Age-depth Model and Dating Technique Across the Shallow Offshore of the Niger Delta Passive Margin: Challenges and Progress during the Late Quaternary*

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1. Abstract*

The importance of an age/depth model in any stratigraphic study especially when working on the Quaternary sediment cannot be over-emphasized. To achieve this, it is important to consider the depositional setting, depth of coring, sedimentation rate, tectonic control, and material availability of the setting in order have a successful age-depth model and dating. These scenarios are complex issues based on the three gravity cores (~ 3m) samples analyzed from the Eastern, Central, and Western parts of the Niger Delta passive margin. Given these challenges, this study considered biostratigraphic-dating method (foraminifera, nannofossils, and palynology) because of unavailability of monospecific planktonic foraminifera / broken shells in the samples that hindered radiometric or isotope dating. After a careful interpretation, the palynological dating method was not successful because most of the pollen and spores species (*Verrucatosporites usmensis*, *Stereisporites* sp., Poaceae, and *Zonocostites ramonae*) identified are stratigraphically ubiquitous (found everywhere) and not viable for succinct dating. In addition, palynology (pollen and spores) among the dating methods is generally unsuccessful and difficult in dating sediments older than mid Pleistocene, considering the regional and global chronostratigraphic chart. Given these conditions, the successful outcome of the age optimization recovered in this study is based on foraminifera and nannofossils biostratigraphic dating methods. These were achieved on the principle of First Occurrence (FOC) and Last Occurrence (LOC) of foraminifera: *Globorotalia truncatulinoides* (late Pleistocene) and *Globorotalia tumida* (mid-Holocene), and nannofossil: *Gephyrocapsa oceanica* (late Pleistocene) and *Emiliania huxleyi* (mid-Holocene), respectively. Thus, the three gravity cores recovered the late Pleistocene (~20/ ~20 ka) to mid-Holocene (~6.5ka) time span for the Late Quaternary Niger Delta. These results enabled the development of an age model (depth/age related) and sedimentation rates at different depths.

2. Objective

- To constrain an age model for the complex deltaic setting of the Niger Delta (shallow offshore) based on samples taken from three strategically positioned Gravity Cores (GCs).
- To use semi-quantitative method to confirm their reliability for further detailed age determinations and identify potential "marker" species within the Niger Delta.

3. Stratigraphy of the Niger Delta and Study locations (Fig.1 and 2)

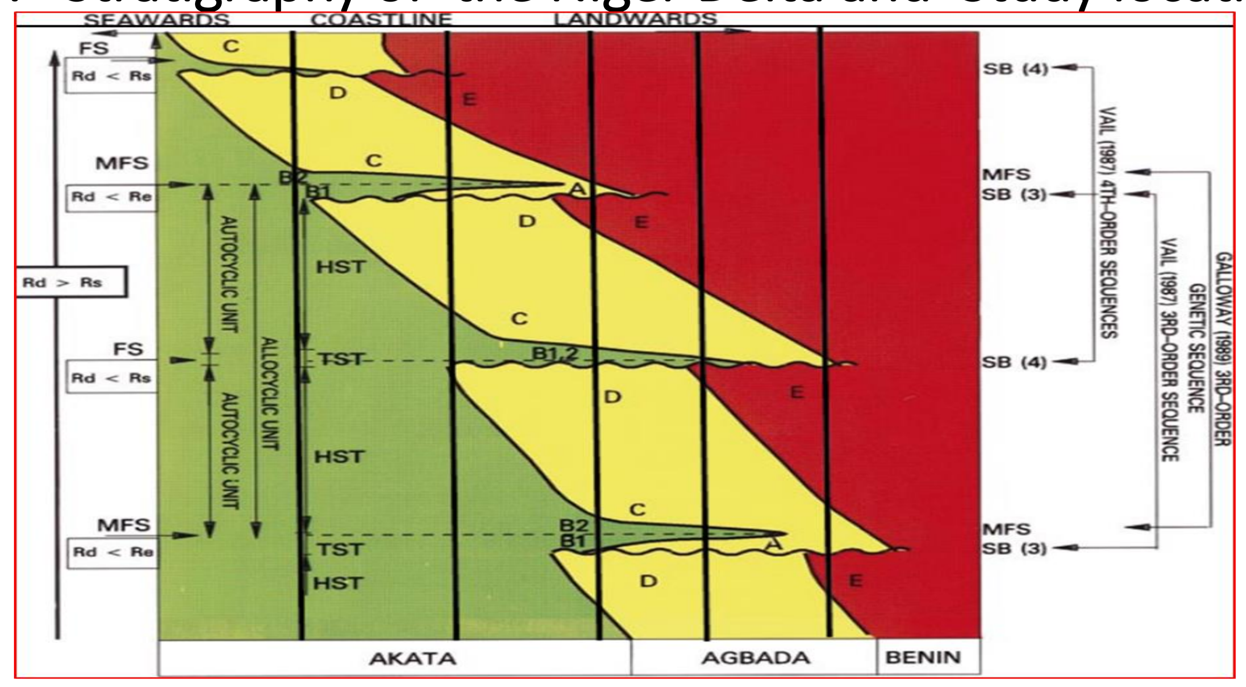
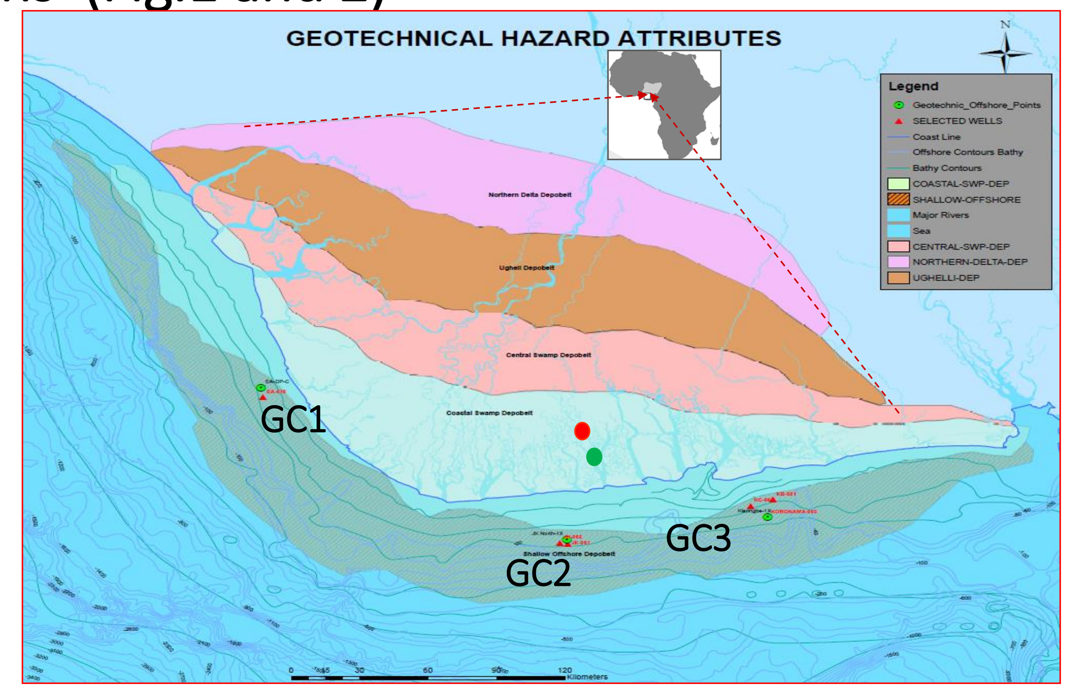


Fig. 1. The stratigraphy and evolution of Niger Delta Formations (modified after Reijers, 2011). Rd = rate of deposition; Rs = rate of subsidence; E = Fluviatile backswamp deposits; D = Upper shoreface heteroliths; C = Lower shoreface heterolths; B2 = Open marine shale; B1 = Transgressive marine shale; HST = highstand systems tracts; TST= transgressive systems tracts; MFS = maximum flooding surface; FS = flooding surface; SB = surface boundary.



- Fig. 2. The Niger Delta location: southern part of Nigeria, southwards of the Gulf of Guinea (Kulke *et al.*, 1995).
- Geotechnical positions of GC1= East, GC2=Central, GC3=West along the Shallow offshore. (GC – Gravity Core)

4. Methodology

- This research involves a multi-proxy study based upon three gravity cores of just under 3 m length each (Figs. 4 & 5).
- Micropaleontological (foraminifera, nannofossils and palynomorphs) (GCs – date) techniques were applied (Figs. 3, 4 & 5).

a) Original Gravity Core b) Core sampling at 2 cm c) Slabbed Core d) Collected core samples in bags

5. Results

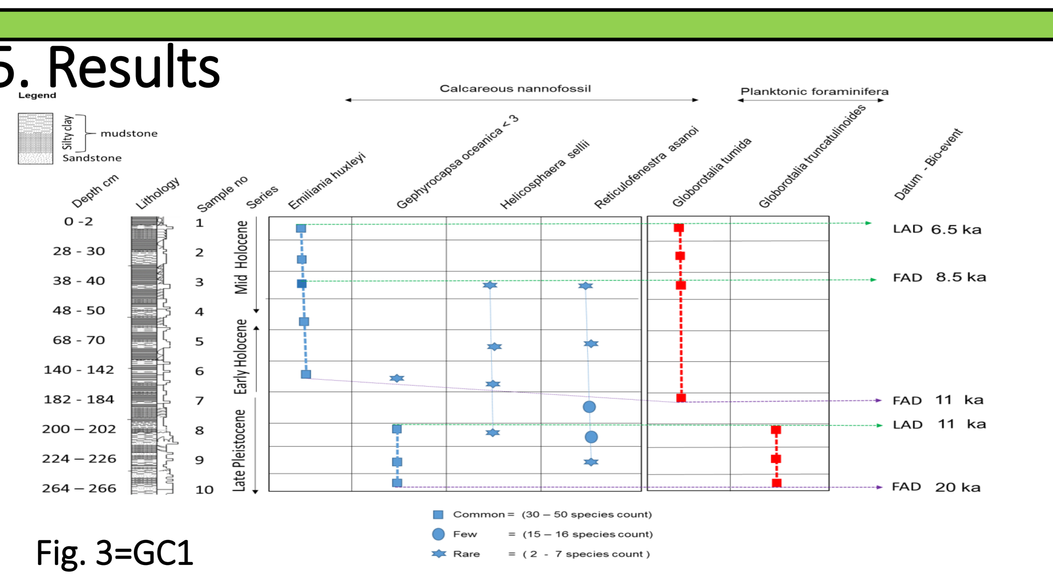


Fig. 3=GC1

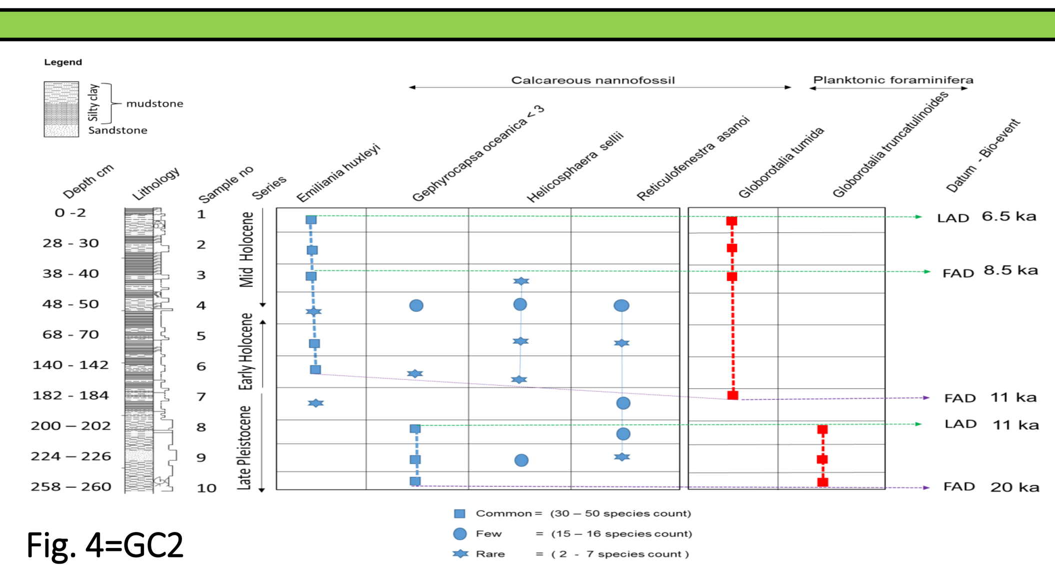


Fig. 4=GC2

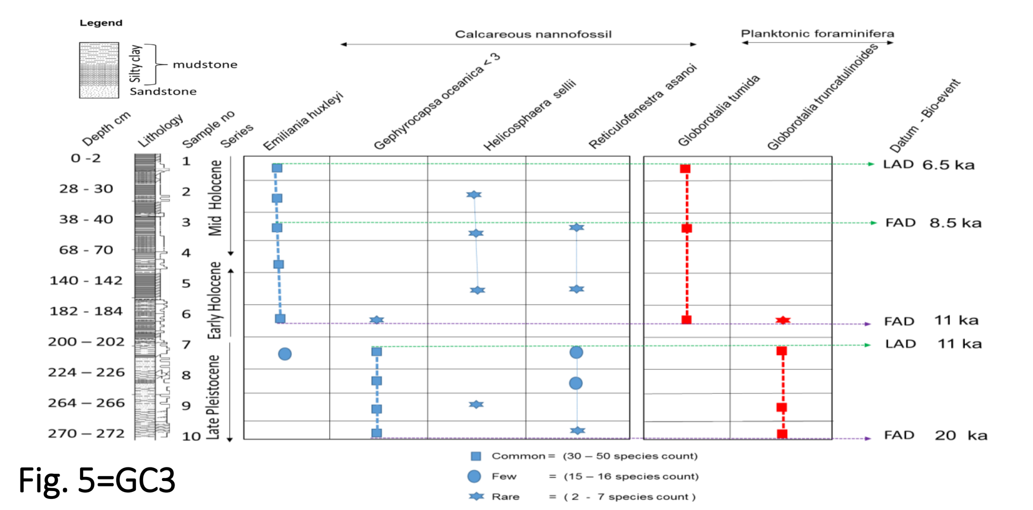


Fig. 5=GC3

Figs. 3, 4 & 5. Distributions of the calcareous nannofossil and planktonic foraminiferal markers species in the GCs and its estimated biostratigraphy. Note: Between 0-40 cm is increasing upwards (*Emiliania huxleyi*) for the three GCs.

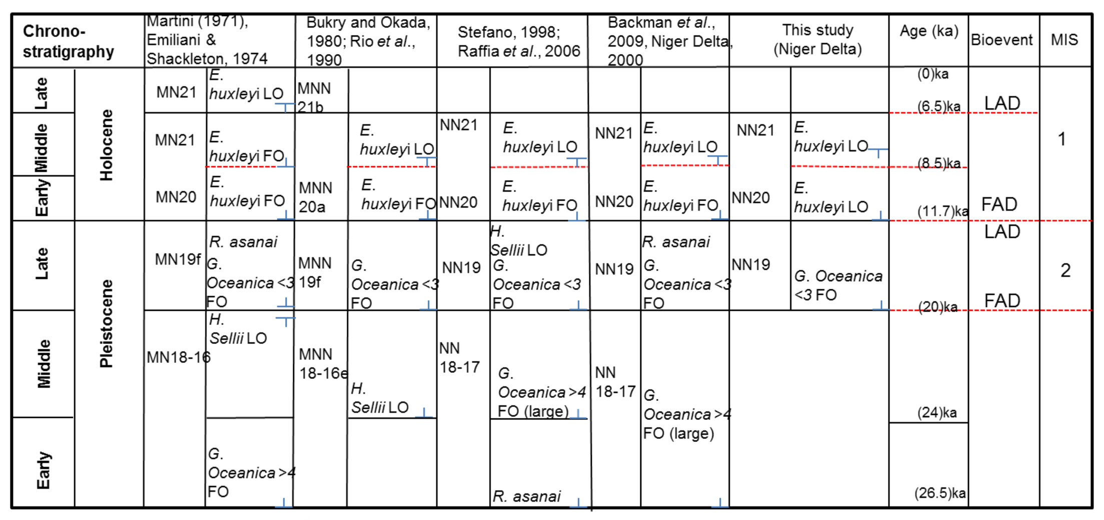


Fig 6. Correlation of the global nannoplankton age zonation with the GCs age constrained and the marine isotope stages (MIS). MNN = Mediterranean Nannoplankton, FOC = first occurrence, LOC = last occurrence, FAD = first appearance datum and continuous occurrence, LAD = last appearance datum and continuous occurrence.

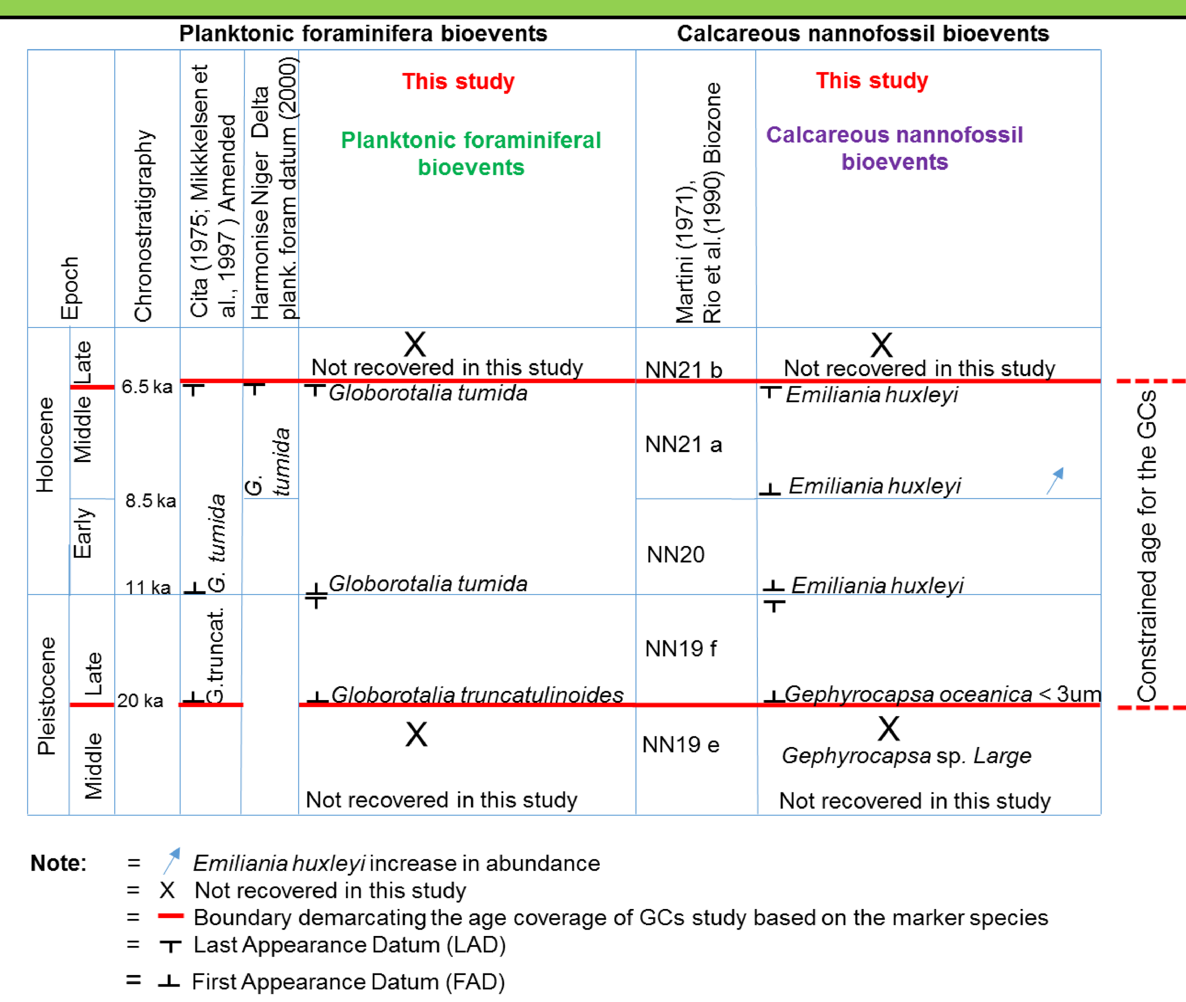
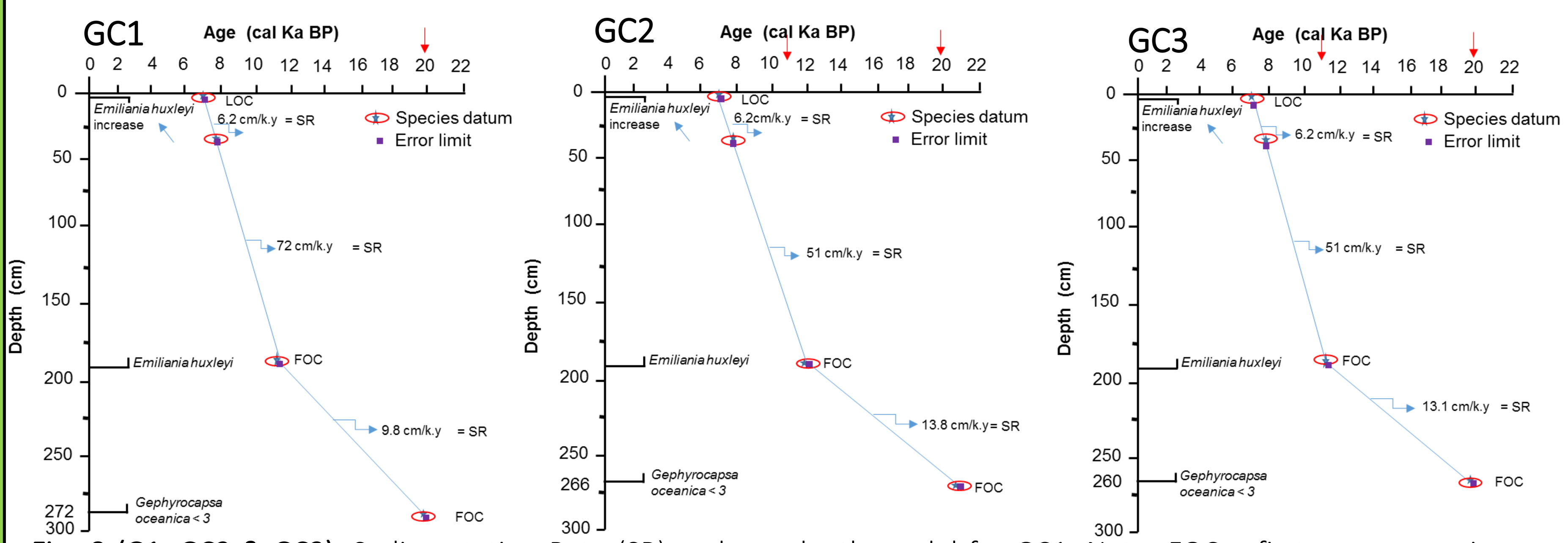


Fig 7. Age model constrained for the three GCs based on planktonic foraminiferal and nannoplankton marker species. This is placed in context with globally-defined zonation.



Figs 8 (G1, GC2 & GC3). Sedimentation Rate (SR) and age-depth model for GC1. Note: FOC = first occurrence in core, LOC = last occurrence in core.

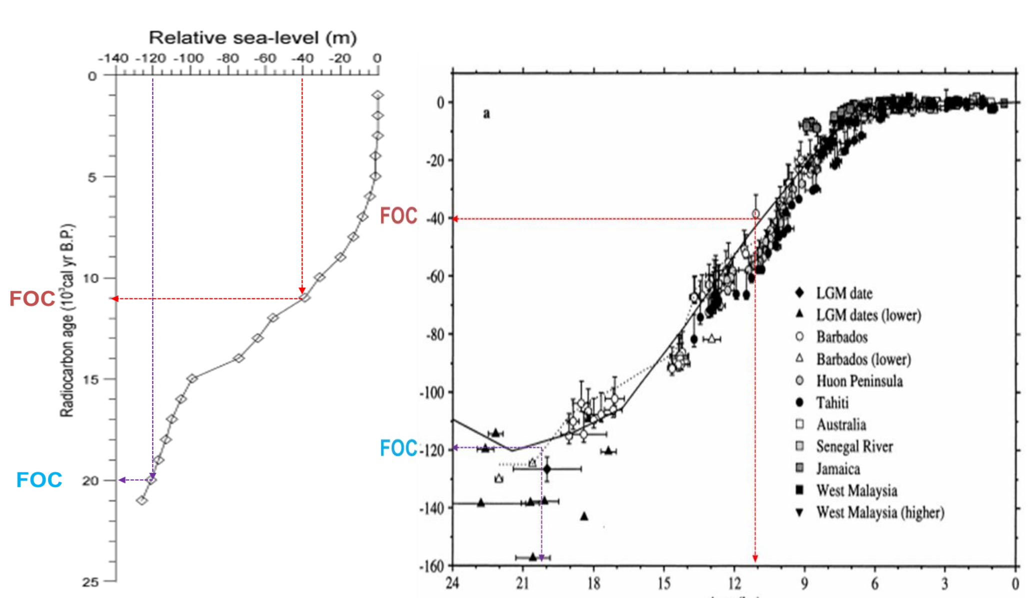
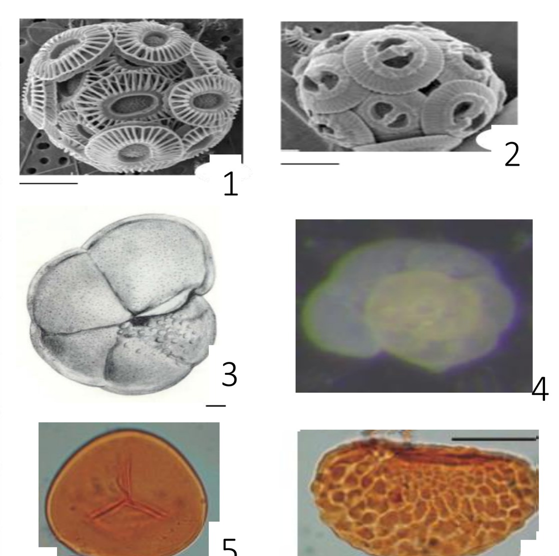


Fig 9. Plots of FADs / FOC on each GC vs. regional / global sea level curves after Peltier (1994) and Fleming *et al.* (1998), respectively.

Plate: 1



1. *Gephyrocapsa oceanica;* 2. *Emiliania huxleyi;* 3. *Globorotalia tumida;* 4. *Globorotalia truncatulinoides;* 5. *Stereisporites* sp. 6. *Verrucatosporites usmensis (Scale bar: for 1 & 2 = 5um; 3 & 4 = 100 um; 5 & 6 = 15um*

6. Implications and Conclusions

I. Absence of the *Globorotalia tumida* at these intervals/depths (Figs 3-5) indicates that the base of the three GCs does not exceed the Late Pleistocene in age (20-11 ka) (Stefano, 1998).

II. The absence of *Globorotalia truncatulinoides* in the mid-top of the three cores indicates that the age does not exceed mid-Early Holocene (11-8.5 ka) (Cita, 1975; Berggren *et al.*, 1995a) (Figs. 3-5).

III. The LOC and FOC of *Gephyrocapsa oceanica is* defined in each of the cores whereas *Emiliania huxleyi* is absent (Raffia *et al.*, 2006; Martini, 1971) (same as I) (Figs. 3-5).

IV. The first down-hole occurrence of marker species *Emiliania huxleyi* is significant and increase up-hole where as *Gephyrocapsa oceanica is absent* (same as II) (Figs. 3-5).

V. Foraminifera *(Globorotalia truncatulinoides* and *Globorotalia tumida* and nannofossil (*Emiliania huxleyi* and *Gephyrocapsa oceanica*) occurrences in the three GCs enabled to establish a stratigraphical framework (Figs. 6 & 7)

VI. The three cores recovered the late Pleistocene (~20/ ~20 ka) to mid-Holocene (~6.5ka) time span (Figs. 6 & 7).

VII. Linking the regional and global sea level curves at 20 ka, instil more confidence in the First Occurrence (FOC) Datum of each marker species in the GC (Fig. 9).

VIII. These results enabled the development of an age model (depth/age related) and sedimentation rates at different depths (Figs 8).

7. Acknowledgement

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8. References

Berggren, W. A., Hilgen, F. J., Langereis, C. G., Kent, D. V., Obradovich, J. D., Raffi, I., Raymo, M. E. and Shackleton, N. J., 1995. Late Neogene chronology: new perspectives in high-resolution stratigraphy. Geological Society of American Bulletin, **107, 1272-1287.**

Cita, M. B., 1975. The Miocene/Pliocene boundary: history and definition. In Saito, T., Burckle, L., H., (Eds.), Late Neogene Epoch Boundaries. Special Publication. **Micropaleontology, 1-30.**

Fleming, K., Johnston, P., Zwartz, D., Yokoyama, Y., Lambeck, K., Chappell, J., 1998. Refining the eustatic sea-level curve since the Last Glacial Maximum using far- and intermediate-field sitesEarth and Planetary Science Letters, **163, 327–342.**

Kulke, H., 1995. Nigeria: (In) Kulke, H., ed. Regional petroleum geology of the World part 11: African, America, Australia and Antarctica: Berlin, Gebruder Bornbraeger, **143-172**.

Peltier, W. R., 1994. Ice age paleotopography. Science**, 265, 195-201.**

Raffia, I., Backman, J., Fornaciari, E., Pälike, H., Rio, D., Lourens, L. and Hilgen, F. J., 2006. A review of calcareous nannofossil astrobiochronology encompassing the past 25 million years. Quaternary Science Reviews, **25, 3113-3137.**

Reijers, T. J. A., 2011. Stratigraphy and sedimentology of the Niger Delta. Geologos, **17, 133-162.**

Stefano, E., 1998. Calcareous nannofossil quantitative biostratigraphy of Holes 969e and 963b (Eastern Mediterranean) In: Robertson, A. H. F., Emeis, K. C., Richter, C., and Camerlenghi, A. (Eds.). Proceedings of the Ocean Drilling Program, Scientific Results, **160, 100-110.**