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GFE Resources

Palynostratigraphy and Organic Facies Analysis of Digby #1

Otway Basin

P.L. Price
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Part 1
(Interpretation)

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DIGBY #1
SUMMARY OF CONCLUSIONS

Biostratigraphy

Interval	Palynostratigraphic Units		Inferred Lithostratigraphy
◆ 449.2 - 735.6m	APK4	*C. striatus*	Eumeralla Fm
◆ 1096.8m	APK321	upper Lower *P notensis*	Eumeralla Fm
◆ 1096.8 - 1220.8m	UNCONFORMITY		
◆ 1220.8m	APK22	lower Lower *P. notensis*	uppermost Laira Fm
◆ 1318.1m	APK212	Upper *F. wonthaggiensis*	Laira Fm
◆ 1364.4 - 1445.2m	APK21	*F. wonthaggiensis*	Laira Fm - u. Pretty Hill Fm
◆ 1457.5 - 1536.4m	APK211	upper Lower *F. wonthaggiensis*	b. Laira Fm - u. Pretty Hill
◆ 1591m	APK12	lower Lower *F. wonthaggiensis*	Pretty Hill Fm
◆ 1600 - 1900m	Unassigned Section		
◆ 1903.2 - 2002m	APK1	Lower *C. australiensis*	Casterton Fm
◆ 2048.2m	APJ62	upper *R. watherooensis*	Casterton Fm

Depositional Environment

◆ Eumeralla Formation	Fluvial - lagoonal; Coastal Plain.
◆ Laira Fm & upper Pretty Hill Fm	Fluvial - lagoonal; Coastal Plain.
◆ Lower Pretty Hill Formation	Braided stream, swamp.
◆ Casterton Formation	Lacustrine, fluvial - lagoonal, swamp; Coastal Plain.

Maturity ("Spore Colour" Estimate)

◆ 449.2 - 1318.1m	"Oil Window"; early mature
◆ 1364.4 - 1536.4m	"Oil Window"; peak generation
◆ 1591 - 1936.4m	"Oil Window"; late mature
◆ 2002 - 2048.2m	Mature Wet Gas & Condensate Zone

Hydrocarbon Source Potential

◆ Eumeralla Fm	Marginal organic content and largely Gas Prone; Organic Matter partly oxidised.
◆ Laira Fm	Adequate organic content but largely Gas Prone.
◆ Pretty Hill Fm	Insufficient to marginal organic content; limited or no hydrocarbon source potential.
◆ upper Casterton Fm	Abundant organic content but OIL source potential may have been largely achieved at the advanced stage of maturity.
◆ lower Casterton Fm	Adequate to abundant organic content but mostly gas prone.

SCOPE OF STUDY

The Otway Group and Casterton Formation penetrated by Digby #1 were sampled by a suite of forty eight Sidewall Cores of which twenty were selected for palynological investigation to determine the age, biostratigraphy, depositional environment, organic facies and hydrocarbon source potential of the Otway Group and Casterton Formation sediments. Vitrinite Reflectance values (Keiraville Konsultants) Rock-Eval Pyrolysis analysis (Geotechnical Services) and more detailed Pyrolysis Gas Chromatography and geochemical biomarker analysis (Geotechnical Services) were conducted on some of the samples; the results of these geochemical investigations were made available during the course of the palynological investigations.

The discussion on results and interpretation of the biostratigraphy, organic facies and hydrocarbon source potential are presented in Part 1 together with some notes on the correlation of the Digby #1 section with some other exploration wells in the region. The results of the study are presented in the Data Tables (Part 2) and the Species Distribution Lists, Species Diversity and Abundance Charts and Group Abundance and Diversity Charts are appended as Enclosures (Part 3).

BIOSTRATIGRAPHY

Introduction

The biostratigraphic nomenclature adopted for this study is based upon that of Price *et al*, 1985 and Filatoff & Price, 1988 developed primarily for the Surat and Eromanga Basin sections but adapted for the Otway Basin by Price, 1993. The units and their relationship to the nomenclatures of Morgan, 1985 and 1992, Dettmann, 1986 and Dettmann and Playford, 1969 and Morgan *et al*, 1995 are summarised on Page 9 and the relationship of the palynostratigraphic units used in this study to the Otway Lithostratigraphy is presented on Page 10.

The units of Dettmann, 1963 and 1986, Dettmann and Playford, 1969, Morgan, 1985, 1988, 1989 and 1992 have been used widely in Otway Basin studies. These nomenclatures however, have been applied in different ways in the various well sections giving some confusion as to what is represented by a particular unit in any given study.

Morgan *et a*l, 1995 reviewed and revised the Otway Basin palynostratigraphy as part of the comprehensive stratigraphic review of the western Otway Basin by MESA (Morton and Drexel Eds., 1995). Although the revised nomenclature of Morgan *et al*, 1995 gives some stability to the Otway Basin palynostratigraphy, the units of Price *et al*, 1985 and Price, 1993 (with some revisions) have been used in this study in an attempt to increase the biostratigraphic resolution and to lessen any possible ambiguity with the earlier nomenclatures. The equivalent units of Morgan *et al*, 1995 however, are given also in the text to assist in relating the results of this study to the stratigraphic interpretation given in the 1995 MESA compilation; reference should be made to Page 9 if there is a need to relate an earlier nomenclature to this study.

In relating this study to earlier subdivisions, particular care should be taken with the *F. wonthaggiensis* Zone, the *C. hughesii* Zone and their stratigraphic relationship as their definition and application have varied from study to study (see

Page 9). This variation in interpretation reflects their development as reliable Otway Basin palynostratigraphic units with additional data becoming available and relates also to regional differences between the Early Cretaceous palynofloras of the Otway Basin and other basins (see Dettmann, 1986 and Dettmann *et al*, 1991); certain of the "index" species prominent in areas such as the Surat/Eromanga Basins, are very scarce and sporadic in their distribution within the Otway Basin.

Dettmann, 1986 and Dettmann *et al*, 1991 also consider the time taken for migration of the parent plants from their point of evolution to the various basins as being discernible and resulted in different order of appearances for the index forms in these basins. The recent well section studies (eg Morgan, 1989, 1990, 1991, 1992, 1993, 1993; Price, 1993; Morgan *et al*, 1995) however, record a similar order of appearance of the index forms in the Otway Basin as Price *et al*, 1985 and Filatoff and Price, 1988 do for the Eromanga Basin. It is likely that facies and environmental variations (giving rise to more subtle and less systematic differences in the distribution of the index forms) are at least as significant as the migration processes suggested by Dettmann, 1986 and Dettmann *et al*, 1991. The application of the Early Cretaceous and Late Jurassic palynostratigraphic units in the Otway Basin, as in other basins, requires the recognition of the facies and preservational constraints upon the distribution of "marker" taxa in order to achieve a reliable biostratigraphic correlation; these factors are still not well understood. Thus the down hole logging of the various "index" taxa must be tempered by palynofacies considerations before a palynostratigraphic unit is assigned.

The Laira Shale/Pretty Hill section palynofloras seem less diverse than the equivalent Cadna-Owie/Murta/Namur Eromanga section perhaps reflecting a more restricted range of environments within the Otway Basin catchment. Ferns, although prominent, are less diverse in the Crayfish Group of the Otway than they are in the Eromanga and the fern derived index group *Cicatricosisporites spp* is scarce in the APK2 and APK1 (*Foraminisporis wonthaggiensis* Zone and *C. australiensis* Zone) assemblages. It is considered therefore, that the distribution of *Cicatricosisporites spp.* (including *C. australiensis*) is often too sporadic in the Otway to be a reliable biostratigraphic marker and a greater reliance is placed on *Dictyotosporites speciosus, Cyclosporites hughesii* and *Ceratosporites equalis*; it is worth noting that, in certain facies within the Surat and Eromanga Basins, the distribution of *Cicatricosisporites* can be erratic also. Some caution is held for the distribution of *Foraminisporis wonthaggiensis* although the consistent occurrence and persistence of similar bryophyte spores such as *Foraminisporis dailyi* and *F. "antewonthaggiensis"* lower in the section perhaps attests to its reliability.

The reliance on the extinction (youngest occurrence) of *Cyclosporites hughesii* as an indication of the top of the *P. notensis* Zone - base of the *C. striatus* Zone boundary (base APK4) in the Otway Basin should be accepted with caution as *C. hughesii* is known to persist up through the *C. paradoxa* Zone (APK5) in the Eromanga Basin; the data from Digby #1 suggests that it may do the same in parts of the Otway Basin.

The relationship of the oldest occurrence of *Pilosisporites notensis* to that of *Foraminisporis asymmetricus* and the *P. notensis* Zone - *F. wonthaggiensis* Zone boundary (base APK22) and the disconformable boundary between the Eumeralla and the Katnook Sandstone - Laira Formation is perhaps blurred by differing applications of the earlier nomenclatures. In Katnook 2 (which seems to represent the most complete section at the basal Eumeralla Formation - Katnook Sandstone - Laira Formation interval) Morgan, 1989 placed the base of the "lower *C. hughesii* Zone" near the base of the Eumeralla Formation at 1896.5m but records *F. asymmetricus* down to 1925m (perhaps within the Windermere Sandstone or the top of the Katnook Sandstone) and *P. notensis* at 2103m (within the uppermost Laira Formation just below the Katnook Sandstone); both taxa are recorded from SWC samples. Thus, while the MESA correlations show the *P. notensis* Zone to be equivalent to the "*C. hughesii* Zone" and show it extending to the base of the Eumeralla Formation, the distribution of *P. notensis* and perhaps *F. asymmetricus* in Katnook 2 suggests that the *P. notensis* Zone and APK22 should extend into the Crayfish Group where the top of that unit is fully preserved. In most other areas (eg Sawpit #1 and Zema #1), lithological evidence, including the absence of the Windermere Sandstone and Katnook Sandstone, suggests there is an erosional break between the Eumeralla Formation and Crayfish Group and the confinement of the *P. notensis* Zone to the Eumeralla Formation (with the lower part, the APK22 equivalent, being eroded) is to be expected.

Notwithstanding these differences of interpretation, certain of the marker species have a regional consistency recognised by most students of the Otway and Eromanga palynology and these have been given greater emphasis in this study. These include the oldest (initial) occurrence of *Pilosisporites grandis* (base APK52), *Coptospora paradoxa* (base APK51), *Crybelosporites striatus* (base APK4), *Pilosisporites notensis* (base APK22), *Foraminisporis wonthaggiensis* (base APK21), *Dictyotosporites speciosus* (base APK122), *Cyclosporites hughesii* (base APK121). Of particular interest in terms of increased reliability of unit APK321 (uppermost part of the Lower *P. notensis Zone*) is the presence of a distinctive undescribed *Foraminisporis* (*F. wonthaggiensis "lunaris"* sp 1519 which, most probably, is conspecific with *F. "reticulowonthaggiensis"* of Morgan) which has a restricted range in both the Otway and Eromanga Basin being confined to about the introduction of *Pilosisporites parvispinosus* and not extending up the section much beyond the top of APK3. (It should be noted that the specimen assigned to *F. wonthaggiensis "lunaris"* in Sawpit #1 by Price, 1993 is better placed within *Stoverisporites microverrucatus* which is known from higher in the sequence). The presence of *F. wonthaggiensis "lunaris"* or *F. "reticulowonthaggiensis"* at the base of the range of *P. parvispinosus* more or less at the top of the range *Cooksonites variabilis* (ie within APK321 or just below the Upper *P. notensis* Zone) is a consistent feature of many Otway Basin wells and enhances the *P. parvispinosus* oldest occurrence as a reliable datum.

OTWAY BASIN NOMENCLATURE

Dettman & Playford, 1969	Dettman 1986	Morgan, 1985 (Otway Basin Review)	Morgan, 1992 (Zema 1)	Morgan *et al*; 1995 (MESA Otway Volume)	APG Consultants		
A. distocarinatus	*A. distocarinatus*	*A. distocarinatus*	*A. distocarinatus*	*A. distocarinatus*	APK7		
P. pannosus	*P. pannosus*	*P. pannosus*	*P. pannosus*	*P. pannosus*	APK6		
C. paradoxa	*C. paradoxa* U	*C. paradoxa* U	*C. paradoxa* U	*C. paradoxa* U	APK5	APK52	
C. paradoxa	*C. paradoxa* L	*C. paradoxa* L	*C. paradoxa* L	*C. paradoxa* L	APK5	APK51	
D. speciosus: *C. striatus*	*D. speciosus*: *C. striatus*	*C. striatus*	*C. striatus*	*C. striatus*	APK4		
D. speciosus: *C. hughesii*	*D. speciosus*: *C. hughesii* Upper	*C. hughesii* U	*C. hughesii* U	*P. notensis* U	APK3	APK32	APK322 / APK321
D. speciosus: *C. hughesii*	*D. speciosus*: *C. hughesii* Mid.	*C. hughesii* M	*C. hughesii* L	*P. notensis* L	APK3	APK31	
D. speciosus: *C. hughesii*	*D. speciosus*: *C. hughesii* Lower	*C. hughesii* M	*C. hughesii* L	*P. notensis* L	APK2	APK22	
D. speciosus: *C. hughesii*	*D. speciosus*: *C. hughesii* Lower	*C. hughesii* L	*F. wonthaggiensis* U	*F. wonthaggiensis* U	APK2	APK21	APK212
D. speciosus: *C. hughesii*	*D. speciosus*: *C. hughesii* Lower	*C. hughesii* L	*F. wonthaggiensis* L	*F. wonthaggiensis* L	APK2	APK21	APK211
C. stylosus	*C. stylosus*	*C. hughesii* L	*F. wonthaggiensis* L	*F. wonthaggiensis* L	APK1	APK12	APK122
C. stylosus	*C. stylosus*	*C. stylosus*	*C. australiensis*	*C. australiensis* U	APK1	APK12	APK121
C. stylosus	*C. stylosus*	*C. stylosus*	*C. australiensis*	*C. australiensis* L	APK1	APK11	
C. stylosus	*C. stylosus*		*R. watherooensis*	*R. watherooensis*	APJ6	APJ62	APJ622
C. stylosus	*C. stylosus*		*R. watherooensis*	*R. watherooensis*	APJ6	APJ62	APJ621
			R. watherooensis	*R. watherooensis*	APJ6	APJ61	
					APJ5		

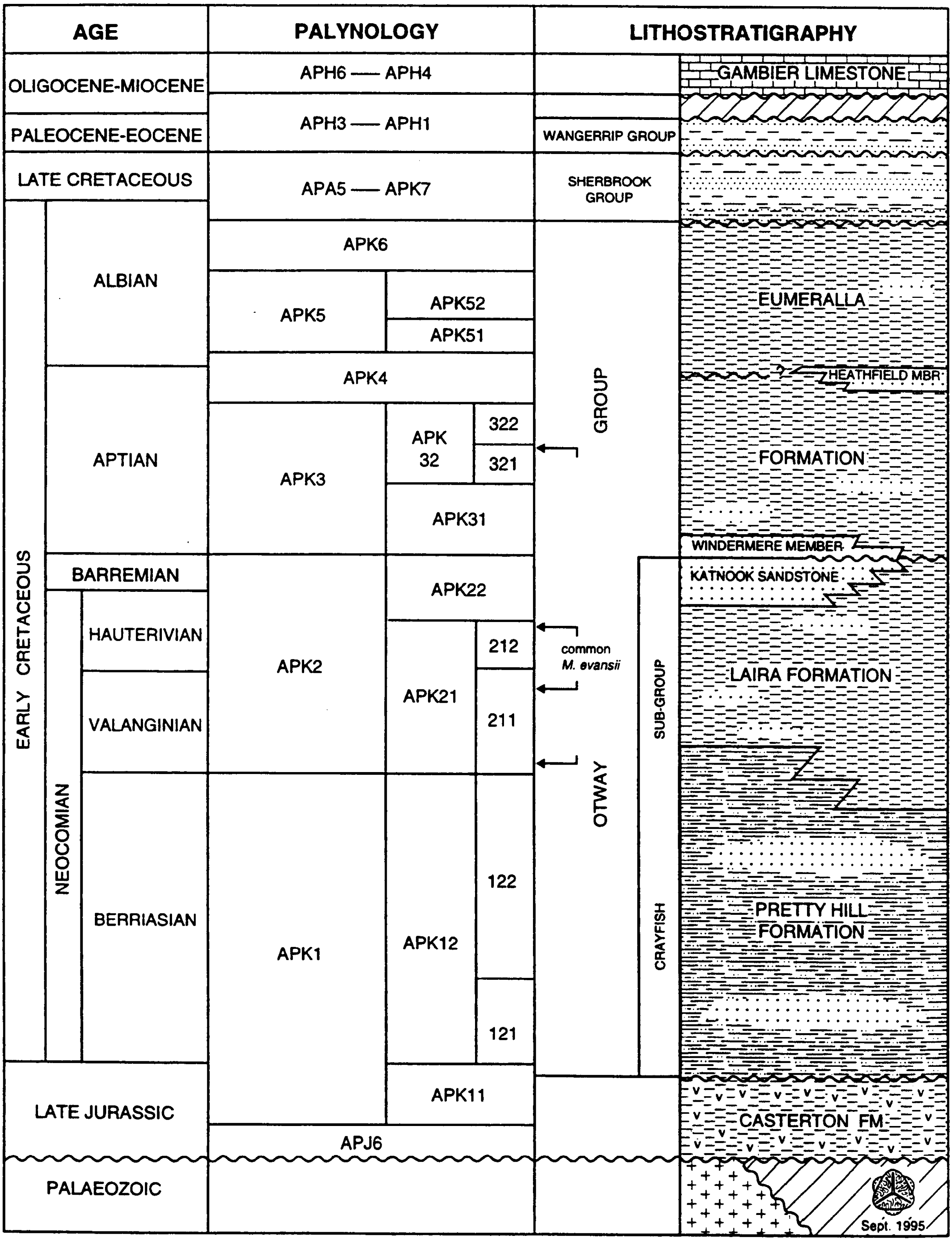
Datum events (from top to base):

- *Phyllocladidites mawsonii*
- *C. paradoxa*
- *Crybelosporites* sp. cf. *C. brenner* (sp. 1255)
- *Phimopollenites pannosus*
- *Pilosisporites grandis*
- *Coptospora paradoxa*
- *Crybelosporites striatus*
- *Cooksonites variabilis*
- *Pilosisporites parvispinosus*
- *Foraminisporis asymmetricus*
- *Pilosisporites notensis*
- *Triporoletes reticulatus*
- *Foraminisporis wonthaggiensis*
- *Dictyotosporites speciosus*
- *Cyclosporites hughesii*
- *Cicatricosisporites* spp.
- *Foraminisporis dailyi*
- *Ceratosporites equalis*
- *Retitriletes watherooensis*
- *Murospora florida*

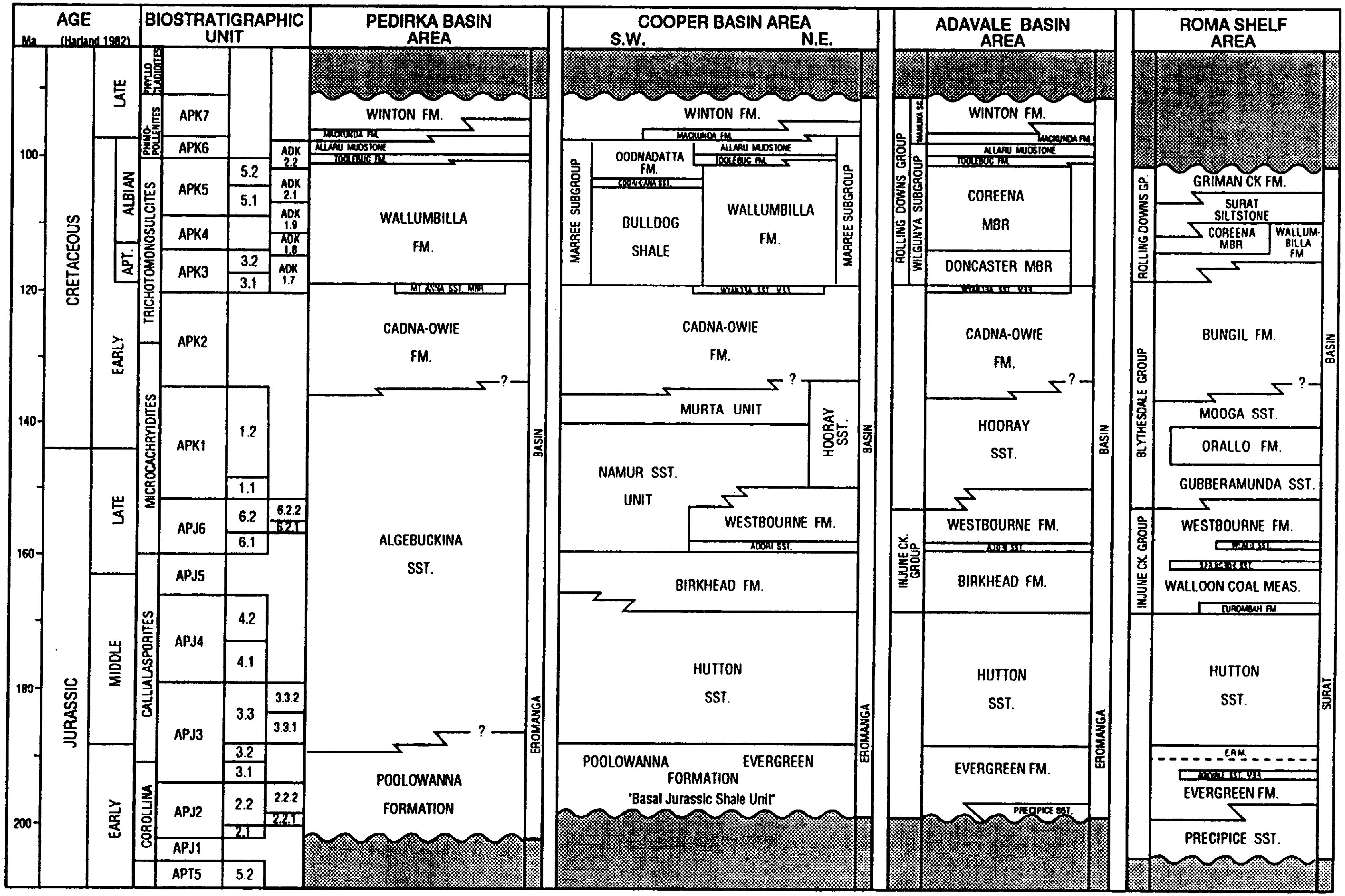
- *M. evansii*
- *F. wonthaggensis lunaris*
- *M. evansii* consistent to frequent
- *Microfaster evansii*

August 1995

STRATIGRAPHIC NOMENCLATURE



JURASSIC-CRETACEOUS STRATIGRAPHY - SOUTHERN GREAT ARTESIAN BASIN



Digby #1 Palynostratigraphic Subdivision

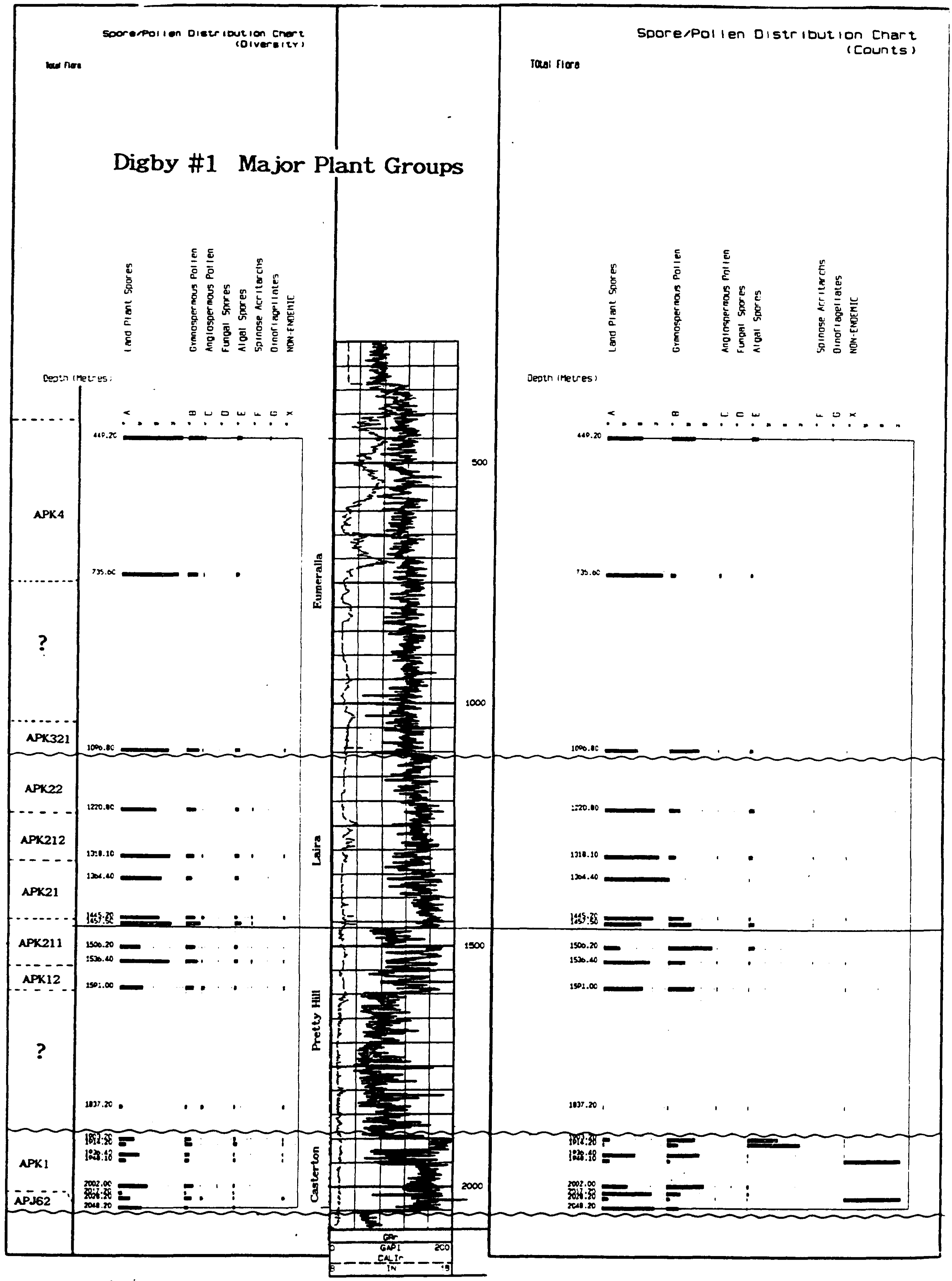
Introduction

The relationship of the palynostratigraphic nomenclature to the lithostratigraphy of the Otway Basin is tabulated on Page 10 and, for comparison, to that of the Surat and Eromanga on Page 11.

The samples were examined in detail from unoxidized total residue, unoxidized greater than 15μm fraction, oxidised total organic residue, and from the less than 1.65 s.g. oxidised fraction. The results of the palynostratigraphic study are presented on a sample by sample basis in the Palynostratigraphical Data Tables in Part 2. It should be noted that on these Tables, the initial biostratigraphic assignment given represents a range in which the sampled horizon is considered to be almost certainly within and the specific assignment that follows is the "best estimate" (often with considerably less certainty) of the horizon's palynostratigraphic position within that range. The Chronostratigraphic and inferred lithostratigraphic assignment given reflect the "best estimate" palynostratigraphic assignment and should be accepted with appropriate caution. The distribution of taxa identified is given on the Total Palynoflora Check List, Total Palynoflora Abundance Chart and Total Palynoflora Oldest Occurrence List (Part 3, Enclosures).

Relative abundance of the forms was established from counts of between 50 to 4,000 specimens, but these counts resolved only the variation in the dominant and major subordinate forms. Significantly higher counts would be required to define the frequency of the minor constituents of the palynofloras and this was considered not to be warranted given the bias introduced by variation in predepositional transport, preservation, processing techniques and sample selection. The statistical data were applied to the relative abundance form species (Land Plant Flora Chart and Aquatic Plant Flora Chart Enclosures) and the relative abundance and diversity (number of species within a group) of the major plant groups (Enclosures and Page 13); the latter defined trends reflecting variation in the depositional environment.

Major Plant Group Diversity & Abundance



Eumeralla Formation

Unit APK4 (*C. striatus* Zone)

The stratigraphically highest two samples (SWC48 449.2m and SWC47 735.6m) from Digby #1 yielded a diverse association including an abundance and diversity of fern spores with lycopods and liverworts being diverse; the associations included some of the early flowering plant pollen. Such assemblages are typical of the late Early Cretaceous palynofloras of eastern Australia. The presence of *Pilosisporites parvispinosus* and *Crybelosporites striatus* in the absence *Coptospora paradoxa* indicates an assignment to Unit APK4 (*C. striatus* Zone) and indicates a position within the mid Eumeralla Formation.

In the immediate region of Digby #1, unit APK4 palynofloras have been recovered in Mocamboro #11 (213m - 360m), possibly Bus Swamp #1 (?465m) and McEachern #1 (699.6m); the 300m or so thickness of APK4 in Digby #1 is perhaps comparable with that at Mocamboro #11 (150 to 300m) and possibly that at McEachern #1. In the Katnook region, APK4 was recognised in Katnook #1 (1498m) and Zema #1 (1556m) but it is difficult to form an opinion as to a typical thickness of the palynostratigraphic unit due to the sparse sample distribution.

Unit APK3 (Upper and upper Lower *P. notensis* Zone)

The assemblage from SWC43 1096.8m included a similar diversity of cryptogams, but included a much higher proportion of Gymnosperm pollen. The association of *Pilosisporites parvispinosus, P. notensis, Cooksonites variabilis* and *Foraminisporis wonthaggiensis "lunaris"* in the absence of *Crybelosporites striatus* indicates an assignment to APK321 (upper Lower *P. notensis* Zone).

Although probably represented by a relatively thin interval in the Otway Eumeralla Formation, unit APK321 is widely distributed; it is present in Zema #1 (1823.5m - ?1896m), Katnook #2 (1857m - 1861.6m), Bus Swamp #1 (756m - 886m) and possibly Mocamboro #11 (?705m - ?778.0m). APK321 palynofloras were recovered and described in detail by Dettmann, 1986 from the Koonwarra Fossil Beds of the onshore Gippsland Basin section. The presence of the distinctive form *Microfasta evansii* at this level in Digby #1 is of interest as, in the Otway Basin, it is generally regarded as being confined to the upper Crayfish Group; it also has been recorded in the lower Eumeralla Formation in Katnook #2 (1877.24m) and possibly Zema #1 (1905m) and is recorded in APK3 associations in the Eromanga Basin and in the Gippsland Koonwarra palynoflora.

Eumeralla - Laira Formation Transition

Unit APK22 - APK31 (Lower *P. notensis* Zone)

The palynoflora from SWC42 1220.8m was a somewhat restricted, poorly preserved *Osmundacidites* dominated assemblage; however, the presence of *Pilosisporites notensis* indicates the association is no older than APK22 (lower Lower *P. notensis* Zone). The general association perhaps suggests it is from APK22 and probably no younger than APP31 (mid Lower *P. notensis* Zone). The presence of *Microfasta evansii* could be taken as an indication of its association with older section but, as noted above, this algal form has been recorded in the lower Eumeralla in other parts of the Otway Basin and is present in APK3 assemblages in the Eromanga Basin; in the Otway Basin the form is more typical of and consistent in the upper Laira Formation palynofloras. Accepting a tentative APK22 assignment, then a position (relative to the Katnook #2 section) in the uppermost Laira Formation or Katnook Sandstone is suggested; however, a position in the basal Eumeralla Formation can not be eliminated entirely.

The palynofloras from this crucial interval in most parts of the Otway Basin are "tatty" and difficult to assign making precise correlation difficult. Nevertheless, a tentative correlation between Digby #1, Bus Swamp #1 and Mocamboro #11 can be suggested. The base of unit APK321 seems to be associated with a slight log change at 775m in Mocamboro #11, at 1110m in Digby #1 and at 820m in Bus Swamp #1. Unit APK22 seems to extend to immediately above the marked log break at 965m in Mocamboro #11 but in Digby #1 the APK22 seems to bottom some 240m above a similar log break to that at 965m in Mocamboro #11 with the

240m section (between 1220.8m and 1460m) being assigned (albeit with some reservation) to the older unit APK21 (Upper *F. wonthaggiensis* Zone). The simple explanation for the different distribution of APK22 in Digby #1 relative to Mocamboro #11 is that this 240m APK21 section is in fact equivalent to the APK22 section in Mocamboro #11 and the Digby #1 APK21 associations from this interval are merely impoverished APK22 palynofloras. It should be noted however, that even though cores and SWCs were used in Mocamboro #11, there were considerable problems with contamination in the samples from 609m and below; clearly younger forms, such as *Coptospora paradoxa* (from APK5), were recorded and the APK3 (*P. notensis* Zone) form, *Foraminisporis asymmetricus*, being recorded at 1006m which is below the significant log character change at 965m thought to represent the top of the Pretty Hill Formation. It believed that the Mocamboro #11 results need to viewed with some caution due to the possibility of misinterpretation from contamination; perhaps the cored section should be re-sampled to help to resolve the correlation.

Being mindful of the doubt held for the Mocamboro #11 palynostratigraphy and giving emphasis to the correlation of unit APK321 relative to the base of the Eumeralla Formation together with the consistency with which *Microfasta evansii* is present between 1096m and 1457m in Digby #1, then the Eumeralla - Laira boundary may be at about 1110m in Digby #1, 775m in Mocamboro #11 (accepting that *F. "reticulowonthaggiensis"* is in place) and 820m in Bus Swamp #1. Accepting this correlation then, apart from the absence of the APK31 to APK22 Windermere Sandstone - Katnook Sandstone interval, minimal section appears to be lost AT THIS LEVEL as the APK22 and APK21 *Microfasta evansii* Laira associations seem to be represented in the Digby #1 well section (APK21 was not recognised Bus Swamp #1).

Laira Formation and Pretty Hill Formation

Unit APK21 (Upper and upper Lower *F. wonthaggiensis* Zone)

A moderately diverse *Osmundacidites* dominated palynoflora which included *Microfasta evansii* was recovered from SWC41 1318.1m; the association of

Foraminisporis wonthaggiensis and *Triporoletes reticulatus* in the absence of *Pilosisporites spp*, *Foraminisporis asymmetricus*, *Crybelosporites striatus* or other younger forms indicates an assignment to APK212 (Upper *F. wonthaggiensis* Zone). While it could be argued that the association may represent an impoverished APK3 (basal Eumeralla) association, the yield and diversity of the recovered palynoflora suggest this is unlikely. The APK212 assignment places it within the upper Laira Shale. It should be noted that this palynoflora is different to the equivalent APK2 association in the Surat or Eromanga Basin where forms such as *Cicatricosisporites spp* and *Contignisporites spp* are more prominent.

The association from SWC39 1364.4m was a rich fairly well preserved association but dominated by essentially one taxon (*Cyathidites minor*); nonetheless, the yield was sufficiently high to gain an impression of the distribution of other taxa. The presence of *Foraminisporis wonthaggiensis* in the recovered association indicates a position in APK21, but the assignment to either of the subunits of APK21 based on the presence or absence of *Triporoletes reticulatus* would be hazardous given the scarcity of other Bryophytes in the assemblage. A scant association from SWC37 1445.2m which included *Microfasta evansii* could be assigned only broadly to APK21.

The associations recovered from SWC36 1457.5m and SWC29 1536.4m were balanced and moderately diverse. The presence of *Foraminisporis wonthaggiensis* in the absence of *Triporoletes reticulatus* in the context of these palynofloras favours an assignment to unit APK211 (upper Lower *F. wonthaggiensis* Zone). Unit APK211 spans the lower Laira Formation and the upper Pretty Hill Formation; the common occurrence of *Microfasta evansii* at 1457.5m perhaps suggests the upper part of the unit is represented and a position within the mid to lower Laira Formation is favoured. *Microfasta evansii* was present (but scarce) at 1536.4m and this horizon may be as low in the Otway sequence as the upper Pretty Hill Formation.

SWC27 1591m yielded a sparse restricted palynoflora which included

Cyclosporites hughesii; as such it is no older than APK121 (Upper *C. australiensis* Zone) but the possibility of it being as young as APK122 (lower Lower *F. wonthaggiensis* Zone) or APK211 (upper Lower *F. wonthaggiensis* Zone) can not be eliminated. The relative abundance of the "common" taxa in SWC27 differs to some extent from that in the overlying APK2 associations; perhaps a APK12 assignment is suggested. As such, a position within the basal Laira Formation or Pretty Hill Formation is indicated.

Unit APK21 is best developed in the Katnook - Sawpit - Zema region where it spans the Laira Formation and, in at least some places (Zema #1), extends into the uppermost Pretty Hill Formation; the relationship of the subunits of APK2 to the lithostratigraphy is given on Page 10. As noted by Morgan, 1993, *Microfasta evansii* is a useful guide to the stratigraphic resolution of this part of the section in addition to the land plant derived marker taxa. In the Katnook - Sawpit - Zema region there is clear evidence of truncation of the top of the Laira Formation. In the Digby region however, although the section is significantly thinner, the APK2 unit seems to be almost fully represented (only the Katnook Sandstone missing) suggesting the rates of subsidence in the Digby area at this time were less than in the Katnook region. Accepting the limitations of the palynostratigraphic determinations imposed by poor preservation in the deeper sections, perhaps there is some suggestion of a facies relationship between the top of the Pretty Hill Formation and the base of the Laira Formation.

Pretty Hill Formation

Unassigned Section

The sand unit spanning from about 1600m to 1900m was represented by only one sample, (SWC22 1837.0m) which, although including a moderate proportion of humic palynodebris, included almost no recognisable spores or pollen (the few that were present were unlikely to be endemic). Both in terms of its lithology and the stratigraphic position of this sand unit, it represents some part of the Pretty Hill Formation; however, it is impossible to indicate on direct palynostratigraphic evidence whether it represents an upper unit conformable with the overlying APK211 section, or if it is conformable with the underlying APK1 Casterton Formation.

Casterton Formation

Unit APK1

The recovered palynofloras from below 1900m lacked the diversity of the assemblages recovered higher in the section (see Page 13) reflecting, in part, the poor preservation at this level. Of the assemblages recovered from this interval, only those from SWC22 1903.2m, SWC21 1914.2m, SWC16 1936.4m, SWC6 2002m and SWC3 2048.2m held any promise of palynostratigraphic resolution with SWC21 1914.2m, SWC6 2002m and SWC3 2048.2m being the most definitive.

The palynomorph and organic facies associations recovered from SWC22 1903.2m and SWC21 1914.2 were distinctive, being characterised by relative high organic yields, a prominence of diaphanous leiosphere remnants and restricted land plant palynoflora with a prominence of wind dispersed gymnosperm pollen and the presence of *Ceratosporites equalis*. The palynofloral association can only be broadly assigned as being no older than APJ621 (upper *R. watherooensis* Zone) and perhaps as young as APK121 (Upper *C. australiensis* Zone). The palynofacies association however, indicates a strong affinity to the lacustrine or lagoonal facies of the Casterton Formation encountered in Sawpit #1 at 2498m and 2505m. The palynofloras from the lagoonal facies in Sawpit #1 were also restricted in diversity (probably reflecting the depositional environment) and broadly assigned as APK121 - APJ62. It should be noted that a thin more fluvial - coastal plain shale sequence assigned to APK122 (Upper *C. australiensis* Zone) overlay the lacustrine facies in Sawpit #1 was regarded by Price, 1993 as being part of the Casterton Formation. This shale unit lacks the pyroclastic sediment which characterises the Casterton and thus, is better placed as a basal unit of the Pretty Hill Formation and unit APK122 is therefore confined to the Pretty Hills Formation.

In Digby #1 at 1936m and 1948m, the organic facies changes down section from a lacustrine - lagoonal facies to a peat bog or dystrophic swamp environment; this older section yielded sparse non-diagnostic palynofloras. Further down section at 2002m a more fluvial lacustrine setting prevails and the palynoflora seemed to regain its diversity and abundance; however, most forms were carbonised and corroded and could not be assigned to species. The assemblage from SWC6 2002m was dominated by gymnosperm pollen and included *Ceratosporites equalis*, *Retitriletes watherooensis*, *Cyclosporites "quasihughesii"*, *Cicatricosisporites ludbrookiae* and *Foraminisporis "antewothaggiensis"*. The association indicates the palynoflora is no older than APK11 (Lower *C. australiensis* Zone) but may be as young as APK12 (Upper *C. australiensis* Zone); the APK11 assignment is very tentatively favoured. In most parts of the Otway Basin, the palynostratigraphic resolution of the lower Pretty Hill Formation and Casterton Formation has been vague due to the poor palynomorph preservation and recoveries. In Sawpit #1 there is an indication that unit APK121 (Upper *C. australiensis* Zone) extends into the basal shale unit of the Pretty Hill Formation. In other sections APK11 (Lower *C. australiensis* Zone) and older have been inferred for the lower Pretty Hill Formation sand units but the inferred antiquity may be a reflection of the impoverished poorly preserved palynofloras recovered at depth.

Unit APJ62

SWC3 2048.2m yielded a sparse poorly preserved (carbonised and corroded) palynoflora in which only the more robust and distinctive forms could be identified. The presence of *Ceratosporites equalis* and *Retitriletes watherooensis* indicates that the section is no older than APJ62 (upper *R. watherooensis* Zone) and, in contrast to the palynoflora at 2002m, the prominence and diversity of *Contignisporites* gives the assemblage a Late Jurassic character suggesting it may slightly older than that at 2002m and perhaps supports an APJ62 assignment.

The Casterton section in Digby #1 seems more extensive than at Sawpit #1 with the sequence at and below 1936.4m in Digby #1 perhaps not being present in Sawpit #1.

Depositional Environment

Environmental Nomenclature

The environmental interpretation given in the Palynostratigraphical Data Tables relates solely to the proportion and association of palynomorphs and palynodebris. The nomenclature used, is as follows:

Fluvial, braided stream or Beach	Extremely low organic yield; inertinitic kerogen; few, if any, recognisable palynomorphs.
Fluvial, overbank	Low to moderate organic yield; abundant and diverse land plant flora; few, if any, non marine aquatic forms. (A - 0-1%)
Peat bog or Dystrophic swamp	Moderate to high organic yield; humic kerogen; abundant but restricted land plant flora; few, if any, non marine aquatic forms. (A - 0-1%)
Fluvial - Lacustrine	Rare to frequent non marine algae. (A - 1-5%)
Lacustrine	Frequent to very abundant non marine algae. (A > 5%)
Inland Sea	Frequent to very abundant non marine algae ± frequent to abundant but very restricted brackish water algae (including spinose acritarchs) (A > 5%)
Coastal Plain	Rare to frequent leiospheres. (L - 1-5%)
Paralic Coastal Plain	Rare to frequent leiospheres; isolated spinose acritarchs (or dinoflagellates). (L - 1-5%; SA - +)
Coastal Lagoon	Frequent to very abundant leiospheres (or *Botryococcus*, or *Pediastrum*). (L - 5%)
Paralic Coastal Lagoon	Frequent to very abundant leiospheres (or *Botryococcus* , or *Pediastrum*) ; isolated to rare spinose acritarchs. (L - 5%;SA - +)
Specialised Marine or Bay	Frequent to abundant leiospheres; subordinate, restricted spinose acritarchs (or dinoflagellates). (L - 5%; SA - 1-5%)
Restricted Marine	Rare to frequent leiospheres; restricted to moderately diverse spinose acritarchs (or dinoflagellate) association; spinose acritarchs (or dinoflagellates) dominant aquatic group but subordinate component of total flora. (L - +; SA - 1-5%)
Nearshore Marine	Spinose acritarchs (or dinoflagellates) diverse but subordinate to land plant flora. (L - +; SA - 5-35%)
Open Marine	Spinose acritarchs (or dinoflagellates) diverse and the dominant floral element. (SA > 35%)

It is emphasised that, as the assignments are based upon gross palynofloral and palynofacies characters which reflect water salinity, nutrient levels and transport, other interpretations are possible. For example, the abundant leiospheres with subordinate spinose acritarch associations may represent brackish conditions of a back barrier lagoon or, alternatively, more open marine conditions but with low salinities which could occur opposite a river mouth. Other floral characters, such as the extreme dominance of saccate pollen over other land plant elements may indicate that wind and surface water rafting of the land plant floral elements prevailed suggesting calm water conditions.

Clearly therefore, the environmental interpretations set out on the Data Tables and discussed below should be regarded as a general indication and a starting point for an integrated interpretation rather than a definitive statement. For reliable palaeo-environmental interpretations, it is essential that the palynofloral data be assessed in the context of detailed sedimentological studies.

Digby #1 Section

Eumeralla Formation

The Eumeralla Formation was not closely sampled in Digby #1 and only a general indication can be given of the depositional environment as it relates to the sampled horizons. In SWC48 449.2m, the aquatic association was notable including mostly leiospheres and a small dinoflagellate but was subordinate to the diverse land plant derived component; the organic content of the sediment was low and the palynodebris seemed partly oxidised and dominated by humic elements. A shallow coastal lagoonal environment is suggested by the palynofacies. A similar palynofacies association is represented in SWC47 735.6m and SWC43 1096.8m although the aquatic association is less conspicuous suggesting a more fluvial regime.

Laira and upper Pretty Hill Formation

As with the Eumeralla Formation sampled in Digby #1, the palynofacies association of the Laira and upper Pretty Hill Formations suggests shallow water lagoonal to fluvial coastal plain deposition. The palynofloras of most samples include a subordinate aquatic association of mostly leiospheres together with *Microfasta evansii* and sporadic occurrences of isolated small spinose acritarchs. Dettmann, 1987 considers *Microfasta evansii* may represent a filamentous member of Zygnemataceae (a green algae group, often from riverine and shallow lacustrine environments) or Rivulariaceae (a Cyanophyte group typical of shallow estuarine environments); the form is widely distributed in fluvial - lacustrine and marginal marine Neocomian to Aptian sediments of eastern Australia. The organic yields are low to moderate dominated by humic kerogen groups with the palynodebris showing some evidence of oxidation; this is consistent with a shallow water depositional setting.

The single sample from the lower Pretty Hill sand unit included few recognisable palynomorphs but included a moderate yield of organic matter dominated by "coaly" palynodebris. The sampled horizon may represent an ephemeral swamp (perhaps of transported wood debris) within a braided stream system.

Casterton Formation

The upper Casterton section in Digby #1 represented by SWC22 1903 and SWC21 1914.2, although thermally altered, are characterised by a distinctive palynofacies of rich organic content with the kerogen groundmass having a micro-texture reminiscent of "granular" oil shale kerogen; leiosphere remnants seemed prevalent and the land plant palynoflora seemed restricted perhaps dominated by wind transported conifer pollen. The palynofacies is reminiscent of that from the Casterton in Sawpit #1 at 2498m and 2505m and is indicative of a fresh to brackish water coastal lagoon with a substantial water depth. The Casterton below this deeper water facies seems to represent a fluvial to shallow water lacustrine system with some dystrophic swamps and peat bogs; again, the advanced stage of thermal alteration makes any environmental interpretation tentative.

MATURITY

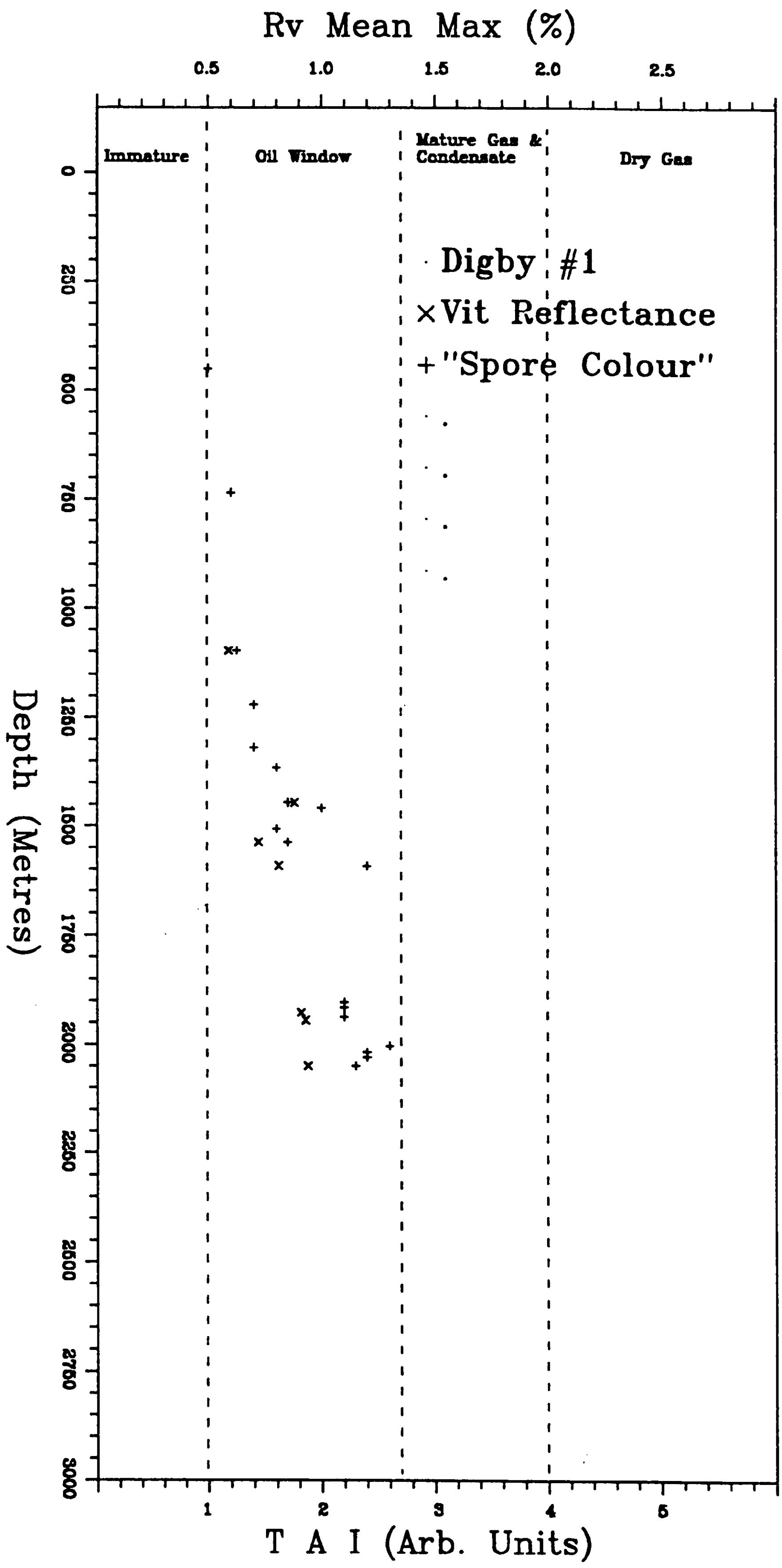
Maturity Estimates

"Spore Colour" Estimates

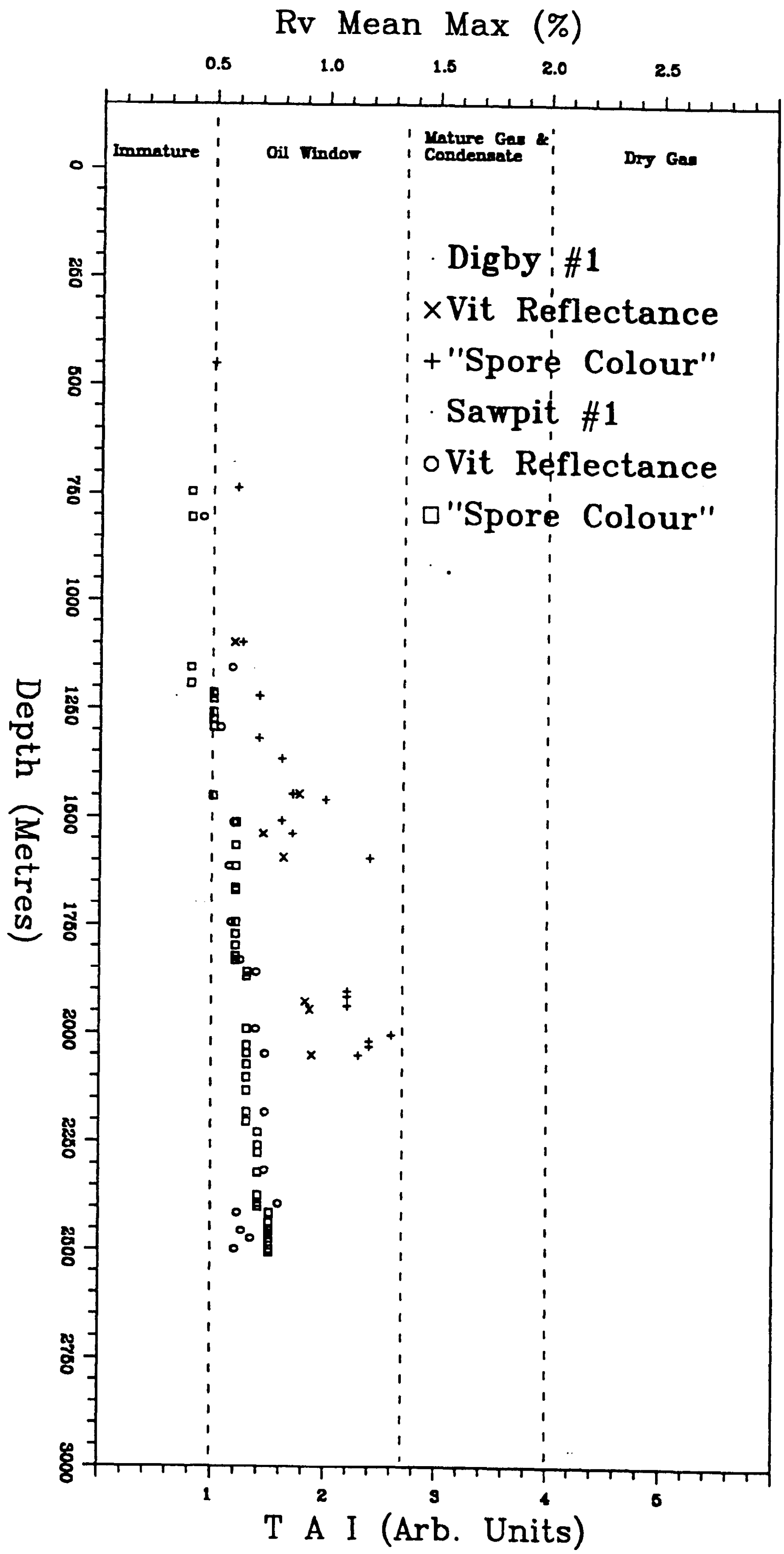
The degree of thermal alteration has been established on the basis of both changes in spore colour and exine structure. These estimates are more reliable if established on sequences of samples. Clearly, the precise colours assumed by the spores, pollen and cuticle during the mature phase of diagenesis are also influenced by environmental/depositional factors (e.g. amount of oxidation, presence of humic compounds) rendering schemes based upon specific spore colours unreliable. For example, when the spores are stained by humic compounds, the colours of the early mature phase spores can be similar to those from the late mature phase. Nevertheless, in a sequence of samples, where the progression or relative sequence of changes is always discernible, it can be a sensitive technique agreeing well with the geochemical rank estimation techniques (e.g. gas chromatography-mass spectroscopy).

Maturity estimates derived from spore colour are sometimes expressed as a "Thermal Alteration Index" (TAI) which is an arbitrary, somewhat ill defined scale with no accepted or consistent Industry standard. It was initially defined by Staplin (1969) using a scale of 1 to 5 but, although widely adopted, it has been variously interpreted and modified so that each organisation has its own version and calibration to the "oil window". The variation is such that the only reliable way of translating spore colour data from one TAI system to another is via an estimate of vitrinite reflectance. Consequently, spore colour standards used in this study are related to known vitrinite reflectance profiles and the Spore Colour maturity data is expressed as an "Estimate of Vitrinite Reflectance"; these values are tabulated on the "Organic Facies Data Tables" (Part 2). The TAI scale (1 to 6) at the base of the Maturity Depth Plot on Pages 25 and 26 is based (very loosely) upon a Robertson Research calibration which ranges from 1 to 10.

Digby #1 Maturity Depth Plot



Digby #1 and Sawpit #1 Maturity Depth Plot



Digby #1 Maturity Estimate

The "spore colour" estimates of thermal maturity are give on the Organic Facies Data Tables (Part 2) and presented graphically on Pages 25 and 26. These estimates suggest the top of the section (449.2m to 1936.4m) is within the "Oil Window" with the base of the section (2002m to 2048,2m) being within the "Mature Wet Gas and Condensate" Zone. The down section progression in the exinal changes was unusually erratic with that at 1457.5m and 1591m being well off trend. Additionally, the maturity increase with depth was significantly higher than that of other wells in the region (eg Sawpit #1; see Page 26).

A similar rather erratic and high maturity trend was recorded by the Vitrinite Reflectance values but was significantly less than the "Spore Colour" estimates. The discrepancy was a unexpected as there was a close correlation between the estimates from "Spore Colour" and Vitrinite Reflectance in Sawpit #1 and the Sawpit #1 material was used as a reference standard for the Digby #1 "Spore Colour" data. One possible explanation is that there has been some igneous activity in the Digby region rapidly heating the section for a short period of time. The activation energies for the various reactions that relate to exinal breakdown and vitrinite reflectance differ and an abnormal heating event could explain the divergence between the two maturity estimates, the higher maturity profile relative to other wells in the region and the somewhat erratic maturity trends. In this regard, it is worth noting that the two more extreme "Spore Colour" estimates (1457.5m and 1591m) are at the top of sand intervals and may have been influenced by migrating hydrothermal solutions if igneous activity near Digby #1 is considered as a possibility.

The RockEval T_{max} values indicate the section is mature and, as the values are higher than those recorded in Sawpit #1, support the Vitrinite Reflectance and "Spore Colour" inference of a higher maturity profile than the regional trend. The geochemical Aromatic compound estimates taken between 1473m and 1944 suggest little maturity variation down section and indicate a moderate degree of thermal alteration; the upper value is consistent with the Vitrinite Reflectance estimates but those from deeper in the section (especially the source rock extracts) seem low.

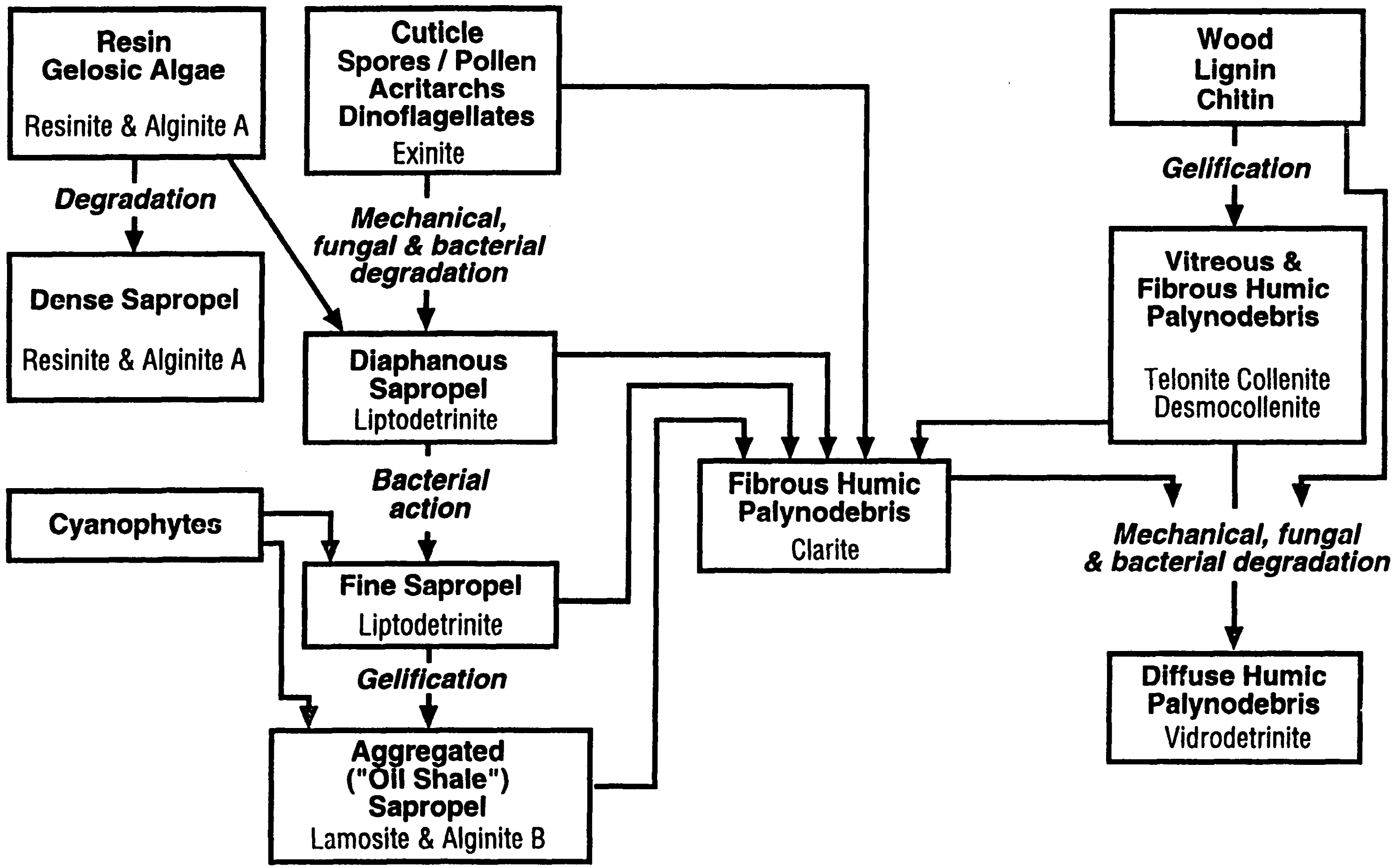
ORGANIC FACIES

Kerogen Classification

As there is no widely accepted standard terminology for the description and classification of palynodebris and for the interpretation of palynofacies and organic facies associations, a brief outline of the terminology used in the present study seems necessary. Traverse, 1994 published a collection of papers relating to the description of dispersed organic particles but these studies mainly addressed palynofacies interpretation, neglecting organic facies considerations and there was still no clear consensus as to terminology amongst the contributors.

The kerogen classification used in this study for the palynofacies and organic facies interpretation is based upon transmitted white light and ultra-violet/blue-violet fluorescence examination of the extracted organic matter. As the classification is aimed at providing both an environmental reconstruction (palynofacies) and an assessment of the hydrocarbon potential (organic facies) of the sampled lithology, it attempts to define the chemical characteristics of the organic matter components by identifying their biological origins and alteration pathways. The organic matter Groups are placed in categories more or less reflecting the degree of alteration of the original biological entity. In contrast to coal petrological classifications, emphasis is given to the translucent lipid organic matter as this group is readily differentiated in transmitted light and because of its significance to liquid hydrocarbon generation.

RELATIONSHIP OF KEROGEN TYPES & COAL MICROLITHOTYPES



Primary Kerogen Types

The primary kerogen groups represent the structured organic material whose biological origins can be established readily on the basis of their morphology. They are grouped together on extremely generalised considerations of their biological affinities, chemical nature and fluorescence characteristics. It should be noted that the name adopted for each group is intended merely to convey the general extent of the group and is not used in a strict sense nor is it intended to define the limits of the group.

The **Gelosic Algae Group** includes such forms as *Gloeocapsomorpha,* (cyanophyte) *Botryococcus* and *Tasmanites* (green algae) which are characterised by isolated or clustered cells with strongly fluorescent thick walls. In the tabulated data sheets, the strongly fluorescent secondary kerogen type **Dense Sapropel** (D) (see below) is grouped with Gelosic Algae (G) but is shown as a separate value where both are a significant proportion of the dispersed organic matter.

The **Dinocyst and Acritarch Group** comprises the thin-walled marine and fresh water phytoplankton (dinoflagellates, spinose acritarchs, leiospheres, etc.) and sedentary algal spore and cyst walls with moderate to strong fluorescent characteristics (when not oxidised).

The **Cuticle and Suberin Group** represents the waxy tissue of land plants. It includes identifiable cuticle, cutinised epidermal tissue, cork and suberinised tissue. Such tissue has a dull to moderate fluorescence when not oxidised or thermally altered.

Spores and Pollen Group comprises identifiable spore and pollen walls from land plants but excludes fungal spores. Variation in chemical composition of spores and pollen may require their separate listing. In the tabulation of the spore/pollen group, spores (S) and pollen (P) may be listed separately if either is a significant proportion of the dispersed organic matter.

Identifiable **Wood Fibres** and lignified tissue are grouped with their alteration products (**Fibrous Humic Palynodebris Group**) as it is unusual to see significant proportions of unaltered wood. Where there is an abundance of wood (W), its proportion is shown separately. Included in this group are the identifiable chitinous forms, including chitinozoa, microforaminifera and scolecodonts, together with fungal spores.

Secondary Kerogen Groups

The secondary kerogen groups include the altered products of the primary kerogen groups or organic matter whose origins are inferred rather than being identified totally by virtue of a preserved, recognisable morphology. The alteration may be mechanical fragmentation, anaerobic and aerobic bacterial and fungal degradation, gelification, together with the bi-products of atmospheric oxidation. A schematic diagram of the alteration pathways and comparison to the Coal Petrological Maceral Classification is given on Page 29.

Dense Sapropel Group represents the highly fluorescent remnants of gelosic algae together with vascular plant resins and "live" bitumen. They are included with Gelosic Algae Group but the proportion of Dense Sapropel (D) will be shown separately when the group represents a significant proportion of the organic residue.

Diaphanous Sapropel Group includes the translucent to diaphanous fragments of about 2 to 20+μm size derived from the initial breakdown of the waxy tissue of aquatic and land plants (including cuticle, spores, pollen and algal cysts) where the original plant structure is barely discernible. At low to moderate levels of maturity, or where not partially oxidised during transport prior to deposition, Diaphanous Sapropel palynodebris is moderately fluorescent although typically less so than the parent primary kerogen type.

Fine Sapropel Group represents a further stage of breakdown of the lipid rich tissue derived from higher plants, algae and cyanophytes. It is recognised by small particle size (less than 2μm) its translucency and moderate fluorescence. When partially oxidised or at high levels of maturity, such fine detritus is indistinguishable from fine humic palynodebris.

Under certain depositional conditions, the altered lipid detritus derived from higher plants, algae, cyanophytes and bacteria may "gelify", forming granular sapropelic or fibrous sapropelic ground mass referred to in this classification as **Aggregated Sapropel** or **"Oil Shale" Sapropel.** Such kerogen forms diffuse, translucent clumps characterised by mottled, moderate to strong fluorescence and with either a granular (G) (e.g. Toolebuc or Moaming oil shale) or a fibrous (F) (e.g. Rundle oil shale) microtexture.

Vitreous Humic Palynodebris is used to describe the "glassy" non-structured material with a sharp translucent edge and conchoidal fracture; it is presumed to represent humic compounds which result from the gelification of lignin. It does not however, correspond exactly to vitrain in the coal petrological sense but may be considered to represent collinite in a general way. It may also include certain forms of inertinite.

Fibrous Humic Palynodebris material represents other forms of modified humic material which are characterised by being nearly opaque, only extremely weakly fluorescent at very low levels of maturity, with fibrous to granular microtexture and lacking a sharp edge to the clasts. This group includes telinite, desmocollinite and inertinite for which no reliable distinction can be made on the basis of transmitted light observations.

As noted above, and although structured, the primary "humic" organic types (wood fibres, chitinous animal tissue, fungal spores), also are included in the fibro-granular humus group; however, if present, they are noted as such in the remarks.

Fine Humic Palynodebris is weakly translucent humic material which occurs as finely disseminated particles while **Diffuse Humic Palynodebris** is a gel-like, dull, translucent, non-fluorescent groundmass. These may represent, in part, the precipitation of dissolved humic compounds from the water column at the time of sediment deposition, or, in the case of diffuse humus, from solution during slide preparation. Oxidised or "over mature" finely divided, lipid detritus is indistinguishable from fine humus detritus and therefore is included in this group.

Fusinitic Palynodebris and **Fine Inert Palynodebris** represents the completely opaque non-fluorescent black fragments. It includes fusain (charcoal) in the strict sense, together with micrinite and, in the case of certain oil shale kerogen, haematite and other finely disseminated opaque mineral intimately bound within the kerogen.

Effects of Thermal Alteration

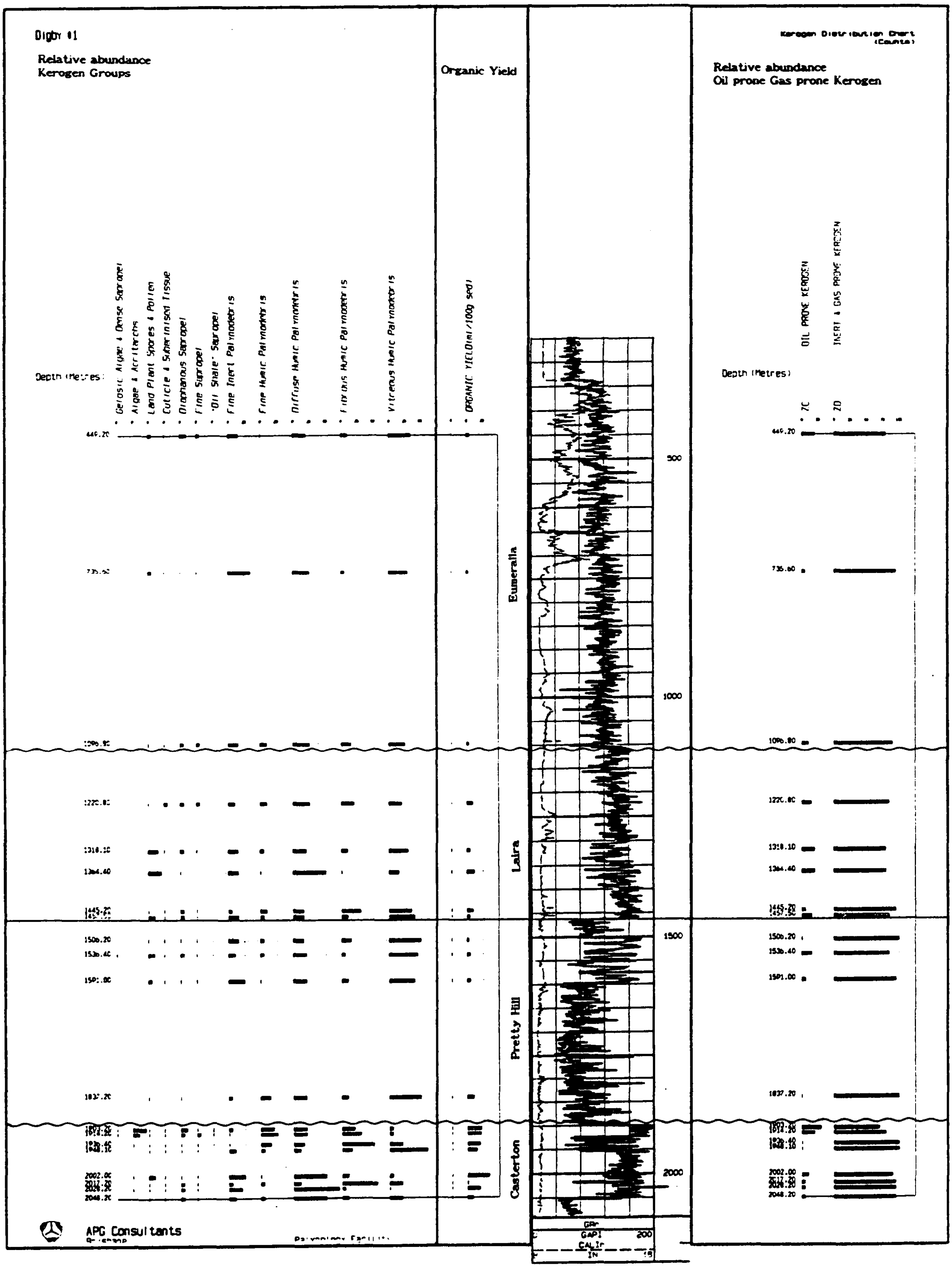
In applying the above classification, some modification to the groupings has to be made with increasing thermal alteration of the organic matter. In broad terms, little distinction can be made between Vitreous Humic Palynodebris, Fibrous Humic Palynodebris groups above Vitrinite Reflectance of about 1% to 1.5%. In such cases, the organic matter is assigned to Fibrous Humic Palynodebris. Similarly, Fine Sapropel, "Oil Shale" Sapropel and Diaphanous Sapropel lose their identity as they yield hydrocarbons with increasing maturation and become indistinguishable from either Diffuse Humic Palynodebris, Fine Humic Palynodebris or Fibrous Humic Palynodebris. Even the structured primary kerogen types, such as spores, pollen and cuticle, cannot be recognised readily at maturity levels much beyond the "oil window"; however, at that stage of maturation the recognition of the lipid kerogen groups has little relevance in terms of oil formation as what oil that could have formed from such kerogen has been formed.

Total Hydrocarbon Yield

An estimate of hydrocarbon yield has been established on the basis of the volume of acid insoluble organic matter recovered from the sediments. These estimates, which are expressed as ml of organic matter per 5mL or 100gms of sediment, are given in Organic Facies Data Tables. These estimates have a strong correlation with the total organic carbon values established by pyrolysis. Predictable variations however come from the presence of some gel-like Diffuse Humic kerogen; where the organic matter includes a high proportion of pyrite; and with certain clay lithologies.

Yield Estimate	Acid-insoluble Organic Yield		Total Organic Carbon
	ml/5mL sed.	mL/100g sed.	% sediment
Extremely low	0.0 - 0.10	0.0 - 0.5	0.2% or less
Very low	0.1 - 0.25	0.5 - 2.5	0.1% to 0.6%
Low	0.25 - 0.50	2.5 - 7.5	0.3% to 1.0%
Moderate	0.50 - 1.0	7.5 - 20	0.7% to 2.0%
High	1.0 - 2.0	20 - 50	1.30% to 2.5%
Very High	2.0 - 4.0	50 - 75	1.5% to 4.0%
Extremely High	>4.0	>75	2.0% or more

The propensity for a sediment to yield liquid hydrocarbon can be estimated on the basis of the proportion of lipid/waxy detritus present in the recovered acid insoluble organic matter. This estimate however, should be tempered and take into account several factors. It is believed that the waxy lipid detritus intimately associated with humic organic matter may not expel oil except under conditions of high thermal stress such as that experienced with pyrolysis analysis techniques (including that of RockEval). In this respect (amongst others) the oil proneness estimates from the RockEval analysis may not exactly parallel those given here. Allowance should be made for the proportion of lipid/waxy detritus partially oxidised (as evidenced by its poor fluorescence response, thinness and dull transmitted light colour) as the potential for such organic matter to yield hydrocarbons is lost or reduced by predepositional oxidation.


Digby #1
Relative abundance
Kerogen Groups
Organic Yield
Kerogen Distribution Chart (Counts)
Relative abundance
Oil prone Gas prone Kerogen
Depth (Metres)
Eumeralla
Laira
Pretty Hill
Casterton
500
1000
1500
2000
APG Consultants

Digby #1 Organic Facies Interpretation

Eumeralla Formation

The sediments sampled in the Eumeralla Formation included low proportions of organic matter and this was dominated by the humic kerogen groups. Waxy material was present in minor amounts and showed some evidence of oxidation. The hydrocarbon potential for the section seems marginal and limited to mostly gas.

Laira Formation

The Laira Formation sediments (1220.8m to 1445.2m) tended to include moderate proportions of organic matter, but like the Eumeralla sediments, the palynodebris tended to be humic with little waxy or lipid rich kerogen. Although its potential to yield hydrocarbon is perhaps better than the Eumeralla Formation, the potential is likely to be mostly for gas.

Pretty Hill Formation

In keeping with the sandy nature of the Pretty Hill section, the sampled sediments tended to be organically lean and considered to be marginal, gas prone source rocks at best.

Casterton Formation

The Casterton sediments were mostly organically rich and as such represent (or may have) good hydrocarbon source rocks. The mature of the organic matter is difficult to determine as it appears (in the palynological preparations) to be at an advanced stage of thermal alteration (late mature). The upper samples (1903.2m and 1914m) seem to include moderate proportions of lipid rich palynodebris (perhaps of algal origin) and as such may have been a good oil prone source rocks. The lower part of the Casterton Formation in Digby #1 included sediments with high organic yields but these seemed more humic and thus, less oil prone.

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Report 634/01

GFE Resources

Palynostratigraphy and Organic Facies Analysis of **Digby #1**

Otway Basin

Part 2
(Data Tables)

P.L. Price
September, 1995

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Sample Sample number Depth Preperation Number	Palynostratigraphic Unit Age	Inferred Lithostratigraphy (*Log Interp*)	Inferred Depositional Environment	Palynomorph			Remarks
				Preservatn	Yield	Diversity	
SWC 48 449.2m P18659	APK4 - APK5 Probably APK4 Early Albian to late Aptian	Eumeralla Formation *(Eumeralla Formation)*	Mostly land plant forms; fresh to brackish water forms notable. ***Fluvial, coastal plain. lagoonal.***	Fair	High	High	A rich palynoflora with a dominance of ferns (*Cyathidites, Cicatricosisporites* and *Osmundacidites* prominent); liverworts notable and diverse (*Foraminisporis* and *Aequitriradites*); conifers prominent (mostly Podocarps). Algal forms conspicuous and moderately diverse (leiospheres and *Sigmopollis* notable). The co association of *C. hughesii* and *C. striatus* has not been recognised in the Otway Basin but is known the Eromanga Basin.
SWC 47 735.6m P18660	APK4 Early Albian to late Aptian	Eumeralla Formation *(Eumeralla Formation)*	Mostly land plant forms; few fresh to brackish water forms. ***Fluvial; coastal plain.***	Poor	Low	Moderate	Palynoflora dominated by ferns (mostly *Cyathidites*); lycopods prominent (*Retitriletes* conspicuous, *Dictyotosporites* notable and diverse; both *C. hughesii* and *C. striatus* present). Conifers sparse. Few algae (mostly *Sigmopollis* and leiospheres).
SWC 43 1096.8m P18661	APK3 Probably APK321. ("*F.w.l.*" datum) Mid Aptian	Eumeralla Formation *(Eumeralla Formation)*	Mostly land plant forms; few fresh to brackish water algae. ***Fluvial; coastal plain.***	Poor	Low	Moderate	Palynoflora dominated by saccate and inaperturate (Conifer) pollen remnants; *Corollina* notable. Spores prominent; mostly ferns (*Cyathidites* and *Osmundacidites*). Lycopods and bryophytes subordinate but relatively diverse. Few leiospheres. Highest stratigraphic observation of *M. evansii* and *C. variabilis* in Digby #1. *Foraminisporis wonthaggiensis "lunaris"* present.
SWC 42 1220.8m P18662	APK22 - APK3 Probably APK22 - APK31 Tentatively APK22 Barremian to late Hauterivian	Laira Formation (note *P. notensis* present in the Laira in Katnook #2) *(Laira Formation)*	Mostly land plant forms; few fresh to brackish water algae. ***Fluvial; coastal plain.***	Very poor	Low	Low	Fern dominated (mostly *Osmundacidites*) palynoflora. Lycopods and Bryophytes scarce but moderately diverse. Conifer pollen scarce; mostly inaperturate pollen. Algae notable; mostly *Sigmopollis* and leiospheres together with an isolated small spinose acritarch and *M. evansii*.

Sample Sample number Depth Preparation Number	Palynostratigraphic Unit Age	Inferred Lithostratigraphy *(Log Interp)*	Inferred Depositional Environment	Palynomorph			Remarks
				Preservatn	Yield	Diversity	
SWC 41 1318.1m P18663	APK2 - APK3 Probably APK212 Hauterivian	Laira Formation *(Laira Formation)*	Mostly land plant forms; few fresh to brackish water forms. ***Fluvial; coastal plain.***	Poor	Moderate	Low	Fern dominated (mostly *Osmundacidites*) palynoflora. Lycopods scarce but moderately diverse. Bryophyte spores sparse. Conifer pollen scarce; mostly inaperturate pollen. Few algae; mostly *Sigmopollis* and leiospheres together with an isolated spinose acritarch and few *M. evansii*.
SWC 39 1364.4m P18664	APK2 - APK3 Possibly APK21 Early Hauterivian to Valanginian	Laira Formation or Upper Pretty Hills Formation *(Laira Formation)*	Almost entirely land plant forms. ***Fluvial, overbank.***	Fair	High	Low	Palynoflora dominated by a single fern species (*Cyathidites minor*); another fern spore (*Osmundacidites*) conspicuous. Lycopods notable and diverse. Few Bryophytes, conifers or aquatic forms.
SWC 37 1445.2m P18665	APK122 - APK3 Possibly APK21 Early Hauterivian to Valanginian	Laira Formation or Upper Pretty Hills Formation *(Laira Formation)*	Mostly land plant forms; Few fresh to brackish water forms. ***Fluvial; coastal plain.***	Very poor	Low	Low	A sparse fern dominated (mostly *Osmundacidites* and *Cyathidites*) palynoflora. Lycopods scarce but moderately diverse. Bryophyte spores sparse. Conifer pollen scarce. Few algae; mostly *Sigmopollis* and leiospheres together with an isolated spinose acritarch and *M. evansii*.
SWC 36 1457.5m P18666	APK2 Probably APK211 (possibly upper part of APK211) Valanginian	Lower Laira Formation or Upper Pretty Hills Formation *(basal Laira Formation)*	Mostly land plant forms; fresh to brackish water forms notable. ***Fluvial; coastal plain.***	Fair (?carbonised)	High	Moderate	A balanced palynoflora with a dominance and diversity of cryptogams, prominent gymnosperm pollen and a subordinate but relatively diverse fresh to brackish water algal association. Spores dominated by ferns (*Cyathidites* and *Osmundacidites*); lycopods *Retitriletes, Kekryphalospora* and *Dictyotosporites*) prominent and diverse; liverworts notable but relatively diverse. Gymnosperms dominated by Podocarps with Cheirolepidiacean forms notable. Algal association dominated by leiospheres with *Microfasta evansii* notable.
SWC 30 1506.2m P18667	APK2 Valanginian	Laira Formation or upper Pretty Hills Formation *(Pretty Hills Formation)*	Mostly land plant and riverine forms; a few fresh to brackish water algae. ***Fluvial; coastal plain.***	Fair - poor	Very low	Low	A sparse but relatively diverse palynoflora. Saccate and inaperturate pollen remnants dominant. Spores prominent and moderately diverse; Ferns (*Cyathidites*) lycopods (*Retitriletes*) and liverworts (*Aequitriradites, Januasporites*) notable. A very sparse leiosphere - algal association.

Sample Sample number Depth Preparation Number	**Palynostratigraphic Unit Age**	**Inferred Lithostratigraphy** (*Log Interp*)	**Inferred Depositional Environment**	**Palynomorph** Preservatn	Yield	Diversity	**Remarks**
SWC 29 1536.4m P18668	APK21 Probably APK211 Valanginian	Lower Laira Formation or upper Pretty Hills Formation *(Pretty Hills Formation)*	Mostly land plant forms; a few brackish to fresh water algae. ***Fluvial, coastal plain.***	Fair	Moderate	Moderate	Diverse spore dominated assemblage. *Osmundacidites* dominate; *Cyathidites* and bisaccate pollen prominent; Lycopod spores (*Retitriletes, Kekryphalospora* and *Dictyotosporites*) prominent and diverse. Sparse leiosphere - algal association; *M. evansii* present.
SWC 27 1591m P18669	APK121 - APK2 Tentatively APK122 ?Berriasian	Pretty Hills Formation *(Pretty Hills Formation)*	Almost entirely land plant forms. ***Fluvial, overbank.***	Fair - poor carbonised	Low	Very low	Spore dominated palynoflora including a prominence of relative few taxa; *Cyathidites, Osmundacidites, Neoraistrickia coalita Ceratosporites equalis* and *Retitriletes nodosus* common. Bisaccate pollen prominent but very restricted in diversity; mostly *Alisporites lowoodensis*. Isolated leiospheres present.
SWC 24 1837.0m P18670	Indeterminate	Indeterminate	Almost entirely coaly palynodebris. ***Peat Bog or Dystrophic Swamp.***	Fair	Almost nil	Almost nil	An extremely scant palynoflora comprising mud borne contamination.
SWC 22 1903.2m P18671	APJ62 - APK4 "Casterton" lagoonal palynofacies Tentatively APK1 ?Berriasian - Tithonian	Casterton Formation *(Casterton Formation)*	Mostly wind dispersed land plant forms and fresh to brackish water algae. ***Coastal lagoon or lacustrine.***	Very poor	Low	Very low	Sparse palynoflora of mostly poorly preserved ?leiosphere and inaperturate pollen remnants. Few recognisable spores; *Osmundacidites, Cyathidites* and *Ceratosporites equalis* notable. Common diffuse tissue (?algal or inaperturate pollen remnants).
SWC 21 1914.2m P18672	APJ62 - APK4 "Casterton" lagoonal palynofacies Tentatively APK1 ?Berriasian - Tithonian	Casterton Formation *(Casterton Formation)*	Mostly fresh to brackish water algae with wind dispersed land plant elements. ***Coastal lagoon or lacustrine.***	Leiospheres fair. Spore-Polln Very poor	High	Extremely low	Leiospheres abundant but are almost the only recognisable palynomorph. Inaperturate and saccate pollen notable and may have been more abundant but few could be positively identified. Spores scarce; *Osmundacidites* and *Ceratosporites equalis* notable. Abundant diffuse tissue (?algal or inaperturate pollen remnants).

Sample Sample number Depth Preparation Number	Palynostratigraphic Unit Age	Inferred Lithostratigraphy (*Log Interp*)	Inferred Depositional Environment	Palynomorph Preservatn	 Yield	 Diversity	Remarks
SWC 16 1936.4m P18673	APJ62 - APK4 Very tentatively APK1 ?Berriasian - Tithonian	Casterton Formation *(Casterton Formation)*	Almost entirely humic palynodebris. ***Peat Bog or Dystrophic Swamp.***	Poor	Extremely low	Extremely low	Extremely sparse palynoflora; mostly ?inaperturate pollen with *Osmundacidites* and *Cyathidites* prominent. Degraded wood fibres and cuticle abundant. Few ?leiospheres present.
SWC 10 1948.1m P18674	Indeterminate	Indeterminate	Almost entirely humic palynodebris. ***Peat Bog.***	Fair	Almost nil	Almost nil	Palynoflora extremely sparse and probably almost entirely derived from mud borne contamination.
SWC 6 2002.0m P18675	APK1 Probably APK11 Tithonian	Casterton Formation *(Casterton Formation)*	Mostly wind dispersed land plant forms; ?Leiospheres notable. ***Fluvial - Lacustrine.***	Extremely poor	High	Low (*see remarks*)	A rich palynoflora dominated by saccate and ?inaperturate pollen remnants. Spores prominent and may have been diverse but few could be identified (exinal detail lost due to advanced stage of thermal alteration); *Osmundacidites, Cyathidites* and *Retitriletes* notable. ?Leiospheres notable but difficult to distinguish from the inaperturate pollen remnants. [*The palynoflora has an Early Cretaceous character; cf SWC 2/2048.2m*]
SWC 5 2017.2m P18676	Mesozoic	Indeterminate *(Casterton Formation)*	Low organic yield of mostly humic palynodebris. ***Fluvial, braided stream or Beach.***	Extremely poor	Almost nil	Almost nil	A few corroded spore and pollen remnants recovered; few of which could be identified.
SWC 4 2028.2m P18677	Tentatively APJ6-APK1 (*see remarks*) ?Tithonian - Kimmeridgian	? Casterton Formation *(Casterton Formation)*	Most of the palynoflora is exotic. ***Indeterminate***	Fair to Extremely poor	Extremely low	very low	A sparse palynoflora which included a few carbonised spore and pollen remnants of similar preservation to the underlying assemblage; these forms may be endemic to the sampled horizon. The majority of the palynomorphs (saccate pollen, inaperturate pollen, Angiosperm pollen, cryptogam spores and acritarchs) and coarse palynodebris (cuticle and wood fibres) were fresh to moderately thermally altered and likely to have been deriver from both a mud additive and from higher in the section. No biostratigraphic reliance can be placed upon the recovered palynoflora.

Sample Sample number Depth Preparation Number	Palynostratigraphic Unit Age	Inferred Lithostratigraphy (*Log Interp*)	Inferred Depositional Environment	Palynomorph			Remarks
				Preservatn	Yield	Diversity	
SWC 3 2048.2m P18678	APJ62 - APK11 Possibly APJ62 Tithonian - Kimmeridgian	Casterton Formation *(Casterton Formation)*	Mostly land plant forms; few fresh to brackish algae. ***Fluvial - Lacustrine.***	Very low	Extremely poor	Extremely low	Palynoflora strongly carbonised with only the more robust forms identifiable. Spore remnants dominant; *Osmundacidites* and *Retitriletes* prominent, *Contignisporites* notable. Saccate and Inaperturate pollen remnants prominent. Leiospheres notable. [*The palynoflora has a Late Jurassic character; cf SWC 6/2002m*]

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Palynost aphy and
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Organic Facies Data

GFE Digby #1

Sample Sample Number Depth Preparation Num.	Lithology	Gelosic Algae & Dense Sapropel	Dinocysts & Acritarch	Cuticle & Suberin	Spores & Pollen	Diaphanous Sapropel	Fine Sapropel	Aggregated (Oil Shale) Sapropel	Fine Inert Debris	Fine Humic Debris	Diffuse Humic Debris	Fibrous Humic Debris	Vitreous Humic Debris	Maturity Spore colour; Est. Vit. Ref UV Fluorescence Response	Organic Yield ml/100g Sed	Remarks
SWC 48 449.2m P18659	Claystone, mid green grey, silty, carbonaceous flecks.			+	5	10	5		15	+	20	10	35	Translucent lt yllw - lt brwn yllw 0.5 Sp VD-M Gm N-ED ***"Oil Window; Early Mature"***	5.2 Low	Spores mostly entire and fresh, some thin. Saccate pollen entire to corroded and fragmented. Cuticle mostly corroded; some humic impregnation; some fresh large laths. Macerated wood fibres notable. Palynodebris mostly finely divided and partly oxidised.
		Gas prone *with limited oil potential.* *Source potential likely to be limited by low organic content.*														
SWC 47 735.6m P18660	Claystone, mid grey, silty, minor carbonaceous flecks.			+	5	+	+		35		25	5	30	Dull translucent yllw brwn 0.6 Sp ED-D Gm N ***"Oil Window; Early Mature"***	2.6 Low	Spores entire to fragmented, mostly corroded. Saccate pollen scarce, mostly fragmented and corroded. Cuticle thin, corroded and fragmented. Palynodebris fine to moderately finely divided and strongly oxidised.
		Gas prone. *Source potential likely to be limited by low organic content.*														
SWC 43 1096.8m P18661	Claystone, mid grey, silty, minor carbonaceous flecks.			+	+	5	5		15	10	25	15	25	Dull yllw brwn 0.6 - 0.65 Sp ED-D/M Gm N ***"Oil Window; Early Mature"***	3.1 Low	Spores entire to fragmented, mostly thin, corroded. Saccate pollen mostly thin, corroded and fragmented. Cuticle corroded and fragmented. Some macerated wood fibres. Palynodebris mostly finely divided and partly oxidised.
		Gas prone *with very limited oil potential.* *Source potential likely to be limited by low organic content.*														
SWC 42 1220.8m P18662	Claystone, mid brown grey, silty, minor carbonaceous flecks.			5	+	5	5		10	10	25	20	20	Dull yllw brwn 0.65 - 0.7 Sp Ed-d Gm N ***"Oil Window; Early Mature"***	8.9 Mod.	Spores mostly entire but thin and stained; some fragmented and corroded. Pollen scarce, thin corroded and fragmented. Cuticle fragmented; some humic impregnation. Macerated wood fibres notable. Palynodebris fine to moderately finely divided and partly oxidised
		Gas prone *with very limited oil potential.*														

Sample Sample Number Depth Preparation Num.	Lithology	Gelosic Algae & Dense Sapropel	Dinocysts & Acritarch	Cuticle & Suberin	Spores & Pollen	Diaphanous Sapropel	Fine Sapropel	Aggregated (Oil Shale) Sapropel	Fine Inert Debris	Fine Humic Debris	Diffuse Humic Debris	Fibrous Humic Debris	Vitreous Humic Debris	Maturity Spore colour; Est. Vit. Ref UV Fluorescence Response	Organic Yield mL/100g Sed	Remarks
SWC 41 1318.1m P18663	Claystone, mid grey, silty, minor carbonaceous flecks. *[SWC fractured; possible contamination.]*			+	15	5	+		15	5	20	10	30	Dull translucent brwn 0.7 Sp N-VD Gm N ***"Oil Window; Early Mature"***	4.3 Low	Spores mostly entire but stained; some thin and corroded. Saccate pollen scarce mostly thin corroded and fragmented. Cuticle mostly corroded and fragmented. Palynodebris fine to moderately finely divided and partly oxidised.
		Gas prone *with limited oil potential.* *Source potential likely to be limited by low organic content.*														
SWC 39 1364.4m P18664	Claystone, mid to dark grey, silty.				20	+			15	+	50	+	15	Dull translucent brwn 0.8 Sp N-ED Gm N ***"Oil Window; Peak Generation"***	11.5 Mod.	Spores entire, but thin (not corroded). Saccate pollen scarce mostly entire and fresh. Cuticle scarce, highly corroded and fragmented. Palynodebris very finely divided and partly oxidised.
		Gas prone *with limited oil potential.*														
SWC 37 1445.2m P18665	Siltstone, mid grey, argillaceous, carbonaceous laminations and flecks.			+	+	5	+		5	10	15	30	35	Dull brwn 0.85 Sp N-ED Gm N ***"Oil Window; Peak Generation"***	9.3 Mod.	Spores and saccate pollen scarce, mostly entire to fragmented. Cuticle highly corroded and fragmented. Macerated wood fibres and fusain notable. Palynodebris fine to coarsely divided and partly oxidised.
		Gas prone.														
SWC 36 1457.5m P18666	Claystone, mid grey, silty.			+	10	5	+		15	5	15	10	40	Dull brwn to brwn blk ?1.0 *[see remarks]* Sp N-ED Gm N ***"Oil Window"***	3.8 Low	Spores mostly entire: some thin corroded and stained,. Saccate pollen mostly entire and fresh, some stained. Cuticle mostly thin corroded and fragmented, some humic impregnation. Palynodebris fine to moderately finely divided and partly oxidised. *[The dark colour of the palynomorphssuggests a high degree of thermal alteration but there is little exinal breakdown.]*
		Gas prone *with very limited oil potential.* *Source potential likely to be limited by low organic content.*														

Sample Sample Number Depth Preparation Num.	**Lithology**	Gelosic Algae & Dense Sapropel	Dinocysts & Acritarch	Cuticle & Suberin	Spores & Pollen	Diaphanous Sapropel	Fine Sapropel	Aggregated (Oil Shale) Sapropel	Fine Inert Debris	Fine Humic Debris	Diffuse Humic Debris	Fibrous Humic Debris	Vitreous Humic Debris	**Maturity** Spore colour; Est. Vit. Ref UV Fluorescence Response	**Organic Yield** mL/100g Sed	**Remarks**
SWC 30 1506.2m P18667	Claystone, mid grey, silty, minor carbonaceous flecks.			+	+	+	+		15	5	15	15	50	Dull brwn 0.8 Sp N Gm N ***"Oil Window; Peak Generation"***	1.9 Very low	Spores and saccate pollen scarce and mostly thin corroded and fragmented. Cuticle scarce and highly corroded and fragmented. Palynodebris fine to moderately coarsely divided and partly oxidised.
		Not a source rock.														
SWC 29 1536.4m P18668	Claystone, mid grey, silty, minor carbonaceous flecks.	+		+	10	5	+		10	5	20	5	45	Dull Brwn. 0.85 Sp ED-D/M Gm N ***"Oil Window; Peak Generation"***	4.3 Low	Spores and saccate pollen mostly entire, fresh to thin and corroded. Cuticle mostly corroded and fragmented, some large laths. Palynodebris fine to moderately coarsely divided. and partly oxidised.
		Gas prone *with very limited oil potential.* *Source potential likely to be limited by low organic content.*														
SWC 27 1591m P18669	Claystone, mid green grey, minor carbonaceous flecks. *(SWC small; possible contamination)*			+	5	+	+		25	+	20	10	40	Dull brwn to brwn blk 1.2 Sp N Gm N ***"Oil Window; Late Mature"***	4.3 Low	Spores and saccate pollen entire to fragmented, somewhat carbonised, some fresh but mostly corroded. Cuticle highly corroded and fragmented. **Some contamination from higher in the section.** Palynodebris mostly finely divided and partly oxidised.
		Gas prone. *Source potential likely to be limited by low organic content.*														
SWC 24 1837.2m P18670	Sandstone, mid grey, very fine grained, silty, common carbonaceous laminations.				+	+			5	15	20	10	50	Few free spores. Vitrinite with very narrow translucent rim.	10.6 Mod	Spores, saccate pollen and cuticle very scarce, fresh to highly corroded and fragmented. **Most, if not all, the palynomorphs are contaminants.** Palynodebris fine to coarsely divided.
		Gas prone.														

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Organic Facies Data

GFE Digby #1

Sample Sample Number Depth Preparation Num.	**Lithology**	Gelosic Algae & Dense Sapropel	Dinocysts & Acritarch	Cuticle & Suberin	Spores & Pollen	Diaphanous Sapropel	Fine Sapropel	Aggregated (Oil Shale) Sapropel	Fine Inert Debris	Fine Humic Debris	Diffuse Humic Debris	Fibrous Humic Debris	Vitreous Humic Debris	**Maturity** Spore colour; Est. Vit. Ref UV Fluorescence Response	**Organic Yield** mL/100g Sed	**Remarks**
SWC 22 1903.2m P18671	Claystone, very dark brown grey - brown black, very carbonaceous, silty.	+	?10	?	?10	10	+	+	5	20	20	20	5	Dull translucent dk brwn 1.0 Sp N ?L ED-D/M Gm N-ED *"Oil Window; Late Mature"*	21.6 High	Spores, saccate pollen and ?inaperturate pollen, very thin, highly corroded ("dissolved"). ?Leiospheres entire to fragmented and corroded. ?Cuticle very thin, highly corroded, fragmented. Palynodebris fine to moderately finely divided. *(The kerogen has the micro-texture of "granular" oil shale sapropel but lacks the fluorescence response; ??too mature or too oxidised)*
		***Gas prone** with some oil potential.* *May have had greater oil potential but this may have been expended given the thermal alteration.*														
SWC 21 1914.2m P18672	Claystone, dark brown black, very carbonaceous.	+	15	?	+	5	5	+	+	25	20	25	5	Dull translucent dk brwn 1.0 Sp N-ED ?L ED-D/M mttld Gm N-ED *"Oil Window; Late Mature"*	20.9 High	Spores, saccate pollen and inaperturate pollen, very thin, highly corroded ("dissolved"). ?Cuticle very thin, highly corroded, fragmented; some humic impregnation. Leiospheres mostly entire, fresh to strongly corroded. Corroded macerated wood fibres notable. Minor fungal remnants. Palynodebris fine to moderately finely divided. *(The kerogen has the micro-texture of "granular" oil shale sapropel but lacks the fluorescence response; ??too mature or too oxidised)*
		***Gas prone** with limited oil potential.* *May have had greater oil potential but this may have been expended given the thermal alteration.*														
SWC 16 1936.4m P18673	Claystone, very dark brown grey to brown black, very carbonaceous.		?	+	+	+	+		+	15	15	50	20	Dull translucent brwn to dull dk brown 1.0 Sp N Gm N *"Oil Window; Late Mature"*	19.2 Mod.	Spores and saccate pollen thin, corroded. Cuticle fragmented, corroded; some humic impregnation; some large laths. Corroded macerated wood prominent. Palynodebris fine to moderately coarsely divided.
		Gas prone. *May have had greater oil potential but this may have been expended given the thermal alteration.*														

Sample Sample Number Depth Preparation Num.	Lithology	Gelosic Algae & Dense Sapropel	Dinocysts & Acritarch	Cuticle & Suberin	Spores & Pollen	Diaphanous Sapropel	Fine Sapropel	Aggregated (Oil Shale) Sapropel	Fine Inert Debris	Fine Humic Debris	Diffuse Humic Debris	Fibrous Humic Debris	Vitreous Humic Debris	Maturity Spore colour; Est. Vit. Ref UV Fluorescence Response	Organic Yield mL/100g Sed	Remarks
SWC 10 1948.1m P18674	Claystone, mid-dark brown grey to grey black, very carbonaceous, sandy in part. *(SWC small; possible contamination.)*			+	+	+	+		10	5	10	15	60	Few, if any, palynomorphs endemic. Vitrain with very narrow translucent rim.	14.2 Mod.	Spores, saccate pollen and cuticle scarce, corroded; some humic impregnation. **Some mud borne contamination; few, if any, palynomorphs endemic.** Palynodebris fine to coarsely divided.
		Gas prone. *May have had greater oil potential but this may have been expended given the thermal alteration.*														
SWC 6 2002.0m P18675	Siltstone, brown grey, very argillaceous, carbonaceous.		+	+	10	+	+		25	+	50	10	5	Dull dk brwn. to brwn black 1.3 No fluor response ***"Condensate Zone"***	33.3 High	Spores and saccate pollen mostly entire but thin and strongly corrode, (carbonised). Cuticle highly corroded and fragmented. Palynodebris very finely divided.
		***Gas prone** with very limited oil potential.* *May have had greater oil potential but this may have been expended given the thermal alteration.*														
SWC 5 2017.2m P18676	Siltstone, dark brown, carbonaceous: Sandstone, light brown, very fine grained. *(SWC small; possible contamination.)*			+	+	?5	+		5	5	10	55	20	Dull dk brwn to brwn black. 1.2 No fluor. response ***"Condensate Zone"***	0.7 Very low	Spores and saccate pollen scarce, corroded, thin. Cuticle highly corroded, fragmented; some humic impregnation. Palynodebris mostly finely divided with some coarse fragments. ?Organic matter partly oxidised.
		Not a source rock.														

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Organic Facies Data

GFE Digby #1

Sample Sample Number Depth Preparation Num.	**Lithology**	Gelosic Algae & Dense Sapropel	Dinocysts & Acritarch	Cuticle & Suberin	Spores & Pollen	Diaphanous Sapropel	Fine Sapropel	Aggregated (Oil Shale) Sapropel	Fine Inert Debris	Fine Humic Debris	Diffuse Humic Debris	Fibrous Humic Debris	Vitreous Humic Debris	**Maturity** Spore colour; Est. Vit. Ref UV Fluorescence Response	**Organic Yield** mL/100g Sed	**Remarks**
SWC 4 2028.2m P18677	Claystone, dark brown grey, silty. *[SWC friable; possible contamination]*		+	+	+	5	+		20		70	5	+	Dull dk brwn to brwn black. 1.2 Sp N L N-ED Gm N ***"Condensate Zone"***	19.7 Mod	Spores and saccate pollen mostly entire but thin, corroded. ?Leiospheres entire, thin. Cuticle scarce, highly corroded. Some macerated wood fibres. **Significant contamination (most of the palynoflora) from a mud additive and mud borne forms from higher in the section.** Palynodebris very finely divided. *[The kerogen has the micro-texture of "granular" oil shale sapropel but lacks the fluorescence response; ??too mature or too oxidised]*
		Gas prone. *May have had greater oil potential but this may have been expended given the thermal alteration.*														
SWC 3 2048.2m P18678	Claystone, mid brown grey, silty. *[SWC small; possible contamination]*			+	+	5	+		10	5	50	10	20	Dull dk brwn to brwn blk. 1.1 - 1.2 No fluor response ***"Condensate Zone"***	8.5 Mod.	Spores and saccate pollen scarce, entire to fragmented, strongly corroded. Cuticle strongly corroded, fragmented; some humic impregnation; some large laths. Macerated wood fibres notable. Palynodebris very fine to moderately coarsely divided. *[The kerogen has the micro-texture of "granular" oil shale sapropel but lacks the fluorescence response; ??too mature or too oxidised]*
		Gas prone. *May have had greater oil potential but this may have been expended given the thermal alteration.*														