PALYNOLOGICAL ANALYSIS OF SAMPLES FROM ANGLESEA-1, TORQUAY SUB-BASIN

by

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PREAMBLE

Spore-pollen and dinoflagellates are amongst the most valuable tools available to the petroleum explorationist for dating and correlating rock units and interpreting the environment of deposition. However a number of important limitations exist. These are chiefly related to sample quality and differences in the time ranges of some species between sedimentary basins:

(A) DATING

Palynological zones are usually defined by overlaps in the vertical [= time] range of several to many spore-pollen or dinoflagellate species. Zone boundaries are mostly defined by first appearances, less often by extinctions. A few <u>rare</u> species are confined to one zone only.

It is important to remember that the times of first appearance and extinction of a species <u>may</u> differ over the geographical range of that species and zonation criteria developed for one basin <u>may</u> not be reliable in adjoining basins.

Nevertheless the zonation scheme developed by Esso Australia Ltd. for the Gippsland Basin has been found to provide reliable dates for conventional cores and, unless gross mud cake contamination has occurred, for sidewall cores in the adjoining basins along the southern margin of Australia. Age-determinations based on cuttings are usually unreliable because of difficulties in distinguishing between <u>in situ</u>, caved and [less frequent] recycled species. The reliability can only be improved by analysing a suite of closely spaced cuttings. Other criteria that are useful include relative abundance, differences in preservation and kerogen type [palynofacies] .

(B) PALAEOENVIRONMENT

The abundance and diversity of dinoflagellates provide a reliable indication of open and restricted marine environments, e.g. shoreface, tidal flat and lagoonal conditions. Several types of algal cysts are good evidence for freshwater lacustrine environments. The absence of dinoflagellates is assumed to indicate the absence of a marine influence

The great majority of spores and pollen recovered in both on- and offshore wells have been transported by wind and/or water from dryland plants, some growing at considerable distance. A variety of plant communities will be represented but because of uncertainties in the ecology of mostly extinct species, spore-pollen can only provide a general indication of the palaeoenvironment, e.g. coastal plain, and climate, e.g. warm humid, if coastal tropical rainforest species are present. The most common terrestrial sediments preserving spore-pollen are fluvial and lacustrine silts and clays.

Some indication of relative abundance is necessary. As with dating, cuttings do not provide a reliable indication of palaeoenvironment.

INTRODUCTION

Sixteen conventional core samples, representing the interval 490-10,065ft. in Anglesea-1, were processed and analysed for spore-pollen and dinoflagellates.

Although yields and preservation were mostly good, many age-determinations are of low confidence due to the simultaneous occurrence of species which seldom overlap in time range or [Early Cretaceous units] carbonization and fragmentation of the spore-pollen. Uncertainties and alternative age-determinations are discussed in the Biostratigraphy Section.

Lithological units and palynological determinations are summarized below. Interpretative and basic data are given in Tables 1 and 2 respectively. Check lists of all species recorded are attached. Lithological and electric log data were not available.

SUMMARY

AGE	UNIT	ZONE	DEPTH RANGE (ft.)	ENVIRONMENT
Middle/Late Eocene	DEMONS BLUFF FORMATION?	Lower/Middle N. asperus	490 - 510	Coastal plain
- - - - -	- - - - -	unconformity?	- - - - -	- - - - -
Early Eocene	EASTERN VIEW FORMATION	P. asperopolus	789 - 809	Coastal plain
Paleocene	"	Upper L. balmei/ A. homomorpha	1090 - 1234	"
"	"	Lower L. balmei	1506 - 1526	"
Campanian	SHERBROOK GP EQUIVALENT	T. lilliei	1778 - 1798	Intra rift valley
- - - - -	- - - - -	unconformity	- - - - -	- - - - -
Lower Albian	OTWAY GROUP	C. striatus	1931 - 6347	Intra rift valley
- - - - -	- - - - -	unconformity?	- - - - -	- - - - -
latest Jurassic - Early Cretaceous	"	no older than C. australiensis	7544 - 10,065	"

Mid-Eumeralla Heathfield.

TD 3068m

GEOLOGICAL COMMENTS

1. Because of the absence of zone index species, it is not certain whether Core 1 [490-510ft.] was cut in Demons Bluff or Eastern View Formation. Core 2 [789-809ft.], 3 [1090-1110ft.] and 4 [1214-1234ft.] represent marine-influenced units within the Eastern View Formation.

2. The latter interval [1090-1234ft.] is correlated with the Apectodinium homomorpha marine transgression recorded in the Gippsland Basin. Despite the occurrence of Apectodinium hyperacantha at 789-809ft., it is unlikely that this sample is a correlative of the A. hyperacantha Zone transgression (cf. Partridge, 1976).

3. Conversely, the palynological data are definite that Anglesea-1 intersected a Late Cretaceous [Campanian] non-marine unit within the Eastern View Formation at 1778-1798ft. The occurrence of this unit, Sherbrook Group Equivalent, is of some interest given the reported absence of Late Cretaceous sediments in the adjacent Port Phillip Basin and Aire Embayment.

4. Because of poor preservation, it is unclear from the palynological data whether Anglesea-1 reached sediments of Neocomian age below 6247ft. but it is certain that the well bottomed [TD 3068m] in sediments no older than latest Jurassic, C. australiensis Zone.

5. TAI values within the Early Cretaceous interval increase from 3 at 1931-51ft. to 4 at 10,045-65ft.

PALAEOENVIRONMENTS

Consistent with its shoreline location, the Anglesea-1 wellsite site was not affected by encroachment of the Southern Ocean until the Paleocene. Based on the relative abundance of spore-pollen and dinoflagellates, the marine-influence was slight during the Eocene, with the wellsite becoming wholly terrestrial again by the Middle/Late Eocene. Cretaceous sediments appear to have accumulated under fluvial and [1778-98ft., 4011-4021ft.] lacustrine depositional conditions within a rift valley setting.

BIOSTRATIGRAPHY

Zone and age-determinations have been made using criteria proposed by Stover & Partridge (1973), Partridge (1976) and Helby et al. (1987), augmented where necessary by time-range data presented in Dettman (1963), Burger (1980), Morgan (1980) and Backhouse (1988) and unpublished observations made on Bass Strait wells drilled by Esso Australia Ltd. The informal subdivision of the T. longus Zone proposed by Macphail (1983: see Helby et al., ibid p.58) is followed here. Zone names have not been altered irrespective of nomenclatural changes to nominate species such as Tricolpites longus [now Forcipites longus: see Dettman & Jarzen, 1988].

In spite of carbonization and fragmentation of the Early Cretaceous palynomorphs, sufficient sculptural detail was preserved to allow reliable identification of the more robust types such as Cicatricosisporites australiensis. Nevertheless it is probable that the more delicate types, including the zone index species Crybelosporites striatus, have not always been preserved and only maximum ages can be given for samples below 7544ft., i.e. Cores 27-33. Recycled Paleozoic and Early Mesozoic spores are present in many samples.

7544-10,065ft. — No older than Cicatricosisporites australiensis Zone, latest Jurassic-Early Cretaceous

The five core samples in this interval yielded low to negligible numbers of carbonized spore-pollen [TAI 4- to 4] of which only Cicatricosisporites australiensis is useful biostratigraphically. Preservation is too poor to be certain that species which first appear in the F. wonthaggiensis to C. striatus Zones are absent. For example possible specimens of Foraminisporis asymmetricus occurs at 7544-50ft. and 10,045-65ft. [Cores 27, 33].

Crybelosporites striatus Zone 1931-6347ft. — Lower Albian

The base of this zone is placed provisionally at Core 23 [6327-47ft.], a sample yielding a carbonized [TAI 3+] palynoflora which includes probable fragments of the nominate species in addition to abundant Cicatricosisporites australiensis and zonate and psilate trilete fern spores.

The first unequivocal occurrence of Crybelosporites striatus is at 5161-71ft. [Core 20] and this species and Cicatricosisporites australiensis are abundant at 4011-21ft. [Core 16].

The excellent preservation [TAI 3] and yield suggest that the depositional environment was lacustrine.

The upper boundary of the zone is placed at 1931-51ft. [Core 7], a sample yielding Crybelosporites striatus and abundant Cicatricosisporites australiensis and other trilete Early Cretaceous spores but apparently not Coptospora paradoxa.

Tricolporites lilliei Zone 1778-1798ft. Campanian

One sample is assigned to this zone, based on multiple occurrences of the nominate species and other Late Cretaceous types that first appear in this zone, e.g. Triporopollenites sectilis, Tricolpites waiparensis, Tetradopollis securus, Proteacidites amolosexinus and P. otwayensis. Gambierina rudata and Late Cretaceous Nothofagidites spp. are abundant. Forcipites sabulosus indicates that the sample is no younger than Lower T. longus Zone.

Perfect preservation and the persistent presence of Rouseisporites reticulatus and Balmeisporites holodictyus indicate a lacustrine depositional environment.

Lower Lygistepollenites balmei Zone 1506-1526ft. Paleocene

The core sample at 1506-26ft. yielded a a palynoflora wholly dominated by small, undescribed species of Proteacidites and Tricolporites, an association typical of the Lower L. balmei Zone. Support for this age-determination is given by multiple occurrences of Amosopollis cruciformis, Tetracolporites verrucosus and the absence of Proteacidites spp. which first appear in the Upper L. balmei zone. The only indicator of a younger date is P. reticuloscabratus [well-preserved unlike the majority of palynomorphs and therefore a possible contaminant]. Tetracolporites multistrixus and Gambierina rudata indicate the sample is no older than Lower L. balmei Zone or younger than Upper L. balmei Zone respectively.

Upper Lygistepollenites balmei/Apectodinium homomorpha Zone 1090-1234ft. Paleocene

Two core samples are assigned to this zone. Both contain marine dinoflagellates [Apectodinium homomorpha, Glaphyracysta retiintexta, Spinidinium spp.] in addition to Lygistepollenites balmei, Gambierina rudata and pollen species which first appear in the Upper L. balmei Zone, e.g. Cyathidites gigantis, Proteacidites annularis and P. grandis.

Specimens of Tricolpites thomasii and Proteacidites reticulatus indicate the palynoflora at 1214-34ft. is contaminated although it is noted that other typically Eocene species such as Anacolosidites acutullus, Cupanieidites orthoteichus and Malvacipollis spp. present in the core samples occur in assemblages of equivalent age in the Gippsland Basin.

Proteacidites asperopolus Zone 789-809ft. Early Eocene

Age-determinations for samples assigned to this and the Lower N. asperus Zone are of very low confidence due to the absence of zone index species and simultaneous occurrence of accessory species which normally do not overlap in range.

The core sample at 789-809ft. is provisionally dated as P. asperopolus Zone, based on occurrences of Apectodinium hyperacantha and Proteacidites tuberculotumulatus ms [species which range no higher than this zone] and Conbaculites apiculatus ms which first appears in this zone in the Gippsland and Bass Basins. An alternative but less likely age-determination is Lower M. diversus/A. hyperacantha Zone based on the association of Proteacidites pachypolus and Apectodinium hyperacantha. Irrespective of uncertainties in the zonal determination, the sample is Early Eocene.

Lower/Middle Nothofagidites asperus Zone 490-510ft. Middle -Late Eocene

This Nothofagidites-Proteacidites dominated palynoflora contains species which in the Gippsland and Bass Basins range no higher than the P. asperopolus Zone [Proteacidites ornatus] or Lower N. asperus Zone [P. asperopolus] associated with one species not previously recorded below the Middle N. asperus Zone. The unusual composition of this wholly terrestrial palynoflora is further highlighted by the presence of an undescribed parasyncolporate species smaller than but otherwise identical with the ms species Jaxtacolpus pieratus which is confined to Maastrichtian and Paleocene sediments in the Bass Basin.

On the data available the palynoflora is no older than P. asperopolus Zone or younger than Middle N. asperus Zone.

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TABLE : SUMMARY OF BASIC PALYNOLOGICAL DATA

ANGLESEA-1

DIVERSITY -	low	medium	high
S & P	less than 10	10-30	greater than 30
D	1-3	3-10	10

SAMPLE NO.	DEPTH (m)	YIELD SPORE-POLLEN	YIELD DINOS	DIVERSITY SPORE-POLLEN	DIVERSITY DINOS	PRESERVATION	LITHOLOGY	PYRIZATION	COMMENTS
Core 1	490-510ft.	high	-	high	-	Good	-	-	
Core 2	789-809ft.	low	v. low	high	low	moderate	-	-	
Core 3	1090-1110ft.	high	medium	high	medium	good	-	-	
Core 4	1214-1234ft.	high	low	high	low	good	-	-	minor contam.
Core 5	1506-1526ft.	high	-	high	-	moderate	-	-	
Core 6	1778-1798ft.	hifh	-	high	-	good	-	-	
Core 7	1931-1951ft.	high	-	high	-	good	-	-	TAI 3
Core 12	3158-3168ft.	medium	-	medium	-	poor	-	-	TAI 3
Core 16	4011-4021ft.	high	-	medium	-	good	-	-	TAI 3
Core 20	5161-5171ft. 1573·1 – 1576·1 m	v. low	-	low	-	poor	-	-	TAI 3?
Core 23	6237-6247ft. 1901 – 1904·1 m	high	-	high	-	poor	-	-	TAI 3+
Core 27	7544-7550ft. 2299·4 – 2301·2 m	v. low	-	low	-	poor	-	-	TAI 4-?
Core 30	8690-8707ft. 2648·7 – 2653·9 m	v. low	-	low	-	poor	-	-	TAI 4-?
Core 31	9156-9176ft. 2790·1 – 2796·8	low	-	medium	-	poor	-	-	TAI 4-
Core 32	9641-9656ft. 2938·6 – 2943·1	low	-	low	-	poor	-	-	TAI 4-
Core 33	10,045-10,065ft. 3061·7 – 3067·8	medium	-	medium	-	poor	-	-	TAI 4

Glossary 9030 (3)

TABLE I: SUMMARY OF INTERPRETATIVE PALYNOLOGICAL DATA

ANGLESEA-1

SAMPLE NO.	DEPTH (m)	SPORE-POLLEN ZONE	DINOFLAGELLATE ZONE	AGE	CONFIDENCE RATING	COMMENTS
Core 1	490-510ft.	Lower/Middle N. asperus	-	Middle-Late Eocene	-	P. asperopolus, P. reticulatus, P. ornatus, P. recavus, P. rugulatus
Core 2	789-809ft.	P. asperopolus	-	Early Eocene	2	C. apiculatus, A. hyperacantha
Core 3	1090-1110ft.	Upper L. balmei	A. homomorpha	Paleocene	1	L. balmei. G. rudata, C. gigantis, P. annularis, C. orthoteichus
Core 4	1214-1234ft.	Upper L. balmei	A. homomorpha	Paleocene	1	As above
Core 5	1506-1526ft.	Lower L. balmei	-	Paleocene	2	G. rudata, abund. Proteacidites, Tricolporites spp.
Core 6	1778-1798ft.	T. lilliei	-	Campanian	1	T. lilliei, T. sectilis, abund. Nothofagidites & Gambierina spp
Core 7	1931-1951ft.	C. striatus	-	Lower Albian	1	C. striatus, abund. C. australiensis
Core 12	3158-3168ft.	C. striatus	-	Lower Albian	1	As above
Core 16	4011-4021ft.	C. striatus	-	Lower Albian	0	Abund. C. striatus
Core 20	5161-5171ft.	C. striatus	-	Lower Albian	1	C. striatus
Core 23	6237-6247ft.	C. striatus	-	Lower Albian	2	C. australiensis common; possible carbonized spms. of C. striatus
Core 27	7544-7550ft.	No older than C. australiensis Zone		latest Jurassic-Early Cretaceous		C. australiensis
Core 30	8690-8707ft.	No older than C. australiensis Zone		latest Jurassic-Early Cretaceous		C. austrlaiensis fragment
Core 31	9156-9176ft.	Indeterminate		-		K. scaberis
Core 32	9641-9656ft.	Indeterminate		-		Gleicheniidites
Core 33	10,045-10,065ft.	No older than C. australiensis Zone		latest Jurassic-Early Cretaceous		C. australiensis frequent