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THE MID-TERTIARY FORAMINIFERAL SEQUENCE

ESSO GIPPSLAND SHELF No.3 WELL.

by.

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INTRODUCTION:

Esso Gippsland Shelf No. 3 Well was drilled in 202 feet of water, 32½ miles due south of Lakes Entrance, on the southeast flank of the "Gippsland Shelf No. 1 structure" some 18½ miles from the No. 1 well.

All depths, discussed here, were those shown on the submitted samples. The datum for all samples was taken from the rotary table at +31 feet M. S. L.

Cutting samples, 7 cores and 8 side wall cores, were examined. Cores 1 to 5 contained foraminifera, although rare and sporadic in cores 4 and 5. The 20" casing shoe was at 714 feet with first "returns" at 783 feet. The caliper log shows considerable wash out immediately below the 13-3/8" casing shoe at 3,250 feet. This wash out was responsible for heavy contamination in the marl sequence below 4,300 feet. Contamination has even penetrated core 2 (4,725 - 38 feet), possibly due to the action of the heavy mud on the marl, which is very plastic in a saturated state.

The Esso Gippsland Shelf No. 1 foraminiferal sequence has been established by Taylor (1965) as a standard biostratigraphic sequence for the offshore Gippsland Basin. This report is mainly a biostratigraphic and palaeocological comparison between the No. 3 and No. 1 sequences.

BIOSTRATIGRAPHIC CORRELATION:

UPPER MIOCENE : ? to 1,700 feet. The Zonule A fauna is present in the first returns (at 790 feet) and persist to 1,000 feet. This fauna is characterised by the absence of Globorotalia spp. and an abundance of Uvigerina sp. 1 and Baggina phillipinensis. Globorotalia menardii first appear at 1,000 feet. The base of the upper Miocene is almost a horizontal surface between the three wells, suggesting uniform sedimentation and structural relationships.

MIDDLE MIOCENE: 1,700 to 4,000 feet.

Zonule C - 1,700 to 2,800 feet. Globorotalia mayeri is first recorded at 1,700 feet and Uvigerina sp. 4 and U. sp. 5 occur within the unit.
Zonule D - 2,800 to 3,600 feet. Bolivina sp. 9 and B. sp. 10 and Globorotalia barisanen. ar recorded at 2,800 feet, whilst G. conica is present below 3,000 feet.

The dense, partially recrystallized limestone of Core 1 (3,500 to 3,528 feet) revealed in thin section two distinct faunas:-

(i) An abundant planktonic fauna, including Orbulina universa, O. suturalis, Globigerinoides glomerosa, G. rubra, and Globoquadrina dehiscens. This fauna is contained within the fine-grained matrix.

(ii) Concentrations of larger foraminifera in coarse limestone fragments which are algal encrusted. The larger foraminifera include Austrillina, Cycloclpeus and Lepidocyclina.

As discussed by Taylor (1965), the highest range of Lepidocyclina does not reach the initial appearance of O. universa. Therefore the faunas are mixed, and the Lepidocyclina fauna is obviously derived. The planktonic fauna in this core suggests that it is near the base of Zonule D. Derived larger foraminifera are present near the base of Zonule D and in Zonule E, in both previous Gippsland Shelf wells.

Zonule E - 3,600 to 4,000 feet. Contains similar bolivinid and uvigerinid faunas to above Zonule, but shows an increased percentage of Globigerinoides spp.

LOWER MIOCENE: 4,000 to 5,300 feet.

An abrupt change in the benthonic faunas is evident at 4,000 feet. Astrononion centroplax, Cibicides brevoralis, C. perforatus, Gyroidinoides sp. 4 and the large costate uvigerinid, "Uvigerina" sp. 9. The planktonic fauna is rich in Globigerinoides spp (sensu stricto). At 4,550 feet the arenaceous fauna is both rich and distinctive including Karreriella sp., Vulvulina sp., and Haplophragmoides rotundata.

Zonule F and G cannot be separated because of lack of core in the interval 4,000 to 4,700 feet, but they are certainly present.

Zonule H - 4,700 to 5,300 feet. Although there is heavy contamination in Core 2 (4,725 to 4,738 feet), the planktonic fauna is dominated by Globigerina woodi and Globigerinoides triloba immatura, rather than by Globigerinoides spp. (sensu stricto). This, together with the appearance of such benthonic forms as Uvigerina sp. 10, Elphidium centrifulagis and Quinqueloculina ornithopetra, strongly indicate Zonule H and the base of the Miocene.

UPPER OLIGOCENE: 5,300 to 5,900 feet.

Zonule I - 5,300 to 5,900 feet. A rich planktonic and benthonic fauna, but with the presence of Globorotalia opima opima and Globigerina euapertura. Bolivina sp. 12 is also recorded.

LOWER OLIGOCENE: 5,900 to 6,040 feet.

Zonule J - 5,900 to 6,040 feet. Rich planktonic fauna including Globorotalia testarugosa and Globigerina angipora suggest Zonule J and the former species correlates it with Jenkins (1960) "pre-Globoquadrina dehiscens dehiscens" Zone, which is at the base of the marl section in the Lakes Entrance area. It is of interest that in the Gippsland Shelf No. 3 Section, Globoquadrina dehiscens praedehiscens is associated with Globorotalia testarugosa although Jenkins does not record it.

LOWER OLIGOCENE to UPPER EOCENE: 6,040 to 6,438 feet.

Zonule K - 6,040 to 6,250 feet. Poor and sporadic faunas within these glauconitic rich sands. Both the benthonic and planktonic faunas are similar to those of Zonule K, but with the addition of Chiloguembelina cubensis and Globigerina linaperta. The top two feet of Core 4 (6,248 to 6,278 feet) contain this fauna.

Upper Eocene - 6,250 to 6,438 feet. Two feet from the top of Core 4, there is a rich arenaceous fauna of Ammobaculites sp., Bathysiphon sp. and Haplophragmoides spp. Below this level (both in core and side wall core) fauna is very rare and mainly arenaceous. This fauna suggests the beginning of a marine transgressive sequence, and although nondescript, is upper Eocene as it precedes the distinctive Zonule K.

6,438 feet to T. D. No fauna was found in side wall cores below 6,438 feet, nor was any fauna found in Core 7 (8,319 to 8,345 feet). No species that range above 6,438 feet were found in rotary cuttings below that level.

TIME RANGE of the Gippsland No. 3 sequence: It is concluded that the initial Tertiary marine transgression commenced in the upper Eocene at or about the 6,438 feet level in the Gippsland Shelf No. 3 sequence. Marine sedimentation persisted to at least the upper Miocene.

No break in sequence is observed between 6,438 and 783 feet.

DEPOSITIONAL HISTORY:

Marine deposition commenced in the upper Eocene with the onset of the mid-Tertiary transgression. Marine circulation was restricted, as is evident by the purely arenaceous faunas and the abundance of glauconite at the base of the section. By the early Oligocene, oceanic currents were unrestricted, bringing in abundant planktonic faunas.

At 5,997 feet (side wall core 30), planktonic specimens constitute some 80% of the fauna, suggesting that the benthonic fauna was not fully established after the more restricted environment below 6,000 feet. Deposition was at a fairly shallow depth, but during the upper Oligocene and lower Miocene, there is some evidence of a gradual deepening in depth. The upper Oligocene and lower Miocene were obviously well removed from the detrital source areas. The arenaceous foraminifera consist of fine-grained material, and even utilize sponge spicules (e. g. Trochamminina sp. in Core 2). The upper Oligocene and lower Miocene marls were probably deposited in outer shelf conditions, when compared with similar marls in the Gippsland Shelf 1 and 2 wells.

The persistence of arenaceous forms in abundance to 4,550 feet, despite the scarcity of sand-sized detrital material, is curious. From other faunal evidence, the abundance of arenaceous forms cannot be attributed to shallow water conditions, restricted circulation conditions or deep water conditions (three of the conditions which apparently contribute to abundance of arenaceous forms).

There is an abrupt change in the depositional sequence at the 4,000 foot level. The benthonic fauna becomes less robust and the planktonic is smaller and less abundant. More open oceanic conditions prevailed and a subtle, indeterminate change has happened on the depositional surface. The supply of deciminated detrital meterial had ceased, but large fragments of reworked lower Miocene limestone were introduced into the environment. Inundation was slow enough for these fragments to be algal encrusted, and were incorporated into a matrix of precipitated $CaCO_3$ and the remains of planktonic organisms. This misplacement of material was probably due to sliding down the depositional slope. Taylor (1965) has recorded that on the culmination of the Gippsland Shelf No. 1 structure (e. g., Gippsland Shelf No. 1 section), derived lower Miocene limestone fragments were introduced into a middle Miocene shallow water deposit. This material probably spilled down the slope and came to rest on a deeper depositional surface where a hiatus is not apparent.

During the middle Miocene, deposition became shallower, until the upper Miocene when the deposition took place above 300 feet below sea level.

The depositional history is fairly similar to that of the Gippsland Shelf No. 1 and 2 wells, except that sedimentation continued throughout

the lower Miocene in this section, and that early middle Miocene deposition took place in a deeper environment.

GEOLOGICAL SETTING

Particularly during the lower and middle Miocene, this section was down slope, both structurally and environmentally, from the Gippsland Shelf No. 1 and 2 wells. It has already been shown (Taylor, 1965) that the Gippsland Shelf No. 1 structure was moving upwards during the lower Miocene, culminating with a hiatus. Deposition resumed early in the middle Miocene with the addition of lower Miocene fragmentary material. In this section, there is no apparent hiatus, but fragmentary lower Miocene derived material is present in the middle Miocene sediments. Mobility on the Gippsland Shelf No. 1 structure is apparent during the lower Miocene and early middle Miocene.

The initial marine transgression took place at much the same time in all three Gippsland Shelf wells, as in parts of the onshore Gippsland Basin. (Hocking and Taylor, 1964). However, the basal sandy sediments (6,438 to 6,040 feet) are thicker in this section than in the other Gippsland Shelf wells. This increase in thickness is assumed to be related to structural position.

The transitional unit, between the non-marine Latrobe Valley Group (including brown coal) and the calcareous Gippsland Formation, was defined and named by Crespin (1943) as the Lakes Entrance Formation. This formation consists of basal sands with glauconite and an upper "micaceous marl." Difficulty is apparent in defining this unit away from the type area (Lakes Entrance) because of (i) only in the Lakes Entrance area is there a close granite and metamorphic rock source for the basal sand constituents and for the mica in the marls; and (ii) an "E-log" has never been run in a well within this type area. To some degree, Crespin's rock unit was defined on faunal characters. But although they are faunal they are not biostratigraphic as they are inherent characters within the rock, not governed by time; i.e., facies. The basal sandy unit of the Lakes Entrance Formation is marine to an extent, but by no means open marine. This is the case above 6,438 feet in Gippsland Shelf No. 3. Crespin's "micaceous marl" is rich in arenaceous foraminifera, which are now regarded more of environmental than biostratigraphic significance. Therefore, in the Gippsland Shelf No. 3 section, I would place the top of the Lakes Entrance Formation at 4,550 feet, where arenaceous foraminifera cease to be a dominant factor.

This designation of the top and bottom of the Lakes Entrance Formation is based on bio-facies and must be regarded as provisional until "E-logs" are run in the Lakes Entrance area. Studies by Hocking and Taylor (1964) suggest that the base and the top of the Lakes Entrance Formation are not time planes, and are diachronous.

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