STRATIGRAPHY
of the
FORAMINIFERAL SEQUENCE
in
HELIOS # 1,
GIPPSLAND BASIN.

for: PHILLIPS AUSTRALIAN OIL COMPANY.

February 8th, 1983.

David Taylor,
23 Ballast Point Road, Birchgrove, 2041.
AUSTRALIA. (02) 82 5643.

BIOSTRATIGRAPHY.

MID EOCENE - 2630.0m to 2596.0m:-

The planktonic foraminiferal sequence in Helios # 1 commenced in the mid Eocene with a series of marine ingressions; represented in three sidewall cores at 2630.0, 3608.0 and 2569.0m. As the range of *Globigerina frontosa* was restricted to the lower half of the mid Eocene Zones N10 and N11 of Blow (1979) and as no associated species were confined in range to the basal mid Eocene or early Eocene, an Assemblage Zone O designation is given for this interval. Zone O implies that the Unit was deposited above the base of the mid Eocene (= Zone P) but not in the upper half of the mid Eocene (= Zone N) even though associated species such as *Globigerina primitiva* range to the top of the mid Eocene. Apart from *Globigerina linaperta*, none of the species in this association range above the mid Eocene Zone N in southern Australia.

LATE EOCENE - 2593.0m and the EOCENE HIATUS at 2593m:-

As *Globigerina linaperta* is not regarded to extend above the top of the Eocene in the Tasman Sea Region (Kennett, 1980), the low diversity planktonic fauna at 2593m is regarded as representing Assemblage Zone K at the top of the late Eocene.

This Zone K determination at 2593.0m, just 3 metres above the early Mid Eocene Zone O fauna at 2596.0m, indicates that a hiatus of some 8 million years in duration occurred. The E-logs suggest that the unconformity surface marking this event was at 2593.0m.

EARLY OLIGOCENE - 2580.0 to 2571.0m and the OLIGOCENE HIATUS at 2580.0m:-

The association in these two sidewall cores is that of Assemblage Zone J-2; confirmed by the presence of *Globigerina brevis* which was restricted to this assemblage at the base of the Oligocene. Also *Globorotalia gemma* does not range above the basal Oligocene in the Tasman Sea Region (Kennett, 1980).

A hiatus is not discernible between the late Eocene and early Oligocene in Helios, though apparent in other sequences (refer discussion on Paleo-environment). However, the widespread Oligocene Hiatus of the *COBIA EVENT* (refer Taylor, 1983) was clearly evident at 2565m (E-log) with the Early Miocene, Zone E-1 present in the sidewall core at 2565m. The time span of this hiatus was of the order of 12 million years.

MIOCENE - 2565.0 to 511.0m:-

A thick sequence of mainly deep water Miocene carbonates was penetrated. The sequence appears to have been continuous. Zone E-1 was not identified, but it

HELIOS ÷ 1
STRATIGRAPHIC SUMMARY.

Sample† Depth m	ZONE*	AGE*	STRAT-UNIT¶ & PALEOENVIRONMENT	E-LOG PICK
345.0 to 350.0	?	? LATE MIOCENE/ PLIOCENE	JEMMYS POINT FORMATION mid-inner shelf (<100m)	
511.0 to 1040.0	B-1 to D-1	LATE to MID MIOCENE	GIPPSLAND LIMESTONE Outer to mid Shelf (200-100m)	
1100.0 to 1330.0	D-1	MID MIOCENE	CANYON FILL MEMBER of Gippsland 1st - Upper Slope with slumping (200-400m)	1340
1345.0 to 1840.0	D-1 to D-2	MID MIOCENE	TASMAN SEA CARBONATES with deep water oozes. Paleo-depth increased up-section from(≈200m) at 2593 to (≈400m) at 1345m.	
1940.0 to 2565.0	E-2 to H-1	EARLY MIOCENE	Evidence of anoxic deposition at and above 2116m as above but oxic conditions	?2142
		(12 m.y.)		2567
2571.0 to 2580.0	J-2	EARLY OLIGOCENE	LAKES ENTRANCE MARL equivalent mid shelf (<100m) increasing paleo-depth up-section to outer shelf (<200m)	2580
2593.0	K	LATE EOCENE	COLQUHOUN FORMATION inner shelf (<40m)	
		(8 m.y.)		2593
2596.0 to 2630.0	O	MID EOCENE	FLOUNDER FORMATION Estuarine/tidal marsh with marine ingressions bearing planktonic forams at 2596.0; 2608.0 & 2630.0.	
2643.0 to 2659.0	?	?		2659
2662 to 2764	?	?	? Marginal marine glauconitic sandy siltstone	

† Summary of results from examination of sixty three sidewall cores as listed in full on Tables 2 to 5.

* Planktonic foraminiferal assemblage zones only - PALYNOLOGY NOT AVAILABLE at time of compilation. Detailed planktonic foraminiferal distribution from 2630.0 to 2255.0m given on TABLE 2 and from 2205.0 to 345.0m on TABLE 4. Reliability of zonal determinations are on Data Sheet - TABLE 1.

¶ Interpretations based on distribution of benthonic micro-fossils and other sediment grains (>.075mm). Refer TABLE 3 for data from 2746.0 to 2255.0m and to TABLE 5 from 2205.0 to 345.0m. For Rock Stratigraphic nomenclature refer this report and to Taylor (1983).

(8 m.y.) Hiatus with time span in parentheses.

was very thin elsewhere, and so thereis no doubt present between E-2 at 1940.0m, where there was a sampling gap.

The 500m interval occupied by Zone D-1 appears disproportionally thicker in comparison with the rest of the Miocene sequence; especially as the time span of D-1 was only 1.5 million years compared with 19 million years for the 2200 metres of Miocene in Helios # 1. However, this acceleration in accumulation rate during Zone D-1 times can be explained in terms of slope slumping and submarine canyon filling (refer Table 5).

No diagnostic planktonic fauna was found above the B-1 assemblage at 511.0m, so the interval above this could be either Late Miocene and/or early Pliocene. Sedimentological evidence suggests deposition above 511.0m was during a regressive phase which is well documented at the top of the Miocene.

PALEOENVIRONMENT and ROCK STRATIGRAPHY.

2764.0 to 2662.0m -

As samples examined in this interval were barren of foraminifera, little comment can be made, save that the presence of glauconite suggests marginal marine conditions.

2659.0 to 2596.0m - FLOUNDER FORMATION -

An interval of siltstones and fine quartz sandstones; glauconitic at the base and sporadically pyritic towards the top. Apart from the basal sample at 2659.0, all other samples were faunally dominated by the arenaceous benthonic foraminifera *Haplophragmoides* spp, which being euryhaline, can withstand fluctuations in salinity. Fish fragments, worm tubes and evidence of bio-turbation were frequent throughout the unit. Such a benthonic association strongly supports an estuarine environment with tidal delta conditions in the lower part of the interval (2659.0 to 2643.0m). Periodic flooding of normal salinity, sea-water, into the estuary is evidenced by the presence of planktonic foraminifera at 2630.0, 2608.0 and 2596.0m. Both the litho and bio facies, as well as the mid Eocene age (planktonic foraminiferal Assemblage Zone C), indicates that this unit was a correlate of the Flounder Formation.

EOCENE HIATUS at 2593.0m.

Facies equivalents of either the Turrum or the Gurnard Formation were not identified in the Helios # 1 sequence; such units may have been removed as a consequence of the succeeding late Eocene Transgression.

2593.0 to 2580.0m - COLQUHOUN FORMATION.

A calcareous clayey polymodal quartz sandstone at 2593.0m contained an abundance of glauconite and pyrite with a very sparse foraminiferal fauna with an uppermost Eocene, Zone K planktonic association. This sample represents the initiation of the widespread late Eocene/early Oligocene transgression onto the Gippsland Basin margins. This facies can be equated with the quartz, glauconitic sandy Colquhoun Formation (refer Taylor, 1983). Deposition of the sample at 2593.0m was in a very shallow inner continental shelf situation; possibly under litteral conditions.

2580.0 to 2571.0m - LAKES ENTRANCE MARL EQUIVALENT.

The fine quartz sandy biogenic marls of this interval are very similar in lithofacies to the LAKES ENTRANCE MARLS of the Basin Margins, however the benthonic foraminiferal faunas and high planktonic percentage at 2571.0 indicate deeper paleo-depths of deposition. The depth increase appears to have been gradational across the Eo/Oligocene boundary from the Colquhoun Formation to those Lakes Entrance Marls. Sudden paleoenvironmental disruption, apparent in other offshore sections, was not evident across the Eo/Oligocene boundary in Helios # 1 (refer Taylor, 1983).

2565.0 to 1340.0m - THE MIOCENE TASMAN SEA CARBONATES & OOZES.

These are a thick sequence of biogenic carbonates, varying in $CaCO_3$ purity and degree of diagenesis. On criteria given by Hayward & Buzas (1979), the benthonic foraminiferal assemblages demonstrated an up-sequence increase in paleo-depth with progradation of the shelf edge, down slope. A regional seismic event within this unit corresponds with a change in oxygen supply between samples at 2145.0 and 2116.0m. At and below 2145.0m, pyrite was not present and faunas suggested reasonable oxygenation. But at and above 2116.0m pyrite (and limonite after pyrite) was generally abundant and benthonic distribution sporadic. Therefore the depositional surface below ?2142.0m (E-log) is regarded as having been oxic, whilst that above ?2142.0m was decidedly anoxic. Reasons for this change in oxygenation may have been related to sudden changes in bottom water mass characteristics during the early Miocene Zone F; for instance, a dramatic

paleotemperature increase is noted in Tasman Sea sediment at around 17 million years (refer Kennett, 1980, Fig. 5). Sediment with Zone F planktonics deposited on the Gippsland Basin margins show records of this oceanic warming by the presence of tropical, benthonic larger foraminifera (e.g. *Lepidocyclina* spp.) In fact this was the only time in the foraminiferal sequence when warm water benthonic species inhabited Gippsland waters.

TASMAN SEA CARBONATES and OOZES is the term used here and by Taylor (1983) for a unit which is usually labelled as the Lakes Entrance Formation in the offshore Gippsland Basin. The persistent sedimentation of this deep water, biogenic carbonate from late Oligocene to the Recent, contrasts with the short time span of the rapidly transgressive Lakes Entrance Formation (late Oligocene to earliest Miocene Zones I to H). The Tasman Sea Carbonates and Oozes are accumulating today seaward of the Gippsland continental shelf edge. They are predominantly globigerinid and nannoplankton oozes with very little terrigineous clay or sand, whilst the Lakes Entrance Formation was deposited on an inner continental shelf platform and contained a high proportion of quartz and clay as the sea transgressed over an exposed eroded surface of granite and Latrobe Groups, sands and silts (refer Hocking & Taylor, 1964). For these reasons, I regard the Lakes Entrance Formation as a misnomer when applied to sediment deposited in the Gippsland Basin Deep.

1330.0 to 1130.0m - CANYON FILL MEMBER of the GIPPSLAND LIMESTONE.

At 1340.0 metres, there was a sudden increase in biogenic debris of shallow water origin (benthonic foraminifera, bryozoa and siliceous sponge spicules). This influx of detrital material also resulted in an overall increase in grain size, though seldom to calcarenite grade. Episodic slumping from the shelf down slope were noted in a number of samples (see Table 5). Such down slope displacement of fauna is common during the Miocene on both sides of the Tasman (Hayward & Buzas, 1979, p.24). Most of the criteria of Gippsland submarine canyon fill sedimentation were present in this interval of Helios # 1. The E-log character change at 1340.0 is taken as base Gippsland Limestone reflecting the sharp break from pelagic carbonates to the more detrital biogenic carbonates above 1340.0

1100.0 to 511.0m - GIPPSLAND LIMESTONE.

Rapid filling of the canyon (refer Page 3) and eustatic regression during Zone D-1, was followed by deposition of the continental shelf with gradual decrease in depositional depth in the late Miocene (refer Table 5).

350.0 to 345.0m - JEMMYS POINT FORMATION.

Marked by shallow water, high energy sedimentation with very poor fauna and a high content of terrigineous silt. The calcareous cement may be dolomitic.

REFERENCES.

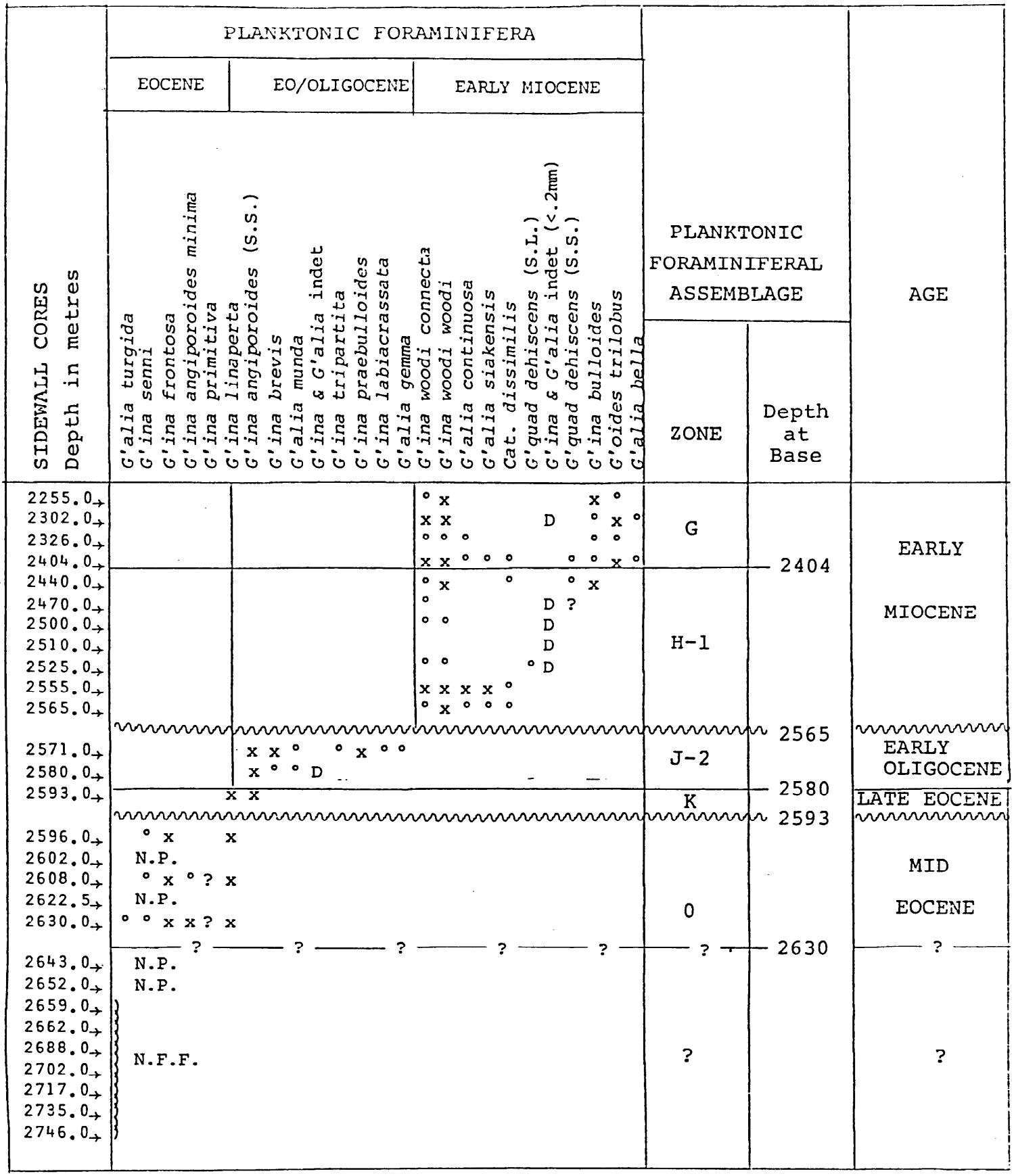
BLOW, W.H., 1979 - *The Cainozoic Globigerinida. A Study of the Morphology, Taxonomy, Evolutionary Relationships and the Stratigraphical Distribution of some Globigerinida (mainly Globigerinacea). 3 Volumes as Sections I & II + Atlas.* Leiden, E.J. Brill.

HAYWARD, B.W. & BUZAS, M.A., 1979 - Taxonomy and Paleoecology of Early Miocene Benthic Foraminifera of Northern New Zealand and the North Tasman Sea. *Smithsonian Conts. to Paleobiology, 36;* 1-154.

HOCKING, J.B. & TAYLOR, D.J., 1964 - The Initial Marine Transgression in the Gippsland Basin, Victoria. *APEA Journ.*, 125-144.

KENNETT, J.P., 1980 - Paleoceanographic and Biogeographic Evolution of the Southern Ocean During the Cenozoic, and Cenozoic Microfossil Datums. *Palaeogeogr., Palaeoclimatol., Palaeoecol., 31(2-4);* 123-152.

TAYLOR, David, 1983 - The Gippsland Basin Enigma - Top Latrobe. *Report to Phillips Australian Oil Company.* Final copy dated Jan. 26, 1983.



KEY:

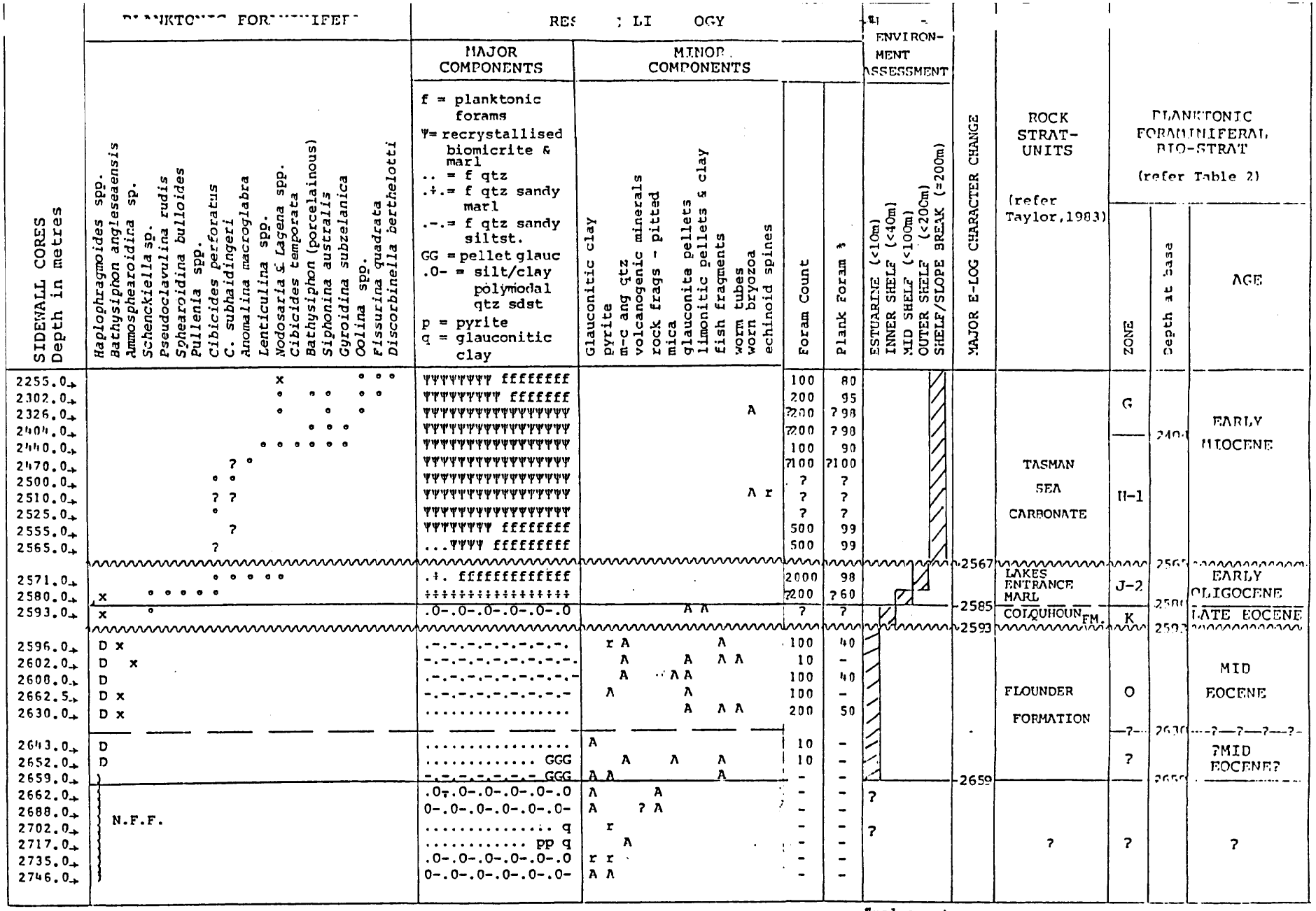
° = <20 specimens
x = >20 specimens
D = Dominant >60% specimens

N.P. = No planktonic foraminifera
N.F.F. = No foraminifera found

TABLE 2: EOCENE, OLIGOCENE to EARLY MIOCENE PLANKTONIC DISTRIBUTION - HELIOS # 1.

refer Table 3 for Miocene Planktonic Foraminiferal Distribution above 2255m.

David Taylor, 3/2/83



KEY: ° = <20 specimens
x = >20 specimens
D = Dominant >60% specimens
N.F.F. = no foraminifera found

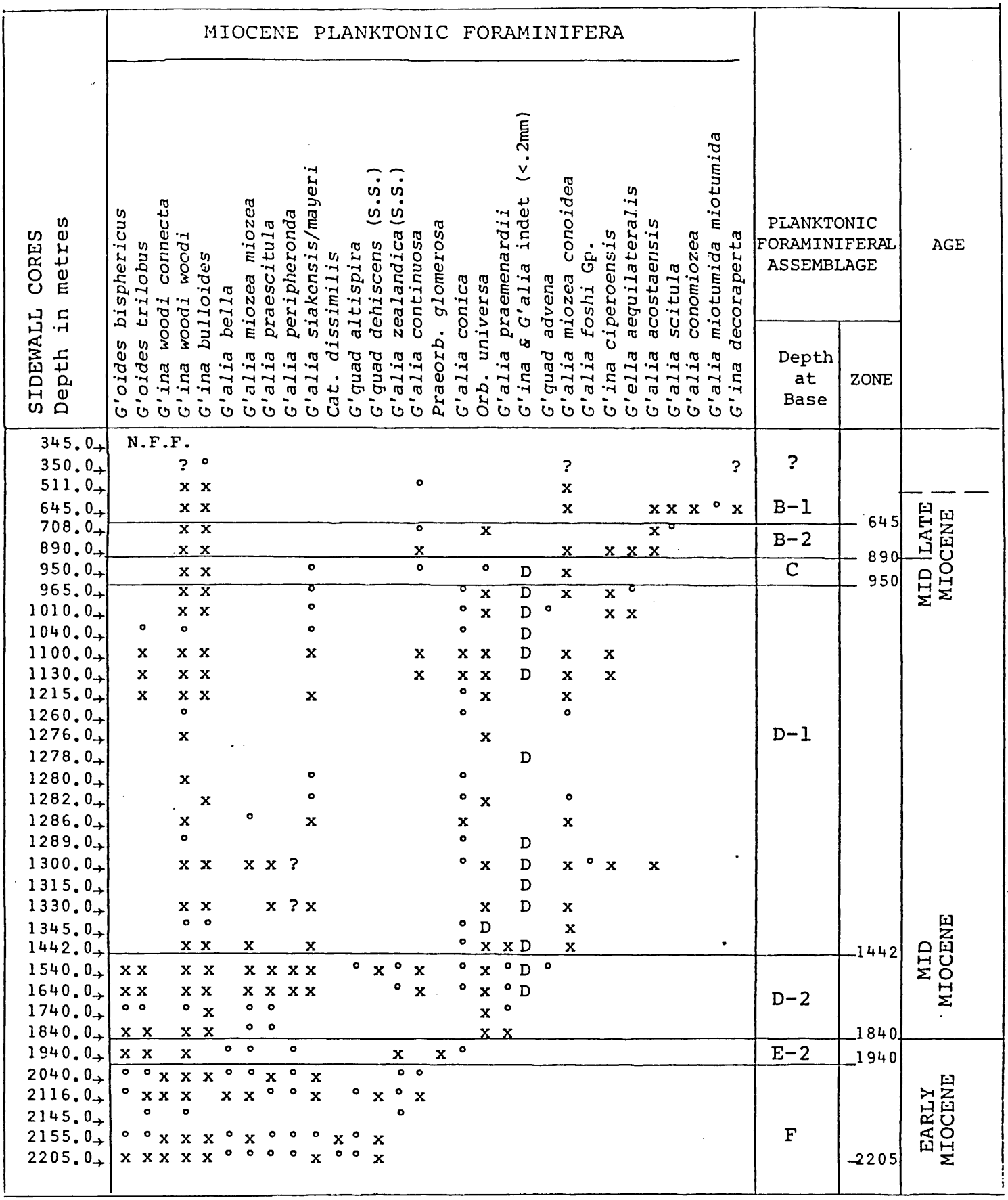
A = abundant 1-5% grains
r = rare <20 grains
? = identification queried

¶paleo-water depth in parentheses

TABLE 3: PALEOENVIRONMENTS - EOCENE to EARLY MIOCENE - HELIOS # 1

refer Table 5 for Miocene Paleoenvironments above 2255m.

David Taylor 4/2/1983.

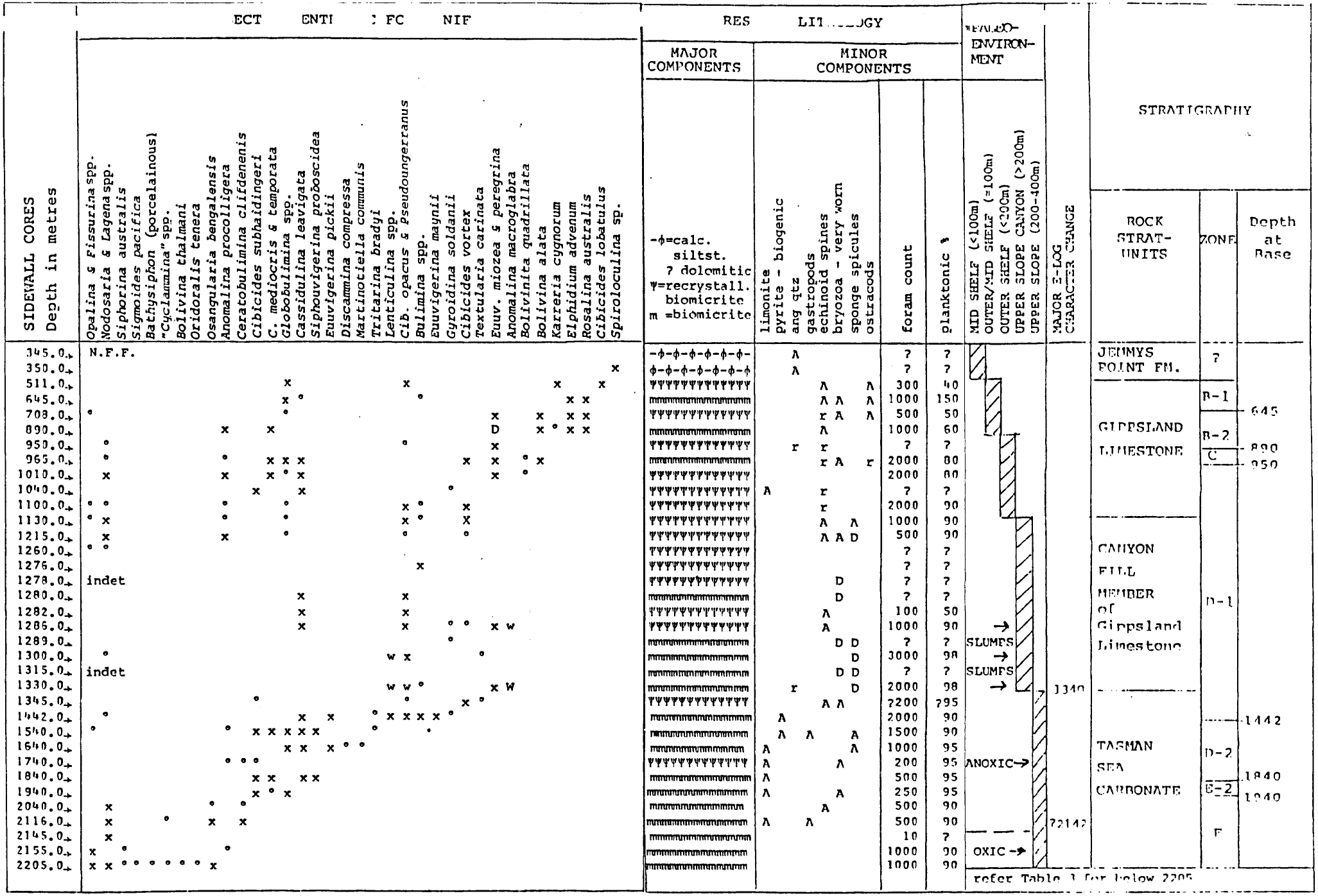


KEY: ° = <20 specimens
x = >20 specimens
D = Dominant >60% specimens
? = doubtful indent.

N.F.F. = no foraminifera found

TABLE 4: MIOCENE PLANKTONIC FORAMINIFERAL DISTRIBUTION - HELIOS # 1.
refer Table 1 for Eocene to Early Miocene below 2205.

David Taylor, 3/2/1983.



KEY: ° = <20 specimens
x = >20 specimens
D = Dominant >60% specimens
N.F.F. = no foraminifera found
w = worn shallow water specimens - displaced
D = 5%-10% of biogenic grains other than forams
A = 1%-5% grains
r = rare <20 grains
¶paleo-water depth in parentheses

TABLE 5: PALEOENVIRONMENTS - MIOCENE - HELIOS # 1

refer Table 1 for Eocene to Early Miocene below 2205.