THE PALEOGENE SEDIMENT IN SOUTH SUMATRA - WHERE HAS IT GONE?

by
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I. BACKGROUND RESEARCH

It has been widely known that South Sumatra Basin yields Paleogene successions (Ferdiyanto et al., 2003). These successions consist of Lemat and Talang Akar Formations (De Coster, 1974) or Lahat and Lower Talang Akar Formations (Clure et al., 2002). The regional stratigraphy of the South Sumatra Basin is shown in Figure 1. The Paleogene sediment is interpreted to form within the occurrence of horst and graben which was caused by the formation of Semangko dextral fault as a result of Late Cretaceous-Early Tertiary tectonism (Suwidiyanto, 2003). In its study, LEMIGAS (2001) classified these successions as the synrift deposit because they were deposited during rifting phase which presumably occurred in Oligo-Miocene age. In fact, finding the Paleogene synrift sediment in South Sumatra is a serious matter. Most studied wells provided by the client lacks biostratigraphic evidences of Paleogene age. The author contributed to this study by investigating the fossil contents of the studied sediment. The result of the biostratigraphic analysis of this sediment encourages the author to publish it as presented in this paper. Therefore, this paper is intended to disclose a comprehensive biostratigraphic data which is obtained from three different disciplines including foraminifer, nannoplankton and palynology.

The Early Tertiary sediment in South Sumatra was generally deposited in the non-marine to transition (deltaic) environment (De Coster, 1973). The previous investigators show that this type of sediment contains rich palynomorph (Hasjim, 1993, Morley, 1995 and Lelono, 2003). Apparently, the age determination mostly referred to the occurrence of age diagnostic pollen. In this case, the appearance of peat swamp element of *Meyeripollis naharkotensis* is used to indicate the Oligocene sediment (LEMIGAS, 1998). Unfortunately, it was lack of support from other microfossil study such as foraminifer and nannoplankton which resulted in least confidence to this interpretation. The occurrence of *M. naharkotensis* has been widely used to designate the Late Paleogene over the Southeast Asian Region (Morley, 1991 and Rahardjo et al., 1994). However, the stratigraphic range of *M. naharkotensis* is somewhat ambiguous as this pollen associates with the occurrence of coals indicating the ever-wet warm climate (Morley, 1991). In fact, this pollen ranges up as far as basal Late Miocene as recorded in the coaly succession of East Kalimantan (Lelono, 2003). On the other hand, in East Java, well section with least coal development shows the distribution of *M. naharkotensis* along the Oligocene section (Lelono, 2003). Nichols (1999) stated that the age indicators strongly controlled by facies reduce their stratigraphic value. This means that the occurrence of *M. naharkotensis* does not necessarily indicate the Late Paleogene. Therefore, it is suggested to consider the existence of coal lithology in applying *M. naharkotensis* for age interpretation.

The occurrence of (?Late Oligocene)-Early Miocene rift sediments led to the conclusion that the rifting phase triggered by Late Cretaceous-Early Tertiary tectonism occurred slightly later in South Sumatra than that in Central Sumatra (LEMIGAS, 2001). Meanwhile, In Central Sumatra, rift deposit occurred during Eocene-Oligocene time (Williams et al., 1985 and Longley et al., 1990). Although De Coster (1974) assumed that South and Central Sumatra Basins had very similar and related history and could be considered as one large basin with many troughs and grabens, the recent biostratigraphic data suggest distinct period of basin development between South and Central Sumatra. This interpretation may not be obtained without accurate biostratigraphic data. Therefore, this paper is published to provide biostratigraphic information which allows explorationists to possess better understanding of the South Sumatra Basin.

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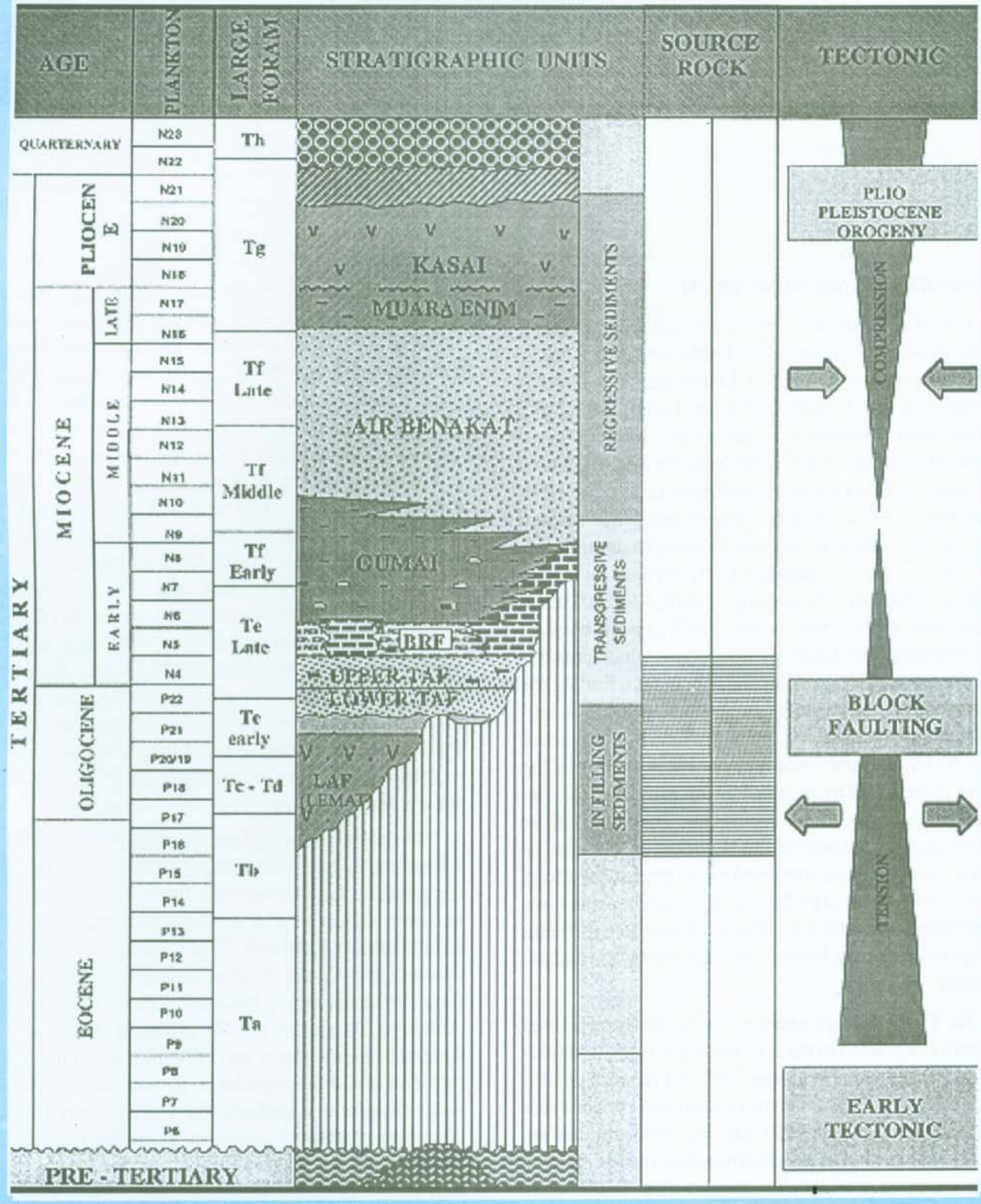

Figure 1
Tectonic and stratigraphic column of the South Sumatra Basin (Sarjito et al., 1991)

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Figure 2
The location of the studied area which illustrates the approximate position of the studied wellls

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II. MATERIALS AND METHODS

This paper includes intensive biostratigraphic studies which cover various locations of on-shore South Sumatra (Figure 2). Samples were mostly collected from more than 35 wells which were drilled by LEMIGAS clients and hence, they are confidential. In order to maintain the commitment between LEMIGAS and its clients regarding data confidentiality, wells are named using alphabetical codes. Six wells are selected to represent the studied wells including E, K, O, LE, LO and NO (Figure 2). In addition, only relevant information is exhibited in this paper due to space limitation. In this case, the biostratigraphic diagrams only show selected taxa which determine interpretation.

Basically, this study combines palynological analysis with nannoplankton or foraminifera analysis in order to get reliable interpretation. Nannoplankton or foraminifera is used to control the age of the sections. This independent age determines the range of age diagnostic palynomorphs. For these purposes, each well is analysed using two different disciplines, for example palynology and nannoplankton analyses or palynology and foraminifera analyses. Samples were split into two parts where possible. One part was used for palynology whilst another part for nannoplankton or foraminifera. For palynology, it is demanded 250 palinomorphs for applying quantitative analysis. Although this particular study does not necessarily require quantitative analysis, the knowledge of pollen assemblages is useful to understand the palaeoclimate and palaeoenvironment. The abundance of palynomorph is plotted in percentage on pollen diagram, which usually fluctuates from one sample to another. On the other hand, nannoplankton and foraminifera are conducted in semi-quantitative analyses. The abundance of species is represented by symbols,

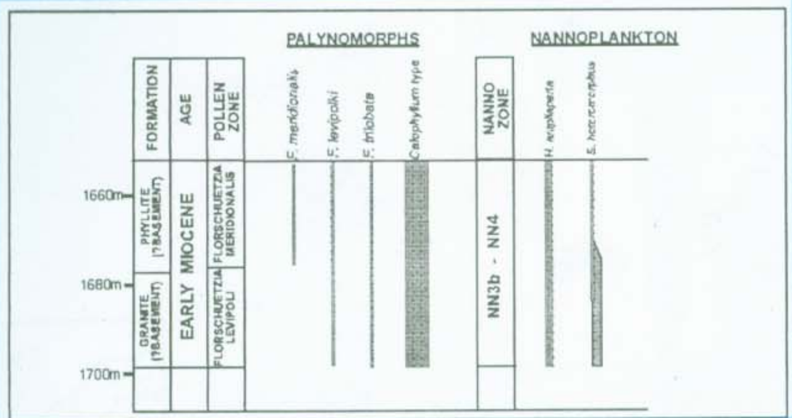

Figure 3
Distribution of the selected palynomorphs and nannoplanktons in Well E which suggests the age of Early Miocene within the lower part of this well

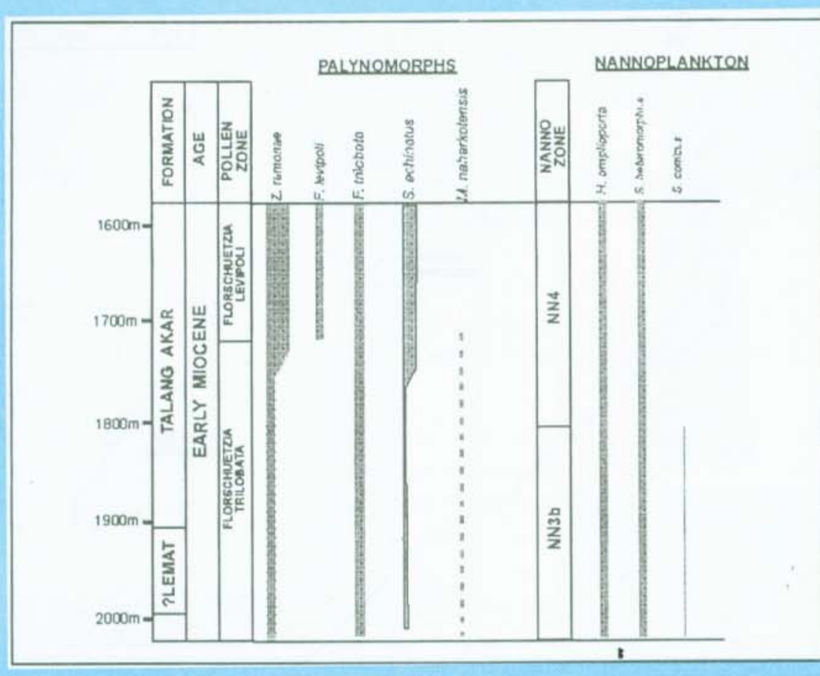

Figure 4
The appearance of palynomorph and nannoplankton indeces in Well K that indicates Early Miocene age within the lowest sedimen existing this well

which indicate rare, common or abundant occurrences. The nanos and forams zonations are reconstructed on the basis of the appearance of index taxa. These taxa are also used to determine the age of the sections.

III. PALYNOLOGY VERSUS NANNOPLANKTON

Generally, the oldest sediment penetrated by the studied wells was deposited in the deltaic environment (LEMIGAS, 2001). For this reason, palynology is applied as a major tool for assessing the age of this sediment. On the other hand, nannoplankton is conducted to confirm the stratigraphic range of age diagnostic palynomorphs which define the age of the studied sediment.

The oldest sediment in Well E ranges from 1651m-1694m (Figure 3). Palynological analysis on this sediment suggests zones of *Florschuetzia meridionalis* (1651m-1671m) and *F. levipoli* (1671m-1694m) which equal to upper part of Early Miocene (Rahardjo, 1994) as seen in Figure 3. The Paleogene palynomorphs are absent from this interval (LEMIGAS, 2001). This interpretation is supported by the result of nannoplankton analysis which defines Zone NN4-NN3b base on the occurrence of *Helicosphaera ampliaperta* in 1651m and *H. ampliaperta* and *Sphenolithus heteromorphus* in 1695m (Martini, 1971, see Figure 3).

The oldest sediment of Well K is situated deeper than that of Well E. It occurs in interval 1596m-1990m (Figure 4). Base

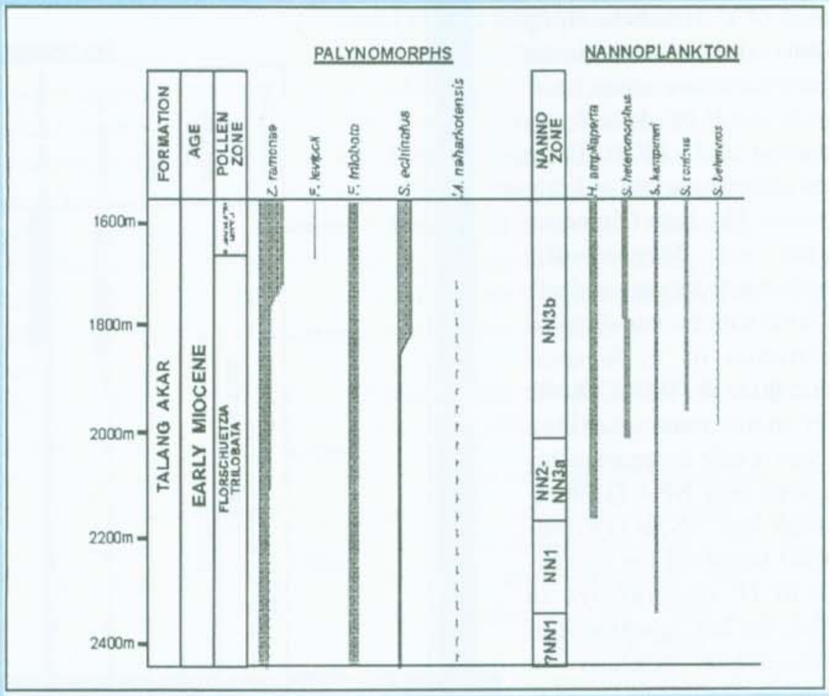

Figure 5
The existence Early Miocene sediment within the lower section of Well O based on the occurrence of selected palynomorphs and nannoplankton indices

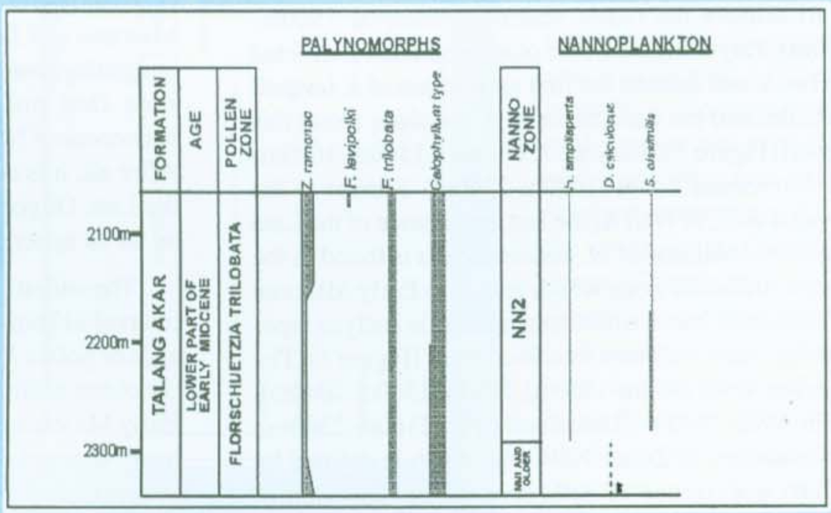

Figure 6
Selected palynomorphs and nannoplanktons existing in Well LE indicates Early Miocene age within the lower part of this well

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on the first appearance of *F. levipoli* in 1718m and the existence of *F. trilobata* along this interval, the oldest sediment is divided into two zones, i.e. *F. levipoli* and *F. trilobata* Zones (Rahardjo et al., 1994). These zones indicate the age of Early Miocene. The Late Oligocene marker of *Meyeripollis naharkotensis* appears in depth of 1718m which contradicts the occurrence of *F. levipoli* (Rahardjo et al., 1994). On the other hand, nannoplankton analysis is able to separate this sediment into NN4 (1596m-1810m) and NN3b (1810m-1990m) based on the appearance of *H. ampliaperta* in 1596m, the last appearance of *Sphenolithus conicus* in 1810m and the occurence of *S. heteromorphus* in 1990m (Martini, 1971, see Figure 4). These zones suggest the age of upper Early Miocene. Having nanno data, it is assumed that *M. naharkotensis* extends up to Early Miocene.

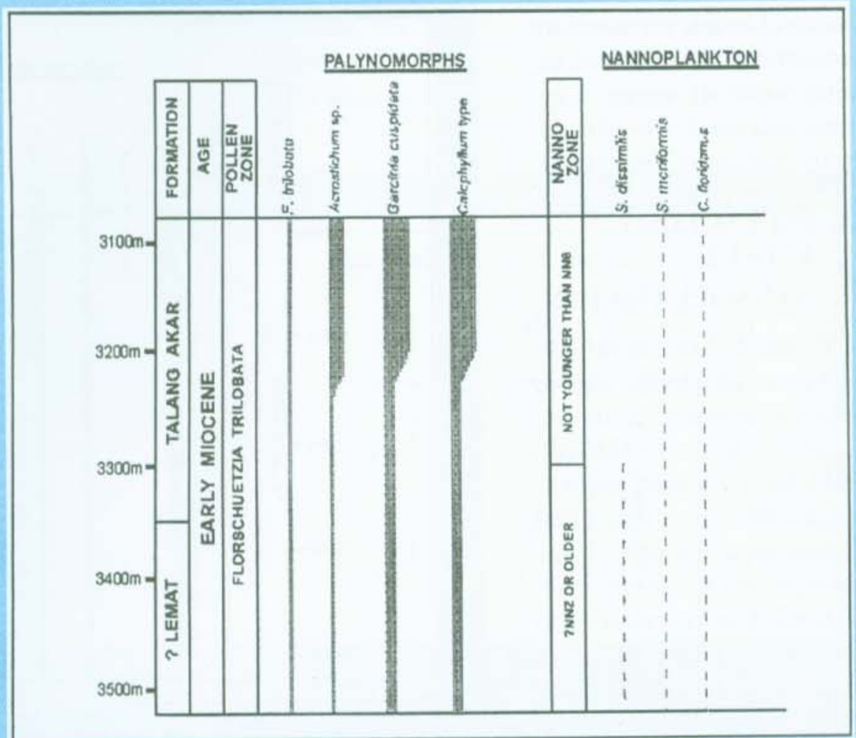

Figure 7
The distribution of selected palynomorphs and nannoplankton in Well LO infers the occurrence of Early Miocene age within the lower part of this well

Compared to Well K, Well O penetrated deeper layers to achieve the oldest sediment (interval 1560m-2360m). Palynologically, the oldest sediment is divided into two zones base on the first appearance of *F. levipoli* in 1620m and the occurrence of *F. trilobata* along this interval (Figure 5). They are *F. levipoli* (1560m-1620m) and *F. trilobata* Zones (1620m-2360m). Similar to the previous well, in Well K, the last appearance of the Late Oligocene indicator of *M. naharkotensis* is found in the upper *F. trilobata* Zone which equals to Early Miocene age (Figure 5). Mean while, nannoplankton analysis separates the oldest sediment into four zones (Figure 5). The zones are NN4 (1440m-1560m), NN3b (1560m-2040m), NN3b-NN2 (2040m-2160m) and NN1 (2160m-2340m). The boundary of Zones NN4 and NN3b is defined by the last occurrence of *Sphenolithus conicus* and *S. belemnos* in 1560m, whilst the boundary of Zones NN3a and NN3b is identified by the first occurrence of *S. heteromorphus* in 2040m (Martini, 1971). More over, NN2/ NN1 boundary is determined by the first occurrence of *Helicosphaera ampliaperta* in 2160m (Martini, 1971). These nannozones indicate the age of Early Miocene and hence, agree with palynological age. By integrating nannoplankton and palynology data, it is clearly seen that pollen of *M. naharkotensis* occupies nannozone of NN3 which is equivalent to Early Miocene. After all, it is concluded that the stratigraphic range of the Late Oligocene marker of *M. naharkotensis* spans as far as upper Early Miocene.

The oldest sediment in Well LE is situated within interval 2176m-2376m (Figure 6). Based on the appearance of pollen *F. trilobata* along interval 2176m-2376m, the oldest sediment is designated to *F. trilobata* Zone or Early Miocene age (Rahardjo et al., 1994). On the other hand, nannoplankton analysis enables to split the oldest sediment into two zones based on the existence of *S. dissimilis* in 2070m and the first appearance of *H. ampliaperta* and the last appearance of *Discoaster calculosus* in 2294m (Figure 6). Referring to Martini (1971) the oldest sediment is assigned to Zone NN2

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(2176m-2294m) and Zone NN1 and older (2294m-2344m). Both zones indicate the age of Early Miocene (Martini, 1971).

In Well LO, the oldest sediment consists of (?) Lemat and Talang Akar Formations which occupies the interval 3100m-3488m (Figure 7). Palynological analysis shows the occurrence of pollen *F. trilobata* within this interval which marks the zone of *F. trilobata* (Rahardjo et al., 1994). Mean while, nannoplankton analysis separates the oldest sediment into not younger than Zone NN6 (3120m-3300m) and Zone NN2 or older (3300m-3488m) based on the appearance of *Cyclicargolithus floridanus* in 3120m and the last appearance of *S. dissimilis* in 3300m as seen in Figure 7 (Martini, 1971).

Well NO penetrated the oldest sediment in interval 1882m-2448m (Figure 8). According to palynological investigation, this sediment belongs to *F. trilobata* Zone base on the occurrence of this pollen throughout the interval 1882m-2448m (Rahardjo et al., 1994). This zone is equivalent to Early Miocene age. On the contrary, nannoplankton analysis infers the presence of Late Oligocene succession (Zone NP24) within interval 2438m-2448m based on the last appearance of *S. distentus* and *S. predistentus* in 2438m and the occurrence of *Discoaster adamanteus* and *S. dissimilis* in 2448m (Martini, 1971, see Figure 8). The nannoplankton study divides the oldest sediment into three zones including Zone NN2 (1882m-1978m), Zone NN1-?NP25 (1978m-2438m) and Zone NP24 (2438m-2448m). Here, nannoplankton analysis improves the age interpretation based on palynological analysis by identifying the thin Late Oligocene sediment (about 10 meters).

IV. STRATIGRAPHIC RANGE OF SOME AGE DIAGNOSTIC POLLEN

Referring to recent data obtained from palynological and nannoplankton analyses, this paper proposes some modification of stratigraphic range of selected palynomorphs which were previously introduced by Morley (1990) and Rahardjo et al., (1994) as shown in Figure 9. This modification may only apply for the Late Oligocene to Early Miocene age of the on-shore South Sumatra.

The major change occurs to the vertical distribution of the Late Paleogene marker of *Meyeripollis naharkotensis*. Rahardjo et al. (1994) postulated that *M. naharkotensis* disappears near Oligocene/ Miocene boundary. However, this study proves the extension of *M. naharkotensis* to the younger succession as far as the upper part of Early Miocene. Therefore, it is inferred that the appearance of *M. naharkotensis* within the sediments across the onshore South Sumatra does not necessarily suggest the Oligocene age. It is really required other analyses to cross check the age of this pollen such as nannoplankton or foaminifer.

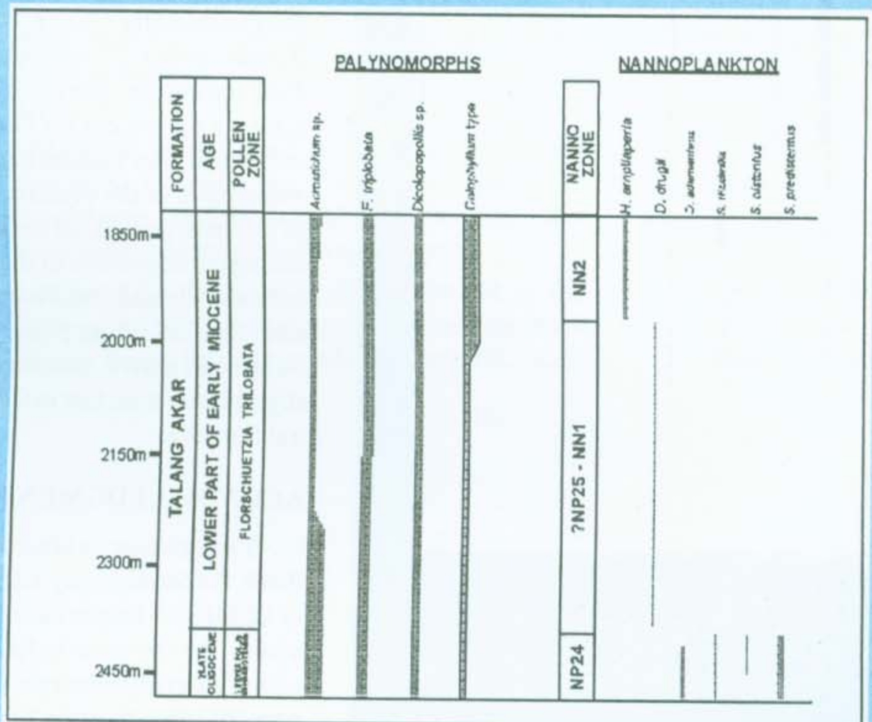

Figure 8
The occurrence of Late Oligocene sediment within the lower part of Well NO based on the last appearance of nannoplankton of Sphenolithus distentus. The Paleogene palynomorph is absent

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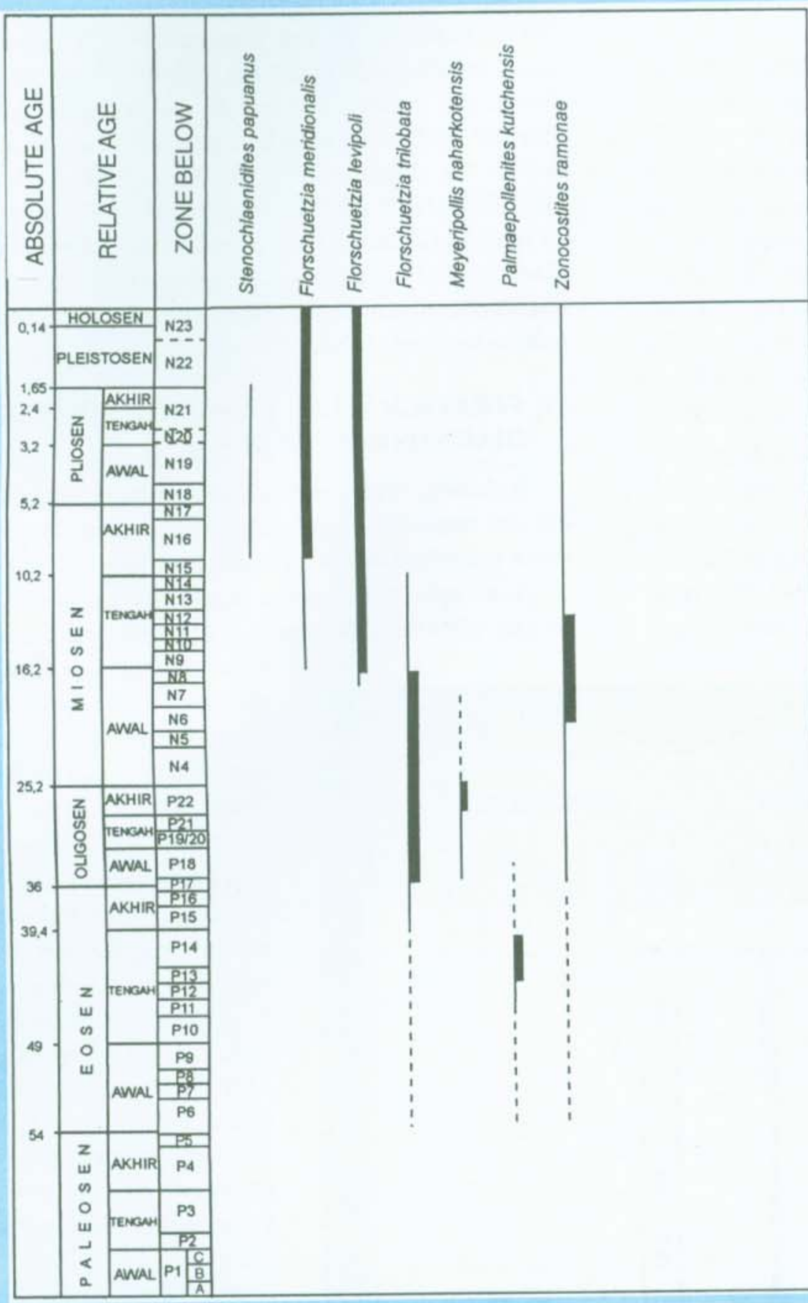

Figure 9
Stratigraphic range of some age-diagnostic palynomorphs in the South Sumatra Basin which may only apply for the Late Oligocene to Early Miocene succession

V. CONCLUSIONS

The occurrence of the thin Late Oligocene succession in the limited wells rises the question regarding the existence of this succession. Generally, the oldest sediment penetrated by the studied wells is designated to Early Miocene age base on palynology and nannoplankton. However, it is believed that the Oligocene sediment hides in low structures of the South Sumatra basin which has not yet been drilled by these wells. This assumption is based on the presence of the thin Late Oligocene sediment in Well NO.

Unlike Paleogene sediment in Central Sumatra basin which is represented by lacustrine sediment, the oldest sediment in South Sumatra basin obtained in this study was mostly deposited in the deltaic environment as indicated by the significant appearance of mangrove and back-mangrove palynomorphs such as *Zonocostites ramonae*, *Florschuetzia group* and *Spinizonocolpites echinatus*. This implies to the assumption of the occurrence of different geological setting during the deposition of those sediments. In addition, it is possible that the rifting phase in South Sumatra occurred slightly later than that in Central Sumatra.

ACKNOWLEDGMENT

The author wishes to thank the Stratigraphy Group of LEMIGAS Exploration Division for its great helps in identifying palynomorphs and nannoplankton from the Talang Akar Formation of the onshore area of South Sumatra Basin. The author is grateful to Barlian Yulianto MSc., who is the leader of the South Sumatra Project for his permission to publish some materials of this project.

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