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STRATIGRAPHY AND MICROPALÆONTOLOGY OF THE CAUVERY BASIN, PART II. TERTIARY SUBCROP SEQUENCE IN KARIKAL

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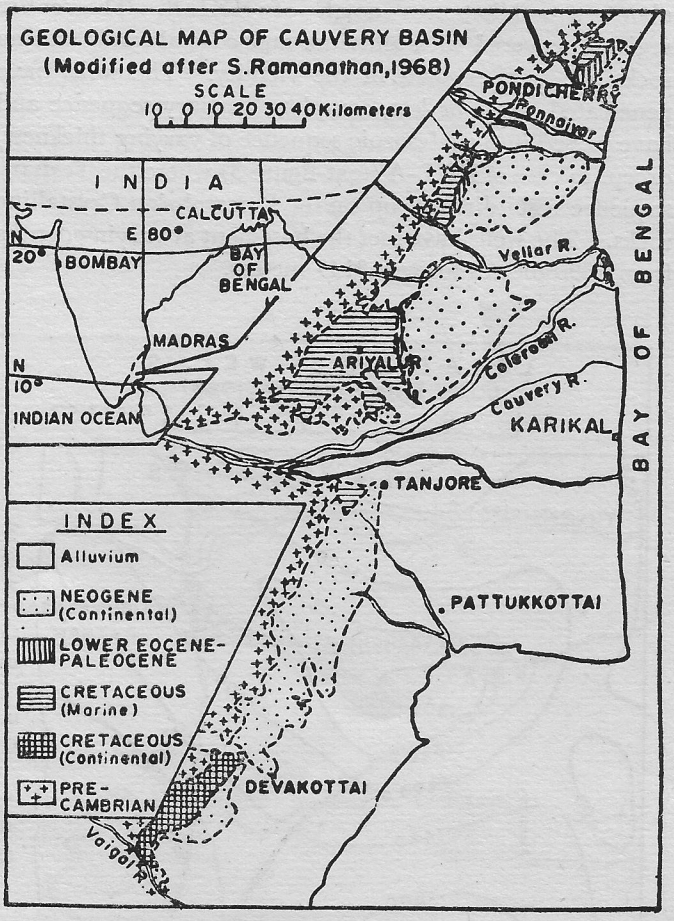
ABSTRACT

Fourteen biostratigraphic zones, based on the distribution of planktonic foraminifera, are proposed for the Tertiary subcrop sequence around Karikal town, near Madras, and these are correlated with local and regional stratigraphic units of the Cauvery Basin and elsewhere. Eighty seven species and subspecies of sixteen foraminiferal genera are identified. The palaeoenvironmental study helps to identify a number of well defined marine transgressive and regressive phases and oscillations in the depth of the basin. The most prominent transgressive and regressive phases equally affecting the entire region under study were during Middle Eocene and during uppermost part of Oligocene respectively.

INTRODUCTION

The occurrence of marine Early Tertiary sediments in the Cauvery Basin towards south of Madras, India (text-figure 1 a) was first reported by Furon and Lemoiné (1939). These sediments occur in a chain of isolated outcrops from near Ariyalur (N. lat. 11°08′00″, E. long. 79°04′40″) to Pondicherry (N. lat. 11°56′00″, E. long. 79°50′10″) and their stratigraphic position have been recognized as ranging from Danian to Early Eocene (Rajagopalan, 1965; Banerji, 1972). Rocks younger than Early Eocene are nowhere exposed in the basin. In recent years, a number of deep wells have been drilled by the Oil and Natural Gas Commission around Karikal (N. lat. 10°55′00″, E. long. 79°50′30″) and several other places in the basin. These drilling have furnished fresh data which made it possible to distinguish a series of marine Tertiary sediments of Paleocene to Pliocene age, overlying a well developed Upper Jurassic-Cretaceous sequence. The Tertiary sequence, which is well represented in Karikal and strongly dominates in planktonic foraminifera, was not, however, investigated in detail and their stratigraphical and ecological potentials have been little exploited to date. A general account of Cenozoic planktons of the Cauvery Basin was given by Raju (1970). The present study is intended to fill up this gap and at the same time (i) to define the planktonic foraminiferal biostratigraphic zones of Paleocene to Burdigalian sequence around Karikal and to list their planktonic foraminifera, (ii) to correlate these zones with world's best studied Tertiary sequences and (iii) to recognize the paleoenvironmental trends in the basin.

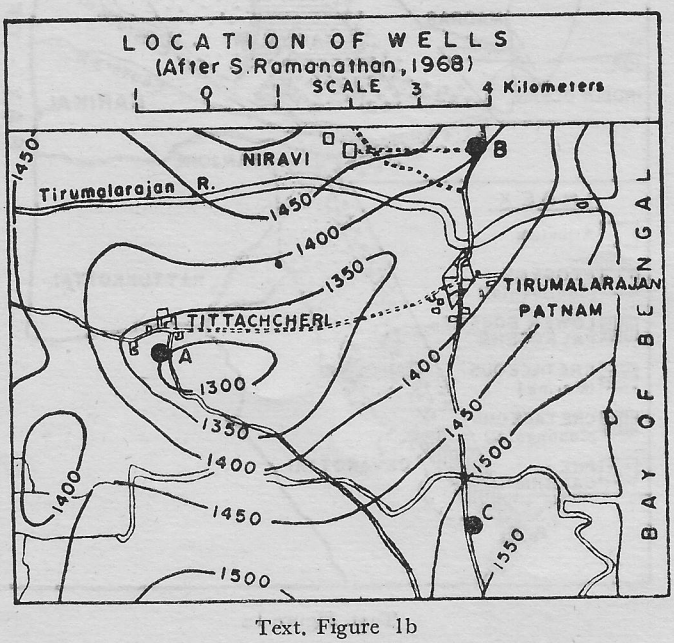


Text. Figure 1a

A detailed account of the generalized foraminiferal biostratigraphic zonation scheme of the entire Tertiary

sequence of the Cauvery Basin is made elsewhere (Banerji and Mohan, 1970; Banerji, 1972). The present report is based on the study of the subcrop sequence encountered in four deep wells, designated as KKL-A, KKL-B, KKL-C and KKL-D, drilled near the eastern coast of the Cauvery Basin around Karikal town, upto a maximum depth of 3147 meters. The drilling was conducted on the basis of the presence of a gravity high near Karikal, which was further substantiated by the detailed seismic reflection survey. The study of this sequence is interesting, as well as, important, since the wells have penetrated through, more or less, a complete Tertiary sequence, hitherto known in this region. The present investigation helps in recognizing various rock and biostratigraphic units useful for precise correlations between other drilled sequences and for solving various stratigraphic problems concerning the Indo-Pacific region.

All the wells are situated in an area of approximately seventy square kilometres; their positions, except for the well KKL-D, are shown in a structural contour map of the region (text-figure 1 b). The well KKL-D is situated about two kilometres north of KKL-B. The entire region is covered with alluvium and coastal sands and no rocks are seen exposed in the vicinity. The wells have penetrated, more or less, complete Tertiary sequence and have passed into a Mesozoic sequence of varying thickness, except in case of KKL-A (text-figure 3) where the Tertiary sequence rests directly up on the Precambrian Crystalline rocks. The wells have met the basement at varying depths from 1698 metres to over 3147 meters.

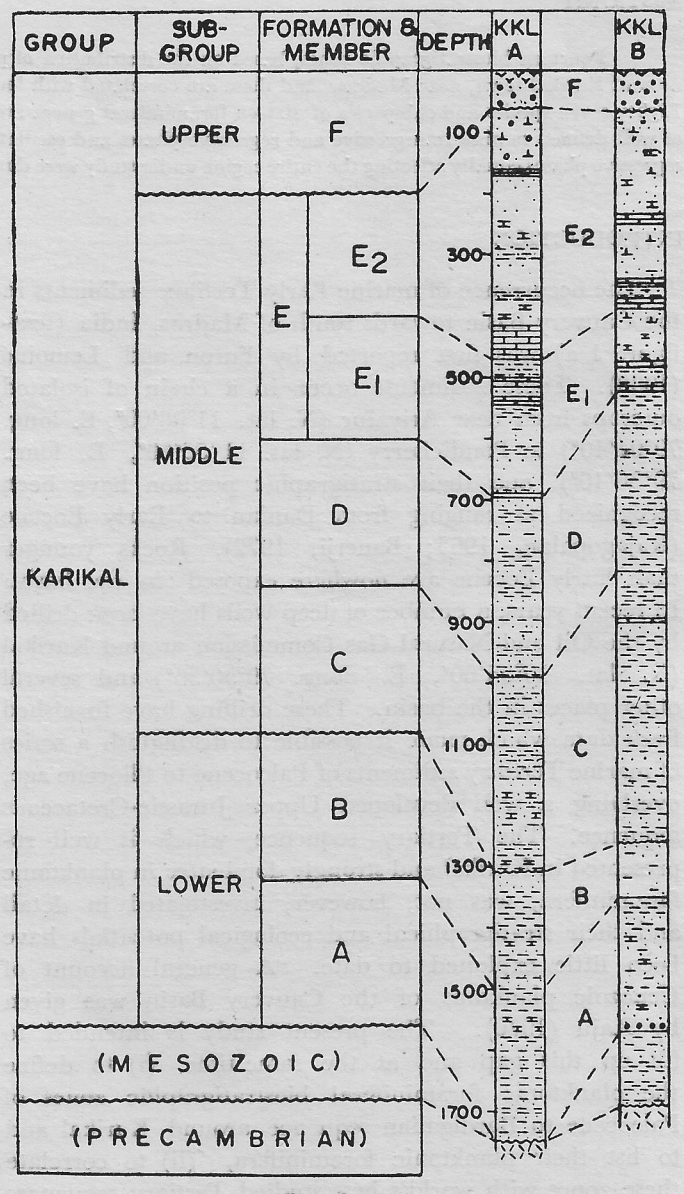


Text. Figure 1b

Text-figure 1—a, Geological map of the Cauvery Basin, b, Structural time contour map (Horizon K-3) and location of wells.

LITHOSTRATIGRAPHY

The most characteristic rock types encountered in the wells are thick alternating sequence of grey to dark grey shales, calcareous sandstones, mudstones and minor limestones. At times the shales are carbonaceous and other rock types are rare. The entire post-Mesozoic sequence is subdivided into a number of rockstratigraphic units, which are designated as Karikal Formations 'A', 'B', 'C', 'D' and 'E'. Two well marked unconformities are recognized in certain wells which delimit the upper boundaries of Karikal Formation 'B' and Karikal Formation 'E' respectively, whereby three Subgroups–Karikal Upper, Karikal Middle and Karikal Lower Sub-groups are established (Table 1). The rock units can be traced in all



Text-figure 2

Rock-stratigraphic units as recognized in wellsKKL-A and KKL-B.

the wells, however, in some cases marked variations in litho-facies from one well to another are noticed (Text-figure 2). A few minor rock units are also developed due to localized environmental control in the sedimentary depositional history. The entire Tertiary subcrop sequence of Karikal area is designated as Karikal Group.

Table 1

Rock-stratigraphic units of Karikal subsurface sequence. (Modified after Ramanathan, 1965)

Group	Sub-group	Formation	Member	Lithology
Karikal Group	Upper ..	F ..		Unconsolidated coarse and gritty sands and earthy ferruginous clays.
			Upper ..	Alternating bands of ill-sorted clays and biohermal limestone.
		E ..		
	Middle ..		Lower ..	Fossiliferous limestone with thin bands of claystones.
		D		Alternating sequences of thick claystones, shales and argillaceous ill-sorted sandstones.
		C		Alternating bands of shales and argillaceous to calcareous sandstones and minor limestones.
	Lower ..	B ..		Predominantly argillaceous sandstones with thin streaks of shales.
		A ..		Dark grey shales with bands of calcareous sandstones and detrital limestones. Shales are at times carbonaceous.
(Mesozoic Sequences)				Grey, greenish grey chloritic, micaceous, occasionally splintery and pyritic shales; fine to medium grained micaceous and felspathic sandstones and minor clays and limestones.
(Precambrian)				Crystalline rocks—gneisses and schists.

— . — . — Unconformity or diastem.

BIOSTRATIGRAPHY

The Karikal subcrop Tertiary sequence is extremly rich in planktonic foraminifera. This type of microfossils are extremely useful for local and distant correlation and for dating marine rocks. The mode of existence, wide geographic distribution and rapid evolutionary development established the planktonic foraminifera as one of the best groups amongst the microfossils for the biostratigraphic investigations and precise correlation.

The Tertiary planktonic foraminifera recorded from the Karikal Group are assigned to 87 species representing 16 genera and 4 families. The best represented genus is *Globorotalia* having 35 species, followed by the genus *Globigerina* having 24 species and the genus *Globigerinoides* having 8 species. Some taxa are poorly present and they could not be assigned to any known species or described here as new species. In such cases their generic identifications are given. The aim of such study has been the establishment of a standard biostratigraphic zonation scheme for the Karikal Sub-crop sequence which may be considered as a type section for the well developed Tertiary sequence of the entire Cauvery Basin. These zones are defined precisely along with their distinctive characters, foraminiferal assemblage, lower and upper boundaries with respect to their encountered depths in the drilled wells. The zones are designated after the most common and restricted species and according to their international usage as recommended by various workers from time to time. However, in several cases the nomenclature of these zones have been modified in this paper, depending upon the restricted range of certain other planktonic species having better representation in the Karikal se-

quence. Only those planktonic species are listed in their respective zones which constitute more than one per cent of the total planktonic foraminiferal assemblage. The paleobathymetric curves drawn for these sections are based on the general faunal assemblage, plankton number and percentage, 'plankton/benthos ratios (Table 2) and litho-

Table 2

Distribution of calcareous and arenaceous benthonic and planktonic foraminifera in Karikal zones.

Biostratigraphic Zones and Subzones	Typical Section (Depth in meters)	Percentage matrix of Calcareous	Arenaceous	Planktons
Globorotalia fohsi robusta Subzone	KKL-C, 244—360	68.75	09.38	21.88
Globorotalia fohsi barisanensis Subzone	KKLC, 488—588	65.30	08.16	25.53
Globigerinatella insueta Zone	KKL-B, 600—810	66.66	14.82	18.52
Globigerina (Catapsydrax) dissimilis Zone	KKL-C, 1170—1390	54.63	09.25	36.12
Globigerina concinna ciperoensis Zone	KKL-C, 1390—1500	62.68	25.38	11.94
Globorotalia increbescens opima Zone	KKL-C, 1500—1560	57.14	07.14	35.72
Globigerina ampliapertura Zone	KKL-B, 1430—1510	65.00	05.00	30.00
Globorotalia cerroazulensis Zone	KKL-B, 1510—1536	58.46	20.00	21.54
Globigerina frontosa Zone	KKL-A, 1580—1652	60.00	..	40.00
Globorotalia palmerae Zone	KKL-A, 1652—1670	63.15	03.95	32.90
Globorotalia aragonensis Zone	KKL-C, 1850—1931	50.00	06.48	43.52
Globorotalia wilcoxensis Zone	KKL-A, 1670—1715	54.12	12.94	32.94
Globorotalia velascoensis Zone	KKL-C, 1931—1966	66.66	12.28	21.06
Globorotalia uncinata Zone	KKL-A, 1725—1733	62.16	12.16	25.68
Globigerinoides daubjergensis Zone	KKL-A, 1733—1748	77.96	08.48	13.56

logic associations. The straitigraphic range of more important planktonic species in the Karikal sequence are illustrated in text-figure 8. The zones and their important planktonic foraminifera and suggested paleobathymetry worked out for these wells are shown in text-figures 3, 4, 5 and 6 and their intercorrelations are given in text-figure 7. The foraminiferal species referred in this paper are well known, therefore, they are not redescribed or illustrated; a faunal reference list is given in the last. The foraminiferal species listed in each zone are arranged alphabetically and not in order of abundance. The biostratigraphic zones recognized in the Mesozoic sequence are not discussed here, their general account for the entire region are given in Banerji (1968) and in Banerji and Mohan (1970).

PALEOCENE, DANIAN

I *Globigerinoides daubjergensis* Zone

Authors. Leonov, G.P. and Alimarina V.P., 1961.

Definition. Range with zonal marker.,

Typical Section. KKL-A, 1733—1748 meters.

Foraminifera. This sequence is not rich in planktonic foraminifera both in numbers and species diversity. *Globigerinoides daubjergensis* (Bronnimann), a characteristic species of this zone, is uniformly present, however, in less numbers. Other planktonic species like *Globigerina inconstans* Subbotina, *Globorotalia compressa* (Plummer), *Globorotalia pseudobulloides* (Plummer) and *Subbotina triloculinoides* (Plummer) are also rare in coccurrence. The latter species is mostly present in the uppermost part of the zone in KKL-A. The benthic assemblage, which is more common than planktons (Table 2), include a number of species of the families Anomalinidae, Bolivinidae, Nodosaridae and Rotaliidae, along with few arenaceous forms as well. These benthonic species have long range in vertical distribution and thus do not help in establishing the zonal correlations to a precise degree.

Correlation. This zone is equivalent to *Globorotalia pseudobulloides* Zone and *Globorotalia trinidadensis* Zone (Danian) of Bolli (1966) and to *Globorotalia compressa/Globigerina daubjergensis* Zone (Upper Danian) of El-Naggar (1969).

II *Globorotalia uncinata* Zone

Author. Bolli, H.M., 1957.

Definition. Interval with zonal marker, from its first appearance to the first appearance of *Globorotalia velascoensis Cushman.*

Typical Section. KKL-A, 1725—1733 meters.

Foraminifera. This interval in Karikal wells is relatively rich in planktonic foraminifera, represented by *Globorotalia angulata* (White), *Globorotalia pseudobulloides* (Plummer), *Globorotalia uncinata* Bolli and *Subbotina triloculinoides* (Plummer). *Globorotalia uncinata* Bolli is uniformly present in this zone. The benthic composition does not vary much from the underlying *Globigerinoides daubjergensis* Zone.

Correlation. This zone is correlated with *Globorotalia uncinata* Zone of Bolli (1957, 1966) and Luterbacher (1964). *Globigerina spiralis* Bolli, present in corresponding zone in Trinidad (Bolli, 1957), is however, not recorded from Karikal sequence.

Remarks. *Globorotalia pseudomenardii* Zone, representing the uppermost level of Danian-Montian sequence in other parts of the Cauvery Basin (Mehrotra and Banerji, 1970) has not been recognized in Karikal. A minor unconformity or diastem at the upper boundary of this Zone is suggested.

LANDENIAN

III *Globorotalia velascoensis* Zone

Author. Bolli, H.M., 1957.

Definition. Range with Zonal marker.

Typical Section. KKL-C, 1931-1966 meters.

Foraminifera: Following planktonic foraminifera are recorded from this zone–*Chiloguembelina wilcoxensis* (Cushman and Ponton), *Globigerina inaequispira* Subbotina, *Globigerina linaperta* Finlay, *Globigerina mckannai* White, *Globigerina* sp., *Globorotalia acuta* Toulmin, *Globorotalia aequa* Cushman and Renz, *Globorotalia elongata* Glaessner, *Globrotalia esnaensis* (Le Roy), *Globorotalia velascoensis* (Cushman) and *Globorotalia whitei* Weiss. Among benthos, members of the family Nodosariidae are more common whereas arenaceous forms are rare.

Correlation. This Zone is correlated with *Globorotalia velascoensis* Zone of Bolli (1957, 1966) and of Vridhachalam subcrop section of the Cauvery Basin (Mehrotra and Banerji, 1970) and with *Globorotalia aequa/Globorotalia esnaensis* Subzone (Landenian) of El-Naggar (1969).

Remarks. The Paleocene biostratigraphic zones are equivalent to the lowermost part of Karikal Formation 'A'.

Paleocene-Eocene Boundary. This boundary is placed within the Karikal Lower Sub-group at the extinction level of *Globorotalia velascoensis* (Cushman) and at the first appearance of *Globorotalia rex* Martin and*Globorotalia wilcoxensis* Cushman and Ponton, and is marked in KKL-A at 1715 metres and in KKL-D at 1910 meters depth.

EOCENE, YPRESIAN

IV *Globorotalia wilcoxensis* Zone

Author. El-Naggar, Z.R., 1966.

Definition. Interval with zonal marker, from its first appearance to the first appearance of *Globorotalia aragonensis* Nuttall.

Typical Section. KKL-A, 1670-1715 meters.

Foraminifera. This is the lowermost highly fossiliferous Tertiary sequence in Karikal. The characteristic planktonic species are—*Chiloguembelina wilcoxensis* (Cushman and Ponton), *Globigerina collactea* Finaly, *Globigerina linaperta* Finlay *Globorotalia aequa* Cushman andRenz.., *Globorotalia broedermanni* Cushman and Bermudez, *Globorotalia esnaensis* (Le Roy), *Globorotalia pseudotopilensis* Subbotina, *Globorotalia rex* Martin, *Globorotalia subbotinae* Morozova, *Globorotalia troelseni* Loeblich and Tappan and *Globorotalia wilcoxensis* Cushman and Ponton. *Globorotalia rex* Martin and *Globorotalia wilcoxensis* Cushman and Ponton are restricted to this Zone, however, the former is extremely rare in the uppermost part of this Zone. The family Nodosariidae continues to dominate amongst the benthonic assemblage.

Correlation. This zone is equivalent to *Globorotalia rex* Zone of Bolli (1957, 1966) and of Luterbacher and Silva (1964) and to *Globorotalia wilcoxensis* Zone of El-Naggar (1966).

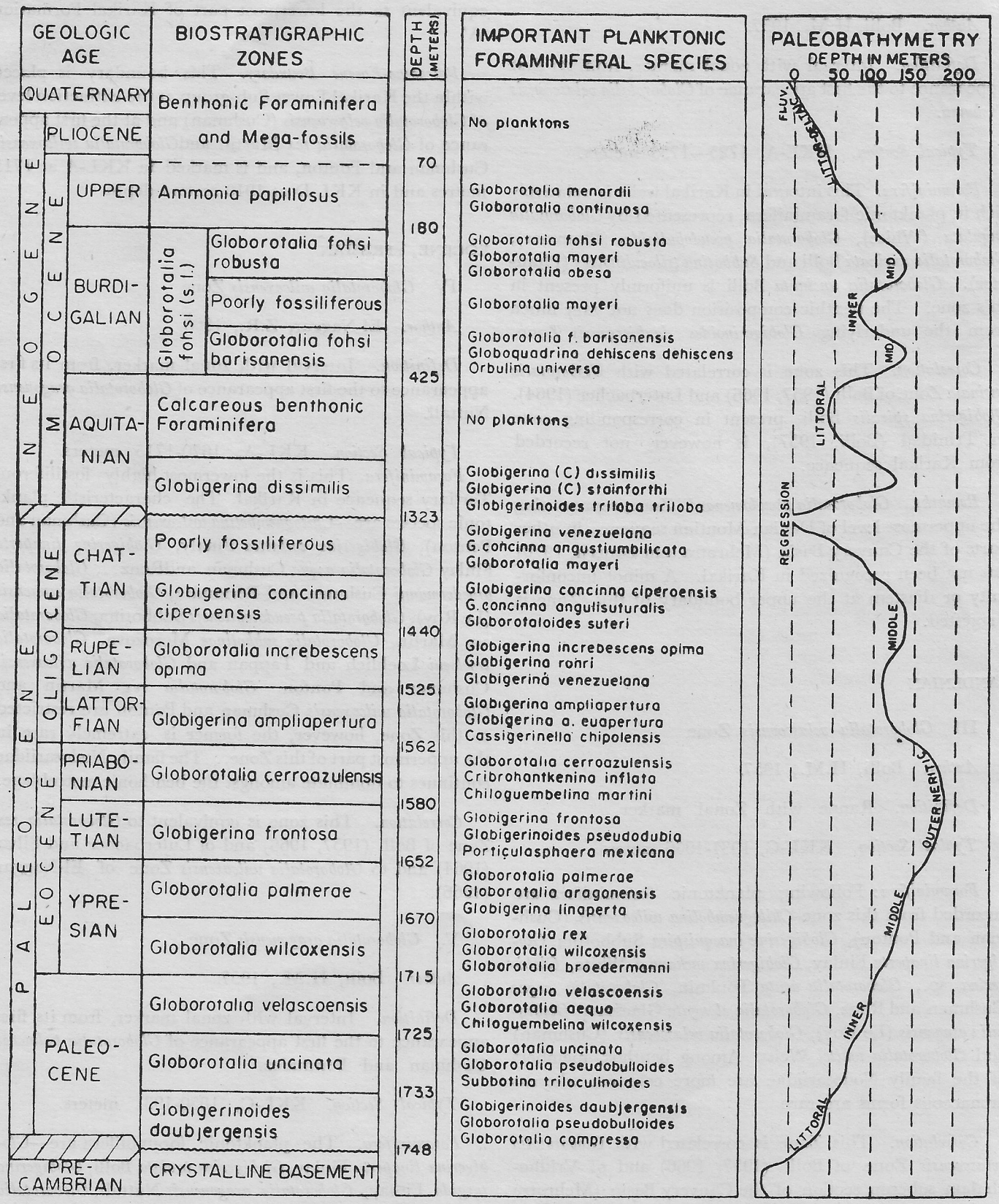
V. *Globorotalia aragonensis* Zone

Author. Bolli, H.M., 1957.

Definition. Interval with zonal marker, from its first appearance to the first appearance of *Globorotalia palmerae* Cushman and Bermudez.

Typical Section. KKL-C, 1850-1931 meters.

Foraminifera. The planktonic foraminifera are—*Globigerina linaperta* Finlay, *Globigerina prolata* Bolli, *Globigerina turgida* Finlay, *Globorotalia aragonensis* Nuttall, *Globorotalia broedermanni* Cushman and Bermudez, *Globorotalia formosa formasa* Bolli and *Globorotalia* sp. The benthonic assem-



Text-figure 3—Biostratigraphic units, geological age and paleobathymetry in well KKL-A.

blage of this zone is very similar to the underlying *Globorotalia wilcoxensis* Zone.

Correlations. This zone is correlated with *Globorotalia formosa formosa* Zone and *Globorotalia aragonensis* Zone of Bolli (1966).

VI *Globorotalia palmerae* Zone

Author. Bolli, H.M., 1957.

Definition. Range with zonal marker.

Typical Section. KKL-A, 1652—1670 meters

Foraminifera. Chiloguembelina martini (Pijers), *Globigerina collactea* Finlay, *Globigerina linaperta* Finlay, *Globigerina prolata* Bolli, *Globigerina turgida* Finlay, *Globorotalia aragonensis* Nuttall, *Globorotalia broedermanni* Cushman and Bermudez, *Globorotalia palmerae* Cushman and Bermudez and *Globorotalia* sp.

Correlation. This zone is equivalent to *Globorotalia palmerae* Zone of Bolli (1957, 1966).

Remarks. This zone is also rich in benthonic foraminifera like species of *Ammodiscus, Assilina, Bathysiphon, Bolivina, Bulimina, Cibicides, Dentalina, Discocyclina,Discorbis, Haphlophragmoides, Lagena, Lenticulina, Nodosaria, Nummulites, Operculina, Pleurostomella, Quinqueloculina, Textularia* and *Trochammina.*

The Ypresian sequence in Karikal area is represented by the lower and middle parts of the Karikal Formation 'A'.

LUTETIAN

VII *Globigerina frontosa* Zone (*s.* 1.)

Author. Bandy, O.L., 1964.

Definition. Range with zonal marker.

Typical Section. KKL-A, 1580—1652 meters.

Subzones. This zone is divided into four subzones, which in descending order, are listed below :

(4) *Globigerina pseudodubia* Subzone (uppermost),

(3) *Porticulasphaera mexicana* Subzone,

(2) *Truncorotaloides topilensis* Subzone and

(1) *Globigerina frontosa* Subzone (*s. s.*) (lowermost.)

This classification of sub-zones is modified after Bandy (1964).

(1) *Globigerina frontosa* Subzone (*s.s.*)

Definition. Interval with zonal marker, from its first appearance to the first appearance of *Truncorotaloides topilensis* (Cushman).

Typical Section.. KKL-A, 1604—1652 meters.

Foraminifera. Following planktonic foraminifera are identified from this subzone *Chiloguembelina martini* (Pijpers), *Globigerina frontosa* Subbotina, *Globigerina linaperta* Finlay, *Globigerina senni* (Backmann), *Globigerina turgida)* Finlay, *Globigerinoides higginsi* Bolli, *Globigerinoides pseudodubia* Bandy, *Globorotalia aragonensis* Nuttall, *Globorotalia broedermanni* Cushman and Bermúdez, *Globorotalia centralis* Cushman and Bermúdez, *Globorotalia lehneri* Cushman and Jarvis, *Globorotalia spinuloinflata* (Bandy), *Hantkenina aragonensis* Nuttall and *Hantkenina mexicana* Cushman.

Globigerina turgida Finlay, *Globigerinoides higginsi* Bolli and *Globorotalia broedermanni* Cushman and Bermúdez are somewhat restricted to the lower part of this subzone, and *Globorotalia centralis* Cushman and Bermúdez and *Globorotalia lehneri* Cushman and Jarvis are common in the upper part, whereas other species are, more or less, uniformly distributed.

Correlation. This subzone is correlated to *Globigerina frontosa* Zone of Bandy (1964) and to *Hantkenina aragonensis* Zone and *Globigerapsis kugleri* Zone of Bolli (1966).

(2) *Truncorotaloides topilensis* Subzone

Definition. Interval with zonal marker, from the first appearance of *Truncorotaloides topilensis* (Cushman) to the first appearance of *Porticulasphaera mexicana* (Cushman).

Typical Section. KKL-A, 1595—1604 meters.

Foraminifera. The common planktonic foraminifera are—*Globigerina frontosa* Subbotina, *Globigerina linaperta* Finlay, *Globigerinatheka barri* Bronnimann, *Globigerinoides pseudodubia* Bandy, *Globorotalia centralis* Cushman and Bermúdez, *Globorotalia lehneri* Cushman and Jarvis, *Globorotalia spinuloinflata* (Bandy). *Hantkenina dumblei* Weinzieral and Applin and *Truncorotaloides topilensis* (Cushman).

Correlation. This subzone is equivalent to *Truncorotaloides topilensis* Zone of Bandy (1964) and to *Globorotalia lehneri* zone of Bolli (1957, 1966).

(3) *Porticulasphaera mexicana* Subzone

Definition. Range with subzonal marker.

Typical Section. KKL-A, 1586—1595 meters.

Foraminifera. This subzone is characterized by the restricted occurrence of *Porticulasphaera mexicana* (Cushman),

however, this species never occurs more than 5% of the total planktonic foraminiferal assemblage. Other species of *Truncorotaloides topilensis* Sub-zone continue to occur almost in the same proportions to this subzone.

Correlation. This subzone is correlated with *Porticulasphaera mexicana* Zone of Bandy (1964) and of Bolli (1957, 1966).

(4) *Globigerinoides pseudodubia* Subzone

Definition. Interval with zonal marker, from the last occurrence of *Porticulasphaera mexicana* (Cushman) to the last occurrence of *Globigerinoides pseudodubia* Bandy.

Typical Section. KKL-A, 1580—1586 meters.

Foraminifera. Chiloguembelina cubensis (Palmer), *Chilofuembelina martini* (Pijpers), *Globigerina linaperta* Finlay, *Globigerina senni* (Backmann), *Globigerina venezuelana* Hedberg, *Globigerinatheka barri* Brönnimann, *Globigerinoides pesudodubia* Bandy, *Globorotalia lehnri* Cashman and Jarvis and *Truncorotaloides topilensis* (Cushman).

Correlation. This subzone is correlated with *Globigerinoides pseudodubia* Zone of Bandy (1964) and with *Truncorotaloides rohri* Zone of Bolli (1966).

Remarks. Globigerina frontosa Subbotina is almost uniformly present in all the Lutetian subzones of Karikal, whereas other three subzonal named species have marked fluctuations in their abundance within the respective sub zones, hence these subdivisions could not be raised to zonal status. Arenaceous foraminifera are almost absent in these sub-zones, and the planktonic calcareous benthonic foraminiferal ratio is approximately 1:1.5. In general benthic composition remains uniform throughout the zone.

The equivalent rock-stratigraphic unit of Lutetian age is middle to upper parts of Karikal Formation 'A'.

PRIABONIAN

VIII *Globorotalia cerroazulensis* Zone

Author. Bolli, H.M., 1966.

Definition. Range with zonal marker.

Typical Section. KKL-B, 1510—1536 meters.

Foraminifera. This zone is characterized by the restricted occurrence of *Cribrohantkenina inflata* (Howe), *Globorotalia cerrozulensis* (Cole) and *Hantkenina alabamensis* Cushman. Other long ranging species like *Chiloguembelina cubensis* (Palmer), *Chiloguembelina martini* (Pijpers), and *Globorotalia centralis* Cushman and Bermúdez die out at the upper boundary of this zone. Few new forms like *Globigerina ampliapertura* Bolli and *Globorotalia increbescens increbescens* (Bandy) appear near the top of this zone and continue to present in the lower part of the Oligocene. Benthonic forms like species of *Nummulites*, *Operculina* and *Pellatispira* are observed in the upper part of this zone, whereas the members of the families Alabaminidae, Cibicididae, Discorbidae, Miliolidae, Nodosariidae, Rotaliidae and Uvigerinidae are present throughout. Arenaceous forms like the members of the families Ammodiscidae, Saccamminidae and Textulariidae, again appear at the base of this zone and are better represented in the upper part of the zone.

Correlation. This zone is equivalent to *Globigerapsis semiinvoluta* Zone and *Globorotalia cerroazulensis* Zone of Bolli (1966) and to Zone P.16 of Blow (1969). The uppermost part of Priabonian represents an unconformity or period of non-deposition of a short duration.

Remarks. The equivalent rock-stratigraphic unit of Priabonian is the upper part of Karikal Formation 'A'.

Eocene-Oilgocene Boundary. This boundary is placed at the extinction level of *Globorotalia cerroazulensis* (Cole) and *Hantkenina alabamensis* Cushman. In Karikal wells, an unconformity distinctly marked by faunal and lithological change represents this boundary.

OLIGOCENE, LATTORFIAN

IX *Globigerina ampliapertura* Zone

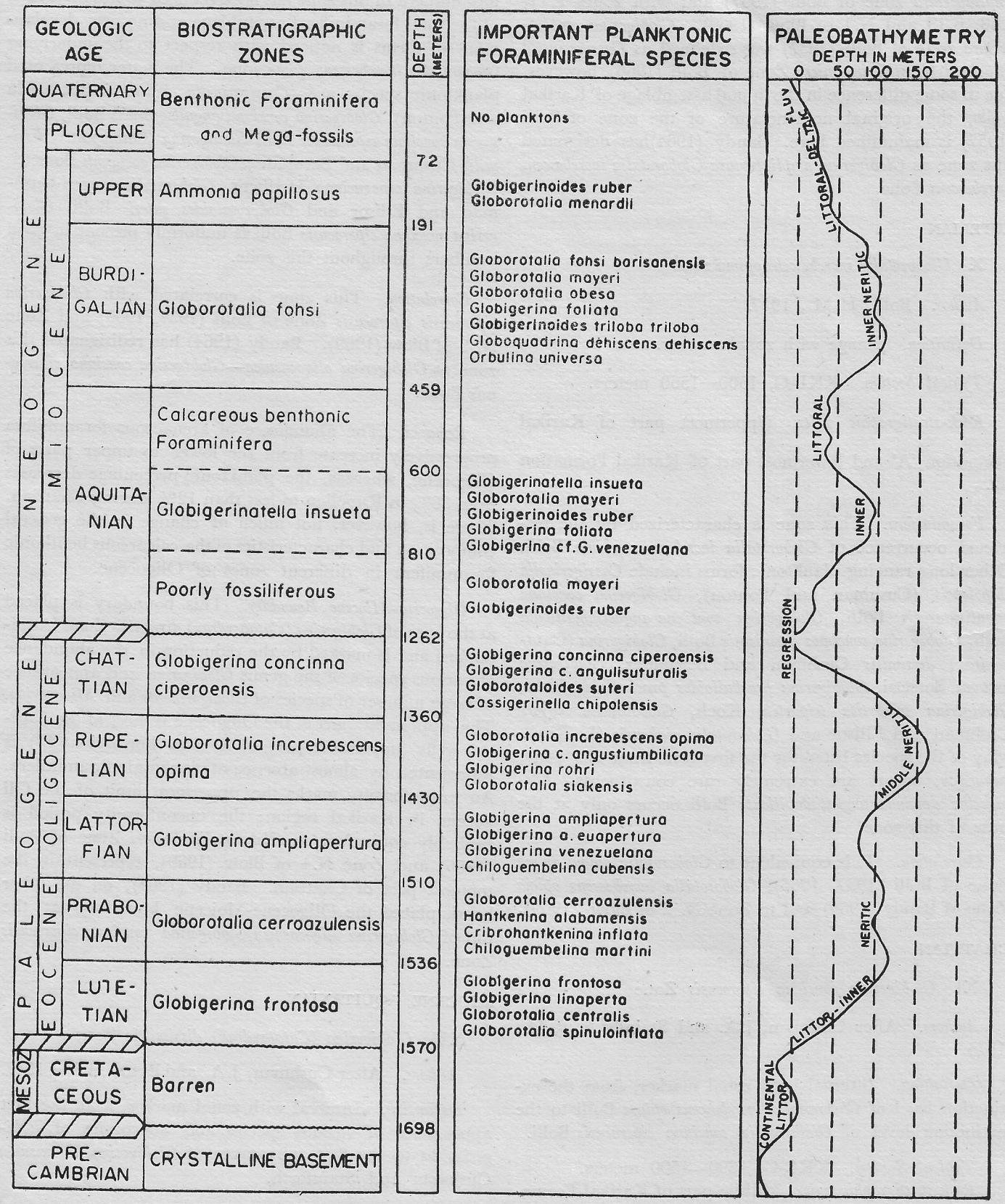
Author: Bolli, H M , 1957.

Definition. Range with zonal marker, from the extinction level of *Globorotalia cerroazulensis* (Cole) to the extinction level of *Globigerina ampliapertura* Bolli.

Typical Section. KKL-B, 1430—1510 meters.

Rock-stratigraphic unit. Upper part of Karikal Formation 'A'.

Foraminifera: The planktonic foraminiferal specie srecorded from this zone are—*Cassigerinella chipolensis* (Cushman and Ponton), *Chiloguembelina cubensis* (Palmer), *Globigerina ampliapertura* Bolli, *Globigerina ampliapertura euapertura* Jenkins, *Globigerina concinna angulisuturalis* Bolli, *Globigerina concinna angustiumbilicata* Bolli, *Globigerina concinna ciperoensis* Bolli, *Globigerina rohri* Bolli, *Globigerina Venezuelana* Hedberg, *Globorotalia increbescens increbescens* (Bandy) and *Globorotaloides suteri* Bolli. Few doubtful specimens of *Globigerina* (*Catapsydrax*) *dissimilis* Cushman and Bermedéz also occur in this zone. *Globigerina ampliapertura* Bolli, *Globigerina ciperoensis ciperoensis* Bolli and *Globorotalia increbescens increbescens* (Bandy) are uniformly present in good numbers throughout this zone, whereas *Cassigerinella Chipolensis* (Cushman and Ponton) occurs sporadically.



Text-figure 4—Biostratigraphic units, geological age and paleobathymetry in well KKL-B.

Correlation. This zone is correlated with *Globigerina ampliapertura* zone of Bolli (1957) and with zones P.17, p.18, p.19 and N.1 of Blow (1969). *Globigerina ampliapertura* zone of Bolli (1957) was redefined as *Cassigerinella chipolensis/Hastigerina micra* Zone of Bolli (1966), however, due to some difference in the faunal assemblage of Karikal wells, the original nomenclature of the zone of Bolli (1957) is maintained here. Bandy (1964)has designated this zone as *Globigerina ampliapertura-Globorotalia increbescens increbescens* Zone.

RUPELIAN

X *Globorotalia increbescens opima* zone

Author. Bolli, H.M., 1957.

Definition. Range with zonal marker.

Typical Section. KKL-C, 1500—1560 meters.

Rock-stratigraphic units. Uppermost part of Karikal Formation 'A' and lowermost part of Karikal Formation 'B'.

Foraminifera. This zone is characterized by the restricted occurrence of *Globorotalia increbescens opima* Bolli. Other long ranging planktonic forms include *Cassigerinella chipolensis* (Cushman and Ponton), *Globigerina concinna angulisuturalis* Bolli, *Globigerina concinna angustiumbilicata* Bolli, *Globigerina concinna ciperoensis* Bolli, *Globigerina* (*Catapsydrax*) *dissimilis* Cushman and Bermúdez, *Globigerina gortanii* Borsetti, *Globigerina praebulloides praebulloides* Blow, *Globigerina tripartita tripartita* Koch, *Globorotalia mayeri* Cushman and Ellisor and *Globorotalia siakensis* (Le Roy). May of the species listed for the first time from this zone, however, occurs are extremely rare constituents. *Globigerina concinna angustiumbilicata* Bolli occurs only at the base of this zone.

Correlation. It is equivalent to *Globorotalia opima opima* Zone of Bolli (1957, 1966), *Globorotalia increbescens opima* Zone of Bandy (1964) and to Zone N. 2 of Blow (1969).

CHATTIAN

XI *Globigerina concinna ciperoensis* Zone

Authors. After Cushman, J.A. and Stainforth, R.M., 1945.

Definition. Interval with zonal marker, from the extinction level of *Globorotalia increbescens opima* Bolli to the extinction level of *Globorotalia concinna ciperoensis* Bolli.

Typical Section. KKL-C, 1390—1500 meters.

Rock-stratigraphic unit. Middle part of Karikal Formation 'B'.

Foraminifera. The relative abundance of planktonic foraminifera in this zone has been reduced to less than 12% of the total foraminiferal assemblage and no new development of forms is noticed with respect to the underlying *Globorotalia increbescens opima* zone. The better represented planktonic species are—*Cassigerinella chipolensis* (Cushman and Ponton), *Globigerina concinna angulisuturalis* Bolli, *Globigerina concinna ciperoensis* Bolli *Globigerina* (*Catapsydrax*) *dissimilis* Cushman and Bermúdez, *Globigerina gortannti* Borsetti, *Globigerina venezuelana* Hedberg, *Globorotalia mayeri* Cushman and Ellisor and *Globorotaloides suteri* Bolli. *Globigerina concinna ciperoensis* Bolli is uniformly present in good numbers throughout this zone.

Correlation. This zone is correlated with *Globigerina ciperoensis ciperoensis* Zone of Bolli (1957, 1966) and Zone N. 3 of Blow (1969). Bandy (1964) has redisignated this zone as *Globigerina oligocaenica—Globigerina concinna ciperoensis* Zone.

Remarks. The abundance of arenaceous foraminifera progressively increase from the lower to upper parts of Oligocene, whereas, the planktonic percentage decreases from 36% in Rupelian to less than 12% during Chattian. There is, however, not much of change in the general composition and characteristics of the calcareous benthonic foraminifera in different zones of Oligocene.

Oligocene-Miocene Boundary. This boundary is placed at the base of *Globigerina* (*Catapsydrax*) *dissimilis* Zone (Aquitanian) and is marked by the reduction in the abundance of various species of the genus *Globigerina* and appearance of large number of species of *Globigerinoids* and *Miogypsina*. The uppermost part of the Oligocene is most of the Karikal wells (uppermost part of Karikal Formation 'B') is represented by almost absence of planktonic foraminifera. An unconformity marks the uppermost limit of the Oligocene in Karikal region; the unconformity period is probably equivalent to *Globorotalia kugleri* Zone of Bolli (1966) and Zone N.4 of Blow (1969), representing the topmost part of Chattian. Bandy (1964), on the other hand, placed the Oligocene-Moicene boundary at the top of *Globigerina oligocaenica/Globigerina concinna ciperoensis* Zone.

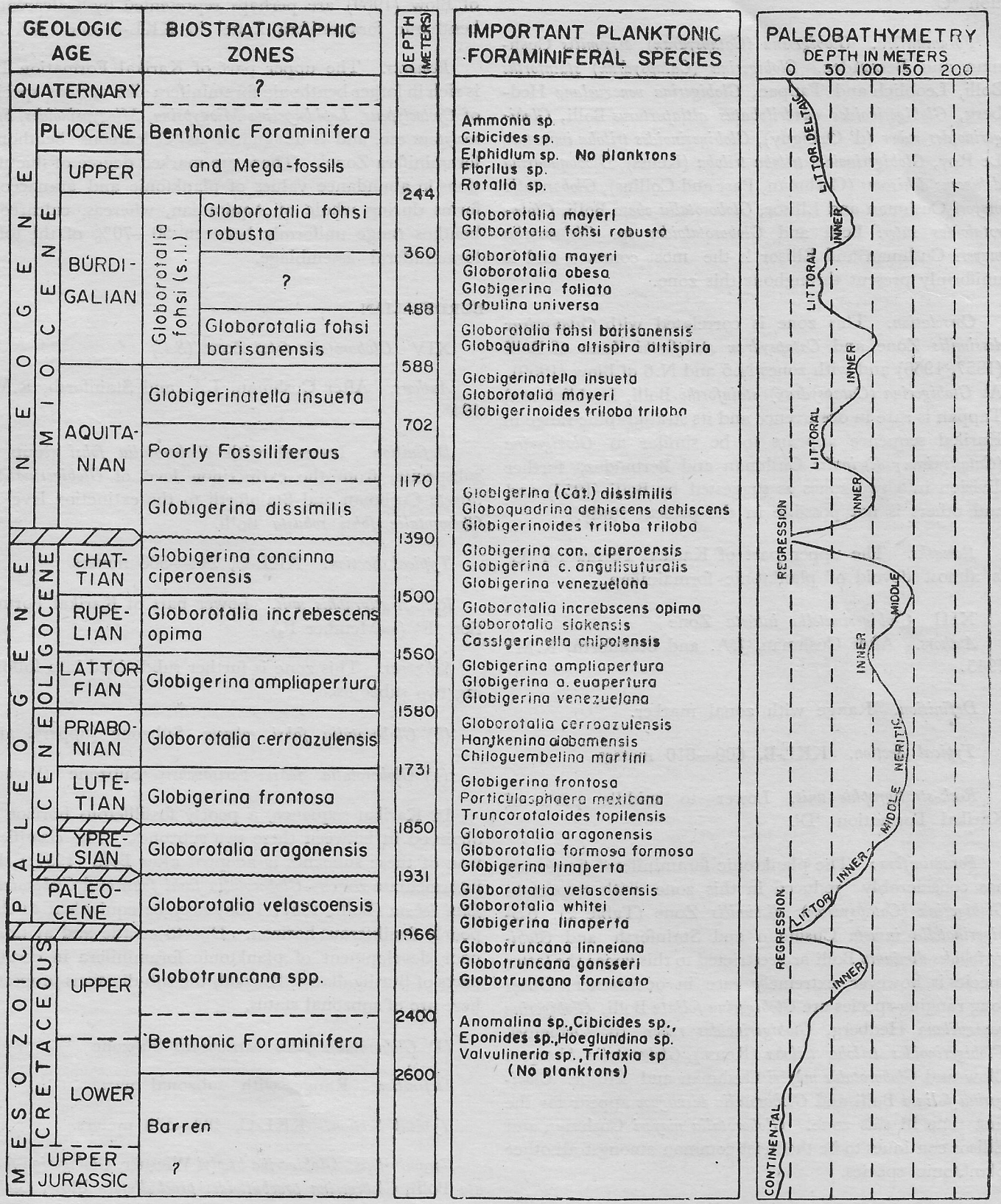
MIOCENE, AQUITANIAN

XII *Globigerina* (*Catapsydrax*) *dissimillis* Zone.

Authors. After Cushman, J.A. and Renz. H.H., 1947.

Definition. Interval with zonal marker, from the first appearance of various species and subspecies of *Globigerinoides* to the first appearance of *Globigerinatella insueta* Cushman and Stainforth.

Typical Section. KKL-C, 1170—1390 meters.



Text-figure 5—Biostratigraphic units, geological age and paleobathymetry in well KKL-C.

Rock-Stratigraphic unit. Lower part of Karikal Formation 'C'

Foraminifera. Globigerina (Catapsydrax) dissimilis Cushman and Bermúdez. *Globigerina (Catapsydrax) stainforthi* Bolli, Leoblich and Tappan, *Globigerina venezuelana* Hedberg, *Globigerinoides quadrilobatus altiaperturus* Bolli, *Globigerinoides ruber* (d' Orbigny), *Globigerinoides triloba immatura* Le Roy, *Globigerinoides triloba triloba* (Reuss), *Globoquadrina dehiscens dehiscens* (Cushman, Parr and Collins), *Globorotalia mayeri* Cushman and Ellisor, *Globorotalia obesa* Bolli, *Globorotaloides suteri* Bolli and *Globorotaloides* sp. *Globorotalia mayeri* Cushman and Ellisor is the most common and is uniformly present throughout this zone.

Correlation. This zone is correlated with *Catapsydrax dissimilis* Zone and *Catapsydrax stainforthi* Zone of Bolli (1957, 1966) and with zones N.5 and N.6 of Blow (1969). As *Globigerina (Catapsydrax) stainforthi* Bolli, Leoblich and Tappan is rare in occurrence and its stratigraphic range in Karikal sequence appears to be similar to *Globigerina (Catapsydrax) dissimilis* Cushman and Bermúdez, further division into two zones as suggested by Bolli (1957) and and others is not possible in the present study.

Remarks. The upper part of Karikal Formation 'C' is almost devoid of planktonic formainifera.

XIII *Globigerinatella insueta* Zone

Authors. After Cushman, J.A. and Stainforth, R.M. 1945.

Definition. Range with zonal marker.

Typical Section. KKL-B, 600—810 meters.

Rock-stratigraphic unit. Lower to middle parts of Karikal Formation 'D'.

Foraminifera: The planktonic foraminiferal frequency has considerably reduced in this zone with respect to *Globigerina (Catapsydrax) dissimilis* Zone (Table 2). *Globigerinatella insueta* Cushman and Stainforth and *Globigerinoides diminuta* Bolli are restricted to this zone; the latter species is, however, extremely rare in occurrence. Other long ranging species are *Globigerina foliata* Bolli, *Globigerina venezuelana* Hedberg, *Globigerinoides ruber* (d' Orbigny), *Globigerinoides triloba triloba* (Reuss), *Globorotalia birnageae* Blow and *Globorotalia mayeri* Cushman and Ellisor. *Globigerina foliata* Bolli and *Globorotalia birnageae* appear for the first time in this zone. *Globorotalia mayeri* Cushman and Ellisor continues to be the most common amongst all other planktonic species.

Correlation. This zone is equivalent to *Globigerinoides insueta* Zone of Bolli (1966) and Zone N.7 of Blow (1969). *Praeorbulina glomerosa* Zone of Bolli (1966) and Zone N8. of Blow (1969) are perhaps represented by 'Calcareous-benthonic foraminifera Zone' in KKL-A and KKL-B

Remarks. The upper part of Karikal Formation D'' is rich in larger benthonic foraminifera like various species of *Cycloclypeus, Lepidocyclina Miogypsina, Miogypsinoides, Spiroclypeus* etc. and is designated as 'Calcareous benthonic foraminifera Zone'. There are marked degree of fluctuations in abundance values of planktonic and aranaceous forms during whole of Aquitanian, whereas, calcareous benthos range uniformly between 50—70% of the total foraminiferal assemblage.

BURDIGALIAN

XIV *Globorotalia fohsi* Zone (*S.l.*)

Authors. After Cushman, J.A. and Stainforth, R.M. 1945.

Definition. Interval with *Globorotalia fohsi* group of subspecies, from the extinctinon level of *Globigerinatella insueta* Cushman and Stainforth to the extinction level of *Globorotalia fohsi robusta* Bolli.

Typical Section. KKL-C, 244—588 meters.

Rock-stratigraphic unit. Lower part of Karikal Formation 'F' (=Member F_2).

Subzones. This zone is further subdivided into following two subzones.

(2) *Globorotalia fohsi robusta* Subzone (upper) and

(1) *Globorotalia fohsi barisanensis* Subzone (lower).

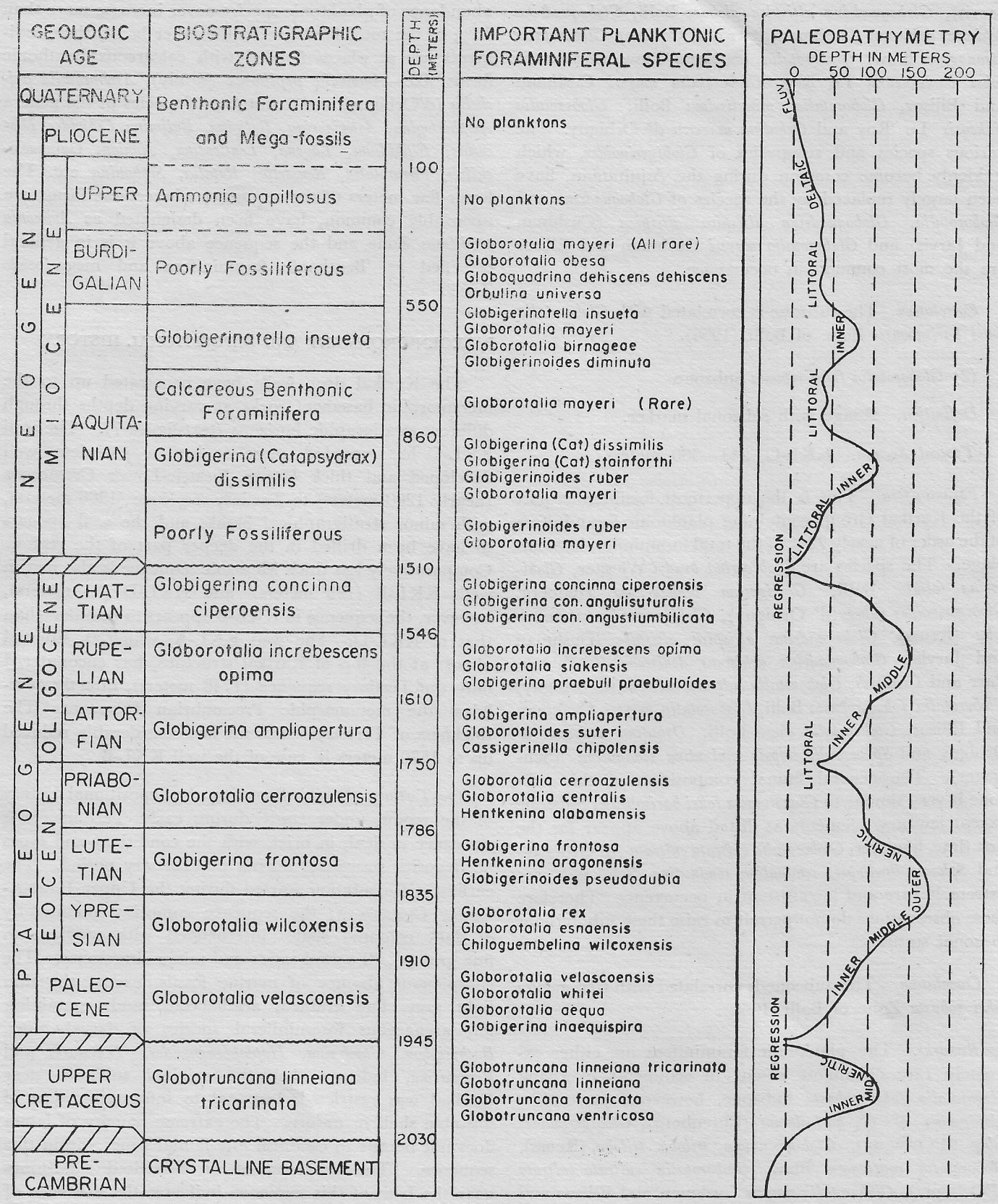
In Karikal sequence, a poorly fossiliferous horizon is observed in between these two subzones. The classification of these suboznes is adopted after Bolli (1957); the intermediate zones—*Globorotalia foshi fohsi* and *Globorotalia fohsi lobata* (Bolli, 1957; 1966) may be equivalent to this poorly fossiliferous horizon. Due to erratic and at times poor development of planktonic foraminifera in certain parts of Burdigalian of Karikal, the sub-divisions proposed here are of subzonal status.

(1) *Globorotalia fohsi barisanensis* Subzone

Definition. Range with subzonal marker.

Typical Section. KKL-C, 488—588 meters.

Foraminifera. Globigerina bradyi Wiesner, *Globigerina foliata* Bolli, *Globigerina praebulloides praebulloides* Blow, *Globigerinoides ruber* (d' Orbigny), *Globigerinoides triloba triloba* (Reuss), *Globoquadrina altispira altispira* (Cushman and



Text-figure 6—Biostratigraphic units, geologlcl age and paleobathymetry in well KKL-D.

Jarvis), *Globoquadrina altispira globosa* Bolli, *Globoquadrina dehiscens dehiscens* (Cushman, Parr and Collins), *Globorotalia biranageae* Blow, *Globorotalia continuosa* Blow, *Globorotalia fohsi barisanensis* Le Roy, *Globorotalia mayeri* Cushman and Ellisor, *Globorotalia minutissima* Bolli, *Globorotalia siakensis* Le Roy and *Orbulina universa* d' Orbigny. The various species and subspecies of *Globigerinoides*, which suddenly become common during the Aquitanian, have been largely replaced by the species of *Globoquadrina* and *Globorotalia*. *Globoquadrina altispira altispira* (Cushman and Jarvis) and *Globorotalia mayeri* Cushman and Ellisor are the most common in occurrence.

Correlation. The subzone is correlated with *Globorotalia fohsi barisanensis* Zone of Bolli (1966).

(2) *Globorotalia fohsi robusta* Subzone

Definition. Range with subzonal marker.

Typical Section. KKL-C, 244—360 meters.

Foraminifera. This is the uppermost fossiliferous part of the Karikal Group containing planktonic foraminifera of the order of nearly 22% of the total foraminiferal assemblage. The species are *Globigerina bradyi* Wiesner, *Globigerina foliata* Bolli, *Globigerina venezuelana* Hedberg, *Globigerinoides ruber* (d' Orbigny), *Globigerinoides triloba triloba* (Reuss), *Globoquadrina altispira altispira* (Cushman and Jarvis), *Globoquadrina dehiscens dehiscens* (Cushman, Parr and Collins), *Globorotalia cultrata cultrata* (d' orbigny) *Globorotalia fohsi robusta* Bolli, *Globorotalia mayeri* Cushman and Ellisor, *Globorotalia obesa* Bolli, *Orbulina universa* d' Orbigny and *Sphaeroidinellopsis seminulina seminulina* (Schwager). The general faunal composition of this subzone is very similar to *Globorotalia fohsi barisanensis* Subzone except few new elements as listed above appear for the first time, however, *Globorotalia cultrata cultrata* (d' Orbigny) and *Sphaeroidinellopsis seminulina seminulina* (Schwager) are extremely rare and inconsistent in occurrence. Therefore these observations do not permit to raise these subdivisions to zonal status.

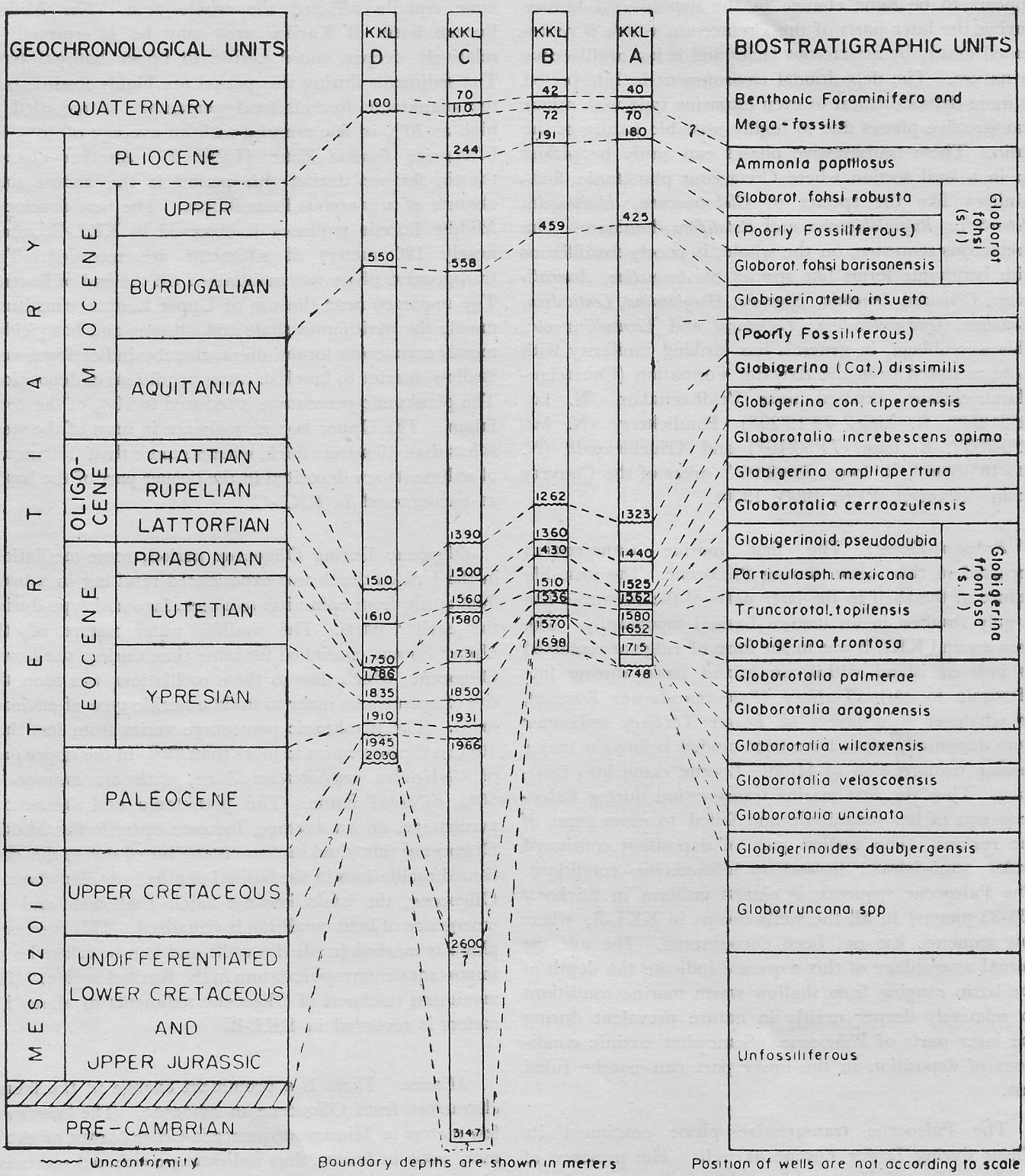
Correlation. This subeone is correlated with *Globorotalia fohsi robusta* Zone of Bolli (1966).

Remarks. The planktonic foraminifera are either extremely rare or almost absent in sediments overlying *Globorotalia fohsi robusta* Subzone, however, species like *Globigerina* cf. *G. pachyderma* (Ehrenberg), *Globigerinoides ruber* (d'Orbigny), *Globigerinoides triloba triloba* (Reuss), *Globorotalia continuosa* Blow, *Globorotalia cultrata cultrata* (d'Orbigny), *Globorotalia mayeri* Cushman and Ellisor and *Globorotalia menardii* (d'Orbigny) continue to occur in sediments few meters above this subzone. The relative abundance of planktonic species never increase more than 10% of the total fauna. On the other hand, these sediments are at places flooded with calcareous benthonic forms like—*Ammonia papillosus* (Brady), *Asterorotalia pulchella* (d'Orbigny) and a number of species of the genera *Amphistegina*, *Asterigerina*, *Bolivina*, *Bulimina*, *Cibicides*, *Discorbis*, *Elphidium*, *Lagena*, *Lenticulina*, *Nonion*, *Quinqueloculina*, *Pararotalia*, *Reussella*, *Rotalia*, *Siphonina* etc. The lower few meters of the sequence, where these forms are invariably common, have been designated as *Ammonia papillosus* Zone and the sequence above it is in general classified as 'Benthonic foraminifera and mega-fossils Zone'.

PALEOENVIRONMENT AND DEPOSITIONAL HISTORY

The Karikal deep wells have penetrated up to the metamorphic basement rocks at varying depths through different stratigraphic horizons (text-figure 7). The well KKL-C has recorded, more or less, a complete, well developed and thick Upper Jurassic-Lower Cretaceous (nearly 1200 meters) to Tertiary sequence (1966 meters), with minor stratigraphical breaks and the well appears to have been drilled in the deeper part of the region. Comparatively less thick Mesozoic sequence is also met in wells KKL-B (128 meters) and KKL-D (85 meters), however, the sequence in KKL-B appears to be older than that of KKL-D. The well KKL-A, which is situated almost at the top of Karikal structure, has encountered only the Tertiary sequence (1748 meters), directly overlying the metamorphic Precambrian basement. The thickness of Tertiary sediments has considerably reduced up to 1570 meters in case of the well KKL-B.

Pre-Tertiary: While discussing the depositional history of the region under study during early Tertiary, it is necessary to deal, in brief, with the conditions and types of deposits prevalent during pre-Tertiary period. The earliest sedimentation started during the Upper Jurassic-Lower Cretaceous; the sequence comprises dominantly of dark coloured shales interbedded with medium to fine grained, ill sorted sands and minor limestones. The conspicuous absence of marine fossils, except the thin light grey, fine grained, argillaceous sands containing few arenaceous foraminiferal species of *Ammobaculites*, *Bathysiphon*, *Gaudryina*, *Haplophragmoides*, *Textularia* and *Verneuilina*, indicate that the original subbasin near Karikal was restricted, lagoonal to infraneritic type of unstable shelf in nature. The extreme paucity of fauna does not permit to establish any faunal zones within this sequence. The development of lateritised sandstones near the base of this sequence indicates the existence of land conditions of short duration during the Lower Cretaceous time. The deposition, on the other hand, was



Text-figure 7—Biostratigraphic zones and their depth boundaries as encountered in Karikal wells.

fairly continuous throughout the Upper Cretaceous, as observed in KKL-C and partly in KKL-D. There appears to be some change in the depositional history during the later parts of the Cretaceous, which is represented mostly by arenaceous facies and is less argillaceous in nature. The depositional environment is interpreted as more deltaic-littoral to even estuarine type with minor transgressive phases due to highly unstable nature of the basin. These transgressive phases can easily be picked up in a well section where Cretaceous planktonic foraminifera like the species of *Globotruncana*, *Hedbergella Heterohelix*, *Rugoglobigerina* and *Rotalipora* dominate. The Cretaceous sequence, on the whole, is poorly fossiliferous with benthonic forms like species of *Anomalina*, *Anomalinoides*, *Cibicides*, *Dorothia*, *Eponides*, *Hoeglundina*, *Lenticulina*, *Planulina*, *Quinqueloculina*, *Textularia* and *Verneuilina* etc. This assemblage, in general, has striking similarity with those recorded from the Ariyalur Formation (Coniacian-Maestrichtian), exposed near Vridhachalam (N. lat. 11°31'00", E. long. 79°19'20"), Pondicherry (N. lat. 11°56'00", E. long. 79°50'10") and Triuchirapalli (N. lat. 10°48'00", E. long. 78°42'00") areas of the Cauvery Basin (Banerji, 1966; 1968; 1970).

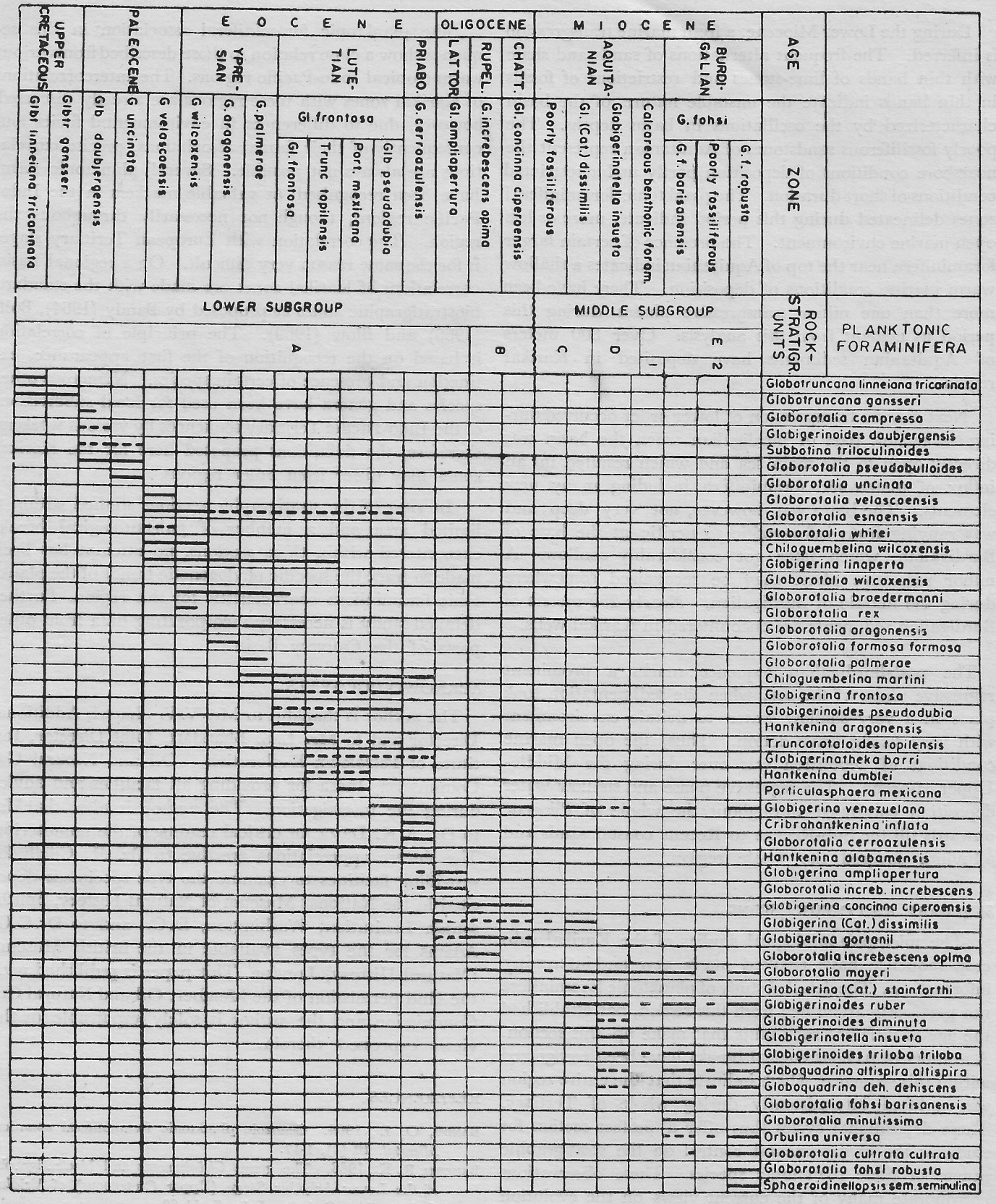
Paleocene-Eocene: The first marine transgression occurred in this region during Paleocene. The unstable nature of the shelf in the later parts of the Mesozoic has largely resulted in an uneven basinal topography. The area around KKL-B was in the form of ridge or remained as isolated island within an inland basin during late Mesozoic to early Tertiary (Paleocene-Lower Eocene), or whatever thin layers of Lower Tertiary sediments were deposited, might have been eroded before the major marine transgression of Middle Eocene came into existence. Thus the first marine transgression during Paleocene was of less magnitude and failed to cover most of the regions. The earliest part of deposition continued under semi-deltaic, littoral to infra-neritic conditions. The Paleocene sequence is almost uniform in thickness (33-35 meters) in all the wells except in KKL-B, where this sequence has not been encountered. The average faunal assemblage of this sequence indicate the depth of the basin ranging from shallow warm marine conditions to relatively deeper neritic in nature prevalent during the later parts of Paleocene. Somewhat euxinic conditions of deposition in the lower part can not be ruled out.

The Paleocene transgressive phase continued its effects during Lower Eocene as well. The presence of few larger foraminifera and few other shallow water forms in the Lower Eocene sequence around 1670 meters depth in KKL-A indicates somewhat reversal of shallow marine conditions of deposition.

The second marine transgression of relatively greater. magnitude occurred during the Middle Eocene, which have equally affected the whole area. The Middle Eocene basin of Karikal area may be interpreted as relatively deeper, outer neritic to upper bathyal type. The sediments during this period are highly fossiliferous; the planktonic foraminiferal percentage is recorded as high as 70% in few samples with an average of 40% for *Globigerina frontosa* Zone (Table 2). Another characteristic feature during this period is the almost total absence of arenaceous foraminifera. The best developed Middle Eocene sequence is observed in KKL-C, where nearly 120 meters of sediments are recorded. This transgressive phase was maintained till the end of Eocene. The sequence near the top of Upper Eocene constitutes mostly the pyritiferous shale and siltstone and has yielded mostly arenaceous foraminifera, thereby indicating a very shallow, marine to brackish water conditions of deposition. The planktonic percentage is reduced to 10% of the total fauna. The Upper Eocene sequence in most of the wells is less than 40 meters thick, whereas more than 150 meters of sediments are deposited in the deeper part of the basin, as encountered in KKL-C.

Oligocene: During Oligocene period, some oscillations in the basinal depth was experienced resulting in a basin fluctuating from epineritic to almost lagoonal type during the earlier parts. The shallow water nature of the Upper Eocene continued for some time during the Lower Oligocene, which due to these oscillations was soon the site of open warm inner to middle neritic type of environment. The planktonic percentage varies from less than 10% in the lower part to more than 35% in the upper part of *Globigerina ampliapertura* Zone, with an average of 30% of total fauna. The planktonic and arenaceous percentage, on an average, increase towards the Middle Oligocene; this dual increase is attributed due to the continued oscillations in the basinal depths. At the close of Oligocene, the basin became much shallower and an emergence of land condition is visualized. This regressive phase is marked in all the wells and can be taken as an important stratigraphic datum in the Karikal region. The maximum thickness of Oligocene sediments of about 250 meters is recorded in KKL-B.

Miocene. There is a prominent change in the faunal characters from Oligocene to Miocene. The lowermost few meters in Miocene sequence is either barren or extremely poor in fauna, thus indicating continued regressive phase during the earliest part of Miocene. The lateritized band, as observed in one of the wells, represents the latest phase of regression during Upper Oligocene-Lower Miocene.



Text-figure 8—Stratigraphic range of planktonic foraminiferal species in Karikal areas. G.=*Globorotalia*, G. f.=*Globorotalia fohsi*, Gl.=*Globigerina*, Gl. (Cat.)=*Globigerina* (*Catapsydrax*), Glb.=*Globigerinoides*, Glbt.=*Globotruncana*, Port. *Porticulasphaera* and Trunc,=*Truncorotaloides*.

During the Lower Miocene, a fresh marine transgression is inferred. The frequent alternations of sands and shale with thin bands of lime-stones and restrictions of fossils in thin bands indicate the unstable nature of the basin characterized by the oscillations in basin depths. The poorly fossiliferous sandstones of Aquitanian represent the nearshore conditions of deposition partly under restricted conditions of short duration. The planktonic foraminiferal zones delineated during this period indicate, more or less open marine environment. The presence of certain larger foraminifera near the top of Aquitanian indicates a shallow warm marine conditions of deposition. There have been more than one minor transgressive phases during this period as evident from this analysis. Over 800 meters of Aquitanian sediments have deposited in Karikal region.

Next marine transgression of lower order occurred during the earliest part of Burdigalian when the basin was directly open to the main sea and which resulted in an influx of planktonic foraminifera including many new elements. The basin was, however, not very deep and was ranging from infra-neritic to neritic at the base of Burdigalian, which later got considerably shallow. A minor regressive phase may be recognized somewhere during the middle of Burdigalian. Nearly 250 meters of Burdigalian sediments are encountered in Karikal wells.

The post-Burdigalian sequence marks a prominent regressive phase of the sea, when the sedimentation took place in a very shallow water to deltaic envoironment with very strong wave action. Thus, the open marine conditions of deposition was over during the Middle-Upper Miocene. The regressive phase and shallow water deposition continued throughout the whole of Pliocene onwards till the Sub-Recent to Recent coastal sands and alluvium covered the whole region.

SUMMARY AND CONCLUSIONS

The micropaleontological studies of the Karikal subcrop sequence have resulted many new and interesting informations. The detailed study of planktonic foraminifera not previously attempted from this region, has established the age of different rock units that make up this section. A number of paleontological breaks have been recognized within this sequence, which indicate that the entire region was uplifted intermittently during whole of Tertiary. These depositional cycles thus offer a perfect section for studying the environmental control on the stratigraphic ranges of these planktonic species. These observations corroborate many of the current views on the evolution of the world's well known species and thus establish their stratigraphic range in hitherto unexplored Indian subcontinent.

The planktonic foraminiferal association in this sequence show a close relation to those described from various warm tropical Indo-Pacific regions. The intercorrelations of Karikal zones with these regions are already discussed however, due to differences in environmental facies and consequently of their faunal associations, precise correlations are always not possible. Several planktonic forms have been recognised as valuable markers in the Indo-Pacific regions, though not necessarily throughout the region. The correlation with European Teritiary stages is for the same reason very difficult. On a regional basis, correlations of Karikal zones are made with the standard biostratigraphic zones as proposed by Bandy (1964), Bolli (1966) and Blow (1969). The principle of correlation is based on the recognition of the first appearance, extinction and presence of certain species. Numerous other species and genera have been used for local subdivisions of the Indo-Pacific Teritiary sequences by various workers, therefore, the definitions proposed here for the Karikal zones may differ from other regions.

In view of the stratigraphic sections studied within a limited area and a number of paleontological breaks encountered within these sections, no attempt has been made to trace the specific phylogenetic trends of the planktonic foraminifera characteristic for this region. Further detailed study is necessary incorporating data from other parts of the Cauvery Basin.

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