosic", with abundant poly-crystalline quartz, kaolinized feldspar, fine-grained rock fragments of uncertain affinities, and abundant carbonate cement in primary pores along with some kaolinite.

Conclusion: Not typical Strzelecki Group. Sandstone lithologies very similar to those found in sample GC223-1. No obvious VRF's present, but some of the unidentified fine-grained rock fragments in the sandstones may be of volcanogenic origin.

GC223-3: 2115.0 m, Cenomanian, Latrobe Group

Sample type and preparation: SWC. Mostly wet, "puggy" clay and drilling mud that could not be sectioned in situ. Sample was washed and a few sand-sized fragments mounted as a strewn slide.

Description: Sample was composed mainly of a white clay that was washed out in preparation. Presumably, this may have been a kaolinite mudstone of granitic affinities or drilling mud. Multi-grain fragments are mostly "arkosic", with kaolinized feldspar, granitic quartz and fine-grained rock fragments of uncertain affinities very similar to those in GC223-2. Carbonate is abundant as a cement in primary pores and as a grain replacement. Kaolinite occurs in pores. Siltstone and chert fragments and plant material are also present.

Conclusion: Not typical Strzelecki Group. Sandstone lithologies very similar to those found in samples GC223-1 and 2. No obvious VRF's present, but some of the unidentified fine-grained rock fragments in the sandstones may be of volcanogenic

GC223-4: 2130-2135 m, ?Strzelecki Group

Sample type and preparation: Washed and sieved cuttings, most fragments only a few aggregated grains. Representative fragments mounted as a strewn slide.

Description: Like sandstone fragments in samples GC2231 to 3. Arkosic sandstone fragments contain granitic quartz, kaolinite, altered feldspar, ?siderite and calcite as cement and grain replacement, and fine-grained rock fragments, some identified as siltstone.

Conclusion: Not typical Strzelecki Group. Sandstone lithologies very similar to those found in samples GC223-1 to 3. No obvious VRF's present, but some of the unidentified fine-grained rock fragments in the sandstones may be of volcanogenic

GC223-5: 2145-2150 m, ?Strzelecki Group

Sample type and preparation: Washed and sieved cuttings, most fragments only a few aggregated grains. Representative fragments were mounted as a strewn slide.

Description: Sandstone fragments similar to those in samples GC223-1 to 4, but with one definite VRF. Arkosic sandstone fragments contain abundant granitic quartz, altered feldspar, and kaolinite and fine-grained rock fragments, some identified as siltstone. Carbonate replacement is pervasive. One flow-textured VRF was noted.

Conclusion: Not typical Strzelecki Group. Sandstone lithologies very similar to those found in samples GC223-1 to 3. One VRF, and some of the unidentified fine-grained rock fragments in the sandstones that may be of volcanogenic, may indicate reworked Strzelecki Group as described above.

References

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ENCLOSURES

PE902123

This is an enclosure indicator page.
The enclosure PE902123 is enclosed within the container PE902122 at this location in this document.

The enclosure PE902123 has the following characteristics:

ITEM_BARCODE =	PE902123
CONTAINER_BARCODE =	PE902122
NAME =	Structural Cross Section Kipper 1 to Sweep 1
BASIN =	GIPPSLAND
PERMIT =	VIC/P19
TYPE =	WELL
SUBTYPE =	CROSS_SECTION
DESCRIPTION =	Structural Cross Section Kipper 1 to Sweep 1
REMARKS =	
DATE_CREATED =	30/06/1990
DATE_RECEIVED =	26/07/1990
W_NO =	W1016
WELL_NAME =	Admiral-1
CONTRACTOR =	ESSO
CLIENT_OP_CO =	ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE902124

This is an enclosure indicator page.
The enclosure PE902124 is enclosed within the container PE902122 at this location in this document.

The enclosure PE902124 has the following characteristics:

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CONTAINER_BARCODE = PE902122
             NAME = Structure Map - Top Latrobe group
            BASIN = GIPPSLAND
           PERMIT = VIC/P19
             TYPE = SEISMIC
          SUBTYPE = HRZN_CONTR_MAP
      DESCRIPTION = Structure Map - Top Latrobe group
          REMARKS =
     DATE_CREATED = 30/06/1990
    DATE_RECEIVED = 26/07/1990
             W_NO = W1016
        WELL_NAME = Admiral-1
       CONTRACTOR = ESSO
     CLIENT_OP_CO = ESSO
```

(Inserted by DNRE - Vic Govt Mines Dept)

PE902125

This is an enclosure indicator page.
The enclosure PE902125 is enclosed within the container PE902122 at this location in this document.

The enclosure PE902125 has the following characteristics:

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CONTAINER_BARCODE =	PE902122
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BASIN =	GIPPSLAND
PERMIT =	VIC/P19
TYPE =	SEISMIC
SUBTYPE =	HRZN_CONTR_MAP
DESCRIPTION =	Structure Map - Intra T.Lilliei Seismic Marker
REMARKS =	
DATE_CREATED =	30/06/1990
DATE_RECEIVED =	26/07/1990
W_NO =	W1016
WELL_NAME =	Admiral-1
CONTRACTOR =	ESSO
CLIENT_OP_CO =	ESSO

PE600976

This is an enclosure indicator page.
The enclosure PE600976 is enclosed within the container PE902122 at this location in this document.

The enclosure PE600976 has the following characteristics:

ITEM_BARCODE = PE600976
CONTAINER_BARCODE = PE902122
NAME = Well Completion Log
BASIN = GIPPSLAND
PERMIT = VIC/P19
TYPE = WELL
SUBTYPE = COMPOSITE_LOG
DESCRIPTION = Well Completion Log
REMARKS =
DATE_CREATED = 03/12/1989
DATE_RECEIVED = 26/07/1990
W_NO = W1016
WELL_NAME = Admiral-1
CONTRACTOR = ESSO
CLIENT_OP_CO = ESSO

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PE600977

This is an enclosure indicator page.
The enclosure PE600977 is enclosed within the container PE902122 at this location in this document.

The enclosure PE600977 has the following characteristics:

ITEM_BARCODE = PE600977
CONTAINER_BARCODE = PE902122
NAME = Formation Evaluation Log
BASIN = GIPPSLAND
PERMIT = VIC/P19
TYPE = WELL
SUBTYPE = MUD_LOG
DESCRIPTION = Formation Evaluation Log
REMARKS =
DATE_CREATED = 02/12/1989
DATE_RECEIVED = 26/07/1990
W_NO = W1016
WELL_NAME = Admiral-1
CONTRACTOR = ESSO
CLIENT_OP_CO = ESSO

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PE902126

This is an enclosure indicator page.
The enclosure PE902126 is enclosed within the container PE902122 at this location in this document.

The enclosure PE902126 has the following characteristics:

ITEM_BARCODE =	PE902126
CONTAINER_BARCODE =	PE902122
NAME =	Synthetic Seismogram
BASIN =	GIPPSLAND
PERMIT =	VIC/P19
TYPE =	WELL
SUBTYPE =	SYNTH_SEISMOGRAPH
DESCRIPTION =	Synthetic Seismogram
REMARKS =	
DATE_CREATED =	27/04/1990
DATE_RECEIVED =	26/07/1990
W_NO =	W1016
WELL_NAME =	Admiral-1
CONTRACTOR =	ESSO
CLIENT_OP_CO =	ESSO

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