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Biostratigraphic Study of the Calcareous Nannofossils of Well 02, Shallow Offshore, Niger Delta, Nigeria

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Abstract A calcareous nannofossils biostratigraphic study has been carried out on the strata penetrated of well 02 located in the shallow offshore area of the Niger Delta, Nigeria. The study is aimed at establishing the age and nannofossils biozonations of the well. The samples were prepared using smear slide technique. Forty calcareous nannofossils species were identified and used to make biostratigraphic deductions of zonations and dating of the sequence. The distribution of the calcareous nannofossils enabled the establishment of three zones of *Helicosphaera ampliaperta* (NN4), *Sphenolithus heteromorphus* (NN5) and *Catinaster coalitus* (NN8) belonging to early Miocene - late Miocene following standard zonation schemes of previous workers. The zones were based on the first and last occurrences of marker species. Nannofossil abundance / diversity patterns calibrated with chronostratigraphical bioevents reveals four condensed sections when correlated to the Global Cycle Chart. This is associated with the 16.0 Ma, 14.8 Ma and 13.4 Ma and 10.89 Ma maximum flooding surfaces.

Keywords Biotratigraphy, Biozonation, Nannofossils, Bioevents, Miocene

1. Introduction

This study focuses on the nannofossils Biostratigraphy of well-02, located on the shallow offshore portion of the Niger Delta. (Fig. 1) The aim of the study is to present biostratigraphic information from the nannofossils recovered from the strata penetrated.

Calcareous nannofossils are tiny (less than 30 microns) marine phytoplanktons. Tappan, 1980 considers the size of Nannoplankton to be less than 2 μm and referred to those between size range of 2-20 μm as ultramicroplankton. They are classified as coccolith and nannolith, Perch- Nielsen, 1985. Coccoliths are disc-shaped plates, while the nannolith has various shapes including the star-shaped discoasters. They thrive in normal marine environments and rarely

tolerate turbidity and freshwater environment, Hay *et al.*, 1967.

Calcareous nannofossils have been studied and reported in several literatures, but not much from the Niger Delta basin. This is attributed to the unpublished works of several nannofossils studies by oil companies who guard their information jealously.

Agagu, 1981, Petters, 1982, 1983, Berggren, 1960, Ozumba, 1995 and Okosun and Liebau, 1999 recognized the Danian age for the sediment on the basis of *Globorotalia pseudobulloides*, *Globigerina triloculinoides*, *Globigerinoides daubjergensis* assemblages and assigned a lower Paleocene age to it. Adegoke *et al.*, 1976 presented a benthonic foraminifera biofacies of the delta. Orife and Avbovbo, 1982 described the stratigraphic and unconformity traps of the Niger Delta, while Ogbé, 1982 established the Paleocology of the Western Niger Delta using foraminifera. He also identified those regressive phases on the basis of Microfauna and flora in the Niger delta.

The Niger Delta stratigraphic committee recently commissioned a biostratigraphic subcommittee mandated to carry out calcareous nannofossils taxonomic project as well as harmonize the various nannofossil schemes in use by different oil companies. The result of this project is yet to be made available for public use. Gallagher, 1990, Farinaciari and Rio, 1996 and Farinaciari *et al.*, 2000 presented quantitative stratigraphic studies on calcareous nannofossil of the Tertiary age.

Stradner, 1959 first reported the Discoasters of the Tertiary in Austria, the unpublished research works of Oyebamiji, 1997, Fadiya, 1999 and Akindipe, 2003 comprise systematic calcareous nannofossils Biostratigraphic studies of some Niger Delta wells which were subdivided using the globally recognize zones of Martini and Bramlette, 1963, Matini and Worsely, 1970 and Matini, 1971, Okada and Bukry, 1980 and Berggren *et al.* 1995 Also Ojo *et al.*, 2009 studied nannofossils encountered from two deep offshore wells and subdivided into eight zones which were correlated.

However, this work is to identify the calcareous nannofossils encountered, establish the nanno zones in the analysed sequence and determine the age of the strata.

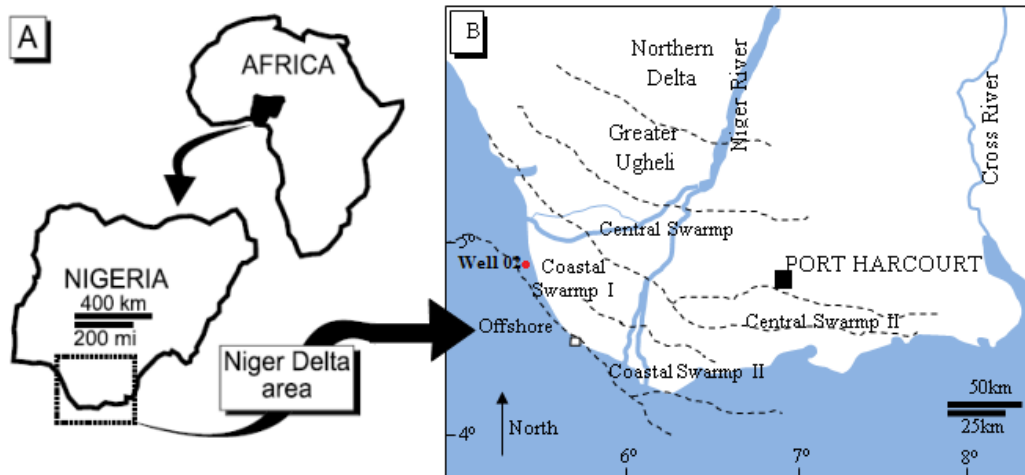


Figure 1. Location map of well 02 shallow offshore Niger Delta, Nigeria

2. Materials and Methods

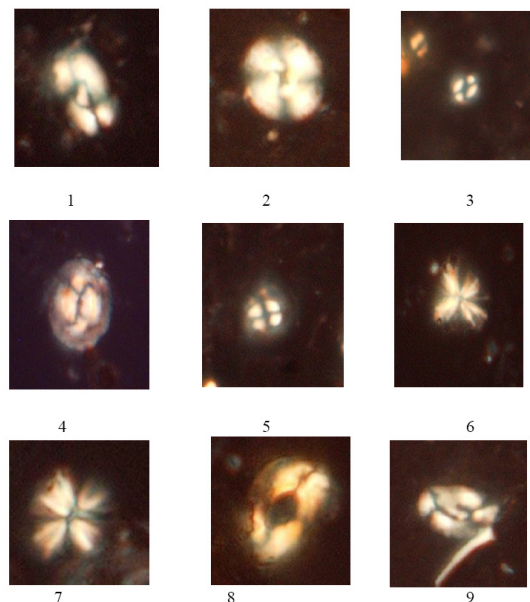
One hundred and twelve ditch cutting samples obtained at 30 ft interval within the range of 6000 -11000 ft from well 02 located in the shallow offshore Niger Delta was utilized for this study. Samples collected at 30 ft interval were to provide a high resolution biostratigraphic data. The well is code - named well 02 for confidential reasons and the sample were provided by one of the multinational oil companies operating in the Niger Delta.

Smear slides method was employed for extracting nannofossils from the cuttings because; it is simple, rapid, cheap and efficient. About 4 g of the sample broken down by soaking and swirling in distilled water, then a small quantity of sodium hexametaphosphate (calgon) is added to help disperse the sediment and ensure even distribution of the particles. A drop of this suspension is then placed on a glass cover slip followed by a drop of distilled water to dilute it and then dried on a hot plate at 60 - 70°C for few minutes and then mounted on a glass slides using a few drops of Norland optical adhesive mounting medium. This was then cured over ultraviolet light for 45 minutes. The prepared slides were examined for their calcareous nannofossil content using a light microscope under crossed polarizers and transmitted light at x 1000 magnification.

3. Results

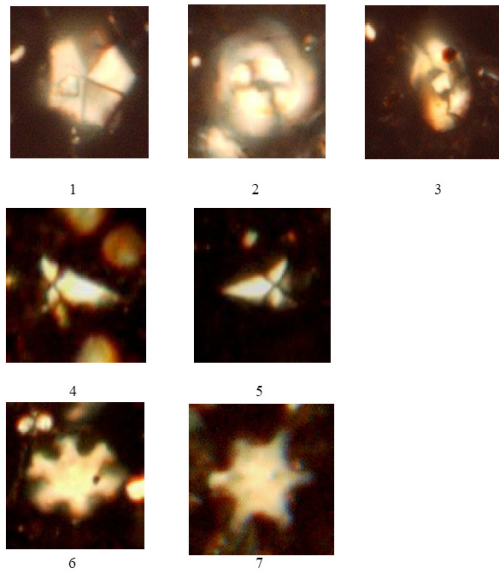
Calcareous nannofossils recovery from this study is fairly abundant, diversified and moderately preserved (Fig. 2, Plates 1 and 2). One hundred and twelve samples from 6000 - 11000 ft of well 02 have been analysed for their calcareous nannofossil content. A total of 40 nannofossils species belonging to 17 genera were recognised. The nannofossils are mainly placoliths, nannoliths and helicoliths. Of these *Helicosphaera carteri* is the most abundant occurring throughout the entire analysed sequence. *Sphenolithus*

heteromorphus also occur in abundance at the upper section of the studied interval and was used to define the upper section of the well. The family Noclacihabdacea represented by the genus *Reticulofenestra* has some of its species differentiated on the basis of size variation *R. haqii* (3-5 μm), *R. minuta* (<3μm), *R. pseudumbilicus* (>7μm), *Helicosphaerid* coccoliths, represented by *Helicosphaera carteri*, *Helicosphaera stalis*, *Helicosphaera obliqua*, *Helicosphaera deflandrei*, *Helicosphaera scissura* and *Helicosphaera ampliapertura* which is a very important zonal index species of the lower section (NN4) of the studied well.



- 1 *Braarudospheca bigelowii* (Gran and Braarud, 1935)
- 2 *Coccolithus miopelagicus* Deflandra, 1947, Bukry, 1971
- 3 *Helicosphaera euphratis* Haq, 1966
- 4-5 *Sphenolithus heteromorphus* Deflandre, 1953
- 6 *Discoaster deflandrei* Bramlette and Riedel, 1954
- 7 *Discoaster sanmiguelensis*, Bukry, 1981

Plate 1. (Calcareous Nannofossils)



- 1 *Helicosphaera intermedia* Martini, 1965
- 2 *Cyclicargolithus floridanus* Roth and Hay in Hay et al, 1967, Bukry, 1971a
- 3-5 *Coccolithus pelagicus* Schiller, 1930
- 6 *Sphenolithus dissimilis* Bukry and Percival, 1971
- 7 *Sphenolithus moriformis* Bronnimann and Stradner, 1960, Bramlette Wilcoxon, 1967
- 8 *Helicosphaera ampliaperata*, Bramlette & Wilcoxon, 1967
- 9 *Helicosphaera obliqua*, Bramlette & Wilcoxon, 1967

Plate 2. (Calcareous Nannofossils)

Three major zones were delineated for the interval (6000 -11000 ft) of well 02, based on the first and last occurrence of marker species. The zones are; *Helicosphaera ampliaperata*, *Sphenolithus heteromorphus* and *Catinaster coalitus*. (Table 1)

3.1.1. *Helicosphaera ampliaperata* Zone

Stratigraphic interval: 8330 -11000 ft

Age- early Miocene

Definition: The top of this zone is recognised in the well and is placed as the first down hole occurrence (FDO) of *Helicosphaera ampliaperata* at 8330 ft. The base was not seen but has been placed at the base of the studied interval. The zone is also characterised by the top occurrence of *Sphenolithus dissimilis* and base occurrence of *Helicosphaera intermedia*. The zone corresponds to the NN4 zone of Martini, 1971 and the CN 3 of Okada and Bukry, 1980.

3.1.2. *Sphenolithus heteromorphus* Zone

Stratigraphic interval: 7370- 8330 ft

Age- middle Miocene

Definition: The zone is defined by the top of *Sphenolithus heteromorphus* at the 7970 ft and the top of *H. ampliaperata* as the base at 8330 ft .The zone is also characterised by the LDO of *H. intermedia* and *H. obliqua*. The zone is equivalent to the NN5 of Martini, 1971 and Okada and Bukry, 1980.

3.1.3. *Catinaster coalitus* Zone

Stratigraphic interval: 6040- 7370 ft

Age: late Miocene

Definition: The zone lies between the base of the *Catinaster coalitus* at 7370 ft and the top of the intervals. The zone is also characterised by FDO's of *Sphenolithus moriformis* and *Calcidiscus leptoporus* and LDO's of *Discoaster bollii* The zone has been correlated to NN8 of Martini, 1971 and CN7 of Okada and Bukry, 1980.

Table I. Calcareous Nannofossils Zonation Recognised in Well 02

Depth (ft)	Epoch/Period	Hardenbol <i>et. al.</i> , (1998) Scheme	Martini (1971)	Okada and Bukry, 1975, 1980	This study	Bioevents
6010	Late Miocene	10.89Ma 13.4Ma	NN8 7375	CN6	<i>C. coalitus</i>	← 6100 FDO <i>Calcidiscus leptoporus</i>
7000						← FDO <i>Catinaster coalitus</i>
8000	Middle Miocene		NN6 - NN7 7970	CN5	<i>S. heteromorphus</i>	← 7040 LDO <i>Discoaster bollii</i>
			NN5	CN4		← 7370-LDO <i>Catinaster coalitus</i>
	Early Miocene	8450 14.8Ma 9290	NN4	CN3	<i>Helicosphaera ampliaperata</i>	← Base - <i>Coronocylcus nitescens</i>
9000						← 7970 -LDO <i>Sphenolithus heteromorphus</i>
10000						← 8180-LDO <i>Helicosphaera obliqua</i>
10500						← 8330-FDO <i>Helicosphaera ampliaperata</i> (14.91Ma)
11000						← 9290 FDO <i>Discoaster deflandrei</i>
						← 10310 FDO <i>Sphenolithus dissimilis</i>
						← 10550 LDO <i>Coalitus pelagicus</i>

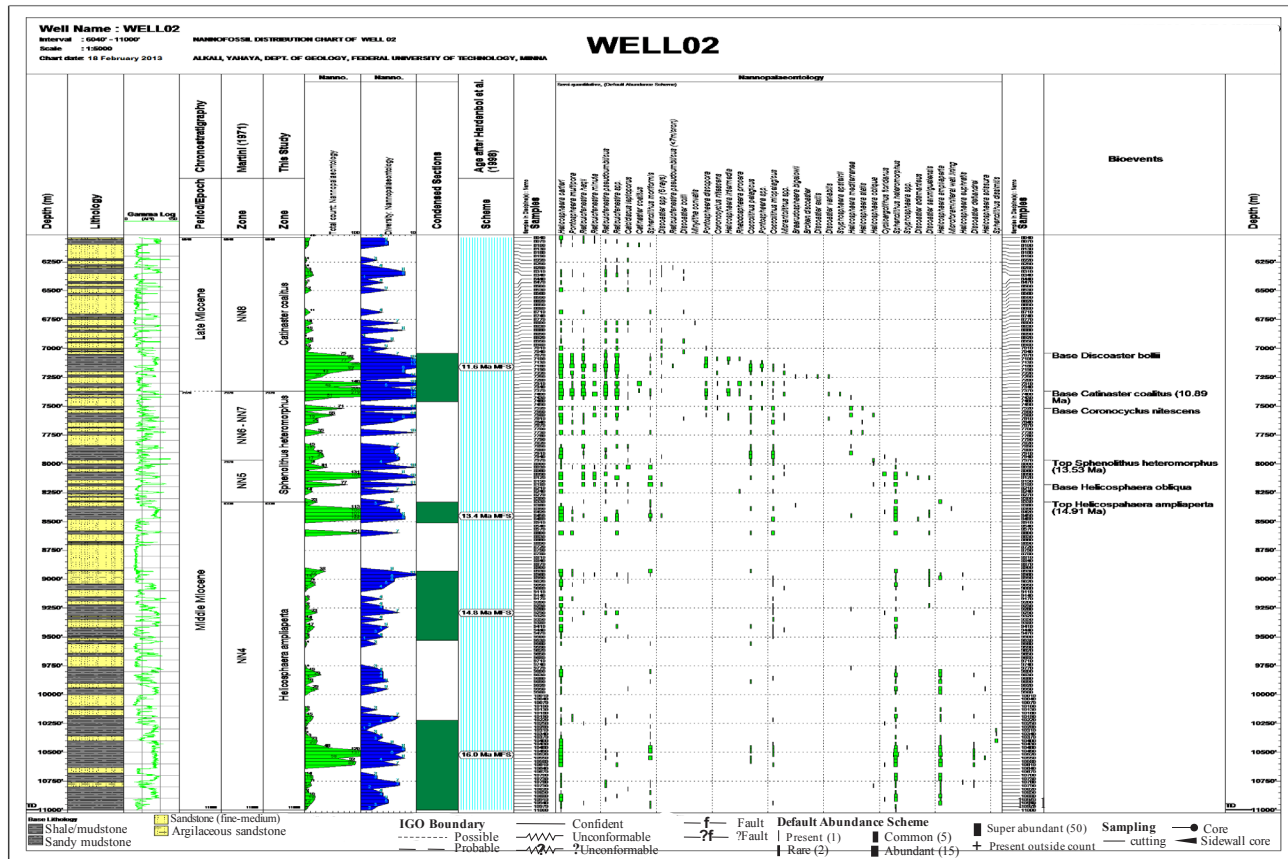


Figure 2. Nannofossil Distribution Chart of Well 02, Shallow Offshore, Niger Delta3.1 Biozonations

4. Conclusion

The investigated interval of well 02 showed fairly abundant, diversified and well preserved calcareous nannofossil assemblage. The distribution pattern of the biostratigraphically significant nannofossil markers within the studied interval (6000 ft - 11000 ft) has been studied using first and last occurrences of marker species and assemblage characteristics.

Nannofossils recovered from the cuttings were mainly placolith, nannoliths and helicoliths. Based on the distribution and occurrences of marker species, three nannofossil zones were establish: *Helicosphaera ampliaperta* (NN4/CN3), *Sphenolithus heteromorphus* (NN5/CN4) and *Catinaster coalitus* (NN6/CN5).The zones have been assigned early Miocene to late Miocene following the Zonation of Martini (1971) and Okada and Bukry (1980).

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