APPENDIX 12 FROM WCR
PALYNOLOGY.
BOGGY CREEK - 1
W1053

APPENDIX-12

Palynology

FAX 02-817-4369

1 March 1992

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Dear Val',

BOGGY CREEK-1

Please find attached my comments regarding your concerns on the age-breakdown for Boggy Creek-1. With one exception, I think there is sufficient ambiguity in the paleo' to achieve a consensus with your interpretation: indeed it would be hard to deny that the breaks are there and the log character of the various units conforms well with the geological prognosis.

Otherwise, what I've done is to:

(a) Verify that the lithologic description of each SWC conforms with the gamma ray signature at that depth [they do].

(b) Check the caliper log for regions of significant caving [possibly significant within the Waarre Sandstone].

(c) In so far as one can without knowledge of salinity conditions, use the SP log to identify areas of possible drilling mud infiltration [there are a number of significant departures from SSP?]

(d) With Andy's permission, discussed the various key microfossils with Robin Helby [all fall within his concept of the species].

Based on this it seems that minor mud contamination would be expected (as was observed) but I am reluctant to cite this as the primary explanation of all mis-matches.

I've adjusted my completion report to take account of the control provided by the logs and sent (under separate cover) the revised version to Andy.

with best wishes

SWC 20 [939.5m]:

The Upper *L. balmei* Zone date is in good agreement with the interpretation of interval 905.2-966m as Pebble Point Formation. Without access to logs it would be unclear whether a sandy sample of this age represents Pebble Point Formation or a sandy unit within the Pember Mudstone.

SWC 19 [981.5m]

The log interpretation of the thick shaley unit between 966-995m as Paaratte Formation requires that this SWC is no younger than Maastrichtian. This age conforms well with the *spore-pollen* present (most are more typical of the *T. longus* Zone but all range into the Danian) but is in conflict with one dinoflagellate species. In this case I am happy to accept an extended range for the latter, particularly as the dinocyst is somewhat variable in its morphology.

SWC 14 [1487.0m]

It is difficult to reconcile the presence of *N. senectus* Zone index spp. (*both* pollen and dinoflagellate indicators are present) with this sample being Paaratte Formation. In my (revised) report, I have suggested that the top of the Belfast is at 1498m, i.e. that the overlying upwardly coarsening sandy interval between 1498-1482m forms the base of the Paaratte. If you consider that the geology is compelling that SWC 14 is within the Belfast, then all I can suggest is that the palynoflora represents mudcake.

SWC 13 [1579.0m]

The *T. apoxyexinus* Zone date and palaeoenvironmental interpretation are wholly consistent with the sample being Belfast Mudstone.

SWC 12 [1688.0m], SWC 8 [1715.0m] & SWC 7 [1722.0m]

It is difficult not to accept the log interpretation of the interval 1658-1741.5m as Waarre Sandstone. Nevertheless all three samples from this interval include the zone index species of the *P. mawsonii* Zone: two (1715.0m, 1722.0m) include taxa that range no higher than this zone or lower than the *A. distocarinatus* Zone in the Otway basin.

My feeling here is the Waarre is in fact time-transgressive (and, as here, includes marginal marine facies) but this tends to be obscured for several reasons:

(a) Early Late Cretaceous palynofloras are typically a 'soup' of long-ranging spores and gymnosperm pollen and usually a very detailed (time consuming) examination is needed to locate *P. mawsonii* Zone indicators near the base of this zone or where sedimentation rates are high. A more cursory effort will indicate that the same palynofloras are *A. distocarinatus* Zone.

(b) It is by no means certain that the *P. mawsonii* Zone can always be separated from the *A. distocarinatus* Zone via spore-pollen indicators in the Bass Strait basins.

Because of this I have summarized the interval in my (revised) report as *P. mawsonii-A. distocarinatus* Zone but I emphasize that I have no problem with your geological interpretation. It isn't really possible to argue that the key microfossils in all three samples are caved, and I regret any confusion arising from this piece of fence-sitting.

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1 March 1992

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- - MAR 2
GAS & FUEL EXPLORATION N.L.

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Dear Andy,

REVISED PALYNOSTRATIGRAPHY BOGGY CREEK-1

Please find attached my completion report on Boggy Creek-1, revised in the light of the logs forwarded late last week. A copy of the letter sent to Val' with the *logs* is enclosed.

I really am most grateful for access to the logs as the mis-matches proved to be more apparent than real.

The major exception is SWC 14 (1487.0m) which on the current dogma has to be Paarate Formation, not Belfast Mudstone. I have suggested in the revised report that the boundary lies at the base of an upward coarsening sequence at 1498m rather than at 1482m, the base of the first relatively thick sand.

The Turonian-Early Santonian *P. mawsonii* Zone for the Waarre Sandstone can be explained in a number of ways - the preferred option being the formation is time-transgressive. Val's *geological* interpretation is not contested.

On this point might I briefly opine again that the age breakdown for the Otway Basin sequence is by no means ultra-reliable. Alan may care to elaborate on the reasons why, including work practices. I would merely note that, unlike the Gippsland Basin, little or no attempt seems to have been made to upgrade the 1970s zonation. With luck, Alan can be persuaded to do a PhD. at Latrobe on the sequence stratigraphy of the southern margin; his work number incidently is 03-479-1517.

with best wishes

Mike

Partridge

PALYNOLOGICAL ANALYSIS, BOGGY CREEK-1

PEP 104, OTWAY BASIN

by

M.K. MACPHAIL

Palaeontological report prepared 28 February 1992
for Gas & Fuel Exploration N.L.

Consultant Palynologist, 20 Abbey St., Gladesville, NSW 2111

INTRODUCTION

Nine sidewall cores, representing the interval 939.5m to 1836.0m in Boggy Creek-1 were processed and examined for spore-pollen and dinoflagellates.

Yields and diversity reflect the low amounts of material available for analysis but in most cases the recovery was adequate to allow the sample to be dated with moderate confidence. The exception is the basal sample (SWC 3: 1836.0m) where mud contamination and possible reworking makes it uncertain whether the indicator species are in situ. The majority of samples are contaminated with low numbers of caved pollen or dinoflagellates.

Palynological determinations and interpreted lithological units are summarized below. Interpretative and basic data are given in Tables 1 and 2 respectively. TAI values are given in Table 3. The stratigraphic distribution of all species is recorded in the attached range chart. Electric log data were made available as a control on the palynology.

SUMMARY

AGE	UNIT	ZONE	DEPTH RANGE (m)	ENVIRONMENT
Paleocene	WANGERRIP GP.	Upper L. balmei	939.5	marine
- - - - - -	- - - - -	- unconformity -	- - - - -	- - - - - -
Maastrichtian	SHERBROOK GP.	Upper T. longus	981.5	marginal marine
Campanian	"	N. senectus	1487.0	marginal marine
Santonian	"	T. apoxyexinus	1579.0	marginal marine
Cenomanian - Turonian	"	P. mawsonii - A. distocarinatus	1668.0-1715.0	marginal marine
"	"	"	1722.0	fluvio-deltaic
- - - - - -	- - - - -	- unconformity -	- - - - -	- - - - - -
Middle - Late Albian?	EUMERALLA FORMATION	P. pannosus?	1836.0	fluvio-lacustrine

GEOLOGICAL COMMENTS

1. The palynological data confirm that Boggy Creek-1 intersected at least 800m of Wangerrip and Sherbrook sediments. The age breakdown confirms log analysis that the unconformity separating these formations occurs between 939.5m and 981.5m.

2. The Upper *L. balmei* Zone date and location within a ca. 36m thick sandstone indicates the sample at 939.5m represents the Pebble Point Formation. It is noted that Tabassi has recorded sandstone units within the Pember Mudstone (Laig *et al.*, 1989).

3. Dinoflagellates and spore-pollen provide conflicting dates for SWC 19 (981.5m) - basal Danian, lowermost *L. balmei* Zone and Maastrichtian, Upper *T. longus* Zone respectively.

   The position of the SWC within a ca. 25m thick claystone near the top of a major (500m thick) interval of interbedded sandstones, siltstones and shales, strongly indicates that the sample is (Maastrichtian) Paaratte Formation.

4. The SWC at 1487.0m yielded a marine dinoflagellate that is restricted to the Campanian, *X. australis* Zone. This date is supported by a pollen type which first appears in the co-eval spore-pollen zone (*N. senectus* Zone). Accordingly the sample is considered to represent Paaratte Formation.

   Electric log data indicate that this sample (a clay-stone) occurs within an upward coarsening sandy unit at the top of a ca. 160m thick shale interval (interpreted as Belfast Mudstone). Based on the palynology, the boundary between the Paaratte Formation and the Belfast Mudstone occurs at the top of this shale (1498m), rather than at the base of the first thick sand at 1482m.

5. The *I. cretaceum/T. apoxyexinus* Zone date for SWC 13 (1579.0m) is consistent with the identification of the interval between ca. 1498-1658m (characterized by a consistently high gamma ray signature) as Belfast Mudstone.

6. SWCs at 1668m, 1715.0m and 1722.5m yielded pollen indicators of the Turonian-earliest Santonian *P. mawsonii* Zone. In contrast, the electric log data indicate that the interval between 1658-1742m comprises relatively thick beds of sandstone, siltstone and shale, a sequence that is typical of the Waarre Sandstone (widely dated as Cenomanian, *A. distocarinatus*

Zone).

In this instance, there are several reasons why a *P. mawsonii* Zone age should not be seen as inconsistent with the interval being Waarre Sandstone:

(a) The indicator species are extremely rare and time-consuming to locate. A more cursory examination would have indicated that the sample was *A. distocarinatus* Zone. This almost certainly will have been the case with many Otway wells which intersect the Waarre Sandstone.

(b) It is possible that the *P. mawsonii* Zone indicators are mud contaminants (considered unlikely).

(c) Recent analyses of wells in the Gippsland and Otway Basin (M.K. Macphail, A.D. Partridge, unpubl.), e.g. Copa-1 in EPP 23, have shown that published palynological criteria used to distinguish the *A. distocarinatus* and *P. mawsonii* Zones are not always reliable. For this reason the interval is shown in the Summary as *P. mawsonii-A. distocarinatus* Zone.

(d) Deposition of the Waarre Sandstone may have extended into Turonian times in some areas of the Otway Basin, i.e the formation is time-transgressive. This is a distinct possibility.

Irrespective of the above qualifications, there is no reason to believe that the interval is any older than Cenomanian, *A. distocarinatus* Zone.

7. Because of difficulties in establishing whether the key spore-pollen species in SWC 3 (1836.0m) are in situ, the age of this sample is uncertain. Alternative picks are *P. pannosus* Zone and *C. hughesii* Zone. Both are consistent with the sample being Eumeralla Formation.

8. TAI values demonstrate that the sediments at and above 1836.0m are not the source of the CO_2 reservoired at ca. 1662-1673m.

PALAEOENVIRONMENTS

1. There is no definite evidence of any marine influence during the deposition of the carbonaceous claystone at 1836.0m.

2. Marine dinoflagellates at 1722.5m are assumed to be caved. The rich gymnosperm and fern palynoflora is characteristic of peat swamp/fluvio-deltaic conditions.

3. Massive pyrite scarring of palynomorphs indicate anoxic conditions during the deposition of the sediment at 1715.0m. The dominant dinoflagellate in this sample is abundant in open marine sediments accumulating in the Timor Sea region during the Middle-Late Albian (R.J. Helby, pers. comm.). The significance of this is unknown but, as at 1668.0m, the abundance of dinocysts relative to spore-pollen and calcareous nature of the sediment is suggestive of a locally intense marine influence at the Boggy Creek-1 wellsite prior to the Santonian.

   The existence of marine conditions here during the Cenomanian-Turonian is in good agreement with rifting along the southern margin although, as noted above, the species are more typical of Early Cretaceous dinocyst floras (relicts of the marine connection between the Otway Basin and epicontinental seas in central and northern Australia? See Frakes *et al.*, 1987)

4. Abundant dinoflagellates confirm that marine conditions persisted at Boggy Creek-1 from the Santonian until at least the Late Paleocene.

BIOSTRATIGRAPHY

Zone and age-determinations have been made using criteria proposed by Stover & Partridge (1973), Helby et al. (1987), and unpublished observations made on Otway and Gippsland Basin wells (Macphail & Hos, 1989; Macphail & Partridge, unpubl.).

It is noted that published spore-pollen criteria used to separate the Cenomanian, *Appendicisporites distocarinatus* Zone and Turonian 'lower' *P. mawsonii* Zone have been found to be unreliable in both the Otway Basin (Copa-1) and Gippsland Basin (e.g. Admiral-1, Judith-1, Shark-1). A number of alternative index species have been identified and are used in this report.

The informal subdivision of the *Tricolpites longus* Zone proposed by Macphail (1984: see Helby *et al.*, 1987 p.58) is followed in this report. The name of the zone is retained in spite of nomenclatural changes to the nominate species, now *Forcipites longus*.

Phimopollenites pannosus Zone? 1836.0m Middle-Late Albian?

The lowest SWC available for analysis [SWC 3 at 1836.0m] yielded a very sparse palynoflora dominated by long-ranging Mesozoic spores and gymnosperm species, in particular *Cyathidites* spp., *Cicatricosisporites australiensis*, *Foraminisporis asymmetricus* and *Triporoletes* spp., and mud contaminants, in particular *Eucalyptus* and species derived from the *O. porifera/I. cretaceum* Zones, e.g. *Odontochitona porifera* and *Proteacidites amolosexinus*.

The sample is provisionally assigned to the *Phimopollenites pannosus* Zone based on two specimens of the nominate species *Phimopollenites pannosus*. It is no older than this zone if these pollen grains are in situ. There is no compelling evidence that the sample is as young as *A. distocarinatus* Zone. Indicator species of the *P. mawsonii* Zone are absent.

If the *P. pannosus* specimens are mud contaminants, then the sample is suggested to be no older than Aptian, *C. hughesii* Zone based on multiple specimens of *F. asymmetricus*. The absolute maximum age will be Neocomian *C. australiensis* Zone based on the relative abundance of *Cicatricosisporites australiensis*.

Phyllocladidites mawsonii Zone 1668.0-1722.5m Turonian-Early Santonian

Three samples, at 1722.5m, 1715.0m and 1668.0m, are assigned to this zone with varying degrees of confidence. It is strongly emphasized that in all cases the dating depends on very rare occurrences of the index species *Phyllocladidites mawsonii*. This pollen is easily overlooked in early Late Cretaceous palynofloras and a caved origin cannot be ruled out. However the other pollen data are compelling that the interval is no older than *A. distocarinatus* Zone or younger than *P. mawsonii* Zone.

(1) The lower boundary is placed at 1722.5m, based on very rare occurrences of the nominate species *Phyllocladidites mawsonii* and *Interulobites intraverrucatus* and more frequent occurrences an undescribed spore that appears to be restricted to *P. mawsonii* Zone sediments in the Otway and Gippsland Basins: *Laevigatosporites musca* ms.

It is emphasized that *Phyllocladidites mawsonii* is extremely rare [1 specimen in two strew mounts each containing upward of 10,000 palynomorphs], suggesting that the sample lies close to the lower boundary of the zone. It is considered unlikely that the pollen grain has been caved. *Interulobites intraverrucatus* confirms that the sample is no older than *A. distocarinatus* Zone (see Helby *et al.*, 1987 p.55).

These spp. are associated with *Appendicisporites distocarinatus* and frequent *Clavifera triplex*, both of which support a general *P. mawsonii/A. distocarinatus* Zone attribution.

The palynoflora is an exceptionally rich one, dominated by long-ranging spores [*Baculatisporites*, *Cyathidites*, *Gleicheniidites*, *Osmundacites* spp., *Stereisporites australis* f. *crassa*] and gymnosperm pollen [chiefly *Podocarpidites*]. Significant numbers of an undescribed freshwater cyst are present. Rare specimens of the marine dinocysts, *Cribroperidinium edwardsii/ muderongensis*, *Odontochitona operculata* and *O. striatoperforata*, are considered to be caved.

(2) The SWC sample at 1715.0m is clearly marine: approximately 30% of the recovery are marine dinocysts and the overwhelming majority of palynomorphs show massive pyrite scarring. These include the most common taxon present, *Palaeoperidinium cretaceum*. Otherwise, the dinoflagellate flora includes *Amosopollis cruciformis*, *Cribroperidinium ewdardsii Cyclonephelium compactum*, a *Diconodinium* sp. within the *D. pusillum* complex, *Heterosphaeridium heterocanthum*, frequent *Odonotochitona operculata*, *Oligosphaeridium pulcherrimum* and *Spiniferites furcatus/ramosus*. It is noted that at least two of these, *Palaeoperidinium cretaceum* and *Diconodinium* cf *pusillum*, are more typical of Middle-Late Albian than Cenomanian-Turonian assemblages.

Spore-pollen spp. present include (very rare) specimens of *Phyllocladidites mawsonii*, *Hoegisporis uniforma* and *Laevigatosporites musca*, associated with more frequent numbers of *Appendicisporites distocarinatus* and *Australopollis obscurus*. Specimens of *Proteacidites* are present although at least one species, *P. amolosexinus*, almost certainly is caved. As with the sample at 1722.5m, the spore-pollen confirm that the maximum and minimum age limits for the sample are *A. distocarinatus* Zone and *P. mawsonii* Zone respectively.

(3) The upper boundary of the zone is placed provisionally at 1668.0m, a sample yielding a sparse palynoflora dominated by long-ranging Cretaceous dinoflagellates including frequent-common *Amosopollis cruciformis*, *Cyclonephelium compactum*, *Heterosphaeridium heterocanthum* and *Valensiella griphus* Norvick & Burger 1975 (a species similar to but larger than *Cassiculosphaeridia reticulata*). None are age-diagnostic but, a date younger than Santonian is unlikely based on the association of *Canningia* sp., *Chlamydophorella* cf *ambigua*, *Cribroperidinium edwardsii*, *Odontochitona operculata*, *O. striatoperforata*, *Oligosphaeridium pulcherrimum* and *Spiniferites furcatus/ramosus*.

If in situ, *Phyllocladidites mawsonii* and undescribed spp. of *Forcipites* and *Proteacidites* confirm that the sample is no older than *P. mawsonii* Zone.

Tricolpites apoxyexinus/Isabelidinium cretaceum Zone
1579.0m Santonian

One sample is assigned to this zone with a high degree of confidence based on the association of *Tricolpites apoxyexinus*, *Forcipites sabulosus*, *Latrobosporites amplus* and *Proteacidites otwayensis* with *Isabelidinium cretaceum* and frequent *Odontochitona porifera* and *Heterosphaeridium* spp.

The sample includes reworked *Appendicisporites distocarinatus* as well as Permian and Early Cretaceous spp.

Nothofagidites senectus/Xenikoon australis Zone 1487.0m
Lower Campanian

The occurrence of multiple specimens of *Xenikoon australis* confirm a *N. senectus/X. australis* Zone age for the SWC sample at 1487.0m. The date is supported by occurrences of *Nothofagidites* cf *kaitangata*, associated with *Tricolporites apoxyexinus*. The palynoflora includes a diverse range of *Forcipites* spp., including *F. renmarkensis*, and *Proteacidites* spp., including *P. amolosexinus*, *P. dierama*, *P. otwayensis* and *P. retiformis*. *Heterosphaeridium heterocanthum* dominates the dinocyst flora.

The single record of *Tetracolporites verrucosus* is not considered to be evidence for a younger (Maastrichtian) age (compare Helby *et al.*, 1987) since the species is known to occur in the *N. senectus* Zone in the Gippsland Basin.

Upper *Forcipites* (*Tricolpites*) *longus* Zone 981.5m Maastrichtian

One sample, at 981.5m, is provisionally assigned to this zone based on the relative abundance of *Stereisporites* (*Tripunctisporis*) sp. in an assemblage including a diverse range of typically Late Cretaceous (ms) species including *Beaupreaidites orbiculatus*, **Proteacidites ademonosus**, *P. cleinei*, *P. protograndis*, *P. otwayensis* ms, *P.* sp. cf *P. wahoonesis* and *Tetradopollis securus*.

The palynoflora is however unusual for this zone in that (a) the dinoflagellate flora includes significant numbers of *Glaphyracysta*, some of which fall within the morphological range of the Paleocene species *G. retiintexta* and (b) the relative abundance of *Gambierina rudata* is very low.

Geological data indicate that a Maastrichtian age is the more probable, implying that *G. retiintexta* has an extended range or that it has been caved. The data are emphatic that the sample is no younger than basal Danian, Lower *L. balmei* Zone or older than upper Maastrichtian Upper *T. longus* Zone.

Upper *Lygistepollenites balmei* Zone 939.5m Paleocene

The SWC at 939.5m is dated as Upper *L. balmei* Zone, based on the frequent specimens of the dinoflagellates *Deflandrea medcalfii* and a variant of *Senegalium dilwynense*, in an assemblage including *Amosopollis cruciformis*, *Australopollis obscurus*, *Bysmapollis emaciatus*, *Latrobosporites amplus*, *Lygistepollenites balmei* and *Phyllocladidites reticulosaccatus*.

Species first appearing in the Eocene are absent except for rare, unexplained specimen of the typically Late Eocene dinoflagellate *Gippslandica extensa*. The palynoflora includes significant numbers of reworked palynomorphs, in particular *Cribroperidinium edwardsii* and *Apteodinium granulosum*.

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TABLE 1: SUMMARY OF INTERPRETATIVE PALYNOLOGICAL DATA

SWC	DEPTH (m)	ZONE S-P	ZONE DINO	CONF. RTG.	COMMENT
20	939.5	U. L.b.	Indet.	2	No younger than this Zone
19	981.5	U. T.l.	Indet.	2	No younger than basal Danian
14	1487.0	N. sen.	X. aus.	0	Xenikoon australis
13	1579.0	T. apx.	I. cret.	1	Isabelidinium cretaceum
12	1668.0	P. maw.	Indet.	2	No older than this zone
08	1715.0	P. maw.	Indet.	1	No younger than this Zone.
07	1722.5	P. maw.	-	1	No older than *A. dist.* Zone
06	1772.0	Indet.	-	-	Mainly mud contaminants
03	1836.0	P. pann.	-	2	No older than C. hughesii Zone?

U. L.b. = Upper *L. balmei* Zone
U. T.l. = Upper *T. longus* Zone
N. sen. = *N. senectus* Zone
X. aus. = *X. australis* Zone
T. apx. = *T. apoxyexinus* Zone
I. cret. = *I. cretaceum* Zone
P. maw. = *P. mawsonii* Zone
A. dist. = *A. distocarinatus* Zone
P. pann. = *P. pannosus* Zone

TABLE 2: **BASIC DATA**

SWC	DEPTH (m)	YIELD S-P	YIELD DINO	DIVERSITY S-P	DIVERSITY DINO	PRES.	LITH.*
20	939.5	low	low	low	med.	mod.	sst.
19	981.5	low	low	med.	low	mod.	clyst.
14	1487.0	low	low	med.	low	poor	clyst.
13	1579.0	low	med.	med.	med.	good	glau. clyst.
12	1668.0	v. low	low	low	med.	mod.	calc. sst.
08	1715.0	med.	med.	med.	med.	poor	dol. sltst.
07	1722.5	high	caved	med.	low	mod.	slst./coal
06	1772.0	negl.	caved	-	-	mod.	slst.
03	1836.0	low	-	low	-	mod.	carb. clyst.

* Lithological descriptions [main rock type/qualifier] taken from typed sidewall core sample description sheets

TABLE 3: **TAI ESTIMATES**

SWC	DEPTH (m)	EST. TAI*	MATURITY	DOMINANT KEROGEN
20	939.5	2.00	Immature	S>V>I>>E
19	981.5	2.00+	Immature	S>V>I>>E
14	1487.0	2.00+	Immature	S>V>I>E
13	1579.0	2.00+	Immature	I>S>V>E
12	1668.0	2.25-	Immature	V>I>E>S
08	1715.0	2.25-	Immature	S>I>V>E
07	1722.5	2.25-	Immature	V>S>I>E
06	1772.0	2.25	Very early oil	S>I>V>E
03	1836.0	2.25	Very early oil	S>I>V>E

E = Exinite & Alginite

I = Inertinite

S = Sapropel (granular)

V = Vitrinite

Palynomorphs with TAI values of 3 to 5, representing the dry gas phase, were not recorded.

* TAI estimates made using fluorescence miscroscopy techniques by International Stratigraphic Consultants P/L. Cottesloe, W.A. 6011. See Appendix 1.

APPENDIX 1

TAI STUDY

ON SAMPLES

FROM BOGGY CREEK NO. 1

OTWAY BASIN

D.P.C. HOS

JANUARY, 1992

FILE MTAI1

INTERNATIONAL STRATIGRAPHIC CONSULTANTS PTY LTD

UNIT 2, 10 STATION STREET
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A total of 9 sidewall core samples from Boggy Creek-1 were submitted for Thermal Alteration Index Analysis. The samples had been prepared by Laola Pty Ltd and comprised unmeasured kerogen and filtered (10 micron) kerogen slides. The methods used for the analysis are discussed in Appendix 1.

Table 1.

Thermal Alteration Index data of the samples from Boggy Creek-1. See Appendix 1 for a description of the parameters.

DEPTH (m)	MATURITY	SPORE COLOUR	UV FLUORESCENCE LIPTINITE COLOUR	TAI	MACERAL PROPORTIONS
939.5	Immature	Light yellow	White - Dull yellow	2.00	Common S>V>I>>E. Very rare dinoflagellates, very oxidised.
981.5	Immature	Light yellow - Yellow	White - Dull yellow	2.00+	Common S>V>I>>E. Rare acritarchs, spores and pollen, very oxidised.
1487.0	Immature	Light yellow - Yellow	White - Light yellow	2.00+	Common S>I>V>E. Common spores and pollen.
1579.5	Immature	Light yellow - Yellow	White	2.00+	Common I>S>V>>E. Rare dinoflagellates, acritarchs, spores and pollen.
1668.0	Very early oil	Yellow - Light yellow	White - Yellow	2.25-	Small kerogen slide only, rare and very oxidised V>I>E>S. Rare dinoflagellates. TAI probably an over-estimate. Some of the palynomorphs appear stained.
1715.0	Very early oil	Yellow	Light yellow	2.25-	Abundant S>I>V>E. Relatively common spores, pollen and dinoflagellates, very oxidised.
1722.5	Very early oil	Yellow - Light orange	Light yellow - Yellow	2.25	Abundant V>S>I>>E. Rare unoxidised palynomorphs.
1772.0	Very early oil	Yellow	Light yellow	2.25	Rare S>I>V>>E. Rare unoxidised palynomorphs.
1836.0	Very early oil	Yellow - Light orange	Light yellow - Dull yellow	2.25	Rare S>I>V>>E. Rare unoxidised acritarchs and spores. Most palynomorphs very oxidised.

APPENDIX NO.1

Explanation of the palynological techniques used to determine maturity.

INTRODUCTION

A rapid and reliable technique for estimating the proportion and abundances of the various kerogen components has been developed that can determine the source rock potential and thermal maturity of the sediments .

Samples that are to be examined for palynology and source rock potential are processed using standard techniques that include acid digestion in cold HCl, cold HF and then boiling HCl. Any remaining mineral matter is removed by flotation of the organic material in a Zn2Br solution of SG 2.10. The float is collected and washed. The volume of organic material recovered (VOM, see below) is measured in a 10ml conical centrifuge tube after spinning at 3000 rpm for 5 minutes.

Two types of kerogen slides are prepared from the residue. A measured proportion by volume of the organic residue (kerogen) is dried on a coverslip with PVA and then mounted on to a microscope slide with plastic resin (Eukit). This constitutes the kerogen slide. A filtered kerogen slide is prepared by similarly taking a measured proportion by volume of the organic residue (kerogen) and removing the fine fraction by filtering with a 10 micron sieve prior to drying on a coverslip with PVA and mounting on to a microscope slide with plastic resin (Eukit).

To estimate the proportion of the major kerogen components the unfiltered kerogen slide is examined using a X25 objective and the percentage of each maceral recorded. Checks are taken to ensure an acceptable level of repeatability is maintained. Alternatively, the kerogen macerals can be listed in order of abundance.

The filtered kerogen slide can be used to determine the abundance of the coarser and rarer kerogen macerals. Because of the greater concentration of palynomorphs it is also useful for searching for unoxidised spores and pollen for TAI determinations.

Keys to the various kerogen macerals are as follows: V = Vitrinite, I = Inertinite, E = Exinite (including alginite), C = Cutinite, S = Sapropel (granular), M = Micrinite, L = Liptinites (undifferentiated).

1. **SAPROPEL COLOUR**
The overall colour of the dispersed organic matter. This originally was the kerogen maceral observed to estimate Thermal Alteration Index (TAI see below). Generally the most dominant colour is that of the non fluorescent sapropel which has a darker colour than the fluorescent sapropel. Not usually recorded as it reflects both the environment of deposition and the maturation level.

2. **SPORE COLOUR**
The colour of the spore or pollen exines in transmitted white light. Variables that can affect the colour (apart from maturation) are the species type and exine thickness as well as any exposure to oxidising environments during and after deposition. The darkest colours of the least oxidised exines are taken as being the most significant. The change in colour from yellow to orange is regarded as indicating the onset of oil generation. Gas generation is suggested as becoming significant as the colours change to brown. Oil generation appears to cease as the spore colours approach dark brown and when they become black significant gas generation also probably ceases.

3. **FLUORESCENCE COLOUR**
The dominant colour of the unoxidised liptinites (exines, alginites, cuticle and some fluorescent sapropel) in reflected UV light observed with a UV330-380/400DM/420K filter combination and a X25 objective. Liptinites that have been oxidised prior to deposition (mostly by recycling) show reduced intensities. The fluorescent colours observed are a complex mixture not comparable to normal colours as seen with white

light. The hues range from light blue to white to light yellow with increasing maturity. The colours change to yellow at the beginning of the oil window (as here interpreted) and change to gold, dull yellow, orange and dull orange to dull red at the base of the oil window. The maturation level of sediments near the base of the oil window and deposited in an oxidising environment can be difficult to interpret.

4. THERMAL ALTERATION INDEX (TAI)

A scale of maturation interpreted from the observed spore colours and fluorescence colours (see above). The maturity level shown is a generalisation of the main hydrocarbons expected to be generated at that particular maturity level from oil prone source rocks but the actual yield is dependent on the type of source rocks present. Correlation with vitrinite reflectance data and other geochemical maturity indicators has been made but the basin history must also be considered when determining maturity levels for the different source rocks. For example at TAI 2.25 only source rocks rich in terrigenous liptinites would start to produce oil whereas it would still be immature for most other source rock types.

TAI	SPORE COLOUR	UV COLOUR	MATURITY
1.00	White	Blue	Biogenic
1.75	Very Light Yellow	Green	Immature
2.00	Light yellow	White	Immature
2.25	Yellow	Light yellow	Very Early Oil
2.50	Light orange	Yellow	Early Oil
2.75	Orange	Gold (Light Orange)	Peak Oil
3.00	Light brown (Dark orange)	Orange	Oil & Gas/Condensate
3.25	Brown (Medium brown)	Dull orange	Gas & Condensate
3.5	Dark Brown	Dull red	Gas
4.00	Black	Nil	Post Mature

PE905702

This is an enclosure indicator page.
The enclosure PE905702 is enclosed within the container PE905700 at this location in this document.

The enclosure PE905702 has the following characteristics:

ITEM_BARCODE =	PE905702
CONTAINER_BARCODE =	PE905700
NAME =	Range Chart
BASIN =	OTWAY
PERMIT =	PEP 104
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Palynology Range Chart (from Appendix 12 of WCR) for Boggy Creek-1
REMARKS =	
DATE_CREATED =	28/01/92
DATE_RECEIVED =	
W_NO =	W1053
WELL_NAME =	BOGGY CREEK-1
CONTRACTOR =	
CLIENT_OP_CO =	GAS AND FUEL EXPLORATION N.L.

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PE900759

This is an enclosure indicator page.
The enclosure PE900759 is enclosed within the container PE905700 at this location in this document.

The enclosure PE900759 has the following characteristics:

ITEM_BARCODE	=	PE900759
CONTAINER_BARCODE	=	PE905700
NAME	=	Palynological Range Chart
BASIN	=	OTWAY
PERMIT	=	PEP104
TYPE	=	WELL
SUBTYPE	=	DIAGRAM
DESCRIPTION	=	Palynological Range Chart for Boggy Creek-1
REMARKS	=	
DATE_CREATED	=	28/01/92
DATE_RECEIVED	=	
W_NO	=	W1053
WELL_NAME	=	BOGGY CREEK-1
CONTRACTOR	=	
CLIENT_OP_CO	=	GAS & FUEL EXPLORATION

(Inserted by DNRE - Vic Govt Mines Dept)