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PELICAN #4 WELL

MICROPALAEONTOLOGY REPORT

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PELICAN #4 SIDE WALL CORES

MICROPALAEONTOLOGY

The samples

Twenty six side wall cores were examined for foraminifera and the depths and lithologies of the samples are given in Figure 1 and Appendix 1.

Procedures

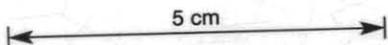
Samples were disaggregated in hot water and washed over a 73 micron sieve. The silt and sand sized fraction was picked for foraminifera. Mounts of the first 300 specimens found were prepared (if there were that many specimens) and the whole sample scanned for diagnostic planktonic species. The nine deepest samples, numbers 69 to 76, have poor faunas, and their total foraminifera content is in the labelled mounts. Slides for other samples have selected planktonic species on the top two rows, and a random count of approximately 300 specimens on the bottom two rows.

Planktonic Zonation

Six planktonic assemblages have been recognised, ranging from the Middle-Late Eocene to the Early Miocene. These assemblages are not meant as zones in the formal sense but represent assemblages of species that can be recognised over a number of samples or have distinct species content.

Depth	S.W.C. No.	Lithology
2910	96	
3010	95	
3200	93	Fine to coarse sandy MARL
3320	92	
3400	91	
3500	90	
3600	89	
3700	88	
3800	87	
3895	86	
4000	85	
4100	84	Grey CLAY with some silty parts
4200	83	
4400	81	
4500	80	
4700	78	Silty MUDSTONE
4800	77	
4900	76	Carbonaceous sandy SILTSTONE
5000	75	Carbonaceous SHALE
5100	74	Laminated sandy MUDSTONE
5200	73	Dark grey CLAYSTONE
5300	72	Buff SILTSTONE
5400	71	Light grey MUDSTONE
5500	70	
5600	69	Black carbonaceous SHALE
5700	68	

FIGURE 1 Synopsis of lithologies in side wall cores examined for foraminifera



Globigerinatheka index assemblage

A single sample, #71, among other samples barren of planktonic foraminifera, contained this characteristic Middle to Late Eocene form.

Globigerina linaperta assemblage

Samples #77 - 81 contain this Late Eocene assemblage which includes Pseudohastigerina micra, Globorotalia aculeata, G. gemma, G. testarugosa, Turborotaloides collecta, Chiloguembelina cubensis, Globigerina brevis and G. linaperta.

Globigerina angioporoides assemblage

Two samples contain this Early Oligocene assemblage which follows the extinction of G. linaperta. It includes Globigerina euapertura, G. ampliapertura, G. angustiumbilitata and Globorotalia nana. Globigerina ciperensis makes an appearance in sample #84.

Globorotalia opima assemblage

This Late Oligocene assemblage ranges from samples #85 - 89, and follows the extinction of G. angioporoides. It includes throughout its range, Globigerina euapertura, G. angustiumbilitata, G. ciperensis, G. labiacrassata, Globorotalia opima and G. nana. Globigerina foliata and G. praebulloides and Globorotalia semivera appear in later samples.

Globigerina woodi assemblage

This Early Miocene assemblage occurs in samples #90 - 92. It is characterised by the appearance of G. woodi and G. woodi connecta. It also sees the first appearance of Cassigerinella chipolensis and Globoquadrina spp.

Globigerinoides trilobus assemblage

This Early Miocene assemblage ranges from samples #93 - 96.

In it Globoquadrina dehiscens first becomes common and Globigerina juvenilis, G. eamesi, G. nepenthoides, Globorotalia siakensis and G. peripheroronda appear.

The distribution of planktonic species is given in chart 1. Included in this chart is the divisions of the Taylor letter scheme, as best can be estimated. While there is general compatibility of this scheme with the present faunal lists, the first stratigraphic appearance of G. opima and G. euapertura is somewhat closer than has been usually found.

Figure 2 shows the total number of planktonic and benthonic foraminifera species found in a random count of approximately 300, and the percentage of planktonic species present. Samples early in the G. linaperta assemblage indicate the onset of normal marine conditions, with an increase in species diversity and the size of the specimens. Sample 77 is transitional as it has a higher than usual planktonic percentage of small specimens, and the benthonic communities had not yet fully established themselves.

FIGURE 2 Pelican #4 Side Wall Cores

The percentage of planktonic species and the total number of species in approximately 300 specimen counts. The total number of species stabilizes at between 25 and 35 by sample #80. Sample 77 has a normal marine distribution of benthonic species (see figure 3) but the large percentage of very small planktonics, along with the reduced diversity of total species, suggests that normal marine conditions through the whole water column were only gradually reached

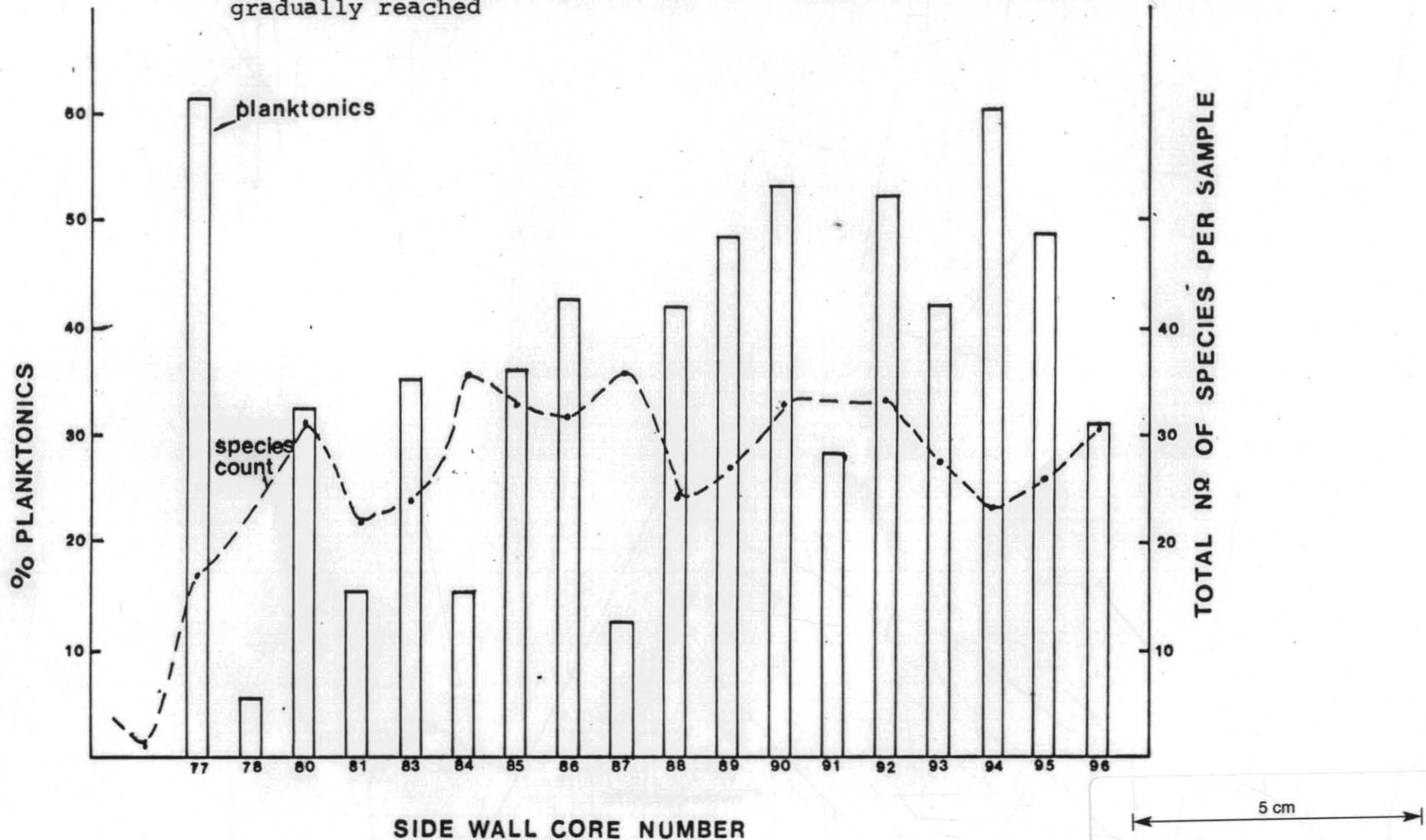


CHART 1

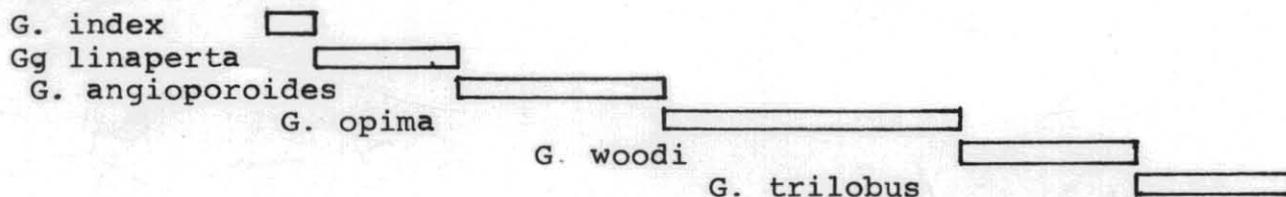
DISTRIBUTION OF PLANKTONIC FORAMINIFERA

SAMPLES
SPECIES

71 77 78 80 81 83 84 85 86 87 88 89 90 91 92 93 95 96

TAYLOR SCHEME	N	L-K	J2	I	H	G
GLOBIGERINATHEKA INDEX	X					
PSEUDOHASTIGERINA MICRA	X					
GLOBOROTALIA ACULEATA	X					
TURBOROTALOIDES COLLECTEA	X					
GLOBIGERINA LINAPERTA	X	X	X	X		
GLOBOROTALIA GEMMA		X	X	X	X	
CHILOGUEMBILINA CUBENSIS		X				
GLOBIGERINA BREVIS			X			
GLOBIGERINA ANGIOPOROIDES			X	CF	X	X
GLOBOROTALIA TESTARUGOSA			X			
GLOBIGERINA AMPLIAPERTURA			X		X	X
GLOBIGERINA EUAPERTURA			X	CF	X	X
GLOBOROTALIA NANA			X	X	X	X
G. ANGUSTIUMBILICATA			X	X	X	X
GLOBOROTALIA OPIMA			X	CF	X	X
GLOBIGERINA CIPEROENSIS			X	X	X	X
GLOBIGERINA LABIACRASSATA			X	X	X	X
GLOBIGERINA FOLIATA			X	X	X	X
GLOBOROTALIA SEMIVERA			X	X	X	X
GLOBIGERINA SP1			X	X	X	X
GLOBOROTALIA SIAKENSIS			X	X	X	X
GLOBIGERINA PRAEBULLOIDES			X	X	X	X
GLOBIGERINA WOODI			X	X	X	X
GLOBIGERINA CONNECTA			X	X	X	X
CASSIGERINELLA CHIPOLENSIS			X	X	X	X
GLOBOROTALIA SP1			X	X	X	X
GLOBOQUADRINA SP1			X	X	X	X
GLOBIGERINA JUVENILIS			X	X	X	X
GLOBIGERINA EAMESI			X	X	X	X
GLOBIGERINOIDES TRILOBUS			X	X	X	X
GLOBOQUADRINA DEHISCENS			X	X	X	X
GLOBIGERINA NEPENTHOIDES			X	X	X	X
GLOBOROTALIA PERIPHERORONDA			X	X	X	X

ASSEMBLAGES



5 cm

Benthonic Foraminifera

The relative percentages of arenaceous, miliolinid and rotalid benthonic foraminifera are plotted in figure three. Changes in sea floor conditions are reflected in the proportions of the various foram groups, and the time and nature of the changes can be determined.

Samples 68 - 76

Late Eocene and older - these samples have a very sparse fauna dominated strongly, or even exclusively, by arenaceous foraminifera. The exception is sample 74, which includes rotalids. Normal marine conditions did not exist and the benthonic environment was stressed. Planktonic foraminifera were usually excluded during this time.

Samples 77 - 83

These are dominated by rotalids with a small percentage of miliolinids and arenaceous forms. The rotalids consist of diverse species with 5 to 10 being common in any sample, as can be seen in the numbers given in chart 2. The diverse rotalids suggest that normal marine deep water conditions were established during the late Eocene.

Samples 84 - 88

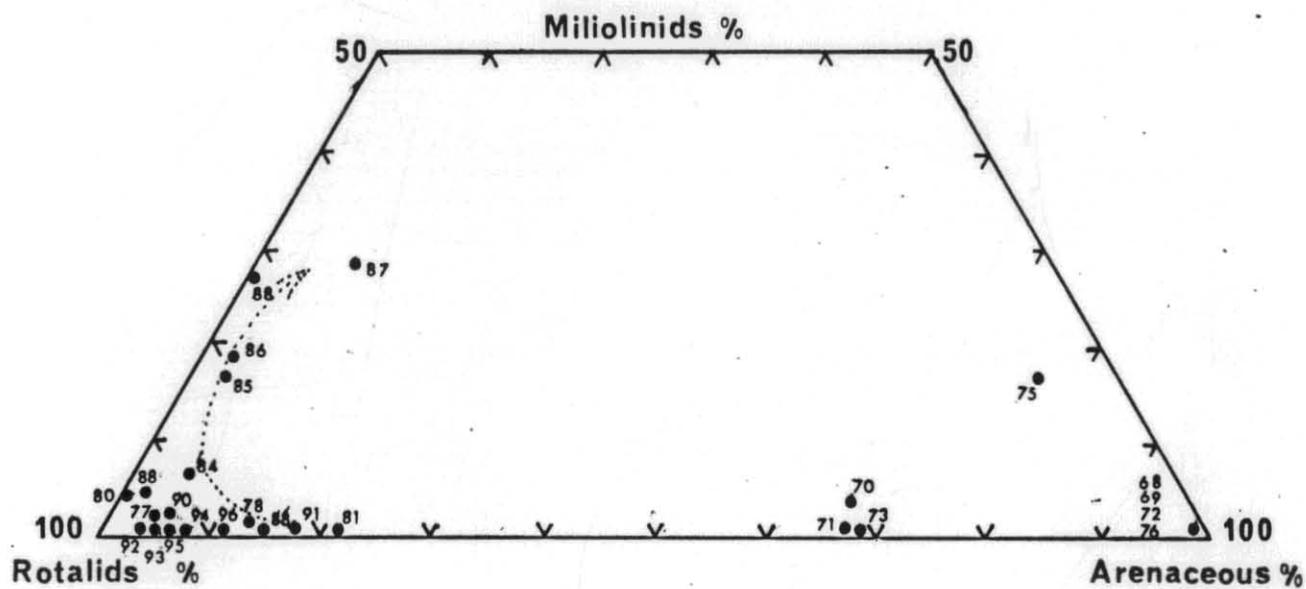
Although still dominated by rotalid species, the samples have a gradually increasing percentage of miliolinids, consistent with an open shelf environment.

Samples 89 - 96

These samples consist of rotalid benthonics with minor arenaceous

forms. Although there are numerous rotalid species present samples are numerically dominated by one or two species only. They also contain many bryozoal fragments. The exception is sample # 90 at the base of the Globigerina woodi assemblage interval, which is a mainly barren clay. Above this sample the larger foraminifera Operculina complanata appears in samples.

FIGURE 3 Pelican #4 Side Wall Cores
 Relative percentages of groups of benthonic foraminifera
 The major change in assemblages occurs above sample 76, when normal benthonic marine conditions were beginning to be established. Note the increase in miliolinid species in samples 83 to 88.



Depositional History

Middle to Late Eocene

Carbonaceous sediments accumulated during this interval. Benthonic faunas are poor, but in the rare samples in which rotalids occur, they represent deep water assemblages. This suggests that the basin was not shallow, but the stress conditions for benthonic organisms were generated by barred basin conditions, with limitations on circulation and oxygenation of bottom sediments. This is supported by the exclusion of planktonic foraminifera in any numbers prior to sample 77 in the Late Eocene. Faunas throughout the Eocene are composed of very small specimens with many juveniles. In the Late Eocene fine grained, well sorted quartz sand forms a significant component of the sediment.

Early Oligocene

In this interval diverse benthonic faunas are contained in clays with calcareous fossil debris - a forerunner of the marls of the Late Oligocene and Early Miocene. Deposition was in a fairly deep shelf or slope environment.

Late Oligocene to Early Miocene

Richly fossiliferous shelf marls accumulated during this interval with gradually shallowing deposition.

SAMPLE DESCRIPTIONS

SAMPLE NUMBER	DEPTH	LITHOLOGY
68	5700'	BLACK CARBONACEOUS MUDSTONE
69	5600'	BLACK CARBONACEOUS SHEARED SHALE
70	5500'	BLACK EXTREMELY CARBONACEOUS SHALE
71	5400'	LIGHT GREY SILTY CLAYSTONE WITH DARKER GREY CARBONACEOUS PATCHES
72	5300	BUFF SILTSTONE WITH IRREGULAR FINE LAMINATIONS
73	5200'	DARK GREY CLAY WITH IRREGULAR BLACK CARBONACEOUS PATCHES. WHITE FORAMINIFERA DISPERSED 6 TO 7 IN CORE CROSS-SECTION. SAMPLE MOSTLY PASSES 73 MICRON SIEVE. NUMEROUS SMALL PYRITIC BURROWS.
74	5100'	BUFF SANDY SILT STREAKED WITH IRREGULAR DARK CARBONACEOUS BANDS 1mm THICK AND 2 TO 5 mm APART. VERY WELL SORTED FINE QUARTZ SAND AND SILT
75	5000'	DARK GREY IRREGULARLY LAMINATED CARBONACEOUS SHALE WITH WHITE FOSSIL FRAGMENTS. MOST OF THE SAMPLE PASSES THE 73 MICRON SIEVE EXCEPT QUARTZ SILT
76	4900'	BUFF FINE SAND VERY WELL SORTED WITH LAYERED CARBONACEOUS FRAGMENTS. INCLUDES FINE HOLLOW CEMENTED WORM TUBES AND CALCAREOUS SPICULES.
77	4800'	BUFF TO DARK BROWN MOTTLED CLAY WITH IRREGULAR CARBONACEOUS PATCHES PARALLEL TO BEDDING. CORE CRACKS ON DESSICATION. VERY FINE CARBONATE PRESENT BUT ONLY A SMALL SAND/SILT FRACTION.
78	4700'	DARK GREY SILTY MUDSTONE WITH FINE WHITE FOSSIL FRAGMENTS
80	4500'	BUFF TO DARK GREY CLAYSTONE WITH CARBONACEOUS FRAGMENTS AND DISPERSED FINE CALCAREOUS FOSSIL FRAGMENTS
81	4400'	BUFF TO DARK GRAY CLAYSTONE WITH OCCASIONAL WHITE FORAMINIFERA AND FOSSIL FRAGMENTS. MOST PASSES THE 73 MICRON SIEVE
83	4200	LIGHT GREY UNIFORM CLAY. MOST PASSES THE 73 MICRON SIEVE WITH THE EXCEPTION OF CARBONACEOUS FRAGMENTS AND LIMONITIC ALTERATIONS OF PYRITE.
84	4100'	DARK GREY CLAY WITH IRREGULAR WHITE CALCAREOUS STRINGERS 1 TO 5mm THICK AND 5 TO 10mm APART. CRACKS ON DESSICATION. ALMOST ALL CLAY PASSES THE SIEVE

- 85 4000' LIGHT GREY CALCAREOUS CLAY WITH IRREGULAR STRINGERS OF CALCAREOUS SAND.
- 86 3895 GREY CALCAREOUS CLAY WITH IRREGULAR STRINGERS OF CALCAREOUS SAND.
- 87 3800' LIGHT GREY CALCAREOUS MARL WITH FINE TO COARSE GRAINED CALCAREOUS SAND STRONGLY LAYERED WITH THIN CLAY BANDS. FOSSILS ARE MAINLY BRYOZOA.
- 88 3700' LIGHT GREY MARL WITH IRREGULAR STRINGERS OF CALCAREOUS SAND.
- 89 3600' LIGHT GREY MARL WITH FINE TO COARSE CALCAREOUS STRINGERS. MANY AGGREGATES NOT BROKEN UP BY BOILING. COARSE BRYOZOA.
- 90 3500' LIGHT GREY MARL WITH SOME FINE TO MEDIUM GRAINED CALCAREOUS SAND. MOST PASSES THE 73 MICRON SIEVE. NO BRYOZOA
- 91 3400 GREY MARL WITH FINE TO MEDIUM GRAINED CALCAREOUS SAND. DISAGGREGATES IN WATER WITH MANY CEMENTED LUMPS TOO HARD TO BREAK. MANY BRYOZOA INCLUDING LARGE LUNULITID FORMS.
- 92 3320' GREY MARL WITH CALCAREOUS FRAGMENTS UP TO 3mm. HOMOGENEOUS DISAGGREGATES MAINLY IN WATER LEAVING CEMENTED AGGREGATES DIFFICULT TO BREAK.
- 93 3200' GREY TO GREEN MARL WITH CALCAREOUS CLASTS UP TO 8mm MAINLY BRYOZOA FOSSILS.
- 94 3010' BUFF UNIFORM SANDY MARL
- 95 2910' BUFF SANDY MARL WITH DARK BROWN STRINGERS PARALLEL TO CORE GIVING A LAYERED APPEARANCE.