THE NEW APPROACH FOR ZONAL SUBDIVISION OF PLIOCENE - PLEISTOCENE NANNOPLANKTON BIOSTRATIGRAPHY IN WAIPOGA-WAROPEN BASIN, PAPUA

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ABSTRACT

Waipoga-Waropen Basin is placed in northern part of Papua on the island of New Guinea. The gas discoveries had been made since 1958 in this basin, however, no economic value of reserves lead to the not producing basin state until this time. The main problem in Waipoga-Waropen Basin is great thickness of Pleistocene sedimentary layers (until 7500m) as product of turbidite system (Wold & Barret, 2000). This makes difficulty in well section correlation based on the conventional biostratigraphy since individual layers within that section is being small part of biozone. Many reworked nannoplankton as implication of turbidite deposit are also being complicated aspect in biostratigraphic analysis.

The Pleistocene ranges from 1.806 m.a. to 11.550 k.a. It was the most recent episode of global cooling or ice age took place. In nannoplankton biostratigraphy, this age is characterized by the extinction of Discoaster brouweri (Discoaster group) at the bottom and the first occurrence of Emiliania huxleyi at the top.

The quatitative nannoplankton investigation of "T" well has been done, and there is evident that its sedimentary section gives the excellent nannoplankton assemblages to subdivide Pleistocene age sediments of Waipoga-Waropen Basin (Zone NN19) into 9 subzones. Biomarkers from the bottom to the top consist of: LO of Discoaster brouweri, FO of Gephyrocapsa caribbeanica, FO of Gephyrocapsa oceanica, LO of Cacidiscus macintyre , LO of Helicosphaera sellii, FO of Reticulofenestra asanoi, FO of Gephyrocapsa parallela, LO of Reticulofenestra asanoi, FO of Helicosphaera inversa and LO of Pseudoemiliania lacunosa. The sediments belong to zone NN 20 that placed in the uppermost part of Pleistocene were not analysed.

Key Words: Nannoplankton, Biostratigraphy, Pliocene, Pleistocene, Waipoga-Waropen Basin

INTRODUCTION

The Waipoga-Waropen Basin is a new nomenclature term for the previous basin unity consisting of Waipoga, Waropen, Biak and Jayapura Basins. This basin is located in northern part of Papua on the island of New Guinea. The gas discoveries has been known since 1958 araound Nienggo platform, Yapen fault zone and Waipoga fault zone of this basin (Figure 1), however, no economic value of reserves lead to the not producing basin state until this time.

The main problem in Waipoga-Waropen Basin is great thickness of Pleistocene sedimentary layers (until 7500 m) (Wold & Barret, 2000). This makes difficulty in well section correlation based on the conventional biostratigraphy due to individual layers within that section is being small part of biozone. The main goal of this paper is to make a finer nannoplankton biostratigraphic subdivision in order to get precise stratigraphic correlation.

The quantitative nannoplankton investigation of

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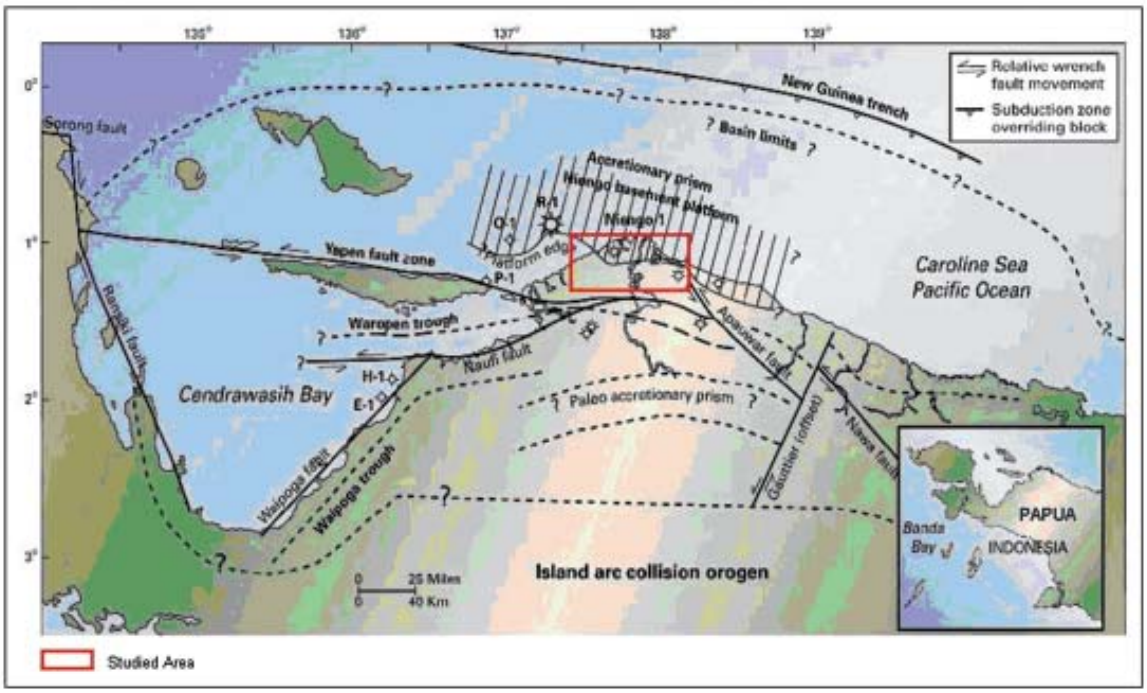

Figure 1
Waipoga-Waropen Tectonics, Northern Papua, Indonesia

"T" well placed onshore of Waipoga-Waropen Basin (Figure 1) has been done, and there is evident that its sedimentary section (claystone with siltstone and sandstone interbeds) gives the excellent nannoplankton dataset to subdivide Zone NN19 of Pleistocene age into 9 precise subzones. The sediments of zone NN 20 that placed in the uppermost part of Pleistocene were not analysed.

II. REGIONAL GEOLOGY OF WAIPOGA-WAROPEN BASIN

The Waipoga Basin lies in the onshore and offshore portion of West Papua. The major tectonic element that formed the Waipoga-Waropen Basin is the convergence between the Pacific Oceanic Plate and the northern New Guinea margin was initiated during the early Pliocene. The depositional axis trends East-West and the basin is bounded to the south by the North Divide Range and to the north by the Mamberamo Basement Uplift (Wold & Barrett, 2000). Throughout the Pliocene and Pleistocene, the basin was a deep depocenter that filled very rapidly with predominantly clastic materials shed from the uplifting mountains to the south. Sediments were rapidly deposited into an outer neritic-to-bathyal setting by a turbidite system, ultimately attaining a thickness of 7,500 meters. By the latest Pleistocene, the basin shallower and was inverted.

An additional key tectonic feature of the Waipoga-Waropen Basin is the Yapen Fault zone, which is a left lateral strike-slip fault and part of the larger Sorong Transform Fault system. The fault zone crosses the block east to west and is identified by a dramatic line of mud volcanoes that follow the fault trace for approximately 90 km.

The sediments of Waipoga-Waropen Basin is dominated by the Pliocene-Pleistocene Mamberamo Formation (Widdowson, 2001). Lithology of this formation is highly argillaceous in character. The sedimentary section drilled by "T" wel is composed of alternation of calcareous claystones, siltstones and sandstones with intercalation argillaceus limestones. This Pleistocene succession unconformably overlies the basement.

III. THE PLEISTOCENE AGE

The name Pleistocene is derived from the Greek *pleistos* (most) and *kainos* (new). The type section

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GSSP (Global Boundary Stratotype Section and Point) for the start of the Pleistocene is in a reference section at Vrica, 4 km south of Crotone in Calabria, southern Italy, whilst for the end of Pleistocene is *North Greenland Ice Core Project* ice core 75º 06' N 42º 18' W. Based on the radiometric dating, the Pleistocene ranges from 1.806 m.a. to 11.550 k.a. It was the most recent episode of global cooling or ice age took place. The paleoclimate research in recent decades from both the land and the sea indicate that at least 17 glacial events clearly occurred during the Pleistocene. The expansion and decay of the ice sheets during that age had a direct effect on the global sea level, wherein the fluctuations occurred from 50m to 150m have been estimated for various glacial-interglacial episodes. Since the last deglaciation which began some 17,000 years ago, the sea level has risen by about 110 m (360 ft) worldwide, drowning all of the ancient lowstand shorelines. One important product of the sea-level drops was the migration of large river deltas to the edges of the continental shelves and to the deeper parts of the basins (Gibbard & van Kolfschoten, 2004).

In modern geological time scales, the Pleistocene is subdivided into a lower and an upper series. In Europe, the lower series is considered equivalent to the Calabrian Stage, while the upper series is equated with the Sicilian and Tyrrehenian stages. In nannoplankton biostratigraphy, this age is characterized by the extinction of temperate to low latitude species *Discoaster brouweri* (*Discoaster* group) at the bottom and the first occurrence of cosmopolitan species *Emiliania huxleyi* at the top.

IV. MATERIAL AND METHODS

The subdivision of Pleistocene nannoplankton biostratigraphy presented in this paper is result of nannoplankton analysis of "T" well section (interval 200m – 3160m). Total number of analyzed samples are 180 samples consisting of 137 ditch cutting and 43 SWC (side wall cores), and those were processed mainly using *smearing method*. The analyzed interval was determined systematically (<1m to 100m) and the observation was undertaken at a magnification of 1000x using light microscope (LM) in quantitative method. Observation techniques comprise *bright field (BF), cross polarized light (XPL), Gypsum plate in XPL* and *phase contrast*. Description of index species refers to Perch-Nielsen (1985) and Bown (1999). The distribution of all recovered nannplankton species (simplified in diversity and sample number) and the scatter diagrams of biomarker occurrences are presented using Microsoft Excel program. The framework of Pleistocene nannoplankton biostratigraphic subdivision is the standard zonation of Martini (1971) since this zonation is used widely for hydrocarbon exploration in all over the world.

V. NANNOPLANKTON ASSEMBLAGES

The nannoplankton assemblages of "T" well sedimentary section were recovered from rare to abundant and from very low to high diversity. Their preservation is poor to good. Generally, zonal and subzonal biomarkers defined here are common and easily accomplished, although they are tend to be rare or absent in several sandstone intervals (*Discoaster brouweri, Gephyrocapsa caribbeanica, Gephyrocapsa oceanica, Helicosphaera sellii, Reticulofenestra asanoi, Gephyrocapsa parallela* and *Pseudoemiliania lacunosa*). In other case, rare *Cacidiscus macintyrei* and *Helicosphaera inversa* were recovered relatively consistent in the analyzed section. These characters are able to fulfill the terms of local biomarkers to obtain the demand about high resolution Pleistocene biostratigraphy and reliable tool in precise stratigraphic correlation. However, many reworked nannoplankton as implication of turbidite deposit can be a complicated aspect in biostratigraphic analysis.

VI. NANNOPLANKTON BIOSTRATIGRAPHIC SUBDIVISION

Based on the nannoplankton assemblage content, the interval 200m - 3160m of "T" well section is included within zone NN18 to NN19 (Figure 2). It means that the sediments of that interval were deposited during the upper part of Late Pliocene to Pleistocene age.

Zone NN18 posited in the upper part of Pliocene age (3096m - 3160m) is indicated by the last occurrence (LO) of *Discoaster brouweri* at 3096m and the absence of *Discoaster pentaradiatus* at the lowest analyzed interval (3160m). This zone cannot be subdivided into subzones. Zone NN19 that placed in Pleistocene age (200m - 3096m) is characterized by the occurrence of *Pseudoemiliania lacunosa* at the top of analyzed interval (200m) and the LO of

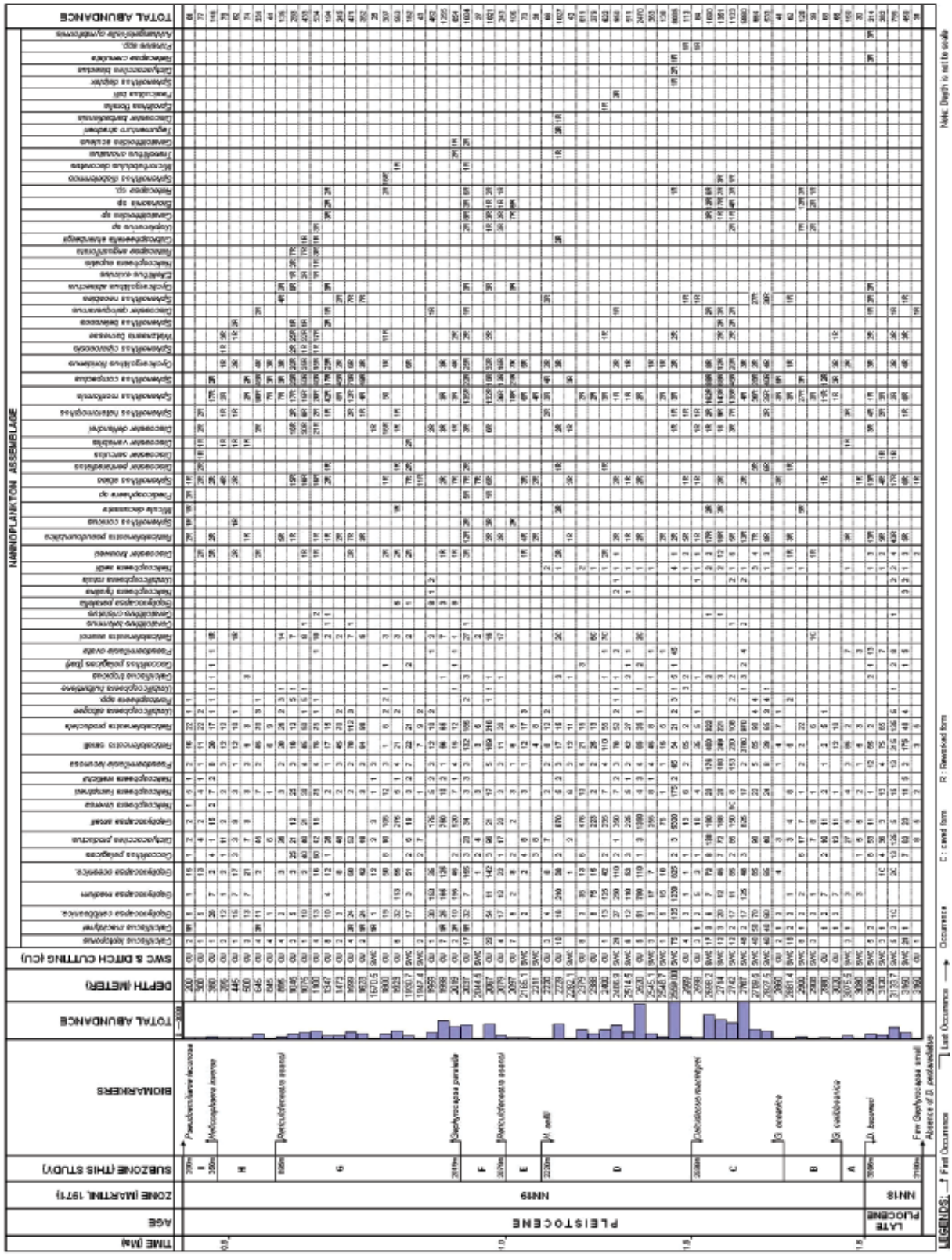

Figure 2
Distribution of nannoplankton species (simplified both in diversity and sample number) and the new approach of Pleistocene biostratigraphic subdivision in "T" well section

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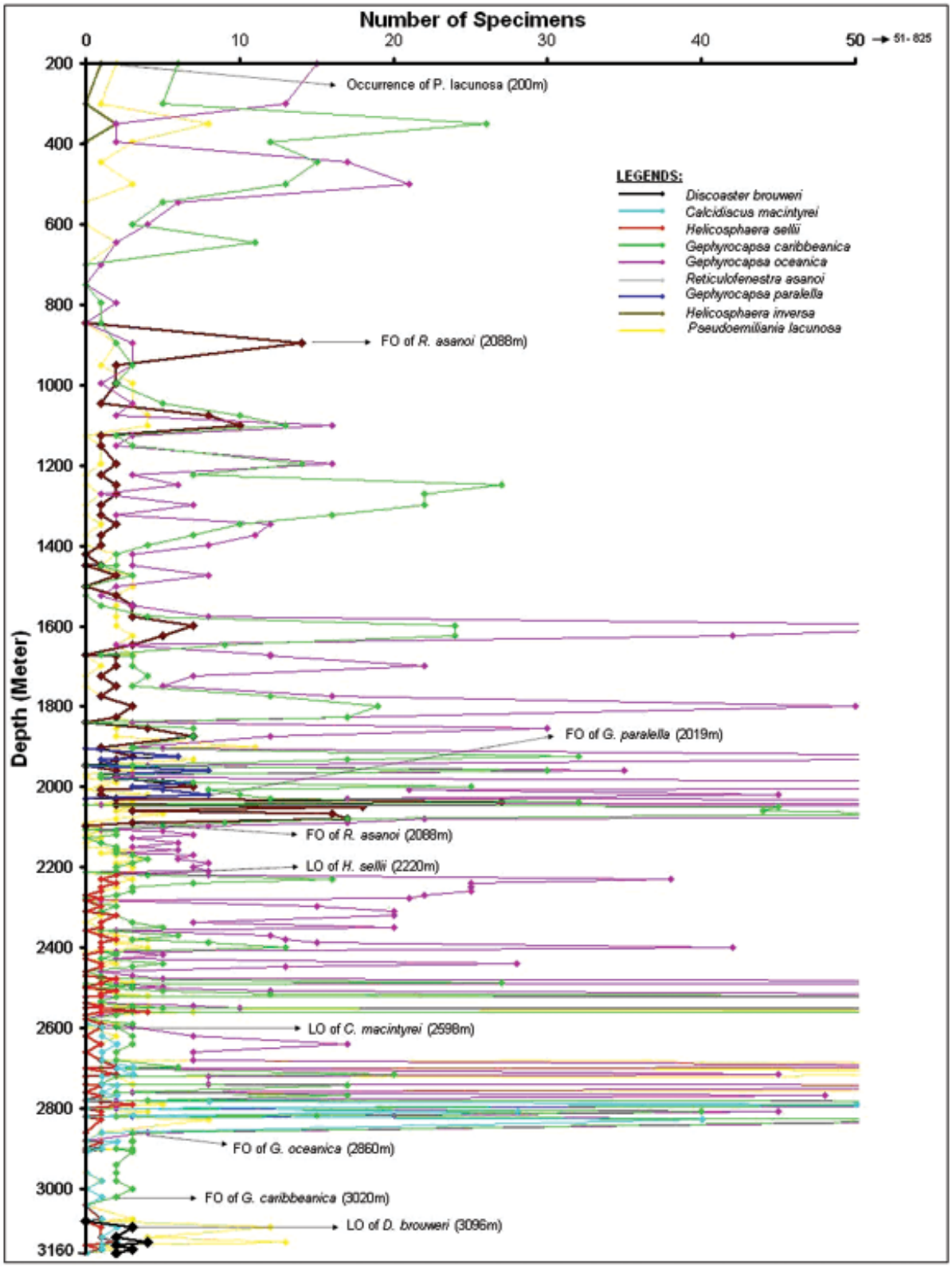

Figure 3
The diagram of index species abundance and the depth of their biostratigraphic events in "T" well section

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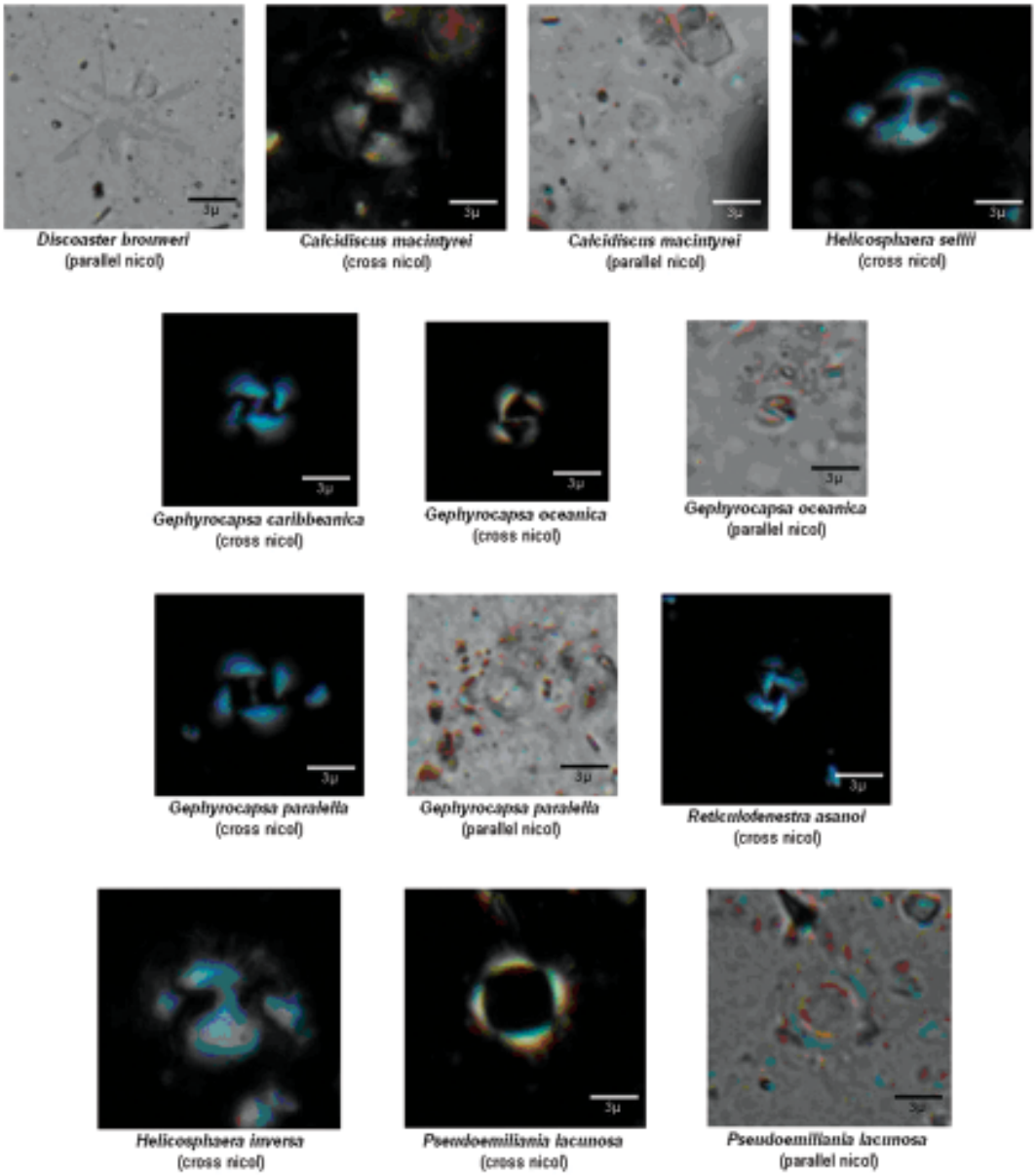
PLATE 1



Nannoplankton index species of the Pleistocene zones & subzones
(photomicrographs: occuler X10, objective X100, magnification changer X2)

Discoaster brouweri at 3096m. Zone NN19 can be subdivided from the top to the bottom into 9 subzones (Figure 2), as follows:

- Subzone NN19-I; Interval 200m-350m

Subzone NN19-I is indicated by the occurrence of *Pseudoemiliania lacunosa* at the top and the first occurrence (FO) of *Helicosphaera inversa* at the bottom. The last occurrence (LO) of *Pseudoemiliania lacunosa* is still possible higher than 200m).

- Subzone NN19-H; Interval 350m-895m

Subzone NN19-H is marked by the FO of *Helicosphaera inversa* at the top and the LO of *Reticulofenestra asanoi* at the bottom.

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- Subzone NN19-G; Interval 895m-2019m

Subzone NN19-G is marked by the LO of *Reticulofenestra asanoi* at the top and the FO of *Gephyrocapsa parallela* at the bottom.

- Subzones NN19-F; Interval 2019m-2079m

Subzone NN19-F is marked by the FO of *Gephyrocapsa parallela* at the top and the FO of *Reticulofenestra asanoi* at the bottom.

- Subzones NN19-E; Interval 2079m-2220m

Subzone NN19-E is characterized by the FO of *Reticulofenestra asanoi* at the top and the LO of *Helicosphaera sellii* at the bottom.

- Subzones NN19-D; Interval 2220m-2598m

Subzone NN19-D is characterized by the LO of *Calcidiscus macintyrei* at the top and the LO of *Helicosphaera sellii* at the bottom.

- Subzones NN19-C; Interval 2598m-2860m

Subzone NN19-C is characterized by the LO of *Calcidiscus macintyrei* at the top and the FO of *Gephyrocapsa oceanica* at the bottom.

- Subzones NN19-B; Interval 2860m-3020m

Subzone NN19-B is indicated by the FO of *Gephyrocapsa oceanica* at the top and the FO of *Gephyrocapsa caribbeanica* at the bottom.

- Subzones NN19-A; Interval 3020m-3096m

Subzone NN19-A is marked by the FO of *Gephyrocapsa caribbeanica* at the top and the LO of *Discoaster brouweri* at the bottom.

The distribution of nannoplankton species recovered in this study can be seen in Figure 2, whilst scatter diagrams of biomarker occurrences are in Figure 3. The photomicrographs of index species are displayed in Plate 1.

VII. CONCLUSIONS

Investigation of nannoplankton on the "T" well sedimentary section posited in Waipoga-Waropen Basin has led to the following conclusions:

1. The sediments of "T" well section posited in onshore Waipoga-waropen Basin gives the excellent nannoplankton data to make a precise subdivision of Pleistocene age sediments.
2. The nannoplankton zone of analyzed interval can be defined as zone NN18 to NN19, wherein the boundary of those two zones coincides with Pliocene/Pleistocene boundary. This boundary is indicated by the last occurrence (LO) of *Discoaster brouweri.*
3. The Pleistocene age represented by zone NN19 can be subdivided into 9 subzones (subzone NN19-A to NN19-I) based on biomarkers consisting of the LO *Discoaster brouweri*, the FO of *Gephyrocapsa caribbeanica*, the FO of *Gephyrocapsa oceanica*, the LO of *Cacidiscus macintyre*, the LO of *Helicosphaera sellii*, the FO of *Reticulofenestra asanoi*, the FO of *Gephyrocapsa parallela*, the LO of *Reticulofenestra asanoi*, the FO of *Helicosphaera inversa* and the LO of *Pseudoemiliania lacunosa*.
4. This precise subdivision can be reliable tool in high resolution biostratigraphic correlation.
5. The great number of reworked nannoplankton specimens (Cretaceous to Pliocene age) can be serious problem in zonal subdivision. On the other hand, it can be evident that the sedimentary succession is product of turbidite system.

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