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THE RELATION BETWEEN THE TROPICAL PLANKTONIC FORAMINIFERAL ZONATION AND THE TERTIARY FAR EAST LETTER CLASSIFICATION

R. HAAK and J.A. POSTUMA[1])

ABSTRACT

A correlation between the tropical planktonic foraminiferal zonation and the Tertiary Far East Letter Classification is presented. Their relationships with world-wide time stratigraphical units and classic European stages are tabulated. The datum planes of the most important planktonic and larger Foraminifera are also shown.

INTRODUCTION

The Tertiary Letter Classification of the Far East has been widely used in the stratigraphy of the Indo-Malaysian area, e.g. Indonesia, the Philippines, Brunei, Sarawak and Sabah. It is based on larger Foraminifera and serves a practical purpose in shallow-water, holomarine shelf deposits.

Both authors have drawn on their own experience in the eastern hemisphere. Naturally, extensive use has been made of modern literature on this subject and in addition very useful information was obtained from recent findings by a number of Royal Dutch Shell palaeontologists working at present in the Far East.

PALEOCENE AND EOCENE

The zonal system used by B e r g g r e n (1969a and 1972) for the Lower Tertiary (P.1 to P.12 inclusive) was considered by B l o w (1970a) to be incorrect. But this part of Blow's P. zonation has not yet properly been published which makes the stratigraphic position of these zones uncertain. The scheme presented in Table 1 does therefore not show a subdivision into individual P. zones for the intervals prior to P.13. The Paleocene zones (P.1 to P.6 inclusive) and the Lower/Middle Eocene zones (P.7 to P.12 inclusive) have merely been lumped, following Blow's view on the relationship of these zones to epochs (Blow, 1970a).

The boundary between Middle and Upper Eocene is placed at the top of the "rohri zone", following the suggestions made at the Eocene Colloquium in Paris 1968 (ref. Colloque sur l'Eocène – Propositions, p. 459-463). *Pellatispira*, characteristic of Tb in the Indo-Malaysian region, ranges down into the "rohri zone" in the Jiwo Hills area of central Java, according to Shell palacontologists in Indonesia. Thus, the base of Tb falls in the uppermost part of the Middle Eocene.

The top of the *Globorotalia cerroazulensis* zone, which zone we consider to be equivalent to P.16, reflects the top of the Eocene and, thus, the boundary between Tb and Tc. B l o w (1969) considered his zone P.17 to represent the uppermost Eocene. This could not be confirmed by our observations. The Lindi area of Tanganyika, the type locality of planktonic zone P.17, seems to be unsuitable for the establishment of world-wide planktonic zones. A reduced number of planktonic species there, associated with larger Foraminifera (Discocyclina, Nummulites; E a m e s and others, 1962, pp. 66-69), points to relatively shallow water conditions of local geographic extent.

OLIGOCENE AND MIOCENE

The *Globigerina ampliapertura* zone (= ? P.18 + N.1) corresponds to the Tc-d of the Letter Classification. Zone P.18 (B l o w, 1969), which represents the interval between the extinction datum of *Globorotalia centralis* and the first appearance of *Globigerina sellii,* has been maintained in our scheme. It remains, however, of questionable world-wide significance as a zone, because the "species" *Globigerina tapuriensis* and *Globigerina sellii*, by which it is defined, are probably not fully developed taxa of the *Globigerina tripartita* group.

At present, we cannot accurately correlate the top of Lower Te (= Te 1-4) with the tropical planktonic zonation, but it falls either within the basal part or coincides with the base of the *Globorotalia kugleri* zone. We concur, therefore, with A d a m s (1970, p. 127 and 128) that the Oligocene/Miocene boundary approximately coincides with the Lower Te/Upper Te boundary. It is recommended that detailed

[1]) Shell Internationale Petroleum Maatschappij B.V., P.O. Box 162, The Hague.

EPOCHS		EUROPEAN STAGES	TIME IN MILLION YEARS: GLAESSNER 1970	TIME IN MILLION YEARS: BERGGREN 1969a	TIME IN MILLION YEARS: BERGGREN 1972	PLANKTONIC FORAMINIFERAL ZONES: BLOW 1969	PLANKTONIC FORAMINIFERAL ZONES: POSTUMA 1971	LETTER CODE FAR EAST	DATUM PLANES: PLANKTONIC FORAMINIFERA TROPICAL SPECIES	DATUM PLANES: LARGER FORAMINIFERA FAR EAST
QUATERNARY						N.23 / N.22	Globorotalia truncatulinoides	Tg-h		
PLIOCENE		Piacenzian	1.85	1.85	1.85	N.21	Globorotalia tosaensis			
						N.20			top Globoquadrina altispira	
						N.19	Globoquadrina altispira			
MIOCENE	Upper	Messinian / Tortonian	5	5	5	N.18	Globorotalia margaritae		base Sphaeroidinella dehiscens	
						N.17	Globorotalia dutertrei			
					10	N.16	Globorotalia acostaensis	Tf Upper (= Tf 3)		top Lepidocyclina
						N.15	Globorotalia menardii		base Globorotalia acostaensis	
	Middle	Serravallian		11.5	13.5	N.14	Globorotalia siakensis			
						N.13	Globigerinoides subquadratus		top Globigerinoides subquadratus	
						N.12	Globorotalia fohsi	Tf Middle (= Tf 2)	top Globorotalia fohsi ?	(?) top Miogypsina
						N.11	Globorotalia lobata			top Flosculinella bontangensis
				13	15	N.10	Globorotalia peripheroacuta	Tf Lower (= Tf 1)		top Miogypsinoides dehaarti
		Langhian				N.9	Globorotalia peripheroronda			
			14-15	14	16	N.7-8	Globigerinatella insueta		base Orbulina	top Spiroclypeus
	Lower	Burdigalian				N.6	Globigerinoides trilobus / C. stainforthi	Te Upper (= Te 5)	base Globigerinatella insueta	top Eulepidina
				17.5	19	N.5	Globigerinoides trilobus / G. binaiensis		top Globigerina binaensis	
		Aquitanian				N.4	Globorotalia kugleri		base Globigerinoides trilobus	base Miogypsina s.str.
			22.5	22.5	22.5				top Globigerina sellii	top Miogypsinoides ubaghsi
						N.3=P.22	Globigerina angulisuturalis	Te Lower (=Te1-4)	base Globorotalia kugleri	top Miogypsinoides complanatus
OLIGOCENE		Chattian		26	26	N.2=P.21				top Heterostegina borneensis
				30	30				base Globigerina angulisuturalis	top Nummulites fichteli
		Rupelian				N.1=P.19/20	Globigerina ampliapertura	Td		
		Lattorfian				P.18		Tc		base Eulepidina
			36	36.5	38	P.16	Globorotalia cerroazulensis	Tb	top Hantkenina	top Discocyclina
EOCENE	Upper	Priabonian				P.15	Globigerapsis mexicana			top Pellatispira
			45	45	43	P.14	Truncorotaloides rohri		base Globigerapsis mexicana / top Truncorotaloides rohri	top Biplanispira / base Pellatispira
	Middle	Lutetian				P.13	Orbulinoides beckmanni	Ta Middle / Upper		top Assilina
						P.12	Globorotalia lehneri			top Nummulites javanus
							Globigerapsis kugleri			top Nummulites gizehensis
							Globorotalia bullbrooki			
	Lower	Ypresian		49	49		Globorotalia formosa-aragonensis		base Hantkenina	
						P.7	Globorotalia rex			
				53.5	53.5	P.6	Globorotalia velascoensis	Ta Lower	top Globorotalia velascoensis	top Miscellaneg miscella
PALEOCENE		Landenian / Montian					Globorotalia pseudomenardii			top Ranikothalia
							Globorotalia angulata			
		Danian					Globorotalia uncinata			
			65	65	65	P.1	Globigerina daubjergensis			

studies of this time-stratigraphical interval are made in the Far East, preferably on surface sections in the appropriate facies-setting, in order to solve this stratigraphic problem.

Miogypsina s.str. – that means all miogypsinids with true lateral chambers – has a range of Upper Te – Middle Tf. Its base coincides grosso modo with that of the *Globorotalia kugleri* zone. *"Miogypsina" primitiva,* which is characterized by scattered vacuoles instead of true lateral chambers, does not belong to *Miogypsina* s.str. as defined above. It ranges throughout the Te.

For the Indo-Pacific region, the *Globigerinoides trilobus* zone (sensu Postuma, 1971) has here (Table 1), been subdivided into a lower part (*Globigerina binaiensis* subzone) and an upper part (*Catapsydrax stainforthi* subzone). The latter is the equivalent of the *C. stainforthi* subzone of Bolli (1966) = N.6. The boundary between the two subzones is characterized by the stratigraphic top of *Globigerina binaiensis,* which, with its typically high, wide and almost flat apertural face, is a common, very characteristic and easily recognizable form in the Far East.

Our own stratigraphic experience in the Far East indicates that base Tf is below the base Orbulina datum. This places the Te/Tf boundary somewhere within N.7-8 (= *Globigerinatella insueta* zone).

In our scheme the Tf is subdivided into a Lower Tf, a Middle Tf and an Upper Tf, approximately corresponding to the original Tf1, Tf2 and Tf3 of the Far East Letter Classification. Such a subdivision has successfully been applied in several parts of the Far East.

The Lower Tf is characterized by the total range of *Flosculinella bontangensis*. The top of the Lower Tf is, furthermore, marked by the stratigraphic top of *Miogypsinoides dehaarti*. Unispiral miogypsinids apparently do not range above Lower Tf. The boundary between Lower and Middle Tf, however, may be critically reviewed at a later stage, since the abovementioned zonal markers are strongly facies-dependent.

The extinction level of *Miogypsina* in the Indo-Malaysian area has been taken by us as the top of the Middle Tf. Its exact stratigraphic position is still unknown at present, but it does not seem to be higher than the *Globorotalia fohsi* zone (N.12). Berggren (1972, p. 208) places this extinction level within zone N.12.

Upper Tf (=Tf3) is defined in this paper as that part of Tf above the extinction level of *Miogypsina*.

Adams distinguishes a Lower Tf (= Tf1 + Tf2) and an Upper Tf (= Tf3). His Lower Tf is apparently equivalent to our Lower and Middle Tf. He already noted that *Miogypsina* probably does not reach into Upper Tf, viz. '....there appears to be no reliable evidence to support the belief that Miogypsina occurs in the Upper Tf....' (1970, p. 120).

We place the Tf/Tg boundary at the level of extinction of *Lepidocyclina*, according to its original definition and the general usage.

The correlation between the Tf/Tg boundary and the tropical planktonic foraminiferal zonation cannot as yet accurately been given. Clarke and Blow (1969, p. 90 and fig. 1) placed it near or at the base of N.15.

During the investigation of well-samples which were collected in the Tonga Islands we found occurrences of *Lepidocyclina radiata,* considered to be one of the latest representatives of the genus *Lepidocyclina* in the Far East, well within the *Globorotalia acostaensis* zone = N.16.
This apparently corroborates the findings of Baumann et al. (1972) who place the top of Tf in N.16, slightly above the N.15 – N.16 boundary.

Little information is known as yet from radiometric age determination which have a bearing on the Letter Classification of the Far East. Page and McDougall (1970) reported on potassium-argon dating of volcanics from New Guinea which are interbedded with sedimentary rocks containing larger Foraminifera characteristic for Tf1-Tf2. These K-Ar dates range from 13-15 m.y. and suggest that the Tf1-Tf2 ranges from 12.5-15 m.y. The same authors (1970) propose an age of 9.3 m.y. for the top of Tf in Fiji. These data fit rather well within the schemes published by Glaessner (1970) and Berggren (1969a), but do not agree so well with the 1972 version of Berggren, which give an offset by 2-3 m.y. for the Middle Miocene when compared with 1969 views.

We have placed the Miocene/Pliocene boundary within the *Globorotalia margaritae* zone (Glaessner, 1970; Postuma, 1971), at the level of the evolutionary appearance of *Sphaeroidinella dehiscens*. The general census of opinion points to an age of around 5 m.y. for this stratigraphic level. Such figure is given by Berggren (1972) and Glaessner (1970). Gill and McDougall (1973) suggest an age of 4.9 m.y. on data obtained from Fiji. In recent literature, however, there is a trend, originating from Mediterranean workers, to carrelate the Miocene/Pliocene boundary, for sake of convenience, with the base of *G. margaritae* zone = base N.18.

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