Late Miocene Planktic Foraminifera Biostratigraphy of Central Bogor Through, Indonesia*

Biostratigrafi ForaminiferaPlanktik Miosen Akhir Cekungan Bogor Bagian Tengah, Indonesia*

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ABSTRACT

Micropaleontology clues, particulary foraminifera are studied in Late Miocene marine sediment from central Bogor Through, Indonesia. Detailed biostratigraphic frame work is provided by the occurrence of diverse and preserved foraminifera. The planktic foraminifera events used to date the Late Miocene of 11.3 to 5.3 Ma duration are based on the appearanceof marker species. In the Late Miocene interval of Central Bogor Through, a total of four planktic foraminifera marker species have been selected; among all: ***Globorotalia acostaensis, Globorotalia plesiotumida, Globorotalia tumida,*** *and* ***Sphaeroidinella dehiscens.****The first appearance of the marker species marked significant biodatums to regional correlation.*

Based on these biodatums, the four interval zones are established. Those are starting from the oldest: ***Globorotalia menardii – Globorotalia acostaensis*** *Interval Zone (N.15 of Blow's zones on Middle - Late Miocene or >11.3my BP),* ***Globorotalia acostaensis – Globorotalia plesiotumida*** *Interval Zone (N.16or 11.3 – 6.2 my BP) ,* ***Globorotalia plesiotumida – Globorotalia tumida*** *Interval Zone (N.17or< 6.2 my BP),*and***Globorotalia tumida – Sphaeroidinella dehiscens*** *Interval Zone (N.18 on Miocene-Pliocene Boundary or<5.3 my BP). This study indicate that throughout Late Miocene interval in central Bogor Through, planktic foraminifera assemblages provide a high accurate biostratigraphy and it is a good tool for correlation.*

Geodynamic activities and sea level fluctuations in the Bogor Trough asymmetric back arc basin recorded particularly in marine clastic sediment sequencescan be intercorrelated. Those events can be reconstructed using foraminifera biostratigraphic studies.

Keywords: biostratigraphy, foraminifera, Late Miocene, central Bogor Through, marker species, zone

ABSTRAK

Petunjuk-petunjuk mikropaleontologi, khususnya foraminifera telah dipelajari dalam sedimen laut Miosen Akhir dari Cekungan Bogor bagian tengah, Indonesia. Kerangka biostratigrafi detil ditentukanoleh kehadiran foraminifera yang beragam dan terawetkan. Even-even foraminifera plantik digunakan untuk menentukan umur Miosen Akhir atau kurun waktu 10.8 hingga 5.3 juta tahun lalu, berdasarkan kehadiran spesies petunjuk. Dalam interval Miosen Akhir di Cekungan Bogor bagian tengah, terdapat empat spesies-spesies petunjuk yang dipilih, yaitu ***Globorotalia acostaensis, Globorotalia plesiotumida, Globorotalia tumida,*** *dan* ***Sphaeroidinella dehiscens****. Pemunculan awal spesies-spesies petunjuk menandai biodatum yang penting untuk korelasi regional.*

Berdasarkan biodatum-biodatum tersebut, dapat disusun empat buah zona selang. Zona-zona ini mulai dari yang paling tua adalah: Zona Selang ***Globorotalia menardii – Globorotalia acostaensis****(N.15 dari zonasi Blow, pada Tengah – Akhir Miosen atau lebih dari 11,3juta tahun lalu),Zona Selang* ***Globorotalia acostaensis – Globorotalia plesiotumida*** *(N.16 atau sekitar 11,3 – 6,2 juta tahun lalu), Zona Selang* ***Globorotalia plesiotumida – Globorotalia tumida*** *(N.17 atau< 6,2 juta tahun lalu), Zona Selang* ***Globorotalia tumida – Sphaeroidinella dehiscens*** *(N.18, pada batas Miosen-Pliosen atau<5,3 my).Studi ini menunjukkan bahwa dalam interval Miosen Akhir di Cekungan Bogor bagian tengah, kumpulan foraminifera planktic membentuk suatu tatanan biostratigrafi akurasi tinggi and baik digunakan untuk korelasi.*

Aktifitas-aktifitas geodinamik dan fluktuasi-fluktuasi muka air laut dari bagian tengah Cekungan Bogor yang terekam terutama pada urutan-urutan sedimen klastik marin akan dapat dikorelasikan. Even-even ini akan dapat direkonstruksi berdasarkan studi-studi biostratigrafi foraminifera.

Kata-kata kunci: *biostratigrafi, foraminifera, Miosen Akhir, Cekungan Bogor bagian tengah, spesies petunjuk, zona*

INTRODUCTION

Since the stratigraphy significance of foraminifera first proposed by Cushman & Stainforth (1945), much work has been done to describe Tertiary zonation based on planktic foraminifera, both for Paleogene and Neogene.

The Tertiary planktic foraminifera zonal scheme haveproposed byBolli in 1957, Bolli & Bermudez in 1965, Banner & Blow in 1965, Blow in 1969, Bolli & Permoli Silva in 1973, Postuma in 1971, Kennett & Srinivasan in 1983 (Bolli & Saunders, 1986; van Gorsel, 1988). Blow's numbered standard biozonation (Blow, 1969, 1979) increasing from oldest to youngest, emended several of the zonal definitions is the most popular zonation to be used in Indonesia. The 22planktic foraminifera zones in Paleogene (numbered P.1 to P.22) and the 23 zonein Neogene to Quaternary (numbered N.1 to N.23) are supposed for a standard Tertiary and Quaternary planktic foraminifera zonations.

The changes of existing zones definitions, retaining the same name or number, as well as the applications of zonal names already in use to zones differently defined, have repeatedly occurred. Many authors write out fossils name or zonal marker to the sequence of zone giving inherent clue to stratigraphic level. Bolli & Saunders (1986) suggested 24 planktic foraminifera zones during Oligocene to Holocene in low latitude province which divided into several subzones.

Foraminifera is widely used for determining age and correlation. Reffering ofzone schemes with the different marker or definitions is necesarry to lead to biostratigraphic interpretation and correlation. In the eastern West Java, Indonesia, the high quality surface data of Miosen marine sediment can be used to study of foraminifera biostratigraphy.That is way the study covered Late Miocene foraminifera biostratigraphic zonation is to be done in central Bogor Through.

The geology and stratigraphy of this area have been dealt by Koolhoven (1936), van Bemmelen (1949), Marks (1957), Djuri (1973), Djuhaeni&Martodjojo (1989), and

Martodjodjo (2003). A succession of strata of Late Miocene sections containing foraminifera commencing from the Cinambo and Halang Formations can be observed in this region.

Detailed biostratigraphic frame work is provided by the occurence of diverse and preserved foraminifera used to date the Late Miocene of 5.3 to 11.3 my duration. This study aims to establish foraminifera biostratigraphic zone based on the appearance of marker species from sedimentary sections in central part of Bogor Through.

For purpose of establishing level of correlation between surface sections in Late Miocene in central Bogor Through, the foraminifera biostratigraphy, particulary Late Miocene age can be interested to be studied. The selected planktic foraminifera events determine by first appearance of marker species should coincide with the datum planes of the previous worker dealing with others area for correlation purposes concerning the stratigraphyc sequence. The co-appearances of the characteristic taxa of foraminifera together with the datum planes can be used as tool for regional correlations.

MATERIALS AND METHODS

The study area occupies the central part of Bogor Through, Java Indonesia (Figure 1). The study was made on the basis ofthree sections in the study field. Total 113 outcrop samples obtained from sections, stratigraphically respectivelly: Section 1 Sungai Cilutung (Pasir Ewekranda), Section 2 Sungai Cilutung (Sungai Cipitung – Sungai Cibujur), and Sungai Cilutung (Bantarujeg area).

The methods of the study include: (1) collecting secondary regional geologic data, (2) collecting field data record (geological mapping) and sample, (3) laboratory work, and (4) integrating all of the analysis result.

Samples were prepared using standard residu methods and determinate under a binocular microscope under 100 to 400 magnification. Identification of the foraminifera refers toPostuma (1971), Stainforth, *et al.* (1975), Saito, *et al.* (1981), Kennett & Srinivasan (1983),

Bolli & Saunders (1986) and Loeblich & Tappan (1988) The preserved foraminifera assemblages in sediment is determined quantitatively.

The establishmment of foraminifera marker species are based on criteria that the selected taxon is distinctive as well as easy recognized so it should be significant and have a wide geographic distribution. The selected events were determinated by the fisrt appearance of the marker species. Biostratigraphyc zone were arranged based on the datum to date the Late Miocene age.

RESULT AND DISCUSSION

1) Stratigraphy

The area includes central area of Bogor Through. The stratigraphyc coloums consist of Cinambo and Halang Formations, and aluvium. The lower part of Cinambo consist of mostly tuffaceous sandstone with calcareous clay-sandstone intercalations, while the calcareous claystone laminationsare more dominant at the upper part. Gradded bedding, parallel lamination, convolute, flute cast and bioturbation sediment structures are recorded in the turbidite deep marine sediments of Cinambo Formations. The lower part of Halang Formation started by breccia, tuffaceous sandstone and calcareous clay-sandstone overlied the erosional basal. The upper part of this formation is composed by tuffaceous sandstone, calcareous claystone, sandstone and conglomeratic sandstone, as well as conglomerate with some coral and mollusc fragment. Gradded bedding, parallel lamination, convolute, slump sediment structures, are founded at the sections.

2) Planktic Foraminifera Marker

From the Late Miocene of central Java Through, a total of four planktic foraminifera marker species have been selected; among all: ***Globorotalia acostaensis, Globorotalia plesiotumida, Globorotalia tumida,*** and ***Sphaeroidinella dehiscens.***

Systematic description and synonym of these marker species refers to Postuma (1971), Stainforth, *et al.* (1975), Saito, et al. (1981), Kennett & Srinivasan (1983), Bolli & Saunders (1986), and Loeblich & Tappan (1988) are as follow:

a) ***Globorotalia acostaensis*** Blow, 1959

Synonym:

Globorotalia (Turborotalia) acostaensis Blow in Banner & Blow, 1967

Globoquadrina continuosa (Blow) in Parker, 1967

Globorotalia (Turborotalia) acostaensis acostaensis Blow in Blow, 1969

Globorotalia (Turborotalia) acostaensis tegillata Bronnimann & Resig, 1971

Description:

Test: thick discoidal low trochospiral; equatorial periphery lobulate; axial periphery rounded. Spiral outline subcircular, strongly lobate; side profile parallel-side with blunty rounded periphery, thickness more than half diameter. Wall: distinctly perforate, rather thick, pustulose around umbilicus, Surface of wall: pitted. Chambers: ovate to subspherical, arranged in about three to six whorls, with five to six chambers in last whorl, increasing regularly in size. Often the last chamber is much reduced in size and occasionally somewhat displaced towards the umbilical side. Sutures: straight, on spiral side radial to slightly curved, depressed; on umbilical side radial, depressed, more distinct than on spiral side. Umbilicus: indistinct, narrow, deep. Aperture interiomarginal, extraumbilical-umbilical, a low arch, usually bordered by a distinctive lip or rim. Size: diameter 0.25 to 0.5 mm.

b) ***Globorotalia plesiotumida*** Blow and Banner, 1965

Synonym:

Globorotalia (Globorotalia) tumida plesiotumida Blow and Banner in Banner & Blow, 1965

Globorotalia tumida plesiotumida Blow and Banner in Bolli, 1966

Globorotalia plesiotumida Blow and Banner in Bermudez & Bolli, 1969

Description:

Test a lenticular, very low trochospiral, rimmed by blunt keel, unequally biconvex, compressed; equatorial periphery slightly lobulate, equatorial profile ear-shaped, last chamber projecting noticeably; axial periphery acute with a distinct keel, axial profile biconvex, slightly more inflated on umbilical than on spiral side. Wall finely perforate; surface are mostly smooth, densely, but granules are developed on the area of the wall of the first three chambers which immediately faces the aperture. Chambers compressed, arranged in three whorls; the five to six chambers of the last whorl increase somewhat irregularly in size as added, especially in radial length. Sutures on

spiral side curved, limbate; later depressed to sunken, oblique to recurved, coalescing into keel, ones becoming almost sub-radial; their distal parts being strongly curved, flush to raised; on umbilical side incised, radial, almost straight, to slightly curved, shallowly depressed. Umbilicus: narrow to closed, deep; umbilical shoulders developed only on last three chambers. Aperture: interiomarginal, extraumbilical-umbilical, a rather low arch from umbilicus almost to keel, bordered by a thick lip along whole length. Size:diameter 0.5 to 0.7 mm.

c) ***Globorotalia tumida***(Brady, 1877)

Synonym:

Pulvinulina menardii tumida Brady, 1877

Globorotalia tumida (Brady) in Cushman, 1927

Globorotalia (Globorotalia) tumida tumida (Brady) in Banner & Blow, 1965

Globorotalia tumida tumida (Bardy) in Bolli, 1970

Description:

Test:a large, moderately low trochospiral, biconvex; spiral side more convex than umbilical side, compressed; equatorial periphery subcircular to slightly lobulate in the final stage, equatorial profile ear-shaped, slightly lobate; axial periphery, tumid trochospire rimmed by heavy, acute with a massive keel, axial profile rhomboid to dropshaped. Wall: finely perforate, thick; Surface of wall: smooth except for the umbilical side of the early chambers of the last whorl and the umbilical margins of the later chambers, centered on umbilicus, which are heavily pustulose. Chambers: compressed, arranged in about three whorls; the six chambers of the last whorl increase regularly to irregularly in size as added, especially in radial length. Sutures: on spiral side limbate, initially smoothly curved, later more sharply curved to hooked obliquely backwards, coalescing into thick keel, their proximal ends almost straight and nearly radial, their distal ends re-curved almost tangentially to the periphery, raised; on umbilical side almost radial to slightly sinuous, depressed. Umbilicus: fairly narrow, deep. Aperture:a slit or low arch between umbilicus and keel, interiomarginal, extraumbilical-umbilical, a rather high arch, partially bordered by a broad, thick lip or flap.Size: diameter 0.7 to 1.0 mm.

d) ***Sphaeroidinella dehiscens***(Parker and Jones, 1865)

Synonym:

Sphaeroidina bulloides dehiscens Parker & Jones, 1865

Sphaeroidinella dehiscens (Parker & Jones) in Bolli, Loeblich & Tappan, 1957

Sphaeroidinella dehiscens excavata Banner & Blow, 1965

Sphaeroidinella dehiscens dehiscens (Parker & Jones) in Blow, 1969

Description:

Test: trochospiral, compact; equatorial periphery very slightly lobulate; axial perpihery rounded. Gross from egg-shaped, gashes by apertural slits.Wall: primarily coarse perforate, covered by secondary layers of shell material greatly reducing the external openings of the pores of the primary wall or sealing them; Surface of wall: smooth and glassy in appearance. Chambers: subglobular, becoming increasingly embracing in the adult, arranged in about three whorls; the three chambers of the last whorl increasing raidly in size, sometimes relative sizes variable and trochoid pattern not obvious, only last 3 chambers visible externally. Sutures: indistinct, radial, slightly depressed to flush where not modified by apertures, typically smooth and vitreous owing to secondary covering, but abrasion or solution may reveal coarsely perforate, almost latticelike primary shell. Primary aperture interiomarginal, umbilical; one or two sutural secondary apertures on opposite side of the final chamber are present. Umbilicus: a deep irregular pit. Apertures: primary aperture umbilical extended by reentrant along intercameral sutures; secondary/supplementary apertures of similar aspect also on spiral side, at least in adults. Apertures may be partially obscured or with lips variying from the smooth or crenulate rims overhanging chamber flanges. Size: diametercommonly to 1.0 mm.

3) Stratigraphyc Distribution of Planktic Foraminifera Marker

The previous studies have recorded the apperance of the proposed planktic foraminifera marker, as follows:

a) ***Globorotalia acostaensis***

The first apperance of ***Globorotalia acostaensis*** is estimated at about 10 Ma (Berggren, 1972 and Saito, 1977). Bolli & Saunders (1986) dated the first appearance of this species is 11.3 Ma.

b) ***Globorotalia plesiotumida***

The first apperance of ***Globorotalia plesiotumida*** are recognized slightly bellow ***Pulleniatina primalis*** datumatabout 6.2 Ma (Saito, 1977)

c) ***Globorotalia tumida***

The first appearance of ***Globorotalia tumida*** has been known by many worker to be very close to the Miocene – Pliocene boundary. No radiomatric time-scale are recorded the datum in Asia Region.

d) ***Sphaeroidinella dehiscens***

The first appearance of ***Sphaeroidinella dehiscens*** has been recognized as a marker horizon for the Miocene-Pliocene Boundary dated 5.3 Ma (Salvador, 1985). Bergreen (1972) dated the first appearance of this species about 5 Ma.

e) **Late Miocene Planktic Foraminifera Biostratigraphy**

For the purpose of establishing planktic foraminifera biostratigraphy in central Bogor Through, interval zone are determinated (Figure 2). The interval zone are biostratigraphic zone lying between two horizon first appearance of planktic foraminifera marker species. On the basis of these events, the four Late Miocene zones were established. There are, starting from the oldest to youngest :

a) ***Globorotalia menardii – Globorotalia acostaensis*** Interval Zone

Definition: The appearance of relatively common ***Globorotalia menardii*** to the first appearance of ***Globorotalia acostaensis***.

Age: Middle Miocene

Remarks: Bolli & Saunders, 1986 reported that the zone as defined originally by Stainford (1948), emended by Bronnimann (1951), redefined by Bolli (1966) as the interval zone defined interval with zonal marker, from last occurrence of ***Globorotalia mayeri*** to the first occurrence of ***Globorotalia acostaensis***. This zone is defined as N.15 zone (Blow, 1969, 1979) on Middle to Late Miocene.

b) ***Globorotalia acostaensis – Globorotalia plesiotumida*** Interval Zone

Definition: Interval with zonal marker, from ***Globorotalia acostaensis*** first appearance to first appearance of ***Globorotalia plesiotumida***

Age : Late Miocene

Remarks: The first of ***Globorotalia (Turborotalia) acostaensis acostaensis*** is used to define the base of N.16 zone (Blow, 1969, 1979) on Late Miocene.

c) ***Globorotalia plesiotumida – Globorotalia tumida*** Interval Zone

Definition: Interval with zonal marker, from ***Globorotalia plesiotumida*** to first appearance of ***Globorotalia tumida***

Age : Late Miocene

Remarks: The first of ***Globorotalia (Globorotalia) tumida plesiotumida*** is used to define the base of N.17 zone (Blow, 1969, 1979) on Late Miocene.

d) ***Globorotalia tumida – Sphaeroidinella dehiscens*** Interval Zone

Definition: Interval with zonal marker, from ***Globorotalia tumida*** to first appearance of ***Sphaeroidinella dehiscens***

Age : Latest Miocene

Remarks: The first of ***Globorotalia (Globorotalia) tumida tumida*** is used to define the base of N.18 zone (Blow, 1969, 1979) near the Miocene-Pliocene Boundary.

The Figure 3 shows the Late Miocene planktic foraminifera biostratigraphy of central Bogor through, and it's correlation with previously standard foraminifera zonation. The biostratigraphy zones indicate that thoughout Late Miocene interval, foraminifera provides a high accurate biostratigraphy and it is a good tool for correlation.

Abundancy, diversity and appearance of indicator species reflected several events marked sea level fluctuation, transgressive and regressive which can be reconstructed on the basis of foraminifera data analysis.

CONCLUSSION

1. A total of four planktic foraminifera marker species have been selected and marked the Late Miocene interval of central Bogor Through, among all: ***Globorotalia acostaensis, Globorotalia plesiotumida, Globorotalia tumida,*** and ***Sphaeroidinella dehiscens.***
2. Planktic foraminifera analysis reveal the appearance of important key zone within Miocene sequences. For the purpose of the establishing level correlation in Bogor Through, on the basis of interval zone lying between two horizon first appearance of planktic foraminifera marker species, the four Late Miocene zones established, starting from the oldest to youngest: ***Globorotalia menardii – Globorotalia***

acostaensis Interval Zone (N.15 of Blow's zones on Middle - Late Miocene or >11.3 my BP), ***Globorotalia acostaensis – Globorotalia plesiotumida*** Interval Zone (N.16 or 11.3 – 6.2 my BP), ***Globorotalia plesiotumida – Globorotalia tumida*** Interval Zone (N.17 or < 6.2 my BP), and ***Globorotalia tumida – Sphaeroidinella dehiscens*** Interval Zone (N.18 on Miocene-Pliocene Boundary or < 5.3 my BP).

3. The Late Miocene planktic biostratigraphy of central Bogor Through is correlated with previously standard foraminifera zonation. The selected events used to date the Late Miocene of 11.3 to 5.3 Ma duration should be useful for stratigraphic correlation in Bogor Through. In this interval, planktic foraminifera provides a high accurate biostratigraphy and it is a good tool for correlation.
4. Abundancy, diversity and appearance of indicator species reflected the environmental changes concerning the sedimentation and geodynamic activities.

SUGGESTION

More study is suggested to be done in northern, southern and eastern of Bogor Through to record several planktic foraminifera events as datum planes defines biostratigraphyc correlation in reconstruction the assymetrical basin.

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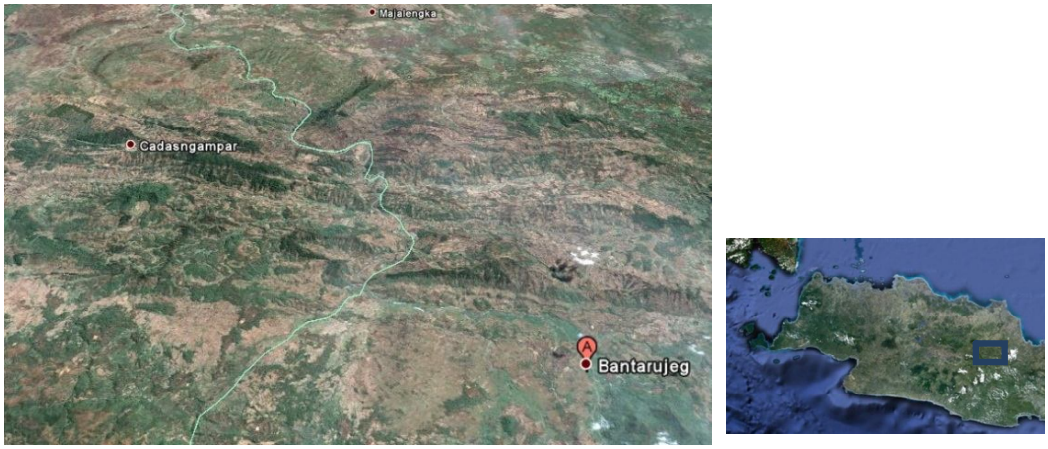

Figure 1. Sampling sections morphology in Central Bogor Through

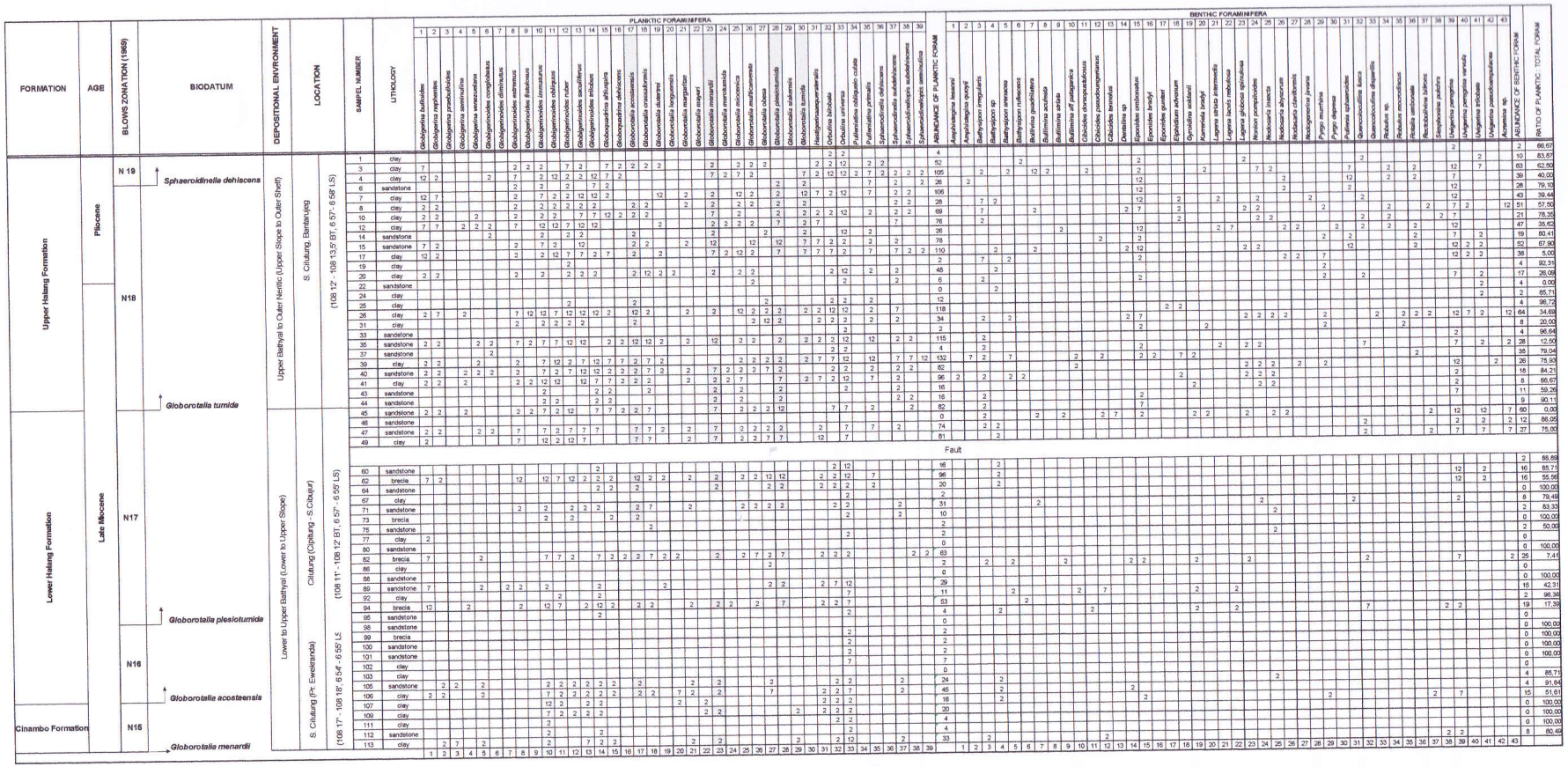

Figure 2. Planktic Foraiminifera Biostratigraphy of Central Bogor Through

MA	CHRONOSTRATIGRAPHY		STANDARD BIOSTRATIGRAPHIC ZONATION			THIS STUDY
			ZONES	DATUM LEVEL		
5	PLIOCENE	5.3		*Sphaeroidinella dehiscens*		*Sphaeroidinella dehiscens*
			N18	*Globorotalia tumida*	*Gr. margaritae*	*Globorotalia tumida*
		MESSINIAN	B	*Pulleniatina primalis*	*D*	
			N17		*Coiling change*	
		6.2	A	*Globorotalia plesiotumid S*	*Gr. acostaensis*	*Globorotalia plesiotumida*
		TORTONIAN	N16			
				Globorotalia acostaensis		*Globorotalia acostaensis*
10		11.3	N15			
Haq. Hardenbol & Vail (1987) in van Gorsel, 1988			Banner & Blow (1965); Bolli (1957); Bolli & Bermudez (1965), Blow (1969); Bolli & Permoli Silva (1973); Postuma (1971) Kennett & Srinivasan (1983) in van Gorsel, 1988			

Figure 3. Correlation of the Late Miocene Planktic Foraminifera Biostratigraphy in Central Bogor Through with Previously Standard Foraminifera Zonation