MICROPALAEONTOLOGICAL ANALYSIS
PATRICIA-1, GIPPSLAND BASIN

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

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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 biostratigraphi 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 12 (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. Calcareous Nannoplankton Sub-division

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.

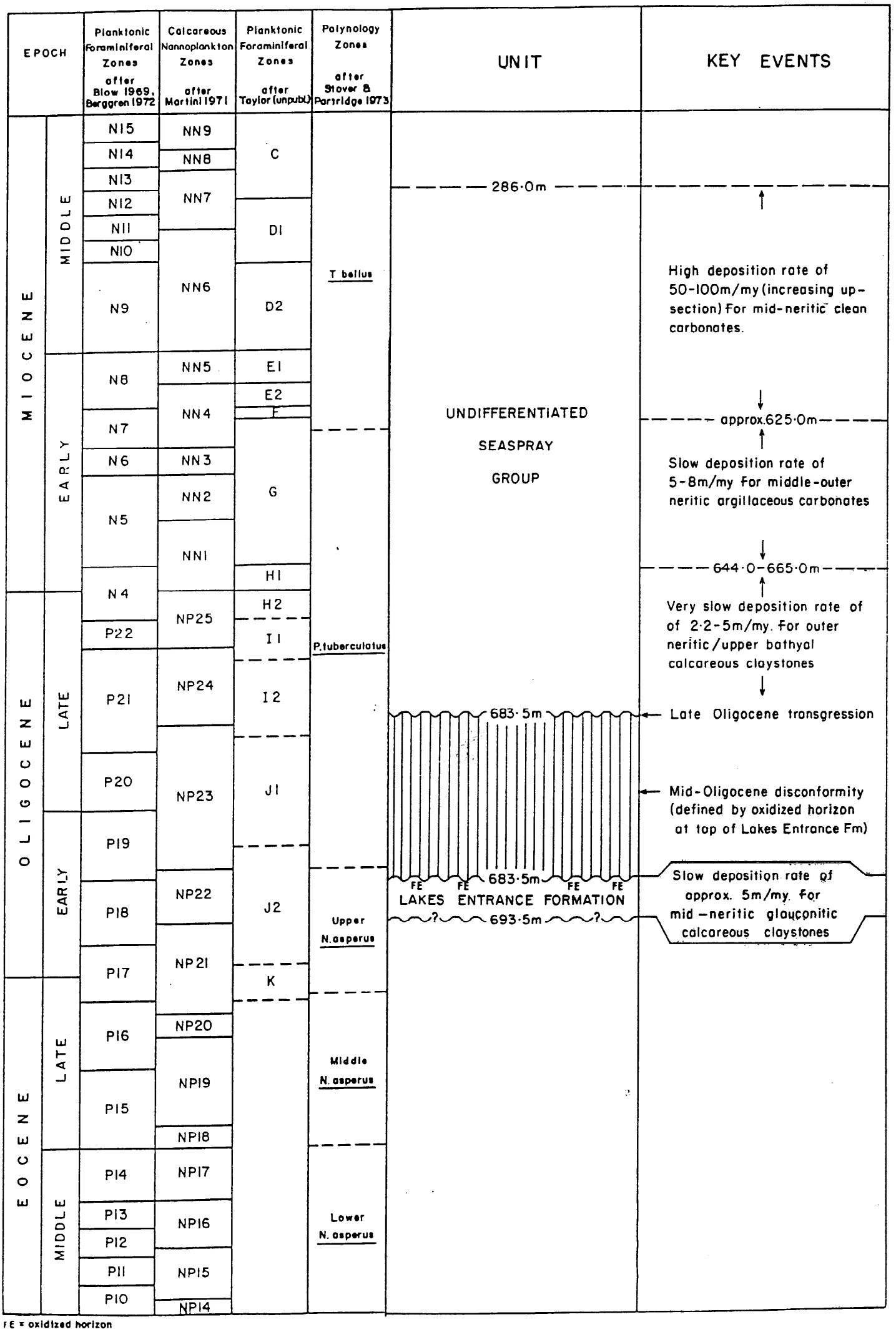

FIGURE No.1 : Chronostratigraphic Chart, Seaspray Group, Patricia-1

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