LASMO ENERGY AUSTRALIA LTD.

VIC/P11

WELL COMPLETION REPORT

PATRICIA - 1

LUME II. INTERPRETATIVE APPENDICES AND ENCLOSURES

REPORT NUMBER: RN93

VOL 2.

18 JAN 1988

CONTENTS

INTERPRETATIVE APPENDICES

INTERPRETATIVE APPENDICES

MICROPALAEONTOLOGICAL ANALYSIS

MICROPALAEO. ANALYSIS

<u>APPENDIX XI</u>

MICROPALAEONTOLOGICAL ANALYSIS

MICROPALAEONTOLOGICAL ANALYSIS
PATRICIA-1, GIPPSLAND BASIN

J.P. Rexilius
Rexilius Stratigraphic Services
38 Samson Street
MOSMAN PARK 6012 W.A.

September, 1987

C O N T E N T S

1. SUMMARY

Patricia-1 was drilled in offshore petroleum permit Vic P/11, Gippsland Basin to a depth of 900m KB. 29 samples have been examined for foraminifera and 16 samples scrutinized for calcareous nannoplankton. A summary of the biostratigraphic and environmental sub-division of the well section between 286.0m and 743.5m is given below:-

Planktonic Foraminiferal Sub-division

286.0m	:	Zone C	upper Middle Miocene
344.0m-445.0m	:	Zone D1	mid Middle Miocene
484.0m-573.0m	:	Zone D2	lower Middle Miocene
589.0m-622.0m	:	Zone F	upper Early Miocene
632.0m-644.0m	:	Zone G	Early Miocene
665.0m-672.0m	:	Zone H1	basal Early Miocene
678.0m	:	Zone H2	latest Late Oligocene
683.0m	:	Zone I2	mid Late Oligocene
685.0m-690.0m	:	indeterminate	-
692.0m-693.5m	:	Zone J2	Early Oligocene
693.5m-743.5m	:	indeterminate	-

Calcareous Nannoplankton Sub-division

670.0m-above 678.0m	:	Zone NN1	lower Early Miocene
678.0m-683.0m	:	Zone NP24	mid Late Oligocene
685.0m-693.5m	:	Zone NP22	mid Early Oligocene
693.5m-743.5m	:	indeterminate	-

Environment Sub-division

286.0m	:	inner-middle neritic
344.0m-385.0m	:	middle neritic
445.0m	:	undifferentiated neritic
484.0m-531.0m	:	middle-outer neritic
563.0m-589.0m	:	middle neritic
606.0m-644.0m	:	middle-outer neritic
665.0m-678.0m	:	outer neritic - upper bathyal
683.0m	:	middle-outer neritic
692.0m	:	inner-middle neritic
699.5m-743.5m	:	indeterminate

II INTRODUCTION

Patricia-1 was drilled in offshore petroleum permit Vic P/11, Gippsland Basin to a depth of 900m KB. Foraminifera were examined from the interval 286.0m to 743.5m and calcareous nannoplankton scrutinized from the interval 670m to 743.5m. Micropalaeontological analysis has been based on core (705.0m-743.5m), sidewall core (286.0m-700.3m) and ditch cuttings (670-700m) samples. Most attention has been focussed on the condensed Early Oligocene - basal Early Miocene section. In this interval sidewall cores and ditch cuttings have been examined for both planktonic foraminifera and calcareous nannoplankton to gain optimum biostratigraphic control. Only ditch cuttings below the log break at 683.5m have been scrutinized for planktonic foraminifera because there are no last appearance defining events above the extinction of *Subbotina angiporoides* (top Zone J1 indicator) in the Late Oligocene - Early Miocene Gippsland Basin planktonic foraminiferal zonation.

The Seaspray Group carbonates contain rich foraminiferal and calcareous nannoplankton assemblages which provide good biostratigraphic and environmental data. In contrast the Gurnard Formation in Patricia-1 is essentially barren of skeletal material with the exception of a single fish tooth remain recorded in a core sample at 720.0m. The lack of foraminifera, calcareous nannoplankton and other skeletal material may have resulted from diagenetic processes which may have removed both calcareous and agglutinated foraminifera. Some pelletal glauconite grains resembling internal molds of foraminifera were noted in some samples within the Gurnard Formation but it was concluded they were most likely primary glauconite pellets.

III BIOSTRATIGRAPHIC ANALYSIS

The planktonic foraminiferal letter zonal scheme of Taylor (in prep.) and the NP-NN calcareous nannoplankton letter scheme of Martini (1971) are used for biostratigraphic sub-division. Foraminiferal studies by Jenkins (1960,1971) and Carter (1964), and calcareous nannoplankton investigations by Edwards (1971), Siesser (1979) and Perch-Nielsen (1985), have also been consulted.

A. Planktonic Foraminiferal Sub-division

1. 286.0m : Zone C (upper Middle Miocene)

The sample at 286.0m is assigned to Zone C on the basis of the association of *Globorotalia miotumida* and *Turborotalia mayeri* without older *(Globorotalia miozea miozea, G.praemenardii* and *Turborotalia praescitula)* and younger *(Turborotalia acostaensis)* taxa.

2. 344.0m-445.0m : Zone D1 (mid Middle Miocene)

The association of *Orbulina universa, Globorotalia miozea miozea, G. praemenardii* and *Turborotalia praescitula* without diverse *Globigerinoides, Praeorbulina* and *Orbulina* indicates that the interval is Zone D1 in age.

3. 484.0m-573.0m : Zone D2 (lower Middle Miocene)

The uphole last appearance of *Orbulina bilobata, O.suturalis* and *Praeorbulina glomerosa* at 484.0m defines the top of Zone D2 in the well section. The occurrence of *Globorotalia miozea conoidea* at 573.0m indicates an age no older than Zone D2. The base Zone D2 indicator species *Orbulina universa* makes its first uphole appearance at 563.0m. The absence of the species at 573.0m is attributed to poor preservation.

4. 589.0m-622.0m : Zone F (upper Early Miocene)

The interval is assigned to Zone F on the basis of the occurrence of *Globigerinoides sicanus* without the *Praeorbulina/Orbulina* group.

5. 632.0m-644.0m : Zone G (Early Miocene)

The uphole appearance of *Globigerinoides trilobus* at 644.0m indicates that the interval is assignable to Zone G.

6. 665.0m-672.0m : Zone H1 (basal Early Miocene)

The interval is assigned to Zone H1 on the basis of the occurrence of *Globigerina woodi connecta* without its descendant *Globigerinoides trilobus*.

7. 678.0m : Zone H2 (latest Late Oligocene)

The occurrence of *Globigerina woodi woodi* without *Globigerina woodi connecta* indicates that the sample at 678.0m is Zone H2 in age.

8. 683.0m : Zone I2 (mid Late Oligocene)

The high yielding assemblage at 683.0m is assigned to Zone I2 on the basis of the occurrence of *Globigerina praebulloides* and *G.euapertura* without *Subbotina angiporoides* (top Zone J1 indicator) and *Globoquadrina dehiscens* (base Zone I1 indicator).

9. 685.0m-690.0m : Indeterminate

Severe caving of rich Late Oligocene and younger taxa obscures possible *in-situ* Early Oligocene forms including *Subbotina angiporoides* and *Turborotalia gemma*.

10. 692.0m-693.5m : Zone J2 (Early Oligocene)

The association of *Subbotina angiporoides* and *Turborotalia gemma* without *Subbotina linaperta* indicates a Zone J2 assignment for the interval.

11. 693.5m-743.5m : Indeterminate

The interval is barren of planktonic foraminifera.

B. <u>Calcareous Nannoplankton Sub-division</u>

1. 670m-above 678.0m : Zone NN1 (lower Early Miocene)

The occurrence of *Cyclicargolithus abisectus* and common *Discoaster deflandre* without older *(Zygrhablithus bijugatus* and *Dictyococcites bisectus)* and younger *(Discoaster druggi)* taxa indicates that the interval is assignable to Zone NN1.

2. 678.0m-683.0m : Zone NP24 (mid Late Oligocene)

The association of *Chiasmolithus altus* and *Cyclicargolithus abisecta* in the interval is indicative of a Zone NP24 assignment.

3. 685.0m - 693.5m : Zone NP22 (mid Early Oligocene)

The interval is assigned to Zone NP22 on the basis of the association of *Chiasmolithus oamaruensis* and *Reticulofenestra umbilica* without *Ericsonia formosa*.

4. 693.5m-743.5m : Indeterminate

The interval is barren of calcareous nannoplankton.

IV ENVIRONMENT OF DEPOSITION

1. 286.0m : inner-middle neritic

The clean bryozoan limestone at 286.0m contains a moderately diverse inner to middle neritic benthonic foraminiferal assemblage including *Globocassidulina subglobosa* (frequent), *Discorbis balcombensis* (few) and *Elphidium crassatum* (few). The low numbers of buliminids is consistent with deposition in an inner to middle neritic environment.

2. 344.0m-385.0m : middle neritic

The carbonates in the interval contain rich benthonic and planktonic foraminiferal assemblages. The percentage of planktonics is approximately 50%. The benthonic foraminiferal fauna includes *Brizalina* (common at 344.0m) *Sphaeroidina bulloides* (few-frequent) and *Siphonaperta* cf. *vellai* (few-frequent). The interval is dominated by sponge spicules with minor bivalve fragments also present. Deposition in a middle neritic environment is envisaged.

3. 445.0m : undifferentiated neritic

The sample at 445.0m lacks a diverse benthonic foraminiferal assemblage. A more definitive environmental interpretation than undifferentiated neritic is not possible using benthonic foraminifera criteria although the moderately diverse planktonic foraminiferal fauna indicates deposition no shallower than middle neritic.

4. 484.0m-531.0m : middle-outer neritic

The carbonates in the interval are dominated by sponge spicules. The foraminiferal faunas are diverse with the percentage of planktonics ranging between 45% and 60%. The abundance of buliminids *(Euvigerina miozea, Bolivina anastomosa, Brizalina* and *Siphouvigerina canariensis)* and moderate numbers of *Sphaeroidina bulloides* is consistent with deposition in a middle to outer neritic depositional environment.

5. 563.0m-589.0m : middle neritic

The poorly preserved benthonic foraminiferal assemblages in the interval include *Sphaeroidina bulloides* (rare to frequent), *Siphouvigerina canariensis* (frequent at 563.0m and 573.0m) and *Pullenia bulloides* (few at 573.0m and 589.0m). The interval contains low to moderate numbers of sponge spicules. The calcareous siltstones in the interval are interpreted to have been deposited in a middle neritic environment.

6. 606.0m-644.0m : middle-outer neritic

The interval marks the first downhole appearance of argillaceous carbonates in the well section. Samples at 622.0m, 632.0m, 640.0m and 644.0m are essentially calcareous claystones while the sample at 606.0m is notably less argillaceous. The percentage of planktonics in the interval is relatively high and ranges between 20% and 75%. The benthonic foraminiferal fauna includes the following bathymetrically significant taxa: *Sphaeroidina bulloides* (frequent at 606.0m), *Marssonella* (rare - few from 606.0m to 632.0m), *Hoeglundina elegans* (few at 632.0m) and *Trifarina bradyi* (frequent at 644.0m). Deposition in a middle to outer neritic environment is envisaged for the sediments in the interval.

7. 665.0m-678.0m : outer neritic-upper bathyal

The calcareous claystones in the interval comprise 60-70% planktonics and include the following benthonic foraminiferal taxa: *Marssonella* (rare at 665.0m only), *Ammodiscus* (rare from 665.0m to 672.0m), *Pleurostomella* (rare at 665.0m), *Trifarina bradyi* (frequent to common), *Sphaeroidina bulloides* (frequent), *Eponides subhaidingeri* (frequent), *Eponides praecinctus* (frequent) and *Brizalina* (frequent to abundant). These benthonic foraminiferal species together with the high percentage of planktonics indicate an outer neritic to upper bathyal environment for the calcareous claystones in the interval.

8. 683.0m : middle-outer neritic

The sample at 683.0m comprises an oxidized glauconitic claystone with significant numbers of oxidized and fresh pelletal glauconite grains. The foraminiferal fauna includes a low diversity but high yielding planktonic assemblage which constitutes approximately 40% of the total assemblage. The benthonic foraminiferal assemblage includes frequent *Trifarina bradyi* and *Sphaeroidina bulloides* and is interpreted to reflect a middle to outer neritic depositional environment.

9. 692.0m : inner-middle neritic

The glauconitic calcareous claystone at 692.0m contains a low yielding and low diversity foraminiferal assemblage with benthonics more conspicuous than planktonics which are rare. The benthonic assemblage contains a significantly higher proportion of agglutinates than assemblages higher in the well section. The benthonic foraminiferal fauna includes *Bathysiphon* (few), *Haplophragmoides* (few) and indeterminate agglutinates (frequent). The occurrence of bivalve fragments together with the agglutinated-dominated foraminiferal assemblage indicates that the glauconitic calcareous claystone at 692.0m was deposited in an inner to middle environment.

10. 699.5m-743.5m : indeterminate

The interval is barren of skeletal material with the exception of a single fish tooth remain at 720.0m. The occurrence of glauconite throughout the interval indicates that the Gurnard Formation siliciclastics were deposited in a probable neritic environment.

V DEPOSITIONAL HISTORY

A discussion of the interpreted depositional history of the Seaspray Group in Patricia-1 is given below (refer to Figure No.1). Lithologies are based on rapid visual inspection of the sidewall core material.

1. The age of the Gurnard Formation (693.5m-744m) could not be determined using foraminifera and calcareous nannoplankton. Samples processed for micro-palaeontology comprised variably glauconitic fine grained sandstones, although the deepest sample at 743.5m lacked glauconite and appeared to be a carbonaceous sandy siltstone. With the exception of a single fish tooth remain at 720.0m, the Gurnard Formation was barren of skeletal material. The Gurnard Formation is suspected to have been deposited in a neritic environment on the basis of its pelletal glauconite content.

2. Early Oligocene glauconitic calcareous claystones of the Lakes Entrance Formation (683.5m-693.5m) probably rest disconformably on the Gurnard Formation siliciclastics. A well defined oxidized horizon (693.5m-700.0m) developed at the top of the Gurnard Formation. Sub-aerial weathering of the top of the Gurnard is suspected to have occurred prior to transgression of the inner to middle neritic Lakes Entrance Formation glauconitic calcareous claystone.

3. A well defined disconformity (mid-Oligocene disconformity) is represented at 683.5m, and as in the suspected Lakes Entrance Formation/Gurnard Formation hiatus, is characterized by an oxidized horizon. In Patricia-1 the oxidized horizon at the top of the Lakes Entrance Formation glauconitic calcareous claystone is thin and defined by a gamma ray spike. The oxidized horizon is confirmed by the occurrence of abundant oxidized pelletal glauconite in the sidewall core sample shot just above the horizon at 683.0m. The hiatus between the undifferentiated Late Oligocene Seaspray Group calcareous claystones and the Early Oligocene Lakes Entrance Formation spans approximately 3-5 my. This disconformity represents a widespread event in the Gippsland Basin and may relate to the significant global sea-level fall proposed by Vail *et al.* (1977).

4. Outer neritic-upper bathyal calcareous claystones transgressed over the mid-Oligocene disconformity surface during Late Oligocene time. The basal section of this depositional cycle is rich in pelletal glauconite (as shown in the sidewall core sample at 683.0m) and probably indicates a very starved section (condensed sequence) at the very base of the transgressive event. The Late Oligocene - basal Early Miocene section in Patricia-1 is condensed with depositional rates of 2.5-5m/my. During Zone G time deposition remained low (5-8m/my) with the carbonates becoming less argillaceous with time.

5. A significant increase in deposition rate occurred during Zone F time with mid-neritic relatively clean carbonates accumulating at approximately 50m/my. The deposition rate increased to 100m/my during the Middle Miocene (Zone D time).

6. Channel-fill carbonates are suspected to be represented in the section above 625m in Patricia-1 but have not been addressed in this study because of lack of sample control and integration of all available data. Such a study should integrate biostratigraphic, biofacies, lithofacies, wireline log and seismic data, and be compared with neighbouring well data.

VI REFERENCES

CARTER, A.N., 1964. Tertiary foraminifera from Gippsland, Victoria and their stratigraphic significance. Geol. Surv. Vict., Mem. 23.

EDWARDS, A.R., 1971. A calcareous nannoplankton zonation of the New Zealand Paleogene. In: FARINACCI, A. (Ed). 2nd plank. Conf., Roma 1970., Proc. 1 : 381-419.

JENKINS, D.J., 1960. Planktonic foraminifera from the Lakes Entrance oil shaft, Victoria, Australia. Micropaleontology 6(4) : 345-371.

JENKINS, D.J., 1971. New Zealand Cenozoic foraminifera. N.Z. Geol. Surv. Bull 42 : 278p.

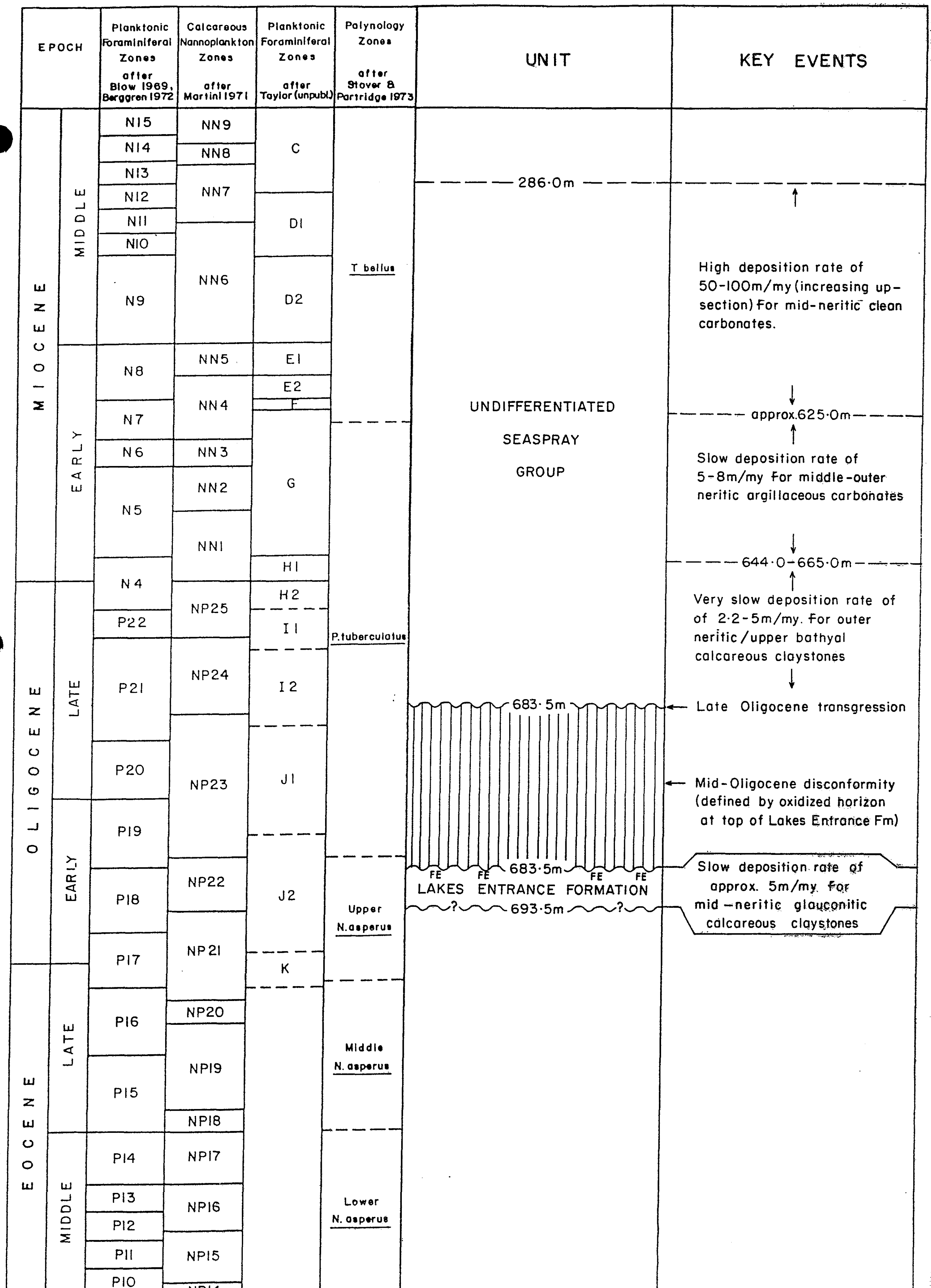
MARTINI, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation. In : FARINACCI, A., (Ed). 2nd plank Conf., Roma 1970., Proc. : 739-785.

PERCH-NIELSEN, K., 1985. Cenozoic calcareous nannofossils. In : BOLLI, H.M., SAUNDERS, J.B., & PERCH-NIELSEN, K. (Editors). Plankton Stratigraphy. Cambridge Univ. Press, Chapter 10 : 427-554.

SIESSER, W.G., 1979. Oligocene-Miocene calcareous nannofossils from the Torquary Basin, Victoria, Australia. Alcheringa, 3 : 159-170.

TAYLOR, D.J., (in prep.). Observed Gippsland biostratigraphic sequences of planktonic foraminiferal assemblages.

VAIL, P.R., MITCHUM, R.M. & THOMPSON, S., 1977. Global cycles of relative changes of sea level. In PAYNTON, C.E. (Editor), Seismic Stratigraphy - applications to Hydrocarbon Exploration. Am. Assoc. Pet. Geol., Mem. 26 : 83-97.



FE = oxidized horizon

FIGURE No.1 : Chronostratigraphic Chart, Seaspray Group, Patricia-1

APPENDIX NO. 1 : Sample list and micropalaeontological data, Patricia-1.

SAMPLE TYPE	DEPTH (mKB)	FORAM YIELD	FORAM PRESERV.	FORAM DIVERSITY	NANNO YIELD	NANNO PRESERV.	NANNO DIVERSITY
SWC	286.0	high	mod/poor	moderate	ns	-	-
SWC	344.0	high	good	high	ns	-	-
SWC	385.0	high	mod/good	mod/high	ns	-	-
SWC	445.0	moderate	moderate	low	ns	-	-
SWC	484.0	high	good	high	ns	-	-
SWC	531.0	high	good	mod/high	ns	-	-
SWC	563.0	high	poor	high	ns	-	-
SWC	573.0	moderate	poor	moderate	ns	-	-
SWC	589.0	mod/high	poor	moderate	ns	-	-
SWC	606.0	high	moderate	mod/high	ns	-	-
SWC	622.0	high	good	high	ns	-	-
SWC	632.0	mod/high	mod/poor	moderate	ns	-	-
SWC	640.0	high	good	high	ns	-	-
SWC	644.0	high	good	high	ns	-	-
SWC	665.0	high	good	high	ns	-	-
SWC	672.0	high	good	high	high	good	moderate
DC	670-675	ns	-	-	high	good	high
SWC	678.0	high	good	high	high	good	moderate
DC	675-680	ns	-	-	high	good	moderate
SWC	683.0	high	moderate	mod/low	high	mod/good	moderate
DC	680-685	ns	-	-	high	good	moderate
DC	685-690	*high	good	low	high	good	moderate
DC	690-695	*high	good	low	high	good	moderate
SWC	692.0	high	mod/good	low	high	good	mod/high
DC	695-700	*mod/high	moderate	low	high	good	mod/high
SWC	699.5	barren	-	-	barren	-	-
SWC	700.3	barren	-	-	barren	-	-
Core	705.0	barren	-	-	barren	-	-
Core	720.0	barren	-	-	barren	-	-
Core	722.0	barren	-	-	barren	-	-
Core	739.8	barren	-	-	barren	-	-
Core	743.5	barren	-	-	barren	-	-

* only planktonics studied ns not studied

PE900463

This is an enclosure indicator page.
The enclosure PE900463 is enclosed within the container PE906239 at this location in this document.

The enclosure PE900463 has the following characteristics:

ITEM_BARCODE =	PE900463
CONTAINER_BARCODE =	PE906239
NAME =	Micropalaeontological Chart
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Micropalaeontological Distribution Chart for Patricia-1
REMARKS =	
DATE_CREATED =	30/09/87
DATE_RECEIVED =	18/01/88
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	REXILIUS STRATIGRAPHIC SERVICES
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA

(Inserted by DNRE - Vic Govt Mines Dept)

PALYNOLOGY REPORT

PALYNOLOGY REPORT

APPENDIX XII

PALYNOLOGICAL REPORT

PALYNOLOGY REPORT

Patricia No.1, 672m - 880m, Gippsland Basin

by

Mary E. Dettmann

Prepared for: October, 1987

LASMO ENERGY AUSTRALIA LTD.

SAMPLE			SOURCE POTENTIAL				OIL SOURCE POTENTIAL				MATURATION					BIOSTRAT.	AGE	DEPOSITIONAL ENVIRONMENT			
type	depth	lithol.	low	mod.	high	v.high	poor	ltd.	fair	good	IM	EM	M	LM	OM			terr.	par.	m.mar.	mar.
swc	672	sst.		*					*		*					n.o.U. P. tuberc.	Mioc.				*
swc	683	sst.	*						*		*					n.o. U N. asperus	n.o.Eoc.				*
swc	692	sst.			*				*		*					n.o. U N asperus	n.o.Eoc.				*
core	705	slst.			*			*			*					M. N. asperus	m/l Eoc.			*	
core	720	slst.	*					*			*					L. N. asperus	m. Eoc.			*	
core	722	slst.		*				*			*					L. N. asperus	m. Eoc.			*	
core	739.8	slst.	*					*			*					L. N. asperus	m. Eoc.			*	
core	743.5	shl.			*			*			*					P. asperopolus	e/m Eoc.	*			
swc	769	shl	Not a source rock													Not determined					
swc	786.5	sst.	Not a source rock													Not determined					
swc	821	shl.		*				*				*				P. pannosus	l. Alb.	*			
swc	880	shl.	*				*					*				P. pannosus	l. Alb.	*			

KEROGEN YIELD: 0.8 1.2 2.4 (ml/10gm)

%H-RICH KEROGEN: 20 60 80

SPORE COLOUR/ TAI VALUE: GY Y A Br Bl; 1.8 2.2 2.5 3.0

TABLE 1. Summary of palynological results showing inferred hydrocarbon source potential, oil source potential, maturation, age, and palaeoenvironments of sediments between 672m and 880m in Patricia No.1.

SUMMARY

The following conclusions are drawn from a palynological examination of sediments between 672m and 880m in Patricia No.1, Gippsland Basin.

Depth(m)	Palynostratigraphy	Age	Environments
672	n.o. Upper P. tuberculatus	n.o.early Miocene	marine
683	n.o. Upper N. asperus	n.o.late Eocene	marine
692	n.o. Upper N. asperus	n.o.late Eocene	marine
705	Middle N. asperus/L. extensa	mid/late Eocene	marginal marine
720	Lower N. asperus/D. heterophylcta	mid Eocene	marginal marine
722	Lower N. asperus	mid Eocene	marginal marine
739.5	Lower N. asperus/D. heterophylcta	mid Eocene	marginal marine
743.5	P. asperopolus	early/mid Eocene	terrestrial
769	unassigned	-	-
786.5	unassigned	-	-
821	P. pannosus	late Albian	terrestrial
880	P. pannosus	late Albian	terrestrial

The palynological evidence indicates that the Latrobe Group includes sediments of early/mid to mid/late Eocene age; productive sediments investigated from the underlying Strzelecki Group are of late Albian age. Dating of the Lakes Entrance Formation is constrained by restricted palynofloras, but confirms that sediments at 672m are no older than early Miocene.

Source Rock Potential

Depth(m)	Kerogen Yield	Kerogen Type	Maturity	(TAI)
672	moderate	fair liquid potential	immature	(1.5)
683	low	fair liquid potential	immature	(1.5)
692	high	limited liquid potential	immature	(1.5)
705	high	limited liquid potential	immature	(1.6)
720	low	limited liquid potential	immature	(1.6)
722	moderate	limited liquid potential	immature	(1.6)
739.8	low	limited liquid potential	immature	(1.6)
743.5	high	limited liquid potential	immature	(1.6)
769	-	poor source rock	-	-
786.5	-	poor source rock	-	-
821	moderate	limited liquid pot.	early mature	(2.0)
880	low	gas prone	early mature	(2.0)

INTRODUCTION

Sidewall and conventional core samples from between 672m and 880m in Patricia No.1, Gippsland Basin have been palynologically analysed to ascertain the age and biostratigraphic relationships of the sediments and to assess the palaeoenvironmental significance and maturation levels of the enclosed organic matter.

Preparation of the samples follows Phipps and Playford (1984). Additionally kerogen slides were made from the unoxidised fractions of the residues and the volume of organic matter per 10 gm of sediment was assessed. Organic residues were recovered from all but two of the samples (769m, 786.5m); the remainder yielded low to high volumes of organic matter in which are represented spores, pollen and algal microfossils. Conclusions drawn from the study are summarised in Table 1. Species distributions are documented in Table 2 and source rock/maturation data as determined palynologically are shown in Table 3.

BIOSTRATIGRAPHY AND AGE

Productive samples examined contain palynomorph assemblages of late Early Cretaceous and early-mid Tertiary ages. Biostratigraphic evaluation of the sequence is in terms of the Cretaceous spore-pollen zones of Dettmann & Playford (1969, see also Helby, Morgan and Partridge 1987) and the Tertiary spore-pollen zones of Stover & Evans (1973) and Stover & Partridge (1973). The Australian Tertiary dinoflagellate sequence awaits detailed documentation, but Partridge (1976) provided a summary account of zones delineable in the Gippsland Basin. These are employed herein.

1. 672m; n.o. Upper P. tuberculatus Zone, n.o. early Miocene

The sample yielded a sparse spore-pollen assemblage in which Acacia pollen (Acaciaepollenites myriosporites) and Foveosporites lacunosus are represented and which indicate assignment as designated above and an age no older than early Miocene.
Dinocysts occur more frequently than do land plant palynomorphs and comprise a restricted assemblage supportive of a Miocene dating. As discussed by Truswell, Sluiter & Harris (1985) Australian mid Tertiary dinocyst assemblages have received little attention in the literature subsequent to the work of Deflandre & Cookson (1955) and further work is necessary to resolve a detailed dinocyst-based biostratigraphy.

2. 683m, 692m; n.o. Upper N. asperus Zone, n.o. mid-late Eocene

The sparse spore-pollen assemblages include Nothofagidites asperus and Proteacidites tuberculatus (692m only), thereby indicating an age no older than mid-late Eocene. The dinocysts suites are similar to that from 672m and a Miocene dating appears likely.

3. <u>705m</u>; Middle N. asperus Zone/ L. extensa Zone, mid-late Eocene

The moderately diverse spore-pollen assemblage is dominated by Nothofagidites and is consistent with those of the lower and middle portions of the N. asperus Zone as delineated in the Gippsland Basin. Stratigraphically significant species represented include Nothofagidites asperus and Proteacidites pachypolus. Dinocysts occur infrequently. Taxa represented include Lentonia extensa and Deflandrea heterophylcta, the former is the nominate species of the L. extensa Zone that Partridge (1976) equates to the Middle N. asperus Zone.

4. <u>720m - 739.5m</u>; Lower N. asperus Zone/ D. heterophylcta Zone, middle Eocene

All three samples provided abundant and diverse spore pollen assemblages in which Nothofagidites occurs abundantly and Haloragacidites harrisii commonly. The presence of Nothofagidites asperus together with Proteacidites pachypolus, P. asperopolus, Tricolpites thomasii and Tricolpites simatus confirm reference to the Lower N. asperus Zone. Dinoflagellates and prasinophycean/chlorophycean microfossils occur in all samples. The dinocysts assemblages are comparable to those reported from the middle Eocene and referable to the D. heterophylcta Zone.

5. 743.5m; P. asperopolus Zone, early-middle Eocene

Taxonomically diverse spores and pollen together with abundant cuticular material occurs in the organic residue extracted from the sample. Amongst the spore-pollen palynomorphs are represented common Haloragacidites harrisii together with frequent Proteacidites pachypolus, P. asperopolus, and Sapotaceoidaepollenites rotundus suggesting attribution to the P. asperopolus Zone. Also represented are species indicative of older zones (e.g. T. longus and L. balmei) and it seems likely that these have been recycled from latest Cretaceous - Paleocene sequences. Species that fall into this category include Gambierina edwardsii, G. rudata, Triporopollenites sectilis and Lygistepollenites balmei.

6. 769m, 786.5m; unassigned

No palynomorphs or organic matter was extracted from the samples.

7. 821m, 880m; P. pannosus Zone, late Albian

Both samples provided moderately diverse palynomorph assemblages in which spores and pollen occur abundantly. The presence of Phimopollenites pannosus together with Interlobites intraverrucatus, Coptospora paradoxa, Perotriletes laceratus, and Foraminisporis asymmetricus clearly indicates attribution to the P. pannosus Zone.

Algal microfossils occur in the samples, but forms represented are not biostratigraphically definitive with respect to the Early and mid Cretaceous.

PALAEOENVIRONMENTAL INFERENCES

Observations from both the kerogen preparations and the palynological strew slides are discussed in terms of their palaeoenvironmental significance.

1. 672m - 692m; n.o. late Eocene (including Miocene)

Organic matter extracted from the samples is dominantly of algal origin and includes dinocysts together with sapropelic detritus. The character of the dinocyst assemblages, the low input of terrestrial detritus, and the representation of linings of foraminiferal tests suggest deposition in marine situations.

2. 705m - 739.5m; middle-late Eocene

Plentiful terrestrial organic matter occurs in the residues in which less abundant algal detritus is also represented. The land plant palynomorphs suggest a contemporaneous vegetation of temperate and subtropical rainforest and fringing communities including podocarpaceous gymnosperms, *Nothofagus*, Proteaceae, Myrtaceae and Casuarinaceae. Frequent fungal palynomorphs are represented by spores, hyphae, and fruiting bodies; these are relics of fungal attack of litter and other vegetable matter. Algal assemblages include both dinocysts and chlorophycean/

prasinophycean types and are consistent with close-to-land deposition in marine influenced environments.

3. 743.5m; early-middle Eocene

Abundant organic matter extracted from the sample is almost entirely of land plant origin. It includes significant proportions of leaf and other cuticles, many of which bear evidence of considerable fungal degradation. The spore pollen assemblage reflects a vegetation of rainforest and mangrove communities consistent with warm temperate to tropical habitats. Algal microfossils occur rarely; they include freshwater chlorophycean forms.

The presence of recycled palynomorphs of latest Cretaceous-Paleocene age suggest that sediments at 743.5m were sourced, at least in part, from latest Cretaxceous - Paleocene sequences.

4. 769m, 786.5m; unassigned

The absence of palynomorphs and other organic debris precludes environmental inferences to be drawn of palynological grounds.

5. 821m, 880m; late Albian

Organic matter extracted from both samples is dominantly of land plant origin. The source of this detritus included rainforest and swamp communities of gymnosperms, ferns, lycopods and bryophytes.

Represented in the upper sample (821m) is a varied assemblage of freshwater chlorophycean algal cysts together with derivatives of aquatic ferns and liverworts. Deposition in a low energy swamp situation is indicated. Palynomorphs in the lower sample (880m) suggest that organic matter was largely sourced from dry land vegetation communities and deposited in a fluvial/ lacustrine situation.

SOURCE ROCK POTENTIAL

1. 672m - 692m; n.o. late Eocene (including Miocene)

The low to high yields of organic matter extracted from the samples include high proportions of algal kerogens and have fair potential to source liquids when mature. Spore colouration, however, indicates that the sediments are immature with respect to the main oil generation zone.

2. 705m - 743.5m; early-late Eocene

The low to high yields of organic matter are dominantly of land plant detritus and include sufficient proportions of lipid-rich macerals for sourcing limited volumes of liquid hydrocarbons when mature. Organic matter is immature as revealed by the greenish yellow colouration of the spores (TAI 1.6).

3. <u>769m, 786.5m</u>; unassigned

The two samples investigated failed to yield organic matter and are not considered likely source rocks.

4. <u>821m, 880m</u>; late Albian

A moderate yield of organic matter was obtained from the upper sample; this includes sufficient proportions of hydrogen rich macerals to support limited petroleum generation. Organic matter of the lower sample consists mainly of opaque detritus that is gas prone. Organic matter of both samples is early mature as suggested by the yellowish amber colouration of the spore (TAI 2.0).

REFERENCES

DEFLANDRE, G. & COOKSON, I.C. 1955. Fossil microplankton from Australian Late Mesozoic and Tertiary sediments. Aust. J. Mar. Freshw. Res. 6, 292-313.

DETTMANN, M.E. & PLAYFORD, G. 1969. Palynology of the Australian Cretaceous: a review. In Stratigraphy and Palaeontology: essays in honour of Dorothy Hill (ed. K.S.W. Campbell) ANU press, Canberra, 174-210.

HELBY, R.J., MORGAN, R., & PARTRIDGE, A.D. 1987. A palynological zonation for the Australian Mesozoic. Mem. Assoc. Australas. Palaeontols. 4, 1-94.

PARTRIDGE, A.D. 1976. The geological expression of eustacy in ther early Tertiary of the Gippsland Basin. APEA Jl. 16, 73-79.

PHIPPS, D. & PLAYFORD, G. 1984. Laboratory techniques for extraction of palynomorphs from sediments. Pap. Dept. Geol. Univ. Qd. 11, 1-23.

STOVER, L. & EVANS, P.R. 1973. Upper Cretaceous-Eocene spore pollen zonation, offshore Gippsland Basin, Australia. Spec. Publs. Geol. Soc. Aust. 4, 55-72.

STOVER, L. & PARTRIDGE, A.D. 1973. Tertiary and Late Cretaceous spores and pollen from the Gippsland Basin, southeastern Australia. Poc. Roy. Soc. Vict. 85, 237-286.

TRUSWELL, E..M., SLUITER, I.R. & HARRIS, W.K. 1985. Palynology of the Oligocene-Miocene in the Oakville-1 corehole, western Murray Basin, South Australia. BMR Jl. Aust. Geol. Geophys. 9, 267-295.

Mary E. Dettmann
Department of Botany
University of Queensland
St. Lucia, Qld. 4067.

7 October, 1987

TABLE 2 PALYNOMORPH DISTRIBUTION

COMPANY: LASMO ENERGY AUSTRALIA LTD. Sheet 1 of 5

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S				
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672				
CRYPTOGAM MICROSPORES:																
Contignisporites glebulentus	+															
Dictyophyllidites pectinataeformis	+	+														
Perotrilites laceratus	+															
Dictyophyllidites crenatus	+															
Cicatricosisporites australiensis	+	+														
Crybelosporites striatus	+	+														
Interlobites intraverrucatus	+															
Biretisporites cf. potoniae	+															
Retitriletes austroclavatidites	+	+														
Retitriletes eminulus	+									+						
Retitriletes clavatoides	+															
Cyathidites australis/minor	+	+			+	+	+	+	+	+	+	+				
Baculatisporites comaumensis	+	+							+	+						
Ceratosporites equalis	+															
Gleicheniidites circinidites	+	+				+		+	+	+						
Stereisporites antiquasporites	+	+				+	+	+		+						
Velosporites triquetrus	+															
Stereisporites pocockii	+	+														
Leptolepidites major	+															
Triporoletes reticulatus	+	+														
Triporoletes involucratus	+	+														
Aequitriradites verrucosus	+	+														
Foveosporites moretonensis	+	+														
Stoverisporites microverrucatus	+															
Laevigatosporites ovatus	+				+			+	+			+				
Aequitriradites spinulosus		+														
Triporoletes radiatus		+														
Cyathidites punctatus		+														
Coptospora paradoxa		+														
Foraminisporis asymmetricus		+														
Foraminisporis dailyi		+														
Antulsporites varigranulatus		+														
Kuylisporites waterbolkii					+			+								
Rugulatisporites mallatus					+		+	+								

Sample type: S = Sidewall core; C = Conventional core;
D = Cuttings.

TABLE 2 PALYNOMORPH DISTRIBUTION

COMPANY: LASMO ENERGY AUSTRALIA LTD. Sheet 2 of 5

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S				
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672				
Laevigatosporites major					+	+	+									
Peromonolites vellosus					+	+										
Clavifera triplex						+										
Stereisporites (Tripunctisporis) sp.						+			+							
Verrucosisporites kopukiensis						+	+									
Verrucatosporites speciosus						+	+	+								
Polypodiaceoisporites tumulatus							+									
Ischyosporites gremius							+	+		+	+					
Peromonolites densus									+							
Microfoveolatosporis sp.									+							
Foveotriletes balteus									+							
Foveotriletes palaequetrus											+					
Foveosporites lacunosus												+				
CRYPTOGAM MEGASPORES:																
Balmeisporites holodictyus		+														
Arcellites reticulatus		+														
Minerisporites marginatus		+														
GYMNOSPERMOUS POLLEN:																
Classopollis chateaunovii	+	+														
Alisporites grandis	+	+														
Alisporites similis	+	+														
Araucariacites australis	+	+				+	+		+	+	+	+				
Cycadopites nitidus	+	+														
Trichotomosulcites subgranulatus	+	+						+	+	+						
Microcachryidites antarcticus	+	+				+		+	+	+						
Vitreisporites pallidus		+														
Podocarpidites ellipticus		+			+	+	+	+	+	+	+	+				
Lygistepollenites balmei					+											
Phyllocladidites mawsonii						+	+	+		+		+				
Lygistepollenites florinii						+	+		+	+	+					
Dilwynites granulatus						+	+	+	+							
Dacrycarpites australensis							+									
ANGIOSPERMOUS POLLEN:																
Clavatipollenites hughesii	+	+														
Phimopollenites pannosus	+	+														

Sample type: S = Sidewall core; C = Conventional core;
D = Cuttings.

TABLE 2 PALYNOMORPH DISTRIBUTION

COMPANY: LASMO ENERGY AUSTRALIA LTD.

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672
Rousea georgensis		+										
Proteacidites beddoesii					+							
Proteacidites asperopolus					+	+						
Proteacidites pachypolus					+	+	+	+	+			
Proteacidites subscabratus					+		+	+	+			
Proteacidites kopiensis					+	+	+					
Propylipollis latrobensis					+							
Propylipollis tripartitus					+	+						
Propylipollis annularis					+	+	+	+	+	+		
Spinozonocolpites prominatus					+	+						
Triporopollenites ambiguus					+		+	+	+			
Schizocolpus marlinensis					+							
Anacolosidites acutulus					+							
Malvacipollis diversus					+							
Margocolporites sp.					+		+					
Gambierina edwardsii					+							
Gambierina rudata					+							
Haloragicidites harrisii					+	+	+	+	+	+	+	+
Triporopollenites sectilis					+							
Tricolporites scabratus					+	+	+					
Cupanieidites orthoteichus					+	+	+	+	+			
Banksieaeidites elongatus					+							
Rhoipites microreticulatus					+			+				
Tricolporites prolata					+			+				+
Sapotaceoidapollenites rotundus					+							
Tricolpites confessus					+							
Nothofagidites emarcidus					+	+	+	+	+	+	+	+
Nothofagidites flemingii					+	+	+	+	+		+	
Nothofagidites brachyspinulosus					+	+			+	+	+	
Nothofagidites heterus					+	+	+	+	+	+		+
Gothanipollis bassensis						+			+			
Tricolpites reticulatus						+						
Nothofagidites asperus						+	+	+	+	+	+	+
Nothofagidites goniatus						+			+			
Anacolosidites luteoides						+						

Sample type: S = Sidewall core; C = Conventional core; D = Cuttings.

PALYNOMORPH DISTRIBUTION

COMPANY: LASMO ENERGY AUSTRALIA LTD. Sheet 4 of 5

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672
Tricolpites simatus						+		+				
Ericipites crassiexinus						+	+	+				
Santalumidites cainozoicus						+	+	+				
Ilexpollenites anguloclavatus						+	+			+		
Myrtaceidites eugeniioides						+	+	+				
Nothofagidites incrassatus						+	+	+	+	+		+
Nothofagidites deminutus						+	+	+	+	+		
Nothofagidites vansteenisii						+		+		+		
Periporollenites demarcatus						+	+	+	+	+		
Banksieaeidites arcuatus						+						
Proteacidites tuberculiformis						+						
Graminiidites sp.						?						+
Proteacidites reflexus						+						
Proteacidites recavus							+					
Triorites psilatus							+	+				
Sparganiaceaepollenites sp.							+	+				
Malvacipollis subtilis							+	+				
Helciporites astrus							+					
Propylipollis crassipora							+		+			
Propylipollis reticuloscabratus							+		+	+		
Liliacidites lanceolatus							+					
Nothofagidites falcatus								+	+	+		+
Tricolpites thomasii								+				
Concolpites leptos								+				
Proteacidites granoratus								+				
Proteacidites incurvatus								+	+			
Proteacidites crassus								+				
Proteacidites adenanthoides								+	+			
Tricolporites leuros									+			
Beaupreaidites elegansiformis									+			
Myrtaceidites parvus										+	+	+
Proteacidites rectomarginus										+		
Proteacidites tuberculatus										+		
Periporopollenites vesicus											+	
Acaciaeopollenites myriosporites												+

Sample type: S = Sidewall core; C = Conventional core;
D = Cuttings.

TABLE 2 PALYNOMORPH DISTRIBUTION

COMPANY: LASMO ENERGY AUSTRALIA LTD.

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672
FUNGAL MICROFOSSILS:												
Spore, fruiting bodies and hyphae	+	+			+	+	+	+	+	+		
ALGAL MICROFOSSILS:												
Sigmopollis cf. carbonis	+	+										
Sigmopollis sp.	+											
Schizosporis reticulatus		+										
Schizophacus spriggii		+			+							
Schizophacus rugulatus		+										
Botryococcus sp.						+						
Spiniferites ramosus						+				+		+
Deflandrea heterophylcta						+	+		+			
Eisenackia crassitabulata						+		+				
Spinidinium essoi						+						
Operculodinium sp.						+	+			+		
Oligosphaeridium sp.						+		+			+	
Paralecaniella indentata						+	+		+			
Impagidinium dispertitum							+	+				
Impagidinium victorianum								+				
Pallambages sp.								+				
Horologinella sp.								+				
Hemiplacaphora semilunifera								+				
Schematophora speciosa								+				
Deflandrea phosphoritica									+			
Lentina extensa									+			
Lecaniella sp.									+			
Areosphaeridium capricornum									+			
Systemophora ancryea									+			
Systemaphora placacantha										+	+	
Lingulodinium machaerophorum										+	+	+
Spiniferites bulloidea										+	+	+
Spiniferites cingulata											+	
Operculodinium centrocarpum											+	+
Hystrichokolpoma stellatum												+

Sample type: S = Sidewall core; C = Conventional core; D = Cuttings.

SAMPLE	DEPTH (m)	LITHOLOGY	ORGANIC MATTER																
			AMOUNT (ml/ 10gm)	TYPE (% composition)													MATURITY		
				Alginite			Sporin./Cutin.					Humic		Vitr.					
				Dispersed	Dense	Algal cysts	Fine (<10µm)	Spores	Leaf tissue	Other	Woody tissue	<20µm	>20µm	<20µm	>20µm	Inertinite	Spore Colour	T.A.I. (after Staplin 1982)	Interpreted Maturity Level
swc	672	sst., f.gr med. grey	1.2	30	40	5	–	+	–	–	–	+	5	+	10	10	greenish yellow	1.5	immature
swc	683	sst., f.gr med. grey	0.7	30	35	10	–	+	–	+	–	–	10	+	10	5	greenish yellow	1.5	immature
swc	692	sst. m. gr & slt.	1.5	30	10	5	–	+	+	5	–	–	20	5	20	5	greenish yellow	1.5	immature
core	705	slst., dk. grey	1.5	20	5	+	–	+	+	5	+	20	30	5	5	10	greenish yellow	1.6	immature
core	720	slst., dk. grey	0.8	15	–	+	10	5	+	15	+	10	20	5	20	+	greenish yellow	1.6	immature
core	722	slst., dk. grey	0.9	15	–	+	10	5	5	10	+	15	30	+	10	+	greenish yellow	1.6	immature
core	739.8	slst., dk. grey	0.5	5	5	+	10	5	+	10	+	+	50	5	10	+	greenish yellow	1.6	immature
core	743.5	shl., med. grey	2.0	–	–	+	10	5	10	30	+	+	30	5	5	5	greenish yellow	1.6	immature

TABLE 3. Organic matter, Patricia No.1, 672m - 880m. (contd.)

SAMPLE	DEPTH (m)	LITHOLOGY	ORGANIC MATTER																
			AMOUNT (ml/ 10gm)	TYPE (% composition)													MATURITY		
				Alginite			Sporin./Cutin.					Humic		Vitr.					
				Dispersed	Dense	Algal cysts	Fine (<10µm)	Spores	Leaf tissue	Other	Woody tissue	<20µm	>20µm	<20µm	>20µm	Inertinite	Spore Colour	T.A.I. (after Staplin 1982)	Interpreted Maturity Level
swc	769	white shl.	-	No recovery													-		
swc	786.5	sst., f.gr., white	-	No recovery													-		
swc	821	shl., dk. grey	1.0	-	-	+	10	20	10	10	+	-	25	5	10	10	yellowish amber	2.0	early mature
swc	880	shl., med. grey	0.6	-	-	+	-	15	-	-	-	-	-	30	45	10	yellowish amber	2.0	early mature

TABLE 3 (contd.). Organic matter, Patricia No.1, 672m - 880m.

APPENDIX XII

PALYNOLOGICAL REPORT

PALYNOLOGY REPORT

Patricia No.1, 672m - 880m, Gippsland Basin

by

Mary E. Dettmann

Prepared for:

LASMO ENERGY AUSTRALIA LTD.

October, 1987

SAMPLE			SOURCE POTENTIAL				OIL SOURCE POTENTIAL				MATURATION					BIOSTRAT.	AGE	DEPOSITIONAL ENVIRONMENT			
type	depth	lithol.	low	mod.	high	v.high	poor	ltd.	fair	good	IM	EM	M	LM	OM			terr.	par.	m.mar.	mar.
swc	672	sst.		*					*		*					n.o.U. P. tuberc.	Mioc				*
swc	683	sst.	*						*		*					n.o. U N. asperus	n.o.Eoc.				*
swc	692	sst.			*				*		*					n.o. U N asperus	n.o.Eoc.				*
core	705	slst.			*			*			*					M. N. asperus	m/l Eoc.			*	
core	720	slst.	*					*			*					L. N. asperus	m. Eoc.			*	
core	722	slst.		*				*			*					L. N. asperus	m. Eoc.			*	
core	739.8	slst.	*					*			*					L. N. asperus	m. Eoc.			*	
core	743.5	shl.			*			*			*					P. asperopolus	e/m Eoc.	*			
swc	769	shl	Not a source rock													Not determined					
swc	786.5	sst.	Not a source rock													Not determined					
swc	821	shl.		*				*				*				P. pannosus	l. Alb.	*			
swc	880	shl.	*				*					*				P. pannosus	l. Alb.	*			
			0.8	1.2	2.4		20	60	80		GY 1.8	Y 2.2	A 2.5	Br 3.0	Bl						
			(ml/10gm) KEROGEN YIELD				%H-RICH KEROGEN				SPORE COLOUR/ TAI VALUE										

TABLE 1. Summary of palynological results showing inferred hydrocarbon source potential, oil source potential, maturation, age, and palaeoenvironments of sediments between 672m and 880m in Patricia No.1.

SUMMARY

The following conclusions are drawn from a palynological examination of sediments between 672m and 880m in Patricia No.1, Gippsland Basin.

Depth(m)	Palynostratigraphy	Age	Environments
672	n.o. Upper P. tuberculatus	n.o.early Miocene	marine
683	n.o. Upper N. asperus	n.o.late Eocene	marine
692	n.o. Upper N. asperus	n.o.late Eocene	marine
705	Middle N. asperus/L. extensa	mid/late Eocene	marginal marine
720	Lower N. asperus/D. heterophylcta	mid Eocene	marginal marine
722	Lower N. asperus	mid Eocene	marginal marine
739.5	Lower N. asperus/D. heterophylcta	mid Eocene	marginal marine
743.5	P. asperopolus	early/mid Eocene	terrestrial
769	unassigned	-	-
786.5	unassigned	-	-
821	P. pannosus	late Albian	terrestrial
880	P. pannosus	late Albian	terrestrial

The palynological evidence indicates that the Latrobe Group includes sediments of early/mid to mid/late Eocene age; productive sediments investigated from the underlying Strzelecki Group are of late Albian age. Dating of the Lakes Entrance Formation is constrained by restricted palynofloras, but confirms that sediments at 672m are no older than early Miocene.

Source Rock Potential

Depth(m)	Kerogen Yield	Kerogen Type	Maturity	(TAI)
672	moderate	fair liquid potential	immature	(1.5)
683	low	fair liquid potential	immature	(1.5)
692	high	limited liquid potential	immature	(1.5)
705	high	limited liquid potential	immature	(1.6)
720	low	limited liquid potential	immature	(1.6)
722	moderate	limited liquid potential	immature	(1.6)
739.8	low	limited liquid potential	immature	(1.6)
743.5	high	limited liquid potential	immature	(1.6)
769	-	poor source rock	-	-
786.5	-	poor source rock	-	-
821	moderate	limited liquid pot.	early mature	(2.0)
880	low	gas prone	early mature	(2.0)

INTRODUCTION

Sidewall and conventional core samples from between 672m and 880m in Patricia No.1, Gippsland Basin have been palynologically analysed to ascertain the age and biostratigraphic relationships of the sediments and to assess the palaeoenvironmental significance and maturation levels of the enclosed organic matter.

Preparation of the samples follows Phipps and Playford (1984). Additionally kerogen slides were made from the unoxidised fractions of the residues and the volume of organic matter per 10 gm of sediment was assessed. Organic residues were recovered from all but two of the samples (769m, 786.5m); the remainder yielded low to high volumes of organic matter in which are represented spores, pollen and algal microfossils. Conclusions drawn from the study are summarised in Table 1. Species distributions are documented in Table 2 and source rock/maturation data as determined palynologically are shown in Table 3.

BIOSTRATIGRAPHY AND AGE

Productive samples examined contain palynomorph assemblages of late Early Cretaceous and early-mid Tertiary ages. Biostratigraphic evaluation of the sequence is in terms of the Cretaceous spore-pollen zones of Dettmann & Playford (1969, see also Helby, Morgan and Partridge 1987) and the Tertiary spore-pollen zones of Stover & Evans (1973) and Stover & Partridge (1973). The Australian Tertiary dinoflagellate sequence awaits detailed documentation, but Partridge (1976) provided a summary account of zones delineable in the Gippsland Basin. These are employed herein.

1. 672m; n.o. Upper P. tuberculatus Zone, n.o. early Miocene

The sample yielded a sparse spore-pollen assemblage in which *Acacia* pollen (*Acaciaepollenites myriosporites*) and *Foveosporites lacunosus* are represented and which indicate assignment as designated above and an age no older than early Miocene.

Dinocysts occur more frequently than do land plant palynomorphs and comprise a restricted assemblage supportive of a Miocene dating. As discussed by Truswell, Sluiter & Harris (1985) Australian mid Tertiary dinocyst assemblages have received little attention in the literature subsequent to the work of Deflandre & Cookson (1955) and further work is necessary to resolve a detailed dinocyst-based biostratigraphy.

2. 683m, 692m; n.o. Upper N. asperus Zone, n.o. mid-late Eocene

The sparse spore-pollen assemblages include *Nothofagidites asperus* and *Proteacidites tuberculatus* (692m only), thereby indicating an age no older than mid-late Eocene. The dinocysts suites are similar to that from 672m and a Miocene dating appears likely.

3. 705m; Middle N. asperus Zone/ L. extensa Zone, mid-late Eocene

The moderately diverse spore-pollen assemblage is dominated by Nothofagidites and is consistent with those of the lower and middle portions of the N. asperus Zone as delineated in the Gippsland Basin. Stratigraphically significant species represented include Nothofagidites asperus and Proteacidites pachypolus. Dinocysts occur infrequently. Taxa represented include Lentonia extensa and Deflandrea heterophylcta, the former is the nominate species of the L. extensa Zone that Partridge (1976) equates to the Middle N. asperus Zone.

4. 720m - 739.5m; Lower N. asperus Zone/ D. heterophylcta Zone, middle Eocene

All three samples provided abundant and diverse spore pollen assemblages in which Nothofagidites occurs abundantly and Haloragacidites harrisii commonly. The presence of Nothofagidites asperus together with Proteacidites pachypolus, P. asperopolus, Tricolpites thomasii and Tricolpites simatus confirm reference to the Lower N. asperus Zone. Dinoflagellates and prasinophycean/chlorophycean microfossils occur in all samples. The dinocysts assemblages are comparable to those reported from the middle Eocene and referable to the D. heterophylcta Zone.

5. 743.5m; P. asperopolus Zone, early-middle Eocene

Taxonomically diverse spores and pollen together with abundant cuticular material occurs in the organic residue extracted from the sample. Amongst the spore-pollen palynomorphs are represented common Haloragacidites harrisii together with frequent Proteacidites pachypolus, P. asperopolus, and Sapotaceoidaepollenites rotundus suggesting attribution to the P. asperopolus Zone. Also represented are species indicative of older zones (e.g. T. longus and L. balmei) and it seems likely that these have been recycled from latest Cretaceous - Paleocene sequences. Species that fall into this category include Gambierina edwardsii, G. rudata, Triporopollenites sectilis and Lygistepollenites balmei.

6. 769m, 786.5m; unassigned

No palynomorphs or organic matter was extracted from the samples.

7. 821m, 880m; P. pannosus Zone, late Albian

Both samples provided moderately diverse palynomorph assemblages in which spores and pollen occur abundantly. The presence of Phimopollenites pannosus together with Interlobites intraverrucatus, Coptospora paradoxa, Perotriletes laceratus, and Foraminisporis asymmetricus clearly indicates attribution to the P. pannosus Zone.

Algal microfossils occur in the samples, but forms represented are not biostratigraphically definitive with respect to the Early and mid Cretaceous.

PALAEOENVIRONMENTAL INFERENCES

Observations from both the kerogen preparations and the palynological strew slides are discussed in terms of their palaeoenvironmental significance.

1. 672m - 692m; n.o. late Eocene (including Miocene)

Organic matter extracted from the samples is dominantly of algal origin and includes dinocysts together with sapropelic detritus. The character of the dinocyst assemblages, the low input of terrestrial detritus, and the representation of linings of foraminiferal tests suggest deposition in marine situations.

2. 705m - 739.5m; middle-late Eocene

Plentiful terrestrial organic matter occurs in the residues in which less abundant algal detritus is also represented. The land plant palynomorphs suggest a contemporaneous vegetation of temperate and subtropical rainforest and fringing communities including podocarpaceous gymnosperms, *Nothofagus*, Proteaceae, Myrtaceae and Casuarinaceae. Frequent fungal palynomorphs are represented by spores, hyphae, and fruiting bodies; these are relics of fungal attack of litter and other vegetable matter. Algal assemblages include both dinocysts and chlorophycean/

prasinophycean types and are consistent with close-to-land deposition in marine influenced environments.

3. 743.5m; early-middle Eocene

Abundant organic matter extracted from the sample is almost entirely of land plant origin. It includes significant proportions of leaf and other cuticles, many of which bear evidence of considerable fungal degradation. The spore pollen assemblage reflects a vegetation of rainforest and mangrove communities consistent with warm temperate to tropical habitats. Algal microfossils occur rarely; they include freshwater chlorophycean forms.

The presence of recycled palynomorphs of latest Cretaceous-Paleocene age suggest that sediments at 743.5m were sourced, at least in part, from latest Cretaxceous - Paleocene sequences.

4. 769m, 786.5m; unassigned

The absence of palynomorphs and other organic debris precludes environmental inferences to be drawn of palynological grounds.

5. 821m, 880m; late Albian

Organic matter extracted from both samples is dominantly of land plant origin. The source of this detritus included rainforest and swamp communities of gymnosperms, ferns, lycopods and bryophytes.

Represented in the upper sample (821m) is a varied assemblage of freshwater chlorophycean algal cysts together with derivatives of aquatic ferns and liverworts. Deposition in a low energy swamp situation is indicated. Palynomorphs in the lower sample (880m) suggest that organic matter was largely sourced from dry land vegetation communities and deposited in a fluvial/ lacustrine situation.

SOURCE ROCK POTENTIAL

1. 672m - 692m; n.o. late Eocene (including Miocene)

The low to high yields of organic matter extracted from the samples include high proportions of algal kerogens and have fair potential to source liquids when mature. Spore colouration, however, indicates that the sediments are immature with respect to the main oil generation zone.

2. 705m - 743.5m; early-late Eocene

The low to high yields of organic matter are dominantly of land plant detritus and include sufficient proportions of lipid-rich macerals for sourcing limited volumes of liquid hydrocarbons when mature. Organic matter is immature as revealed by the greenish yellow colouration of the spores (TAI 1.6).

3. 769m, 786.5m; unassigned

The two samples investigated failed to yield organic matter and are not considered likely source rocks.

4. 821m, 880m; late Albian

A moderate yield of organic matter was obtained from the upper sample; this includes sufficient proportions of hydrogen rich macerals to support limited petroleum generation. Organic matter of the lower sample consists mainly of opaque detritus that is gas prone. Organic matter of both samples is early mature as suggested by the yellowish amber colouration of the spore (TAI 2.0).

REFERENCES

DEFLANDRE, G. & COOKSON, I.C. 1955. Fossil microplankton from Australian Late Mesozoic and Tertiary sediments. Aust. J. Mar. Freshw. Res. 6, 292-313.

DETTMANN, M.E. & PLAYFORD, G. 1969. Palynology of the Australian Cretaceous: a review. In Stratigraphy and Palaeontology: essays in honour of Dorothy Hill (ed. K.S.W. Campbell) ANU press, Canberra, 174-210.

HELBY, R.J., MORGAN, R., & PARTRIDGE, A.D. 1987. A palynological zonation for the Australian Mesozoic. Mem. Assoc. Australas. Palaeontols. 4, 1-94.

PARTRIDGE, A.D. 1976. The geological expression of eustacy in ther early Tertiary of the Gippsland Basin. APEA Jl. 16, 73-79.

PHIPPS, D. & PLAYFORD, G. 1984. Laboratory techniques for extraction of palynomorphs from sediments. Pap. Dept. Geol. Univ. Qd. 11, 1-23.

STOVER, L. & EVANS, P.R. 1973. Upper Cretaceous-Eocene spore pollen zonation, offshore Gippsland Basin, Australia. Spec. Publs. Geol. Soc. Aust. 4, 55-72.

STOVER, L. & PARTRIDGE, A.D. 1973. Tertiary and Late Cretaceous spores and pollen from the Gippsland Basin, southeastern Australia. Poc. Roy. Soc. Vict. 85, 237-286.

TRUSWELL, E..M., SLUITER, I.R. & HARRIS, W.K. 1985. Palynology of the Oligocene-Miocene in the Oakville-1 corehole, western Murray Basin, South Australia. BMR Jl. Aust. Geol. Geophys. 9, 267-295.

Mary E. Dettmann
Department of Botany
University of Queensland
St. Lucia, Qld. 4067.

7 October, 1987

COMPANY: LASMO ENERGY AUSTRALIA LTD.

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672
CRYPTOGAM MICROSPORES:												
Contignisporites glebulentus	+											
Dictyophyllidites pectinataeformis	+	+										
Perotrilites laceratus	+											
Dictyophyllidites crenatus	+											
Cicatricosisporites australiensis	+	+										
Crybelosporites striatus	+	+										
Interlobites intraverrucatus	+											
Biretisporites cf. potoniae	+											
Retitriletes austroclavatidites	+	+										
Retitriletes eminulus	+									+		
Retitriletes clavatoides	+											
Cyathidites australis/minor	+	+			+	+	+	+	+	+	+	+
Baculatisporites comaumensis	+	+							+	+		
Ceratosporites equalis	+											
Gleicheniidites circinidites	+	+				+		+	+	+		
Stereisporites antiquasporites	+	+				+	+	+		+		
Velosporites triquetrus	+											
Stereisporites pocockii	+	+										
Leptolepidites major	+											
Triporoletes reticulatus	+	+										
Triporoletes involucratus	+	+										
Aequitriradites verrucosus	+	+										
Foveosporites moretonensis	+	+										
Stoverisporites microverrucatus	+											
Laevigatosporites ovatus	+				+			+	+			+
Aequitriradites spinulosus		+										
Triporoletes radiatus		+										
Cyathidites punctatus		+										
Coptospora paradoxa		+										
Foraminisporis asymmetricus		+										
Foraminisporis dailyi		+										
Antulsporites varigranulatus		+										
Kuylisporites waterbolkii					+			+				
Rugulatisporites mallatus					+		+	+				

Sample type: S = Sidewall core; C = Conventional core;
D = Cuttings.

COMPANY: LASMO ENERGY AUSTRALIA LTD.

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S				
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672				
Laevicatosporites major					+	+	+									
Peromonolites vellosus					+	+										
Clavifera triplex						+										
Stereisporites (Tripunctisporis) sp.						+			+							
Verrucosisporites kopukiensis						+	+									
Verrucatosporites speciosus						+	+	+								
Polypodiaceoisporites tumulatus							+									
Ischyosporites gremius							+	+		+	+					
Peromonolites densus									+							
Microfoveolatosporis sp.									+							
Foveotriletes balteus									+							
Foveotriletes palaequetrus											+					
Foveosporites lacunosus												+				
CRYPTOGAM MEGASPORES:																
Balmeisporites holodictyus		+														
Arcellites reticulatus		+														
Minerisporites marginatus		+														
GYMNOSPERMOUS POLLEN:																
Classopollis chateaunovii	+	+														
Alisporites grandis	+	+														
Alisporites similis	+	+														
Araucariacites australis	+	+				+	+		+	+	+	+				
Cycadopites nitidus	+	+														
Trichotomosulcites subgranulatus	+	+						+	+	+						
Microcachryidites antarcticus	+	+				+		+	+	+						
Vitreisporites pallidus		+														
Podocarpidites ellipticus		+			+	+	+	+	+	+	+	+				
Lygistepollenites balmei					+											
Phyllocladidites mawsonii						+	+	+		+		+				
Lygistepollenites florinii						+	+		+	+	+					
Dilwynites granulatus						+	+	+	+							
Dacrycarpites australensis							+									
ANGIOSPERMOUS POLLEN:																
Clavatipollenites hughesii	+	+														
Phimopollenites pannosus	+	+														

Sample type: S = Sidewall core; C = Conventional core; D = Cuttings.

COMPANY: LASMO ENERGY AUSTRALIA LTD. Sheet 3 of 5

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S				
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672				
Rousea georgensis		+														
Proteacidites beddoesii					+											
Proteacidites asperopolus					+	+										
Proteacidites pachypolus					+	+	+	+	+							
Proteacidites subscabratus					+		+	+	+							
Proteacidites kopiensis					+	+	+									
Propylipollis latrobensis					+											
Propylipollis tripartitus					+	+										
Propylipollis annularis					+	+	+	+	+	+						
Spinozonocolpites prominatus					+	+										
Triporopollenites ambiguus					+		+	+	+							
Schizocolpus marlinensis					+											
Anacolosidites acutulus					+											
Malvacipollis diversus					+											
Margocolporites sp.					+		+									
Gambierina edwardsii					+											
Gambierina rudata					+											
Haloragicidites harrisii					+	+	+	+	+	+	+	+				
Triporopollenites sectilis					+											
Tricolporites scabratus					+	+	+									
Cupanieidites orthoteichus					+	+	+	+	+							
Banksieaeidites elongatus					+											
Rhoipites microreticulatus					+			+								
Tricolporites prolata					+			+				+				
Sapotaceoidapollenites rotundus					+											
Tricolpites confessus					+											
Nothofagidites emarcidus					+	+	+	+	+	+	+	+				
Nothofagidites flemingii					+	+	+	+	+		+					
Nothofagidites brachyspinulosus					+	+			+	+	+					
Nothofagidites heterus					+	+	+	+	+	+		+				
Gothanipollis bassensis						+			+							
Tricolpites reticulatus						+										
Nothofagidites asperus						+	+	+	+	+	+	+				
Nothofagidites goniatus						+			+							
Anacolosidites lutecides						+										

Sample type: S = Sidewall core; C = Conventional core; D = Cuttings.

COMPANY: LASMO ENERGY AUSTRALIA LTD.

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S				
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672				
Tricolpites simatus						+		+								
Ericipites crassiexinus						+	+	+								
Santalumidites cainozoicus						+	+	+								
Ilexpollenites anguloclavatus						+	+			+						
Myrtaceidites eugeniioides						+	+	+								
Nothofagidites incrassatus						+	+	+	+	+		+				
Nothofagidites deminutus						+	+	+	+	+						
Nothofagidites vansteenisii						+		+		+						
Periporollenites demarcatus						+	+	+	+	+						
Banksieaeidites arcuatus						+										
Proteacidites tuberculiformis						+										
Graminiidites sp.						?						+				
Proteacidites reflexus						+										
Proteacidites recavus							+									
Triorites psilatus							+	+								
Sparganiaceaepollenites sp.							+	+								
Malvacipollis subtilis							+	+								
Helciporites astrus							+									
Propylipollis crassipora							+		+							
Propylipollis reticuloscabratus							+		+	+						
Liliacidites lanceolatus							+									
Nothofagidites falcatus								+	+	+		+				
Tricolpites thomasii								+								
Concolpites leptos								+								
Proteacidites granoratus								+								
Proteacidites incurvatus								+	+							
Proteacidites crassus								+								
Proteacidites adenanthoides								+	+							
Tricolporites leuros									+							
Beaupreaidites elegansiformis									+							
Myrtaceidites parvus										+	+	+				
Proteacidites rectomarginus										+						
Proteacidites tuberculatus										+						
Periporopollenites vesicus											+					
Acaciaeopollenites myriosporites												+				

Sample type: S = Sidewall core; C = Conventional core;
D = Cuttings.

COMPANY: LASMO ENERGY AUSTRALIA LTD.

WELL: PATRICIA No.1 BASIN: GIPPSLAND

Sample type	S	S	S	S	C	C	C	C	C	S	S	S
Palynomorph / Depth (m)	880	821	786.5	769	743.5	739.8	722	720	705	692	683	672
FUNGAL MICROFOSSILS:												
Spore, fruiting bodies and hyphae	+	+			+	+	+	+	+	+		
ALGAL MICROFOSSILS:												
Sigmopollis cf. carbonis	+	+										
Sigmopollis sp.	+											
Schizosporis reticulatus		+										
Schizophacus spriggii		+			+							
Schizophacus rugulatus		+										
Botryococcus sp.						+						
Spiniferites ramosus						+				+		+
Deflandrea heterophylcta						+	+		+			
Eisenackia crassitabulata						+		+				
Spinidinium essoi						+						
Operculodinium sp.						+	+			+		
Oligosphaeridium sp.						+		+			+	
Paralecaniella indentata						+	+		+			
Impagidinium dispertitum							+	+				
Impagidinium victorianum								+				
Pallambages sp.								+				
Horologinella sp.								+				
Hemiplacaphora semilunifera								+				
Schematophora speciosa								+				
Deflandrea phosphoritica									+			
Lentina extensa									+			
Lecaniella sp.									+			
Areosphaeridium capricornum									+			
Systemophora ancryea									+			
Systemaphora placacantha										+	+	
Lingulodinium machaerophorum										+	+	+
Spiniferites bulloidea										+	+	+
Spiniferites cingulata											+	
Operculodinium centrocarpum											+	+
Hystrichokolpoma stellatum												+

Sample type: S = Sidewall core; C = Conventional core;
D = Cuttings.

SAMPLE	DEPTH (m)	LITHOLOGY	ORGANIC MATTER: AMOUNT (ml/10gm)	TYPE (% composition): Alginite: Dispersed	Alginite: Dense	Alginite: Algal cysts	Sporin./Cutin.: Fine (<10µm)	Sporin./Cutin.: Spores	Sporin./Cutin.: Leaf tissue	Sporin./Cutin.: Other	Woody tissue	Humic: <20µm	Humic: > 20µm	Vitr.: <20µm	Vitr.: > 20µm	Inertinite	MATURITY: Spore Colour	T.A.I. (after Staplin 1982)	Interpreted Maturity Level
swc	672	sst., f.gr med. grey	1.2	30	40	5	–	+	–	–	–	+	5	+	10	10	greenish yellow	1.5	immature
swc	683	sst., f.gr med. grey	0.7	30	35	10	–	+	–	+	–	–	10	+	10	5	greenish yellow	1.5	immature
swc	692	sst. m. gr & slt.	1.5	30	10	5	–	+	+	5	–	–	20	5	20	5	greenish yellow	1.5	immature
core	705	slst., dk. grey	1.5	20	5	+	–	+	+	5	+	20	30	5	5	10	greenish yellow	1.6	immature
core	720	slst., dk. grey	0.8	15	–	+	10	5	+	15	+	10	20	5	20	+	greenish yellow	1.6	immature
core	722	slst., dk. grey	0.9	15	–	+	10	5	5	10	+	15	30	+	10	+	greenish yellow	1.6	immature
core	739.8	slst., dk. grey	0.5	5	5	+	10	5	+	10	+	+	50	5	10	+	greenish yellow	1.6	immature
core	743.5	shl., med. grey	2.0	–	–	+	10	5	10	30	+	+	30	5	5	5	greenish yellow	1.6	immature

TABLE 3. Organic matter, Patricia No.1, 672m - 880m. (contd.)

SAMPLE	DEPTH (m)	LITHOLOGY	AMOUNT (ml/10gm)	Alginite: Dispersed	Alginite: Dense	Alginite: Algal cysts	Sporin./Cutin.: Fine (<10µm)	Sporin./Cutin.: Spores	Sporin./Cutin.: Leaf tissue	Sporin./Cutin.: Other	Woody tissue	Humic: <20µm	Humic: > 20µm	Vitr.: <20µm	Vitr.: > 20µm	Inertinite	Spore Colour	T.A.I. (after Staplin 1982)	Interpreted Maturity Level
swc	769	white shl.	-	No recovery													-		
swc	786.5	sst., f.gr., white	-	No recovery													-		
swc	821	shl., dk. grey	1.0	-	-	+	10	20	10	10	+	-	25	5	10	10	yellowish amber	2.0	early mature
swc	880	shl., med. grey	0.6	-	-	+	-	15	-	-	-	-	-	30	45	10	yellowish amber	2.0	early mature

Column groups: ORGANIC MATTER — AMOUNT; TYPE (% composition); MATURITY.

TABLE 3 (contd.). Organic matter, Patricia No.1, 672m - 880m.

PRELIMINARY LOG ANALYSIS

PRELIMINARY

LOG ANALYSIS

APPENDIX XIII

PRELIMINARY LOG ANALYSIS REPORT

LASMO ENERGY AUSTRALIA LTD

PATRICIA NO. 1

PRELIMINARY
LOG ANALYSIS REPORT

LASMO Energy Australia Ltd

JULY, 1987

APC:lvh/2580K:0029K

Geologist: A.P. Calcraft

Report No.: RN 85(A)

Copy No. : ________

C O N T E N T S

FIGURES

TABLES

ENCLOSURES

1.0 INTRODUCTION

There were two wireline logging suites run in the Patricia No. 1 well.

The suites consisted of :

Run 1 218 - 647 metres KB
DLL-MSFL-BHC-GR-SP

Run 2 461 - 899.5 metres KB
DLL-LDL-CNL-MSFL-GR-SP
LSS-NGS
Velocity Survey
CST
RFT

The data from both suites were generally of satisfactory technical quality except for the sonic log which showed cycle skipping due to severe attenuation of the signal in the gas zone, and the PEF curve which was affected by baryte in the mud cake.

Patricia No. 1 penetrated a similar lithological section to that encountered at nearby Baleen No. 1. Gas was encountered in the 'greensand unit' that lies between the Latrobe Group and the Lakes Entrance Formation. The stratigraphic status of this "greensand unit" is presently unclear.

The "greensand unit" is a fine grained glauconitic sandstone with common mica, iron oxides, pyrite and possibly other minerals. To help analyse this complicated reservoir the basic logging suite run at Baleen No. 1 was supplemented by a Natural Gamma Ray Spectroscopy Tool (NGS) and a lithodensity tool (LDT) together with core over the reservoir at Patricia No. 1.

Gas was also encountered in sandstone 'coarse clastics' of the Latrobe Group.

This report documents a preliminary log analyses of these reservoirs. It gives comparative porosities and water saturations throughout the reservoirs and allows identification of problems to be solved by core analysis.

This report makes numerous assumptions about the mineralogy of reservoir, and further work, especially XRD, petrology and special core analysis on core samples is required, to allow a more accurate log analysis.

2.0 ANALYSIS METHOD AND PARAMETERS

2.1 THE RESERVOIR

The section between 700 and 775 metres KB consists largely of unconsolidated sandstone with varying proportions of clay and other minerals. However the precise nature of the reservoir at Patricia No. 1 is not yet understood.

The principal zone of interest is the 'greensand unit' between 700 and 745 metres KB. The same stratigraphic unit was encountered at Baleen No. 1 and petrographic sidewall cores showed that the reservoir at Baleen No. 1 is a fine grained glauconitic quartz sand with common mica, iron oxide (Goethite), iron rich carbonate and clay. The XRD analysis indicated that most of the clay is kaolinite. Since the wireline log response of the 'greensand unit' in Patricia No. 1 is very similar to that at Baleen No. 1 the mineralogy is, in the absence of other data, assumed to be the same in both wells.

Glauconite was described in the Baleen No. 1 reservoir but analysis of the NGS data of Patricia shows that the Thorium/Potassium ratios are too low to be glauconite according to the Schlumberger and Gearhart chart books. However, according to Greensmith (Petrology of the Sedimentary Rocks) glauconite tends to be a term used by geologists to describe any green or green-black mineral in a marine rock. He goes on to explain that there are four types of 'glauconite' all with differing chemical compositions. There is true glauconite, a clay mineral with a well ordered, non-swelling high potassium mica type of lattice and two types of potassium poor glauconites with either a swelling montmorillonite lattice or a non swelling mica lattice. The final glauconite type is a mixture of glauconite proper and varying proportions of kaolinite, illite and chlorite. The glauconite in our reservoir is interpreted to be a low potassium type because of the low proportion of potassium (about 2%) indicated by the NGS log.

The Latrobe Group sandstone is regarded as a normal shaly sandstone with minor accessory minerals.

2.2 ANALYSIS METHOD

The presence of radioactive and dense minerals in the 'greensand unit' means that the normal methods of determining clay content using the gamma ray and porosity logs will tend to overestimate the shale content. The presence of gas also influences the porosity logs.

If the dominant clay type is assumed to be kaolin, a Rhomaa (Apparent matrix density) against Umaa (Apparent volumetric cross section) crossplot can be constructed with quartz and clay points defined. The quartz end point requires adjusting for gas effects in the gas reservoir as shown on Enclosure 2. An 'average heavy mineral' point was derived by taking the intersection of possible quartz-heavy mineral and kaolin-heavy mineral boundary lines. Proportions of these three end members were calculated by solving a three dimensional matrix.

The shale or clay content of the reservoir is probably over-estimated using the Rhomaa-Umaa crossplot because the presence of mica, and possibly low potassium glauconites, tend to cause points to plot towards the clay point. However, a PEF vs Thorium/Potassium crossplot shows that 'mica' can be distinguished from kaolinite and hence the clay content can be extracted from the 'clay and mica' value derived from the Rhomaa vs Umaa crossplot. This final value of clay was defined as VSHUR and the final clay content of the reservoir was calculated in the usual manner using the minimum value of the VSHUR, (density-neutron) and VSHGR (gamma ray), shale indicators.

The final clay content of the reservoir dervied in the manner described is consistent in quantity and distribution with that described from core by the wellsite geologist. However it will need to be checked against subsequent petrographic studies on the core.

The presence of glauconite, pyrite and iron oxides in the reservoir means that the rock matrix itself may be conductive. To compensate for this m and n values were lowered from 2.0 to 1.5 in the 'greensand unit'. The validity of these assumptions requires testing by determining a, m and n by Special Core Analysis.

The analysis follows an otherwise standard complex lithology model approach using Mincom's GPLOG analysis package. The analysis option used in the GPLOG package computes invaded zone hydrocarbon saturations and corrects the neutron and density logs for hydrocarbon effects and a matrix density and porosity calculated. The maximum allowable matrix density was increased from the commonly used value of 2.71 to 4.0 to cater for the iron oxide and pyrite rich sections of the reservoir.

The water resistivity is essentially unknown. An Rwa approach was used to estimate the water resistivity in the water bearing zone in the Latrobe Formation and a water salinity equivalent to 2,700 ppm NaCl derived. The use of this water salinity throughout computes rather high water saturations (about 60-70%) within the gas bearing section. Esso workers in their 1986 APEA paper showed that water salinities in Gippsland Basin hydrocarbon reservoirs could be significantly higher than those in the aquifer immediately underneath and was commonly in the range 20-30,000 ppm. The analysis was rerun for water salinities of 10,000, 20,000 and 30,000 ppm NaCl within the gas zone. The analysis using a water salinity of 10,000 ppm generates water saturations in the 20-30% and this is the one that is interpreted to be closest to reality. Further work incorporating the results of special core analysis is required to confirm this interpretation.

2.3 LOG ANALYSIS PARAMETERS

The log analysis parameters used for the analysis are tabulated in Table 1.

Rw = 2.0 @ ... calculated

TABLE 1
LOG ANALYSIS PARAMETERS

WELL NAME: PATRICIA NO. 1 LOGGER: Schlumberger

TD (Total Depth): 899.5 metres
BHT (Bottom Hole Temp.° F): 115
MSF (Surface Temp.° F): 40
Interval Analysed: 701 - 775 metres

BITSIZ (Bit Size): 12.25 inches
RMF75 (Filtrate Resistivity): 0.35 ohm-m
RHOF (Formation Water Density): 1.03

Zone	Greensand	Latrobe-Gas	Latrobe-Water
Base of Zone	740	750	800
VSHOPT VSH Selection Logic	Min	Min	Min
RHOMA Expected Matrix Density	2.65	2.65	2.65
RMAMIN Min. Allowable Matrix Density	2.64	2.64	2.64
RMAMAX Max. Allowable Matrix Density	4.00	4.00	4.00
A Tortuosity Constant	0.81	0.81	0.81
M Cementation Exponent	1.5	2	2
N Saturation Exponent	1.5	2	2
GRMIN Gamma Minimum	23	23	23
GRMAX Gamma Maximum	120	120	120
RHOSH Shale Density	2.45	2.45	2.45
PHINSH Neutron Shale Porosity	0.44	0.44	0.44
DTSH Shale Sonic Time	130	130	130
RBON Matrix Density when phin = 0	2.52	2.46	2.59
RB20N Matrix Density when phin = 20	2.18	2.13	2.25
DTON Matrix Sonic Time when phin = 0	61	61	60
DT20N Matrix Sonic Time when phin = 20	112	112	98
RB40DT Matrix Density when dt = 40	2.83	2.83	2.83
RB80DT Matrix Density when dt = 80	2.35	2.35	2.35
Rhomaa Quartz	2.56	2.56	2.65
Umaa Quartz	5.0	5.0	4.8
Rhomaa Clay	3.02	3.02	3.02
Umaa Clay	6.2	6.2	6.2
Rhomaa H.M.	3.0	3.0	3.0
Umaa H.M.	45	45	45
Thorium/Potassium Ratio Clay	20	20	20
Thorium/Potassium Ratio Non Clay	2.5	2.5	2.5
RSH Shale Resisitivity	2	2	2
VSHGR Allow VSH Gamma	Y	Y	Y
VSHND Allow VSH Neutron-density	Y	Y	Y
VSHSD Allow VSH Sonic-density	N	N	N
VSHSN Allow VSH Sonic-neutron	N	N	N
VRU Allow VSH Rhomaa-Umaa	Y	Y	Y
VSHMN Allow VSH MN	N	N	N
RW75 Formation Rw @ 75 F	5.5	5.5	2.0
Equivalent Water Salinity (ppm NaCl)	10,000	10,000	2,700
HLOG Gas Correction Type	2	2	2
RHOH Hydrocarbon Density	0.06	0.06	0.06
SWGAS Maximum Sw cutt off Sw Gas Corr.	0.7	0.7	0.7
BLOG Allow Bad-hole Logic	N	N	N
DCMAX Max. Allowable Oversize Hole	-	-	-
DRMA Max. Allowable DRHO Reading	-	-	-

2.4 MNEMONICS

The log analysis output plots display several computed log types and the following nomenclature is used :

On the Final Analysis Plot (Enclosure 4)

RHOAVG	=	Average calculated rock density including shale or clay.
HYD VOL	=	Hydrocarbon Volume or POROSITY *(1-Sw)
HYD WEIGHT	=	Hydrocarbon Weight or HYD VOL *HYDROCARBON DENSITY
SW	=	Water saturation using Juhasz Equation (a dual water type of equation)
Matrix	=	Matrix material, density set to 2.65 for quartz sandstone
Mineral 1	=	Light matrix mineral, density set to 2.64 (quartz sandstone)
Mineral 2	=	Heavy matrix mineral, density set to 4.00

On the Data Presentation Plot (Enclosure 3)

VSH	=	Shale or clay content of the reservoir
VSHGR	=	VSH calculated using the gamma ray log
VSHDN	=	VSH calculated using the density-neutron indicator
VSHSD	=	VSH calculated using the sonic-density indicator
Vc	=	VSH calculated using the Rhomaa-Umaa crossplot
VSHUR	=	VSH calculated using VC and removing mica
Rhomaa	=	Apparent matrix density
Umaa	=	Apparent volumetric cross section
Va	=	Proportion quartz from Rhomaa-Umaa crossplot
Vb	=	Proportion of heavy mineral from Rhomaa-Umaa crossplot
CGR	=	Gamma ray derived from Thorium and Potassium
Th-U	=	Thorium/Uranium Ratio
U-Pot	=	Uranium/Potassium Ratio

Th-K	=	Thorium/Potassium Ratio
RLLS	=	Environmentally corrected LLS
RLLD	=	Environmentally corrected LLD
RT	=	Calculated true formation resistivity
PHIA	=	Crossplot porosity from density-neutron crossplot
NPL	=	Environmentally corrected neutron porosity

3.0 THE ANALYSIS

3.1 THE 'GREENSAND UNIT'

The clay content of this unit is interpreted to range between zero and 30% with an average value of approximately 15%. Porosities are generally in the 30-40% range and average at approximately 33%.

Porosities and porosity trends are consistent with those measured from core analysis though the log analysis porosities are slightly lower than core porosities. This may be due either to a closer grain packing in the reservoir or to drying out of clays in the core plug cleaning process prior to making core measurements.

Water saturations of 20-30% are computed with a water salinity of 10,000 ppm NaCl. This value of water salinity is interpreted as the most likely case - higher salinities are possible but give improbably low water saturations while lower salinities would imply saturations that appear improbably high, given the high porosity and good permeability demonstrated by the core.

3.2 THE LATROBE GROUP

This unit has an interpreted clay content of zero to 20% with interpreted porosities of 15-29%. Water saturations range from 30-40% using a water salinity of 10,000 ppm NaCl within the gas bearing reservoir. A gas-water contact was placed at 750 metres RT based on wire line log character and this was subsequently confirmed by RFT pressure date. A water salinity of 2,700 ppm NaCl was used below the gas-water contact.

There is an anomalous hydrocarbon saturations computed between 763 and 770 metres KB associated with shale. The shale parameters have been optimized for the gas bearing reservoir and may not properly apply to the water sand. Both the shale content and the water saturations between these depths are interpreted to be computational anomalies.

4.0 SUMMARY

The results of the log analysis are presented graphically in Enclosure 4 and Figures 1 to 6. Gas bearing sandstones occur in the interval 700 to 750 metres KB is interpreted as likely to flow gas.

The lithological complexity of the reservoir and the uncertainty regarding the salinity of the water within the reservoir means that these results are preliminary. Further study, incorporating petrology, XRD, and special core analysis is required to adequately analyse this complex reservoir.

Porosity and Water Saturation cutoffs have been applied to estimate net pay. A porosity cutoff of 25% was used because this corresponds to levels where the resistivity of the MSFL log which measures the resistivity of the filtrate invaded zone and the deep resistivity logs (LLD, RLLD or RT) are very similar. This suggests that there has been no filtrate invasion and so any hydrocarbons present are probably not producible. The porosities and permeabilities from core analysis suggest that a porsity of 21% corresponds to a permeability of 1mD and that this may be an appropriate porosity cutoff. However the core measurements were made on dried and mechanically disturbed samples that may not be representative of the actual reservoir. The 40% Water Saturation cutoff was based on the desire to exclude high water saturation values but in fact very few levels are excluded using this criterion.

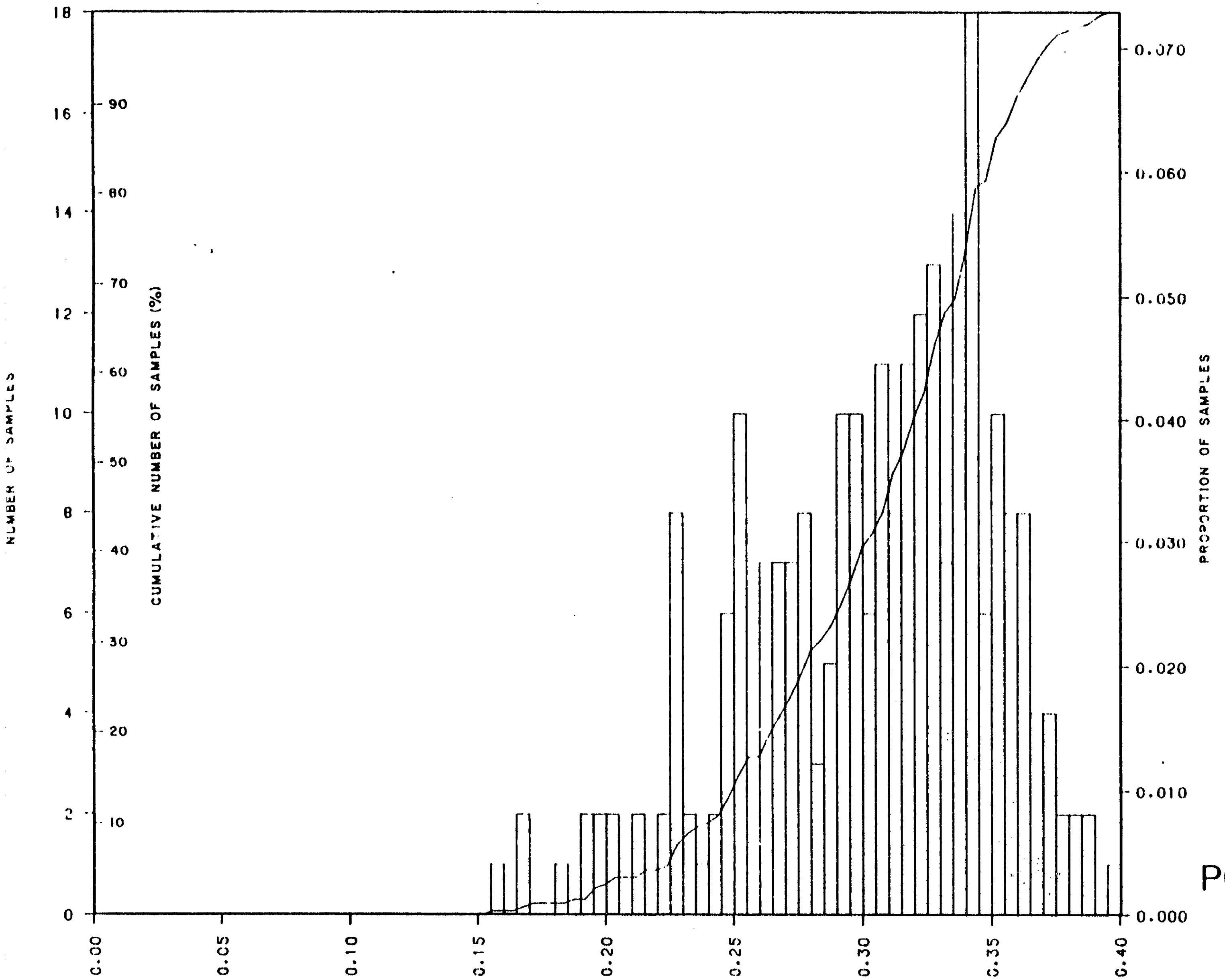
Summary

Reservoir	'Greensand Unit'	Latrobe Group
Depth	701 - 740	744 - 750
Shale content	0 - 30% (15)	0 - 20% (10)
Porosity	20 - 38% (30.5)	25 - 30% (23)
Water Saturation	20 - 40% (30)	30 - 45% (39)
Net Pay	33.9 metres	5.2 metres
Sw cut off	40%	40%
Porosity cut off	25%	20%

This value of net pay may be require adjustment if further study shows cut offs for net pay need altering.

HISTOGRAM OF POR

PATRICIA-1, G SAND



Hole name: PATRICIA-1

Top depth: 701.40

Bottom depth: 739.00

No. of samples: 247

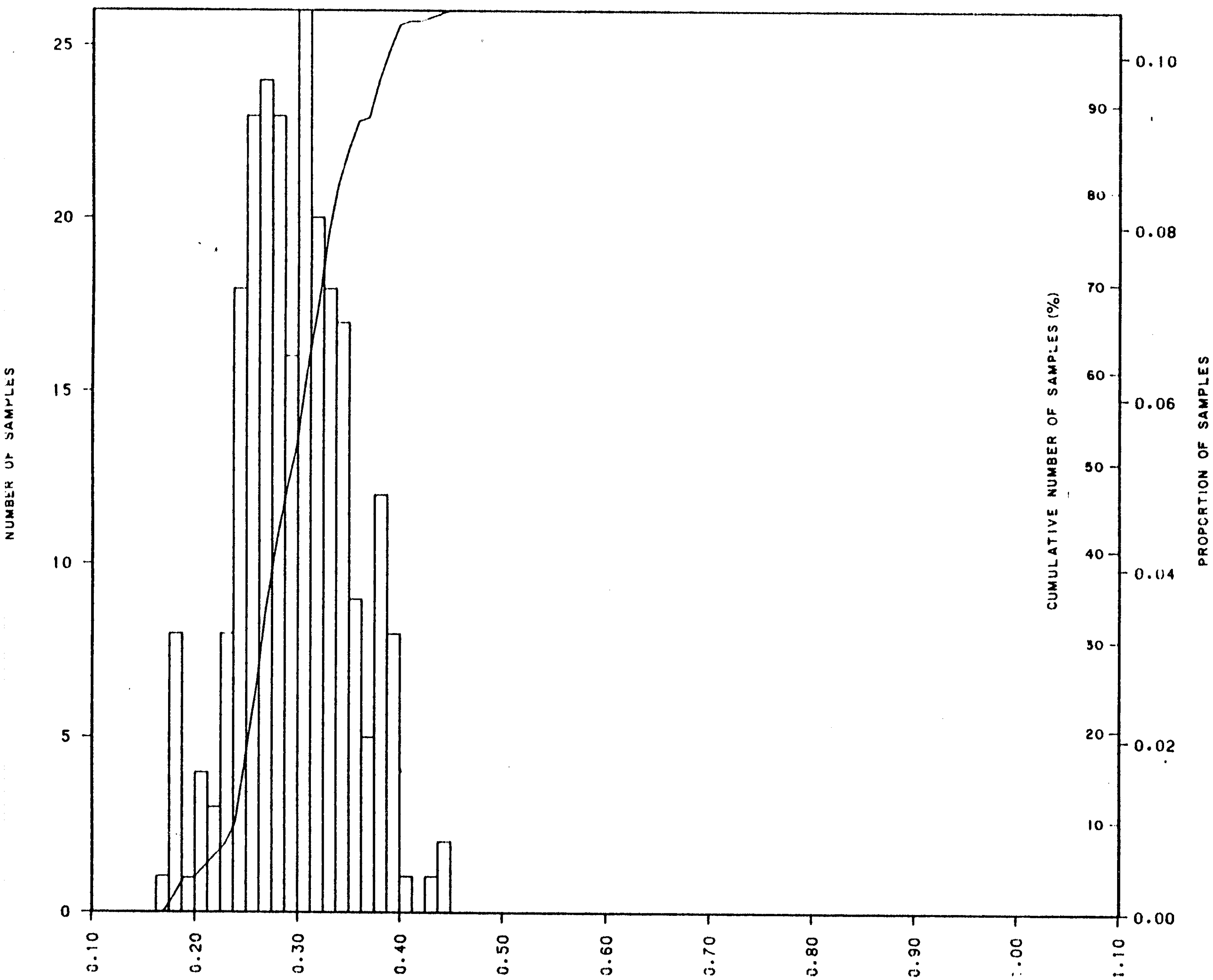
Average: 0.305

Std. Deviation: 0.047

Mode: 0.343

POROSITY FREQUENCY PLOT 'GREENSAND UNIT'

HISTOGRAM OF SW.
PATRICIA-1, G SAND



Hole name: PATRICIA-1

Top depth: 701.42

Bottom depth: 739.00

No. of samples: 247

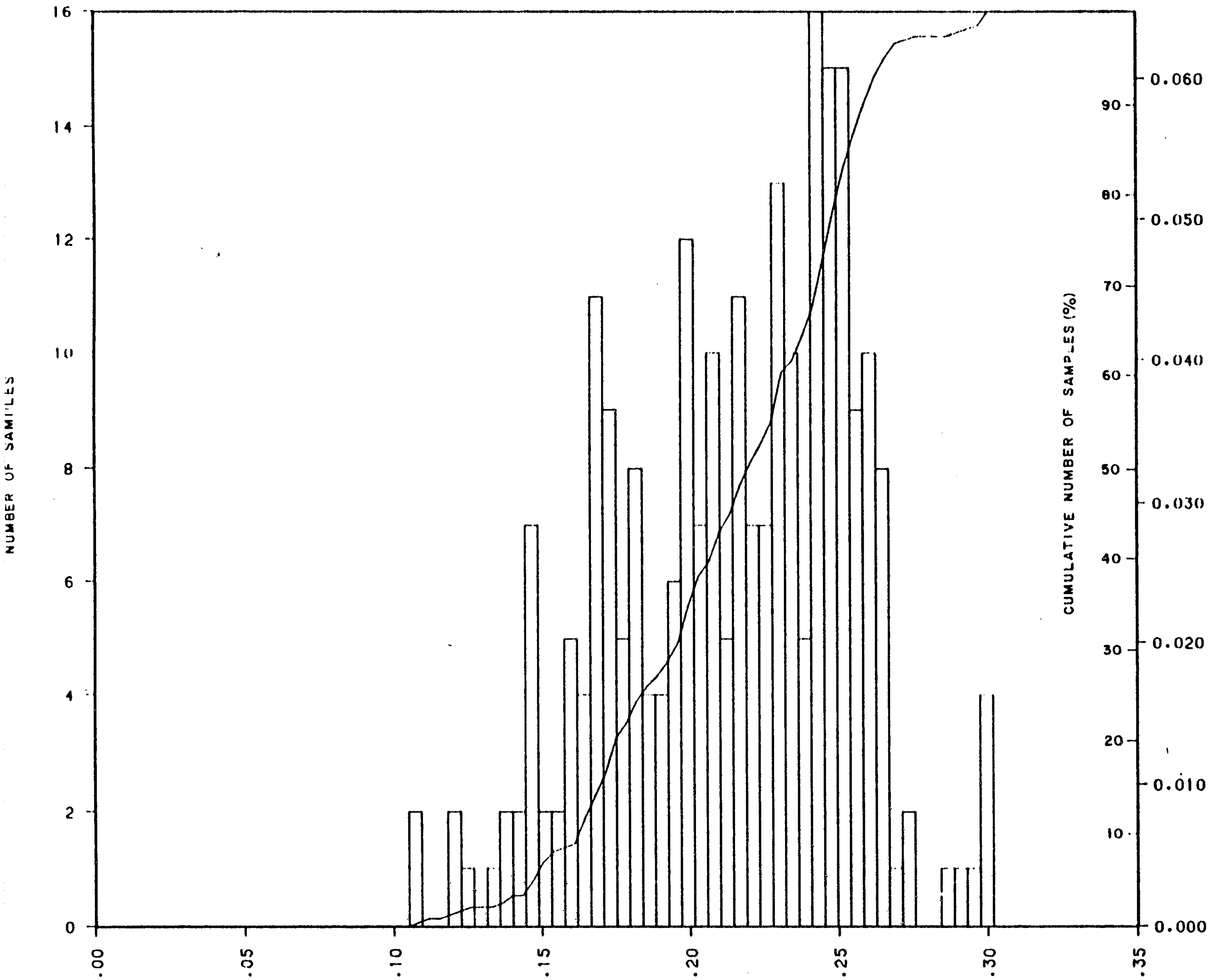
Average: 0.298

Std. Deviation: 0.052

Mode: 0.306

SW FREQUENCY PLOT 'GREENSAND UNIT'

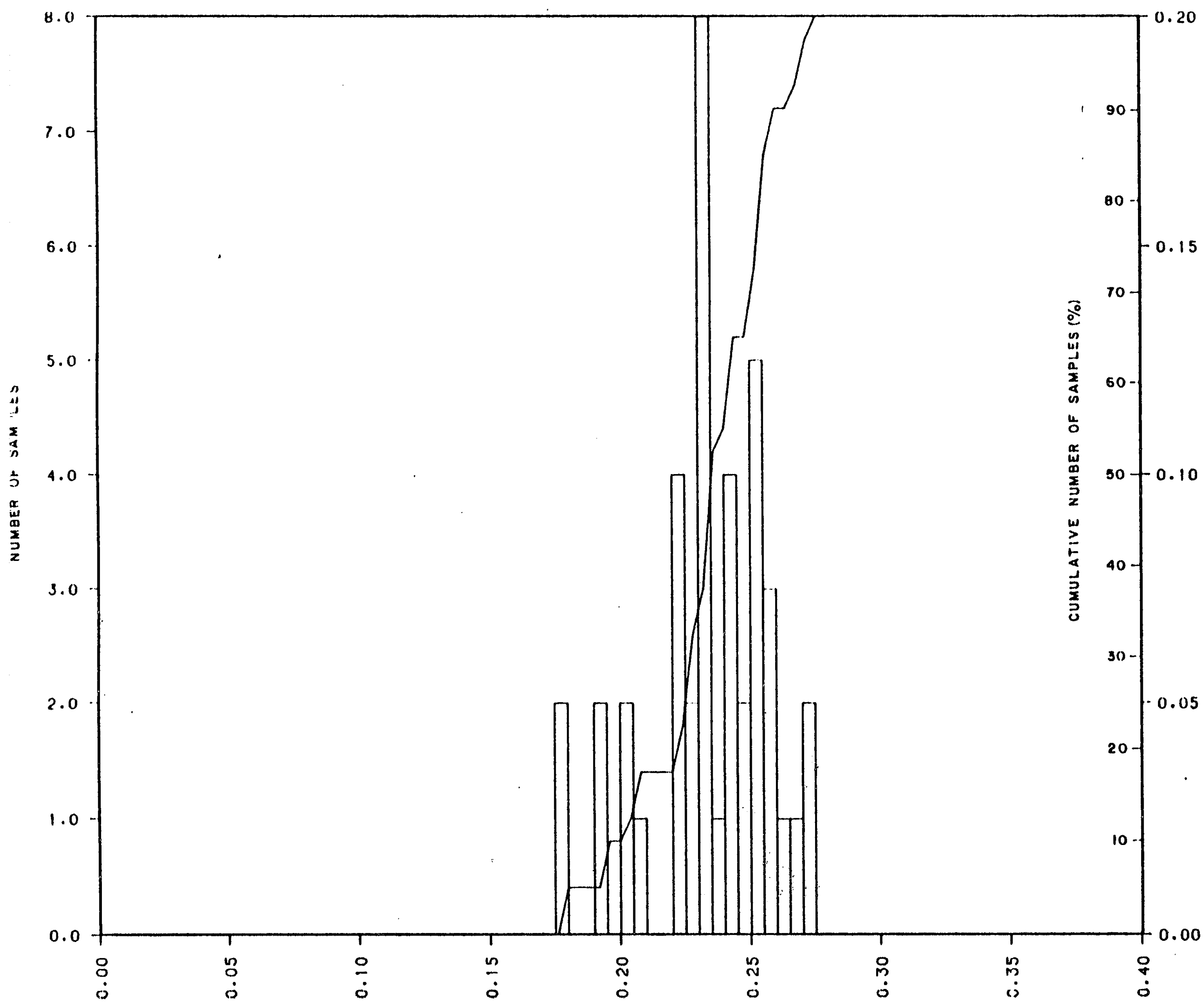
HISTOGRAM OF HYD-VOL
PATRICIA-1, G SAND



Hole name: PATRICIA-1
Top depth: 701.40
Bottom depth: 739.00
No. of samples: 247
Average: 0.215
Std. Deviation: 0.040
Mode: 0.243

HYD-VOL FREQUENCY PLOT 'GREENSAND UNIT'

HISTOGRAM OF POR
PATRICIA-1, U LATROBE
(gas zone only)



Hole name: PATRICIA-1

Top depth: 744.00

Bottom depth: 750.00

No. of samples: 40

Average: 0.234

Std. Deviation: 0.023

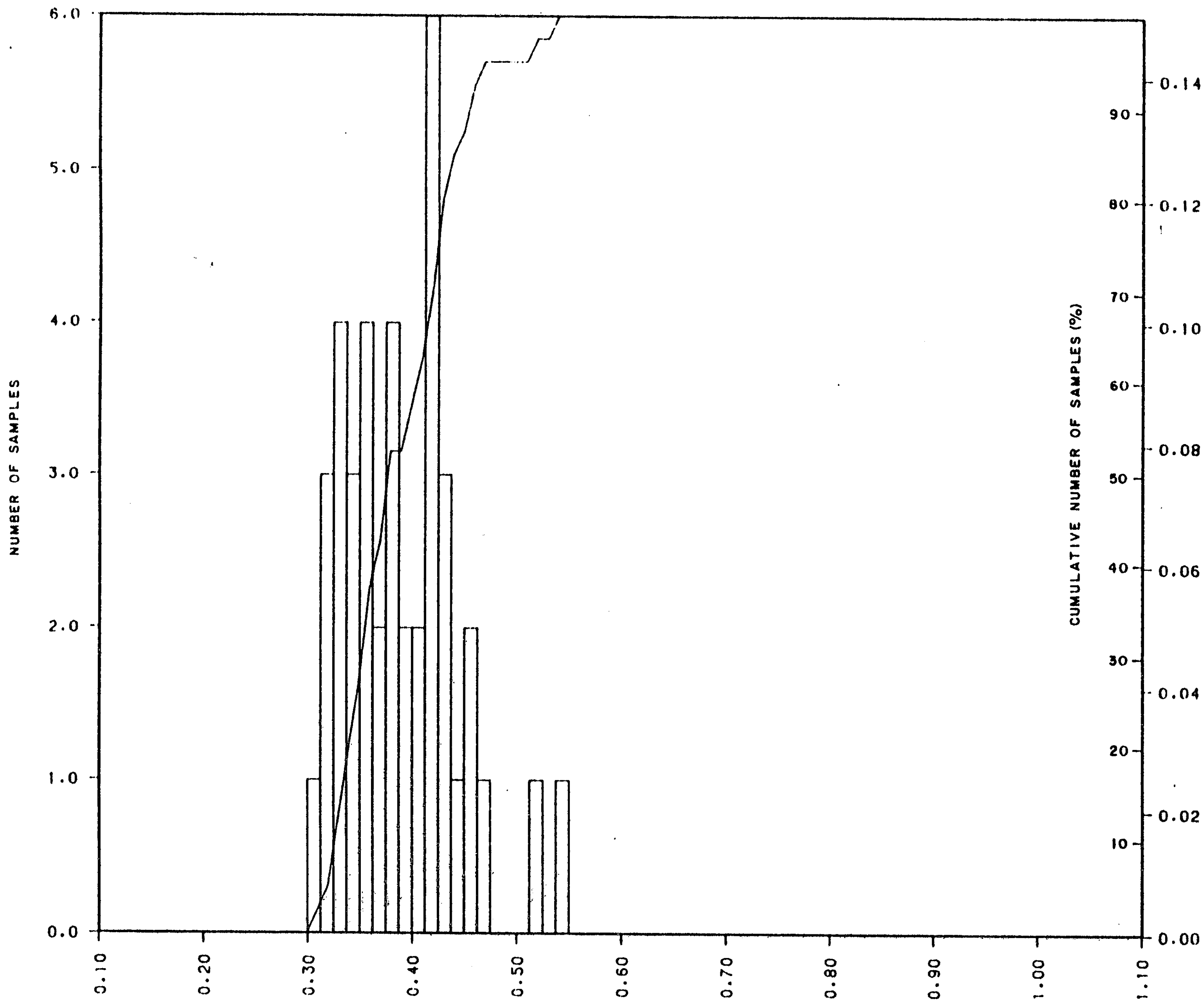
Mode: 0.233

POROSITY FREQUENCY PLOT
UPPER LATROBE

HISTOGRAM OF SW

PATRICIA-1, U LATROBE

(gas zone only)



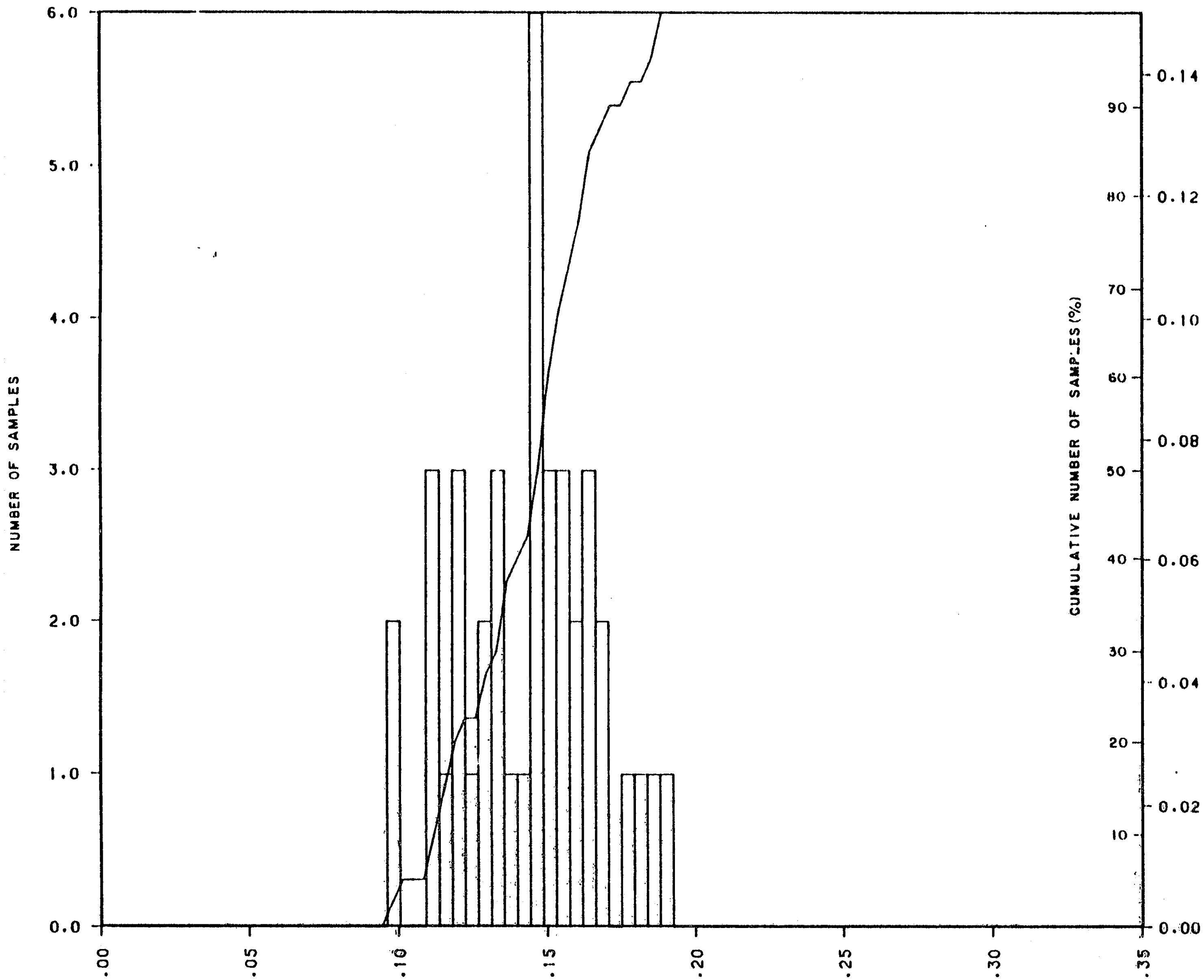
Hole name:	PATRICIA-1
Top depth:	744.00
Bottom depth:	750.00
No. of samples:	40
Average:	0.389
Std. Deviation:	0.054
Mode:	0.419

SW FREQUENCY PLOT
UPPER LATROBE

HISTOGRAM OF HYD-VOL

PATRICIA-1, U LATROBE

(gas zone only)



Hole name: PATRICIA-1

Top depth: 744.00

Bottom depth: 750.00

No. of samples: 40

Average: 0.144

Std. Deviation: 0.023

Mode: 0.147

HYD-VOL FREQUENCY PLOT

UPPER LATROBE

5.0 BIBLIOGRAPHY AND REFERENCES

An Introduction to the Rock Forming Minerals by Deer, Howie and Zussman. ISBN 0 582 44210 9 pub. Longmans, 1986

Litho-density Log Interpretation J.S. Gardner and J.L. Dumanoir, Schlumberger

Petrology of the Sedimentary Rocks by J.T. Greensmith ISBN 004 552007 0 pub. George Allen and Unwin Ltd., 1971

Freshwater Influx in the Gippsland Basin: Impact on Formation Evaluation, Hydrocarbon Volumes and Hydrocarbon Migration: K. Kultan, J.B. Kulla and R.G. Neumann, APEA 1986

Shaly Sand Evaluation using Gamma Ray Spectrometry, Applied to the North Sea Jurassic G. Marett, P. Chevalier, P. Souhaite and J. Suau

Log Analysis Problems and Solutions in Complex Lithology Reservoirs N. Ruhvets and D.W. Oliver, SPE 14187

Natural Gamma Ray Spectrometry; Essentials of NGS Interpretation, Schlumberger

Interpretation of Micaceous Sandstones in the North Sea J. Suau and J. Spurlin, Schlumberger, 1982

PE906240

This is an enclosure indicator page.
The enclosure PE906240 is enclosed within the container PE906239 at this location in this document.

The enclosure PE906240 has the following characteristics:

ITEM_BARCODE =	PE906240
CONTAINER_BARCODE =	PE906239
NAME =	G-Sand and Upper Latrobe Cross-Plots
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	MONTAGE
DESCRIPTION =	Greensand and Upper Latrobe Geochemical Cross-Plots
REMARKS =	
DATE_CREATED =	13/07/87
DATE_RECEIVED =	18/01/88
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE906241

This is an enclosure indicator page.
The enclosure PE906241 is enclosed within the container PE906239 at this location in this document.

The enclosure PE906241 has the following characteristics:

ITEM_BARCODE =	PE906241
CONTAINER_BARCODE =	PE906239
NAME =	G-Sand and Upper Latrobe Plots
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	MONTAGE
DESCRIPTION =	Greensand and Upper Latrobe Plots of Neutron, Sonic and Gamma Ray data
REMARKS =	
DATE_CREATED =	13/07/87
DATE_RECEIVED =	18/01/88
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE603586

This is an enclosure indicator page.
The enclosure PE603586 is enclosed within the container PE906239 at this location in this document.

The enclosure PE603586 has the following characteristics:

ITEM_BARCODE = PE603586
CONTAINER_BARCODE = PE906239
NAME = CPI/Downhole Logs
BASIN = GIPPSLAND
PERMIT = VIC/P11
TYPE = WELL
SUBTYPE = CPI
DESCRIPTION = CPI/Downhole Logs for Patricia-1 including Gamma Ray, SW and Porosity
REMARKS =
DATE_CREATED =
DATE_RECEIVED = 18/01/88
W_NO = W963
WELL_NAME = PATRICIA-1
CONTRACTOR =
CLIENT_OP_CO = LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE603587

This is an enclosure indicator page.
The enclosure PE603587 is enclosed within the container PE906239 at this location in this document.

The enclosure PE603587 has the following characteristics:

ITEM_BARCODE =	PE603587
CONTAINER_BARCODE =	PE906239
NAME =	Rock Composition Log
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	Rock Composition/Geochemical Log for Patricia-1
REMARKS =	
DATE_CREATED =	
DATE_RECEIVED =	18/01/88
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PETROLOGY

REPORT

PETROLOGY REPORT

APPENDIX XIV

PETROLOGY REPORT

amdel
technology and enterprise
Amdel Limited - Inc. in S.A.

Amdel
31 Flemington Street,
Frewville, S.A. 5063

Telephone: (08) 372 2700

Address all correspondence to:
P.O. Box 114,
Eastwood, S.A. 5063

Telex: AA82520
Facsimile: (08) 79 6623

25 August 1987

F 3/0/0
F 6881/88 - Part 1

Lasmo Energy Australia Pty Limited
GPO Box 976
BRISBANE QLD 4001

Attention: Mr D. Lowry

REPORT F 6881/88 - Part 1

YOUR REFERENCE:	Letter of 24 July 1987, AFE 322
MATERIAL:	Core samples
LOCALITY:	PATRICIA-1
IDENTIFICATION:	710, 713, 722, 731.2, sand

Investigation and Report by: Dr Brian G. Steveson

Manager, Petroleum Services Section: Dr Brian G. Steveson

Brian G Steveson.

for Dr William G. Spencer
General Manager
Applied Sciences Group

cap

1. INTRODUCTION

Following telephone discussions on 23 July, Lasmo submitted to Amdel Limited the following samples (from Patricia-1):

1. Three friable sandstones, 710 m, 722 m, 731.2 m
2. One more compact sandstone, 713 m
3. Separator sand, produced with gas.

A letter of 24 July 1987 refers to this work. This part-report gives results obtained so far.

2. PETROGRAPHY

2.1 Summary of Petrography

The average size of the detrital grains is close to the conventional boundary between sandstone and siltstone of 0.063 mm. Quartz and feldspar form equant, distinctly angular grains and are probably of a common, plutonic type. Mica is a ubiquitous detrital constituent and biotite, although not usually as abundant as muscovite, generally shows pleochroism in shades of brown and little chloritisation; it is therefore chemically fresh. Occasionally there are rather large, altered biotite clasts. Lithic fragments vary in abundance and appear to be metasedimentary and sedimentary argillaceous lithologies.

The rocks contain mixed layer clays, kaolinite and chlorite but no ferruginous phyllosilicates such as chamosite or glauconite. The locus of these clays is the brown matrix which pervades all the friable parts of the reservoir. In thin section this matrix is contiguous as an abundant network between the grains. No doubt the staining is due to secondary iron oxide/hydroxide phases derived from the alteration of pyrite, siderite and possibly detrital ?goethite or hematite. No evidence for original detrital glauconite was seen. The iron oxide/hydroxide staining is thought to be a late, local diagenetic phenomenon.

The habit and distribution of siderite is well shown in the photomicrographs: it commonly forms distinctive small crystals, often rimmed with secondary ferruginous minerals, and is either in polycrystalline aggregates or as simple crystals immersed in the matrix. Siderite clearly crystallised in the diagenetic environment and there is no evidence of any detrital precursors, therefore it is most likely that siderite has been introduced, crystallised from circulating waters and underwent limited alteration to goethitic phases. The apparent abundance of the latter suggests that siderite alteration is not the only source of the brown stains.

The more compact sample differs from the friable rocks in that it contains more siderite and the cementation results from the presence of this mineral.

From the point of view of reservoir performance, the abundance of mixed-layer smectite-illite is most relevant since it represents the most reactive mineral phase present. The introduction of fresh waters into the reservoir may well cause swelling problems, especially relevant if the porosity is attributable to micropores. The iron-rich nature of several minerals in the reservoir - siderite, chlorite, pyrite, geothite - should be noted; acidizing of the reservoir could release iron and result in the formation of intractable precipitates unless steps are taken to keep the iron in solution.

2.2 Petrographic Descriptions

Sample: Patricia-1, 710 m: TSC49137

Rock Name:

Coarse sideritic siltstone

Thin Section:

An optical estimate of the constituents gives the following:

Constituent	%
Detrital grains	
Quartz and Feldspar	50-60
Mica	2
Lithics	2
Heavy minerals	<1
Siderite	15
Brown clay and goethite	20-30

The rock is a coarse siltstone or very fine-grained sandstone with an abundant matrix of material which is dark brown in plane polarised light and black between crossed Nicols.

Quartz and feldspar have been well sorted and most grains fall in the range of 0.05 to 0.1 mm; they are distinctly angular and equant. The grains are commonly completely surrounded by matrix and show no pressure solution or related effects. Feldspar can only rarely be identified; it is present as non-twinned turbid grains and rare instances of rather fresh plagioclase. The rock contains both muscovite and, less commonly, biotite as rather short detrital flakes. Biotite is sufficiently fresh to show pleochroism. As well as these well-formed flakes, there are areas of the brown matrix which are probably relatively small altered or iron-stained mica flakes.

Lithics in the listing above refers to turbid grey or brown patches, within the matrix, which are partly altered clayey fragments similar in size to quartz and feldspar grains. It is likely that these are sedimentary or metasedimentary lithic clasts.

The matrix of this rock consists of two distinct parts. Siderite is characteristically present as small (0.02 mm) equant crystals in aggregates or widely scattered between the silt-grade detritus. All the siderite is more or less brown in colour and (in the siderite aggregates particularly) tends to be rimmed with brown secondary material. Elsewhere the matrix consists of presumed clays stained and obscured by secondary brown material which is probably poorly crystalline (or amorphous) iron oxide/hydroxide.

The thin section contains a moderate amount of very patchy fine porosity apparently associated largely with removal of some matrix material (rather than being of specifically primary origin).

Sample: Patricia-1, 722 m: TSC49138

Rock Name:
Argillaceous siltstone

Thin Section:
An optical estimate of the constituents gives the following:

Constituent	%
Quartz and Feldspar	45
Mica	5-10
Opaques	2
Lithic clasts	15
Brown-stained clay matrix	30-35
Siderite	<1

In comparison to the sample from 710 m, this rock is characterised by the paucity of carbonate, the presence of numerous argillaceous clasts and a more patchy and less stained matrix.

Quartz, feldspar and lithic clasts are moderately sorted about an average size of 0.07 mm but there is a wide size range which includes rare lithic clasts up to 0.2 mm. Lithics include numerous small aggregates of grey, turbid clay with varying birefringence and smaller proportions of brown, featureless grains, concretion-like grains (of deep brown ?goethitic material) and rare cherts. Feldspar could be identified by a faint turbid alteration but otherwise it is not possible to distinguish it from quartz. Micas are abundant and both muscovite and brown pleochroic biotite form well defined flakes with a preferred orientation.

Brown-stained clay matrix forms a contiguous network around the detrital grains, in places it coalesces with larger, but ragged aggregates of clay, goethite and rare finely-granular siderite (morphologically similar to that from 710 m).

Also spatially associated with 'matrix' is material which is opaque even under intense illumination. Some of this forms ragged, equant granules up to 0.02 mm in size, the remainder is present as elongate and irregular features. It is probable that the small granules, at least, are pyrite.

Sample: Patricia-1, 731.2 m: TSC49139

Rock Name:
Argillaceous siltstone

Thin Section:
An optical estimate of the constituents gives the following:

Constituent	%
Quartz and Feldspar	55
Mica	<2
Matrix	45

In many ways this sample is petrographically more straightforward than the samples from 710 m and 722 m. Lithic material is either absent or so altered and stained as to be indistinguishable from the matrix; mica is a trace component only.

Quartz and feldspar from equant, angular grains well sorted about an average size of 0.05-0.08 mm. The grains are completely embedded in matrix and no grain-to-grain contacts are present in the section.

The matrix shows varying shades of brown in plane polarised light and is generally very dark between crossed Nicols. It is assumed that the material is essentially clay derived from a genuine muddy matrix. There is no doubt that the brown colouration is from secondary iron minerals related to geothite, lepidocrocite and similar oxide/hydroxide phases. As well, however, 'matrix' includes granular, ragged patches of opaques (?pyrite) and small granules of siderite. The extent to which the matrix includes obscured lithic clasts is difficult to assess. Some shadowy outlines of lithic fragments can definitely be seen within matrix but it is unlikely that lithics comprised more than 3-5% of the original siltstone.

Sample: Patricia-1, Separator sand: TSC49140B

Thin Section:

This friable, fine sand was obtained with the gas flow during testing of the well.

The sand consists largely of angular, equant quartz grains 0.05 to 0.1 mm in size with rare grains as small as 0.02 mm and up to 0.18 mm in size. There are traces, only, of mica flakes of a similar size.

Heavy minerals appear to be more abundant in this sand than in the formation samples described; perhaps 3% if siderite is included, half this otherwise. Siderite and opaques, tourmaline and zircon all are present as grains commonly about 0.05 mm in size.

The petrography of this sand is consistent with its having been derived from the reservoir sandstones/siltstones; evidently the brown-stained matrix clays have been washed away as slimes.

Sample: Patricia-1, 713 m: TSC49140A

Rock Name:
Sideritic siltstone

Thin Section:
An optical estimate of the constituents gives the following:

Constituent	%
Quartz and Feldspar	55
Mica	3-5
Lithics	2
Siderite	25
Brown matrix	15-20

A detailed description will not be given since the intention in examining this sample is to explain the relatively compact nature of the core at this depth.

The detrital quartz, feldspar, lithics and mica are similar to those in the three friable core samples. Although there is a network of brown-stained matrix clay - as in the friable lithologies - the rock also contains rather abundant siderite and it is this which is responsible for the greater cementation of the sample.

Siderite is typically present as small equant crystals 0.02 to 0.04 mm in size, similar to those at 710 m for example. Most of the siderite occurs in aggregates where it occupies much of the intergranular space. If the thin section is examined macroscopically paler patches up to 1 cm in size can be seen and it is these that are siderite-rich. Many fields of view in the darker parts of the rock are similar to the other samples and siderite is present within the matrix only as widely dispersed small crystals.

3. X-RAY DIFFRACTION RESULTS

3.1 Procedure

A portion of each sample was powdered finely and used to prepare an X-ray diffractometer trace which was interpreted by standard procedures.

Further, weighed, lightly pre-ground subsamples were taken and dispersed in water with the aid of deflocculants and an electric blender, and allowed to sediment to produce −2 µm e.s.d. size fractions by the pipette method. The resulting dispersions were examined by plummet balance to determine their solids contents, and were then used to produce oriented clay preparations on ceramic plates. Two plates were prepared per sample, both being saturated with Mg^{++} ions, and one in addition being treated with glycerol. When air-dry, these were examined in the X-ray diffractometer. Additional diagnostic examinations carried out consisted of examination of the glycerol-free plate after heating for one hour at 550°C.

3.2 Results

The results are given in Table 1, which lists the following:

(a) The mineralogy of the total sample, as derived from examination of the bulk material, with supporting evidence as available. The minerals found are listed in approximate order of decreasing abundance, using the semiquantitative abbreviations given. Coverage of clays may be incomplete, and for full clay mineralogy Section (c) should be consulted. This section (a) is for information on non-clay minerals and to give a general idea of the makeup and proportion.

(b) The proportion of the sample found to separate into the −2 µm size fraction, as determined by the plummet balance. The figure obtained applies only to the pre-treatment and dispersions conditions used.

(c) The mineralogy of the −2 µm fraction, given as in Section (a).

TABLE 1: BULK AND CLAY FRACTION MINERALOGY OF FOUR SAMPLES, PATRICIA-1

Sample	710		713		722		731.2	
Bulk Mineralogy:	Q	D	Q	D	Q	D	Q	D
	M	A	Sid	SD	K	A	K	A
	K	A	K	A	M	A	M	A
	Sid	A	M	A	F'	Tr	F'	Tr-A
	F'	A	F'	Tr	Py	Tr	Sid?	Tr
							Py	Tr
-2 um fraction %:	7		6		13		8	
Mineralogy:	ML	D	ML	D	ML	D	ML	D
	K	SD	K	A	K	SD	K	SD
	M	A	G	A	M	A-SD	M	A
	C	Tr	M	Tr	C	Tr-A	C	Tr-A
	Q	Tr	Q	Tr	Q	Tr	Q	Tr

Mineral Key

C Chlorite
F' K feldspar
G Goethite (poorly crystalline)
K Kaolinite (poorly crystalline)
M Mica (muscovite, well crystalline)
ML Mixed-layer smectite-illite with approx. equal proportions of the two layer types
Py Pyrite
Sid Siderite
Q Quartz

Semiquantitative Abbreviations

D = Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.

SD = Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.

A = Accessory. Components judged to be present between the levels of roughly 5 and 20%.

Tr = Trace. Components judged to be below about 5%.

4. GRAIN SIZE DISTRIBUTION

Each friable sample was carefully disaggregated with a spray of water (which was all that was required) and wet-sieved on screens from 0.21 mm to 0.053 mm. An abundant -0.053 mm slurry was obtained and the size distribution of this was determined by conventional pipette methods.

The results are as follows:

Sample		710 m	722 m	731.2 m
		cumulative % coarser than		
mm	ø			
0.21	2.25	0.5	0.5	0.6
0.18	2.5	0.9	0.9	0.8
0.15	2.75	3.1	2.2	1.7
0.125	3.0	6.8	2.9	3.4
0.105	3.25	19.9	4.0	6.1
0.088	3.5	49	7.9	26.6
0.074	3.75	66.4	19.1	51.9
0.063	4.0	73.3	30.0	62.9
0.053	4.25	73.8	31	65.2
0.04	4.6	75	40	70
0.03	5.06	79	49	73
0.02	5.64	82	58	77
0.01	6.64	87	71	84
0.005	7.64	90	80	89
0.002	9.0	93	88	96

Figure 1 shows the cumulative grain size distributions and Figure 2 shows the calculated size-frequency curve.

FIGURE 1

Cumulative grain-size distribution
(probability ordinate)

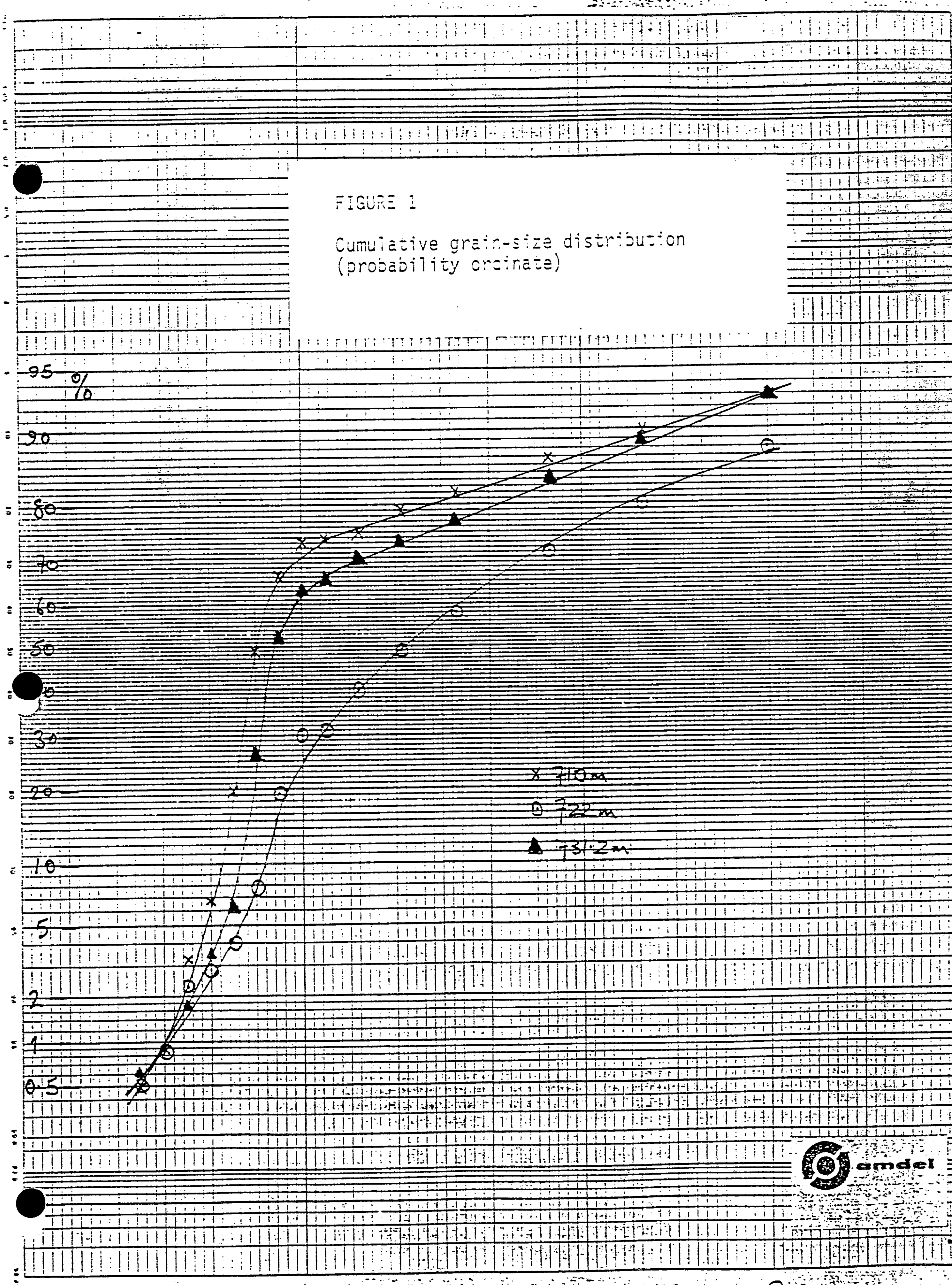
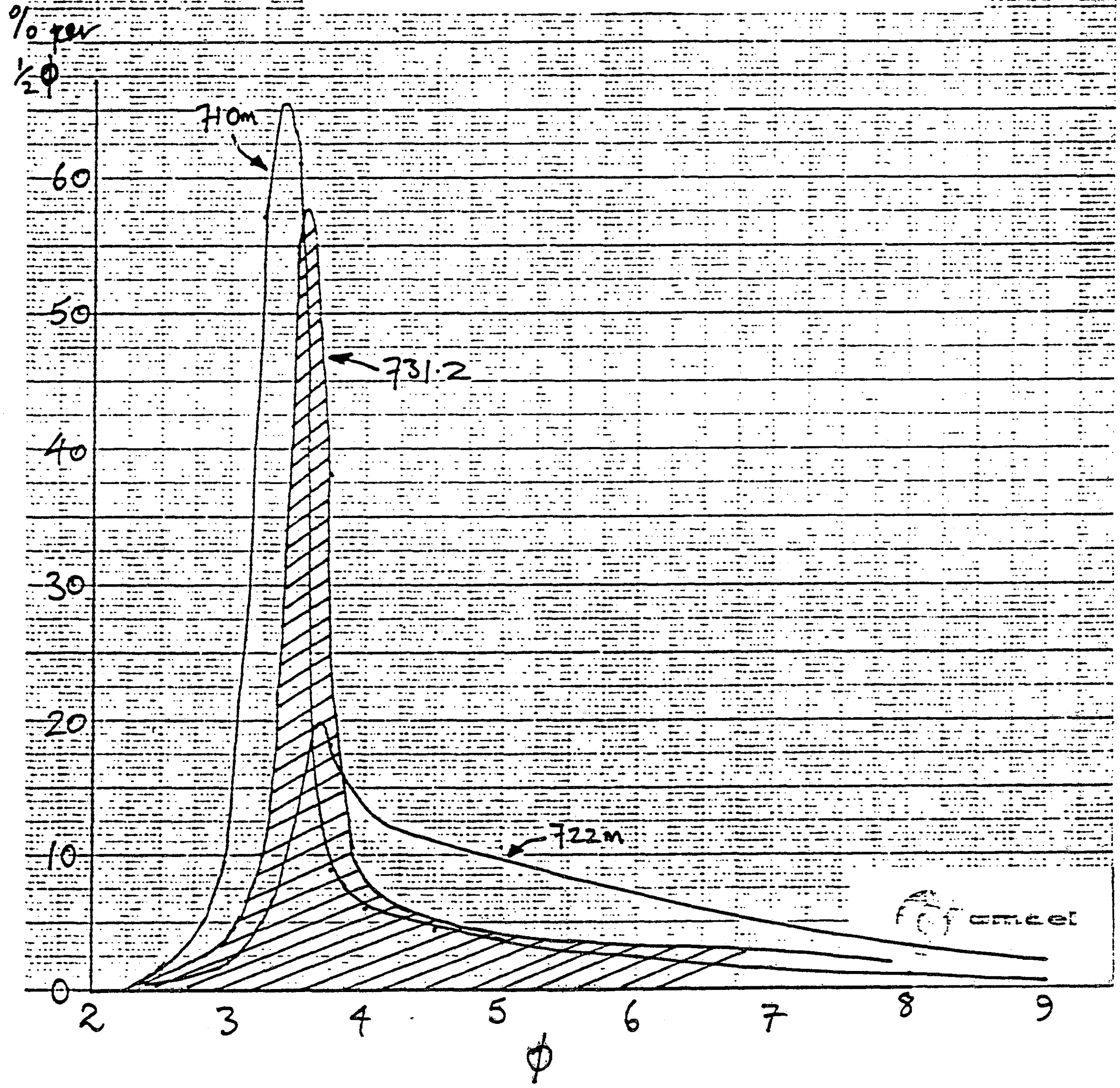


FIGURE 2

Size frequency curve



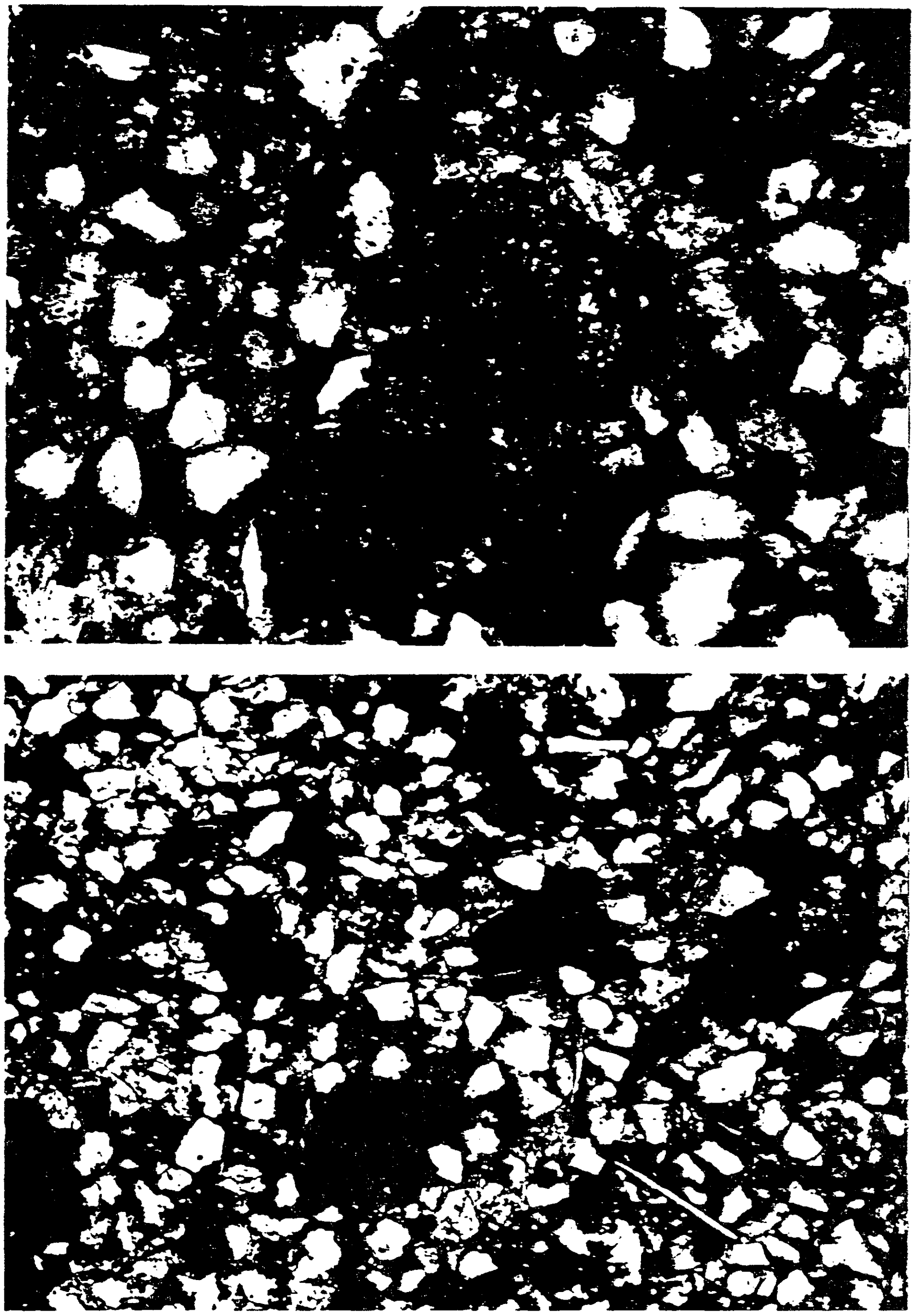


FIGURE 3: 710 m – both fields plane polarised light. The upper field shows a high power (field length ≈0.1 mm) view of an aggregate of siderite crystals. Some show a central 'nucleus'. The lower field is at lower magnification (field length 0.2 mm) and shows a typical area of the thin section. Note large aggregates of brown biotite and very thin, elongate muscovite. Quartz is well-sorted and the matrix is contiguous over the whole field.

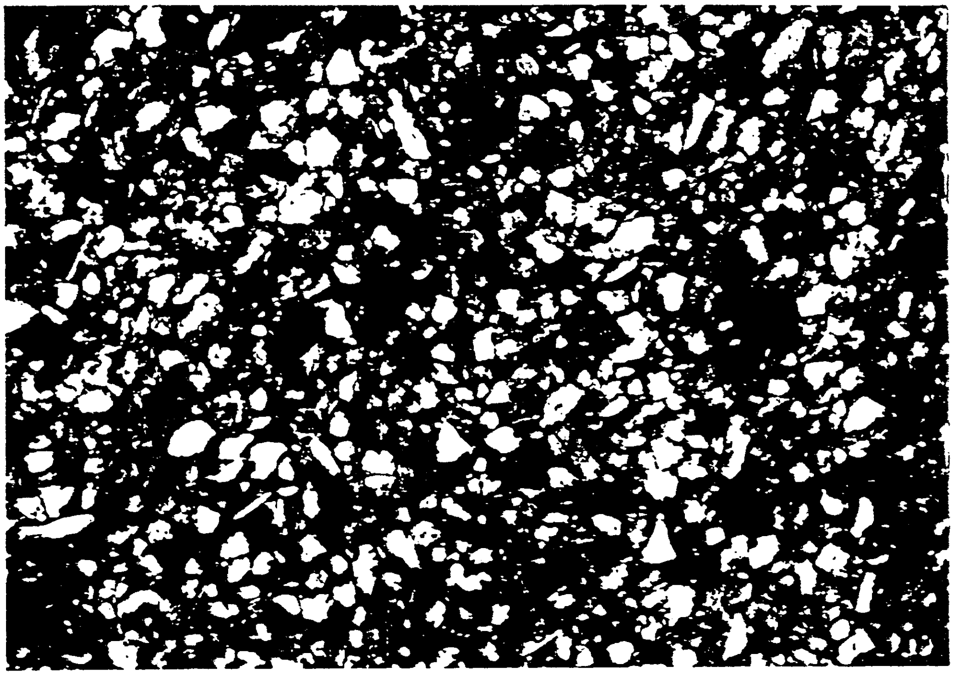
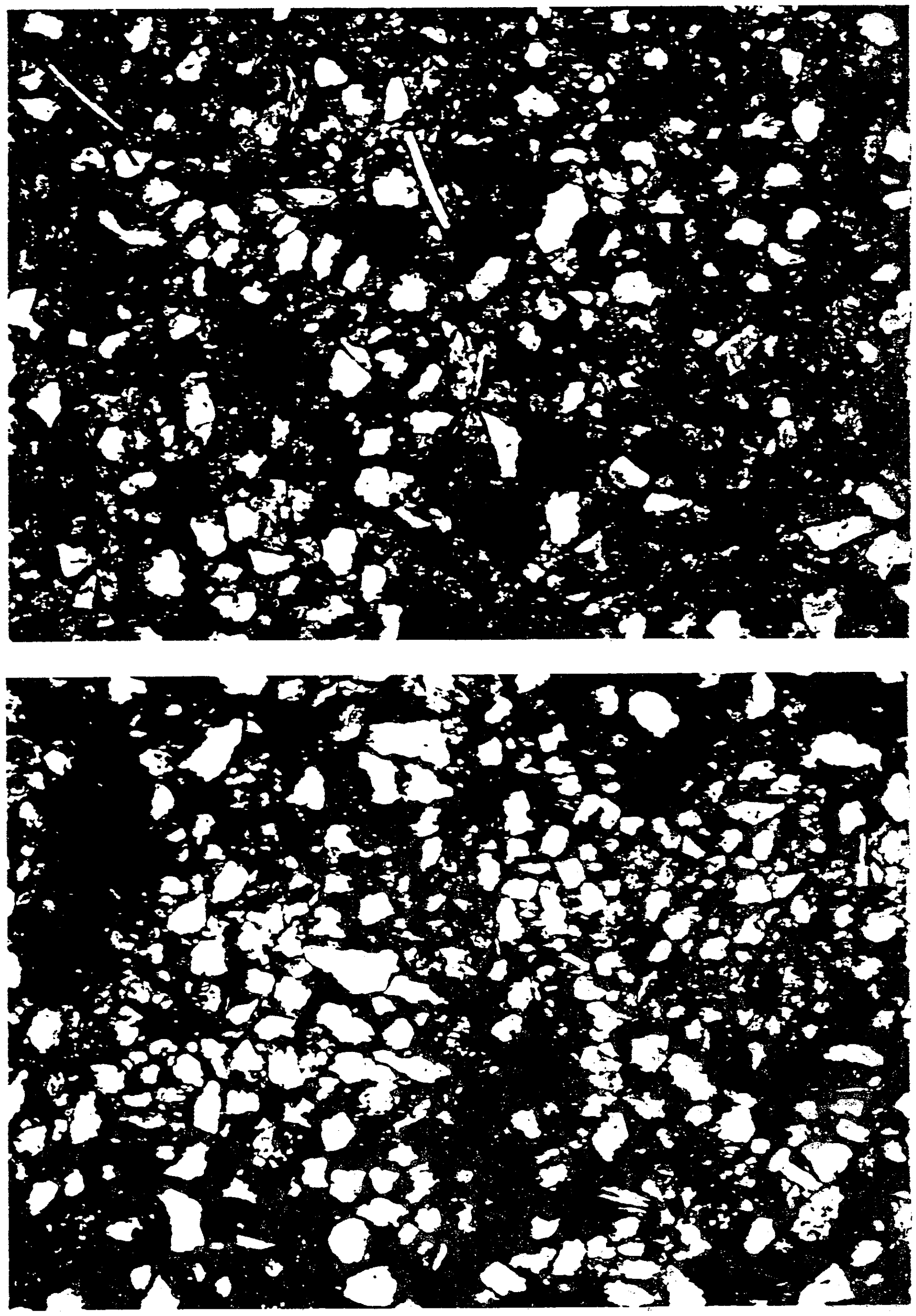


FIGURE 4: 722 m (field length 0.2 mm).
A typical area. Dark brown clay is more abundant than in 710 m and the quartz definitely finer-grained.



<u>FIGURE 5:</u> 713 m (field length 0.2 mm).
The upper field shows part of the paler, siderite-rich parts of the thin section. Siderite (buff colour) comprises more than 50% of the volume of the rock and completely fills intergranular spaces. The lower field is typical of the dark parts of the thin section. Siderite is present in an indefinite area across the centre but much of the matrix is stained clay material as in the friable parts of the reservoir.

amdel
technology and enterprise

Amdel Limited
(Incorporated in S.A.)
31 Flemington Street,
Frewville, S.A. 5063

Telephone: (08) 372 2700

P.O. Box 114,
Eastwood, S.A. 5063

Telex: AA82520
Facsimile: (08) 79 6623

21 September 1987

F 3/0/0
F 6881/88 - Part 2

RECEIVED
23 SEP 1987
Ans'd.............

Lasmo Energy Australia Limited
GPO Box 976
BRISBANE QLD 4001

Attention: Mr D. Lowry

<u>REPORT F 6881/88 - Part 2</u>

YOUR REFERENCE: AFE 322

MATERIAL: Core samples

LOCALITY: PATRICIA-1

Investigation and Report by: Dr Brian G. Steveson

Manager, Petroleum Services Section: Dr Brian G. Steveson

Brian Steveson

for Dr William G. Spencer
General Manager
Applied Sciences Group

cap

Size fractions of the sample from 722 m were submitted for chemical analysis by XRF. The results are given on the attached sheet; because of limited and varying sample amounts, the detection limit varies also and this is shown by the '<' symbols on the results.

In terms of mineralogy, the following relevant conversion factors may be used:

Zr x 2 gives ppm zircon
Ce x 4 gives ppm monazite
Y x 3 gives ppm xenotime

It is clear that these minerals comprise very small proportions of the size fractions (note that 10,000 ppm = 1%). The relatively high values of U and Th compared to the Zr, Ce, La and Y suggest that U and Th do not occur in the lattices of zircon, monazite or xenotime but probably as traces in some major mineral.

The distribution of U and Th with size clearly indicates a dearth of these elements in the clays (of which the -300# fractions are largely composed) and hence it is unlikely that gamma log results are directly related to clay content.

We have attempted to measure the gamma radiation of size fractions using the equipment for gamma logging of cores but it is insufficiently sensitive. We have suitable apparatus currently delayed in Australian Customs; when this is delivered to us we will obtain definitive gamma spectra readings from the size fractions.

NATA Certificate

Results in ppm

Sample		U	Th	Ce	La	Y	Zr
+72#	0·21 mm	<80	<80	<400	<400	<80	240
+85#	·18	<120	<120	<600	*720	<120	380
+100#	·15	<40	<40	<200	*200	<40	280
+120#	125	<80	*80	<400	<400	<80	220
+150#	105	*100	<60	<300	<300	<60	160
+170#	088	<20	<20	<100	*300	<20	120
-200#	074	<20	<20	<100	<100	<20	120
+240#	0625	<20	<20	<100	<100	*20	110
+300#	053	<60	<60	<300	<300	<60	110
-300#	<053	<4	<4	*130	* 30	<4	375

See page X2 for detection limits.

Detection limits

Sample	U	Th	Ce	La	Y	Zr
+72#	80	80	400	400	80	80
+85#	120	120	600	600	120	120
+100#	40	40	200	200	40	40
+120#	80	80	400	400	80	80
+150#	60	60	300	300	60	60
+170#	20	20	100	100	20	20
+200#	20	20	100	100	20	20
+240#	20	20	100	100	20	20
+300#	60	60	300	300	60	60
-300#	4	4	20	20	4	4

Detection limits for each sample are tabled above D.L.'s are different for each sample due to restrctions on sample size.

ENCLOSURES

ENCLOSURES

MUD LOG

MUDLOG

PE603581

This is an enclosure indicator page.
The enclosure PE603581 is enclosed within the container PE906239 at this location in this document.

The enclosure PE603581 has the following characteristics:

ITEM_BARCODE =	PE603581
CONTAINER_BARCODE =	PE906239
NAME =	Mud Log
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	MUD_LOG
DESCRIPTION =	Mud Log for Patricia-1
REMARKS =	
DATE_CREATED =	3/07/87
DATE_RECEIVED =	14/07/87
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

WELL SITE LITHOLOGY LOG

ELLSITE LITHOLOGY LOG

PE603588

This is an enclosure indicator page.
The enclosure PE603588 is enclosed within the container PE906239 at this location in this document.

The enclosure PE603588 has the following characteristics:

ITEM_BARCODE =	PE603588
CONTAINER_BARCODE =	PE906239
NAME =	Wellsite Lithology Log
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	Wellsite Lithology Log for Patricia-1
REMARKS =	
DATE_CREATED =	3/07/87
DATE_RECEIVED =	18/01/88
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

COMPOSITE LOG

COMPOSITE LOG

PE603585

This is an enclosure indicator page.
The enclosure PE603585 is enclosed within the container PE906239 at this location in this document.

The enclosure PE603585 has the following characteristics:

ITEM_BARCODE = PE603585
CONTAINER_BARCODE = PE906239
NAME = Composite Well Log
BASIN = GIPPSLAND
PERMIT = VIC/P11
TYPE = WELL
SUBTYPE = COMPOSITE_LOG
DESCRIPTION = Composite Well Log for Patricia-1
REMARKS =
DATE_CREATED = 18/07/87
DATE_RECEIVED = 18/01/88
W_NO = W963
WELL_NAME = PATRICIA-1
CONTRACTOR =
CLIENT_OP_CO = LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

SEISMIC CALIBRATION LOG

SEISMIC CALIBRATION LOG

PE603589

This is an enclosure indicator page.
The enclosure PE603589 is enclosed within the container PE906239 at this location in this document.

The enclosure PE603589 has the following characteristics:

ITEM_BARCODE =	PE603589
CONTAINER_BARCODE =	PE906239
NAME =	Seismic Calibration Log
BASIN =	GIPPSLAND
PERMIT =	VIC/P11
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	Seismic Calibration Log for Patricia-1
REMARKS =	
DATE_CREATED =	6/07/87
DATE_RECEIVED =	18/01/88
W_NO =	W963
WELL_NAME =	PATRICIA-1
CONTRACTOR =	SCHLUMBERGER
CLIENT_OP_CO =	LASMO ENERGY AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)