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**Research Article**

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# The Refinement of the NN4 Nannozone in the Niger Delta and its Stratigraphic Implication

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**Abstract** Six (6) wells spread across three Depobelts namely: the Offshore Depobelt (DOFS-1 and DOFS-2 wells), the Central Swamp Depobelt (CENSW-1, CENSW-2 and CENSW-3 wells) and the Greater Ughelli Depobelt (GUGH-1 well) were analysed to review the stratigraphic definition of the NN4 Nannozone by refining its Time-stratigraphic resolution. The NannoZone was subdivided into two Sub-Zones (NN4A and NN4B) based on the Acme occurrence of Helicosphaera ampliaperta. The use of this bioevent as a stratigraphic index/datum is predicated on its regional spread and consistency when calibrated with established Micropaleontological and Palynological Zones, as well as the regional Sea Level Cycle of the Delta in the Early Miocene epoch. This bio-datum is observed to occur within the N7 Planktonic Zone, straddles the P680/P670 Palynological Zone boundary and approximates the 17.4Ma Maximum Flooding Surface (MFS) which occurs in Niger Delta Cycle 6 within the Super Cycle TB2 / Cycle 2.2. The delineation of this Acme bioevent can therefore be used as an indication of the penetration of the listed biozones (N7 Microzone and the P680/P670Palynological Zone boundary) as well as the 17.4Ma Transgressive Event in the Niger Delta. This subdivision and calibration has further refined the time intervals to about 0.9Ma for the NN4A subzone and 1.8Ma for the NN4B subzone from the previous 2.4Ma duration of the undifferentiated NN4 NannoZone; thus improving the Time-stratigraphic resolution in the Early Miocene epoch of the Niger Delta.

**Keywords** Refinement, NN4 Nannozone, Stratigraphic Implication

## Introduction

The refinement of Biozones or other stratigraphic datums have become imperative as scientific research reveal additional, higher (finer) scale information that provide better understanding and finer subdivision of time; both in relative and absolute terms. Most of the research is driven by oil exploration activities in hydrocarbon-bearing regions; where in the course of exploration and production activities, certain trends are observed and put through scientific procedures to ascertain the validity of the observations/inferences. The Niger Delta, being a prolific hydrocarbon region has driven research efforts in stratigraphy and other related disciplines to the benefit of the entire Gulf of Guinea province.

The refinement of Biozones can be Local (Field-wide or Regional) or Provincial. However, every refinement is first and foremost local, and as such fundamental in the identification of provincial/worldwide events.

Several workers such as Blow [1-2], Evamy and others [3], Gemeraad and others [4], Bolli and Saunders [5], Perch-Nielsen [6], Haq and others [7], Stacher [8], Okada and Bukry [9], Martini [10], as well as Berggren and others [11]; contributed to the present understanding of the stratigraphy of the Niger Delta. This is continually being refined, especially by the oil and gas industry experts in the course of exploration and exploitation work in the Delta; although some those findings are proprietary. This work is a result of several of such activities.

The NN4 NannoZone in the Niger Delta is an adaptation of its definition by Martini [10]; where the Top of the Biozone is defined based on the First Downhole Occurrence (FDO) / Highest Occurrence (HO) of *Helicosphaera ampliaperta* and the Base defined by the FDO/HO of *Sphenolithus belemnos.* However, the equivalent of this NannoZone in the Okada and Bukry [12] Scheme, the CN3 NannoZone, uses the same criterion for the definition of the Top but the Base was defined by the Last Downhole Occurrence (LDO) / Lowest Occurrence (LO) of *Sphenolithus heteromorphus.* These criteria as used by these authors in defining the Base of the Nannozone are used interchangeably depending on which is observed to be consistent in a study.

The work of Fadiya and Salami [13] in part, dealt with this same subject matter: the subdivision of the NN4 NannoZone into the NN4A and NN4B subzones based on the Acme Occurrence of *Helicosphaera ampliaperta* but the focus was restricted to the Deep Offshore (Offshore Depobelt). The delineation of this bio-event is hinged on the identification of its "Acme"; which is relative in this context. It refers to a relatively higher downhole occurrence after which the species count begins to drop.

This study extends/widens the scope by tying this biodatum to the already defined Micropaleontological and Palynological Zones/SubZones as well as a Chronostratigraphic datum across four Depobelts (Offshore, Coastal Swamp, Central Swamp and Greater Ughelli) in the Niger Delta (Fig. 1). The objective of the study is to further refine the time interval defined by the NN4 NannoZone in both relative and absolute terms.

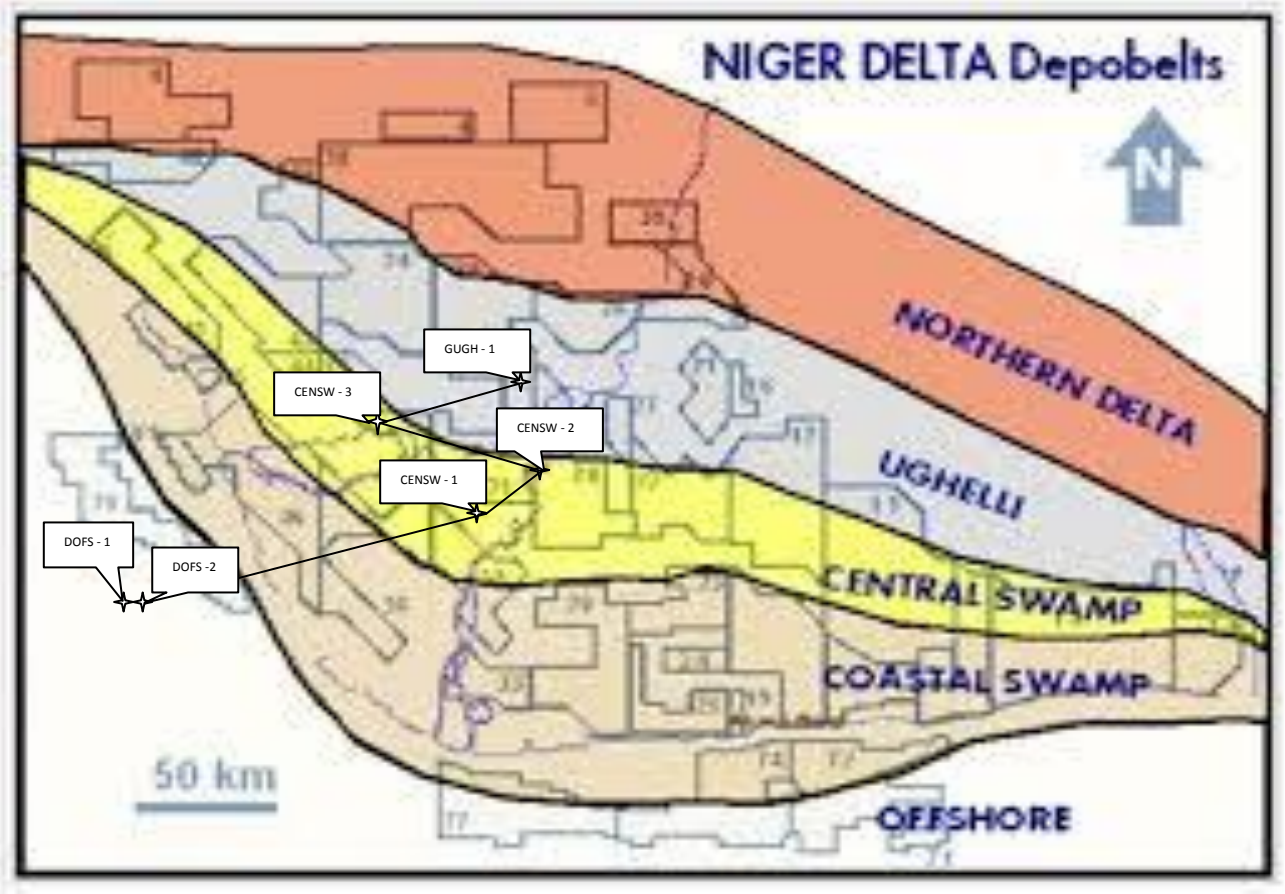


*Figure 1: Niger Delta Depositional Map Showing the Depobelts and Location of Studied Wells*

**Materials and Methods**

Ditch cutting, sidewall and core samples from six (6) wells spread across three (3) depobelts were variously processed, analysed and interpreted using standard methods in Nannopaleontology, Foraminiferal micropaleontology and Palynology. These interpretations were further integrated with wireline logs and Sedimentological data to make Sequence stratigraphic deductions. The stratigraphic interpretation charts were generated using the STRATABUGS software.

**Results and Discussion**

The subdivision of the NN4 NannoZone into the NN4A and NN4B subzones is predicated on the Acme Occurrence of *Helicosphaera ampliaperta* and is observed to consistently occur within the N7 Planktonic Foraminifera Zone of Blow [2 & 3] straddles the P670/P680 Palynological subzones of Evamy and others [5] and approximates the 17.4Ma Maximum Flooding Surface (MFS) of Haq and others [8] in the Niger Delta (Fig. 2). The approximation of this chrono-datum 17.4Ma by the bio-datum having been observed in the well sections used in this study (Figs. 3 – 8) can thus be used to infer the penetration of this transgressive event in the Niger Delta. The Acme is observed at 17, 250ft in DOFS-1 Well, 14,670ft in DOFS-2 Well, 11,825ft in CENSW-1 Well, 8750ft in CENSW-2 Well, 12,172ft in CENSW-3 Well and at 10,220ft in GUGH-1 Well (Fig. 9).

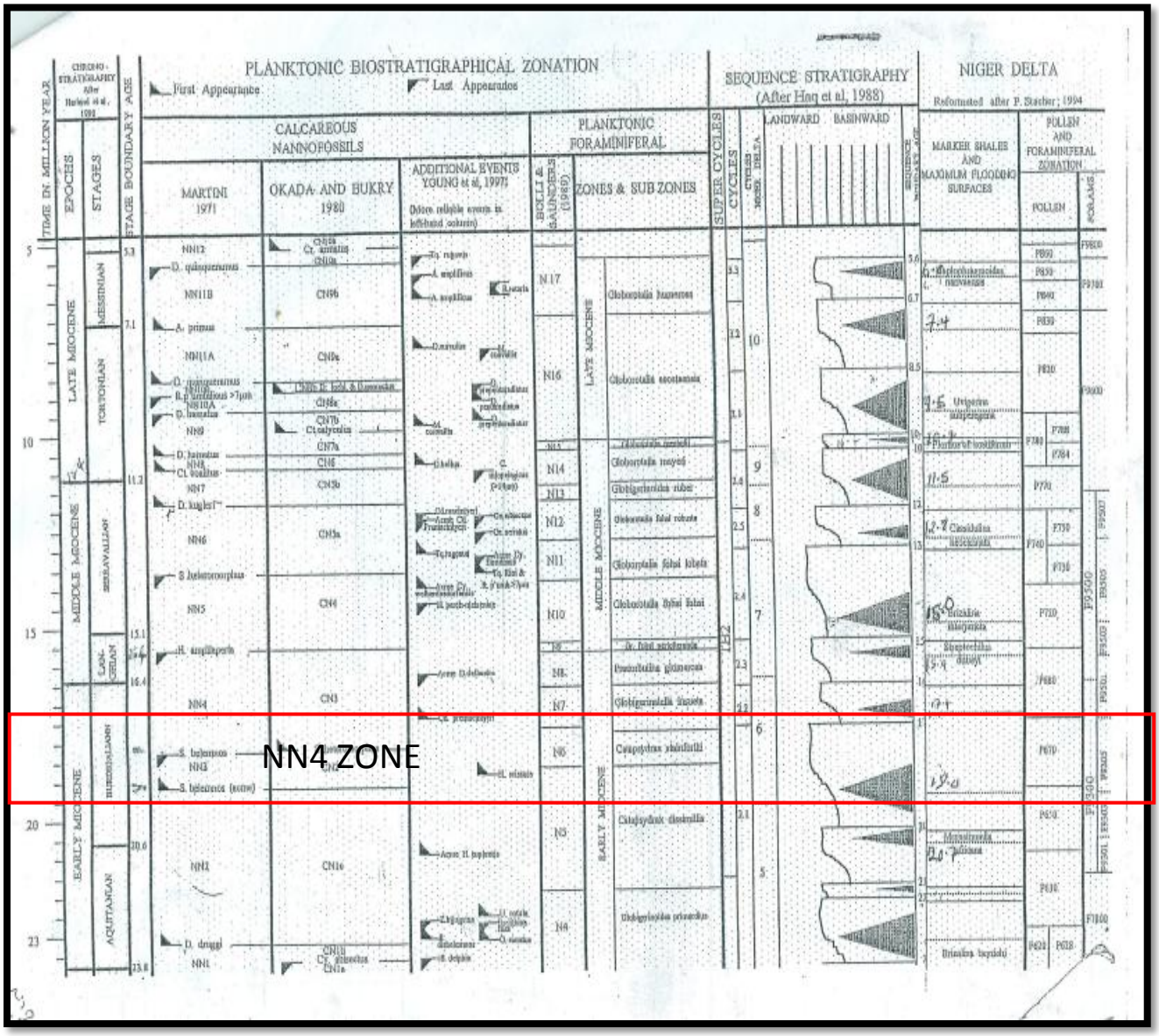


*Figure 2: Niger Delta Chronostratigraphic Chart*

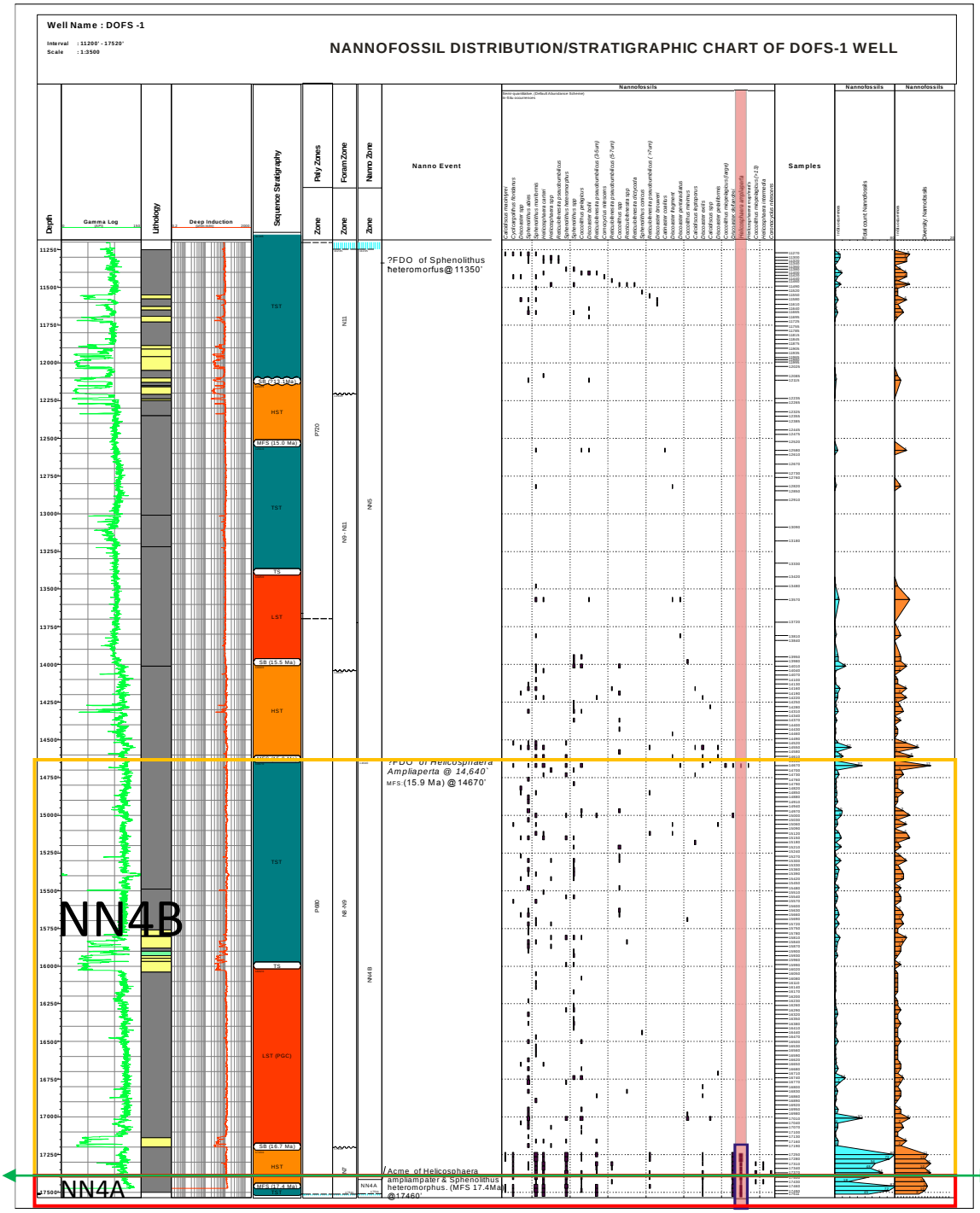


*Figure 3: Nannofossil Distribution Chart of DOFS -1 Well*

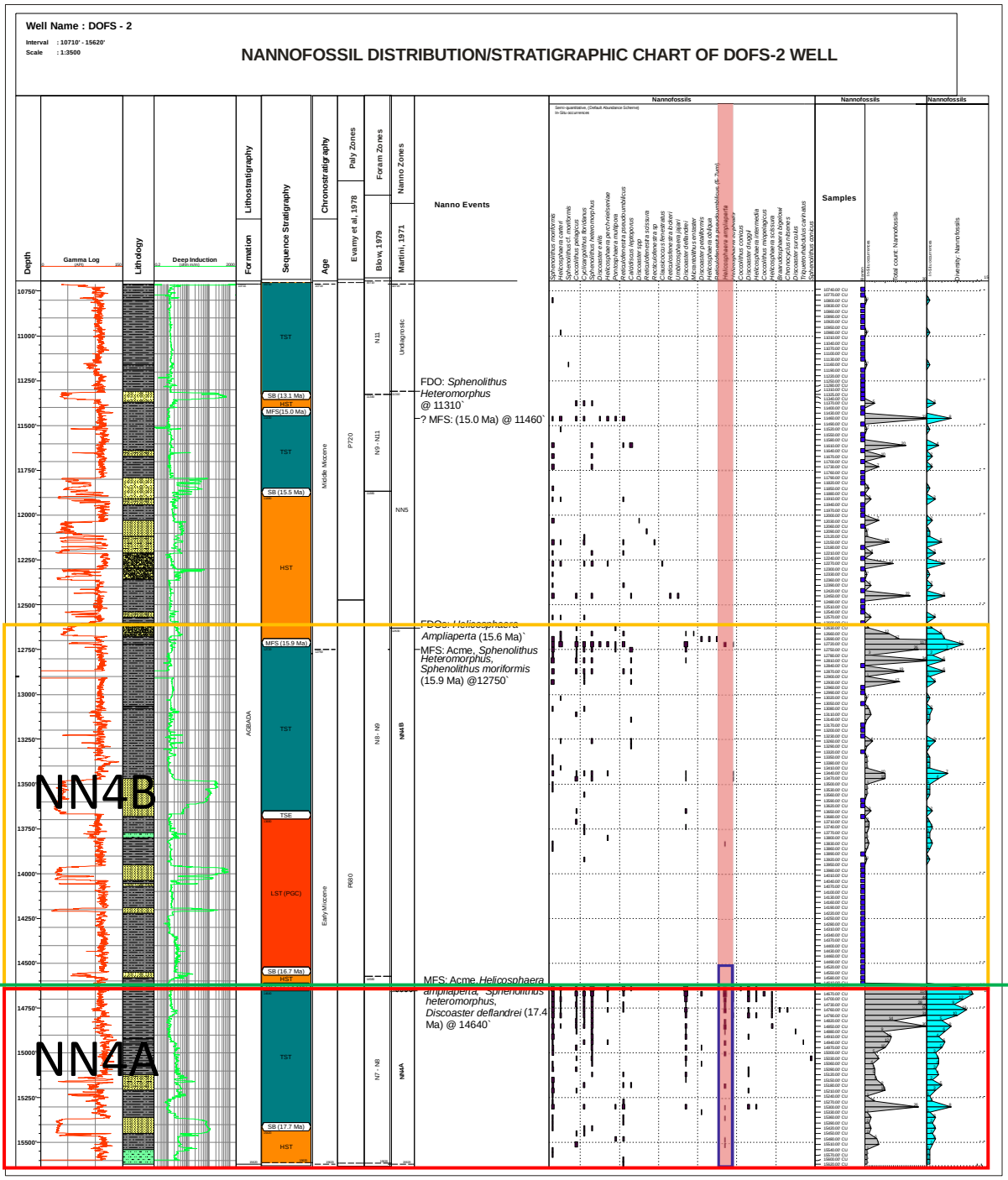


*Figure 4: Nannofossil Distribution Chart of DOFS -2 Well*

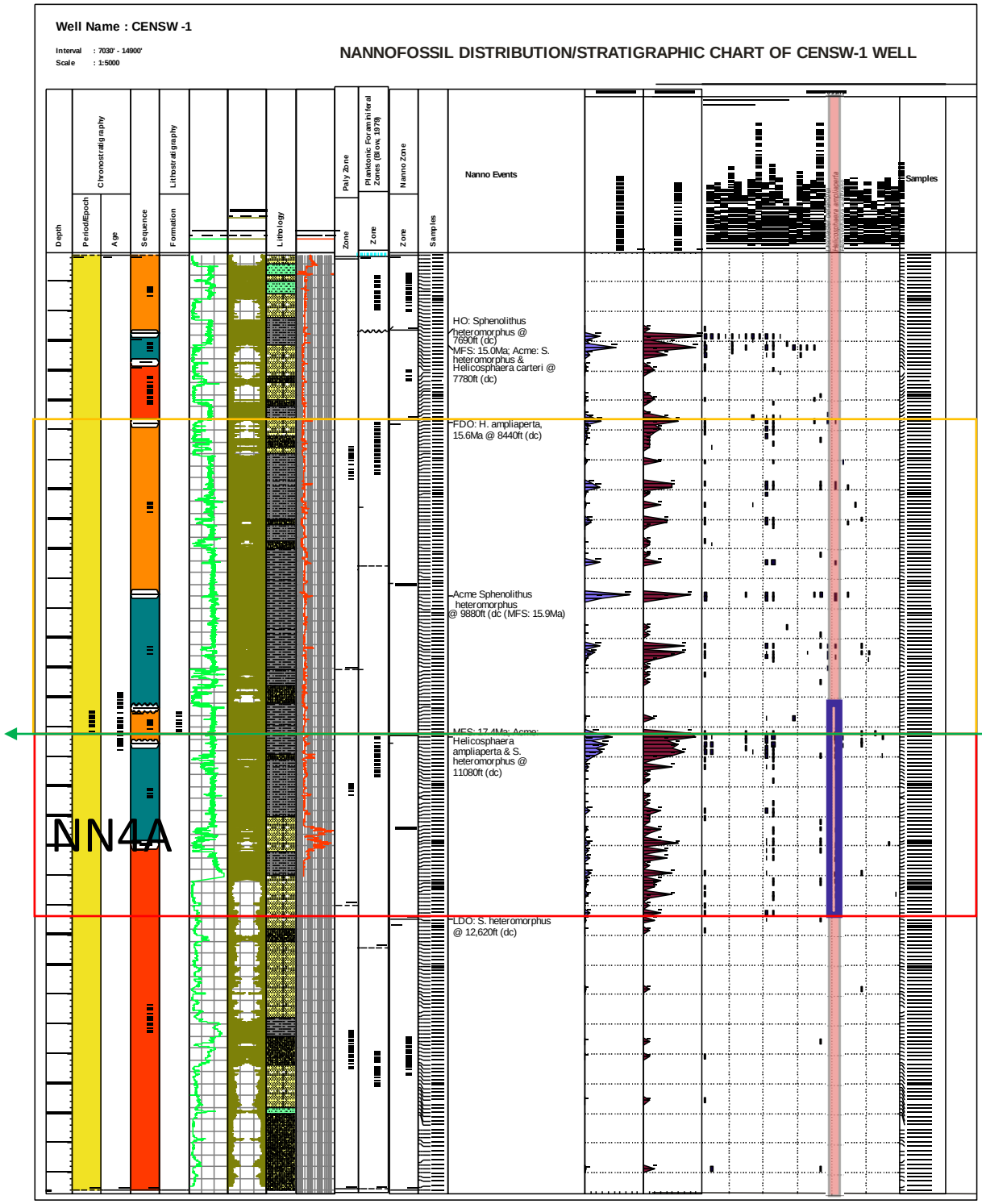


*Figure 5: Nannofossil Distribution Chart of CNSW – 1 Well*

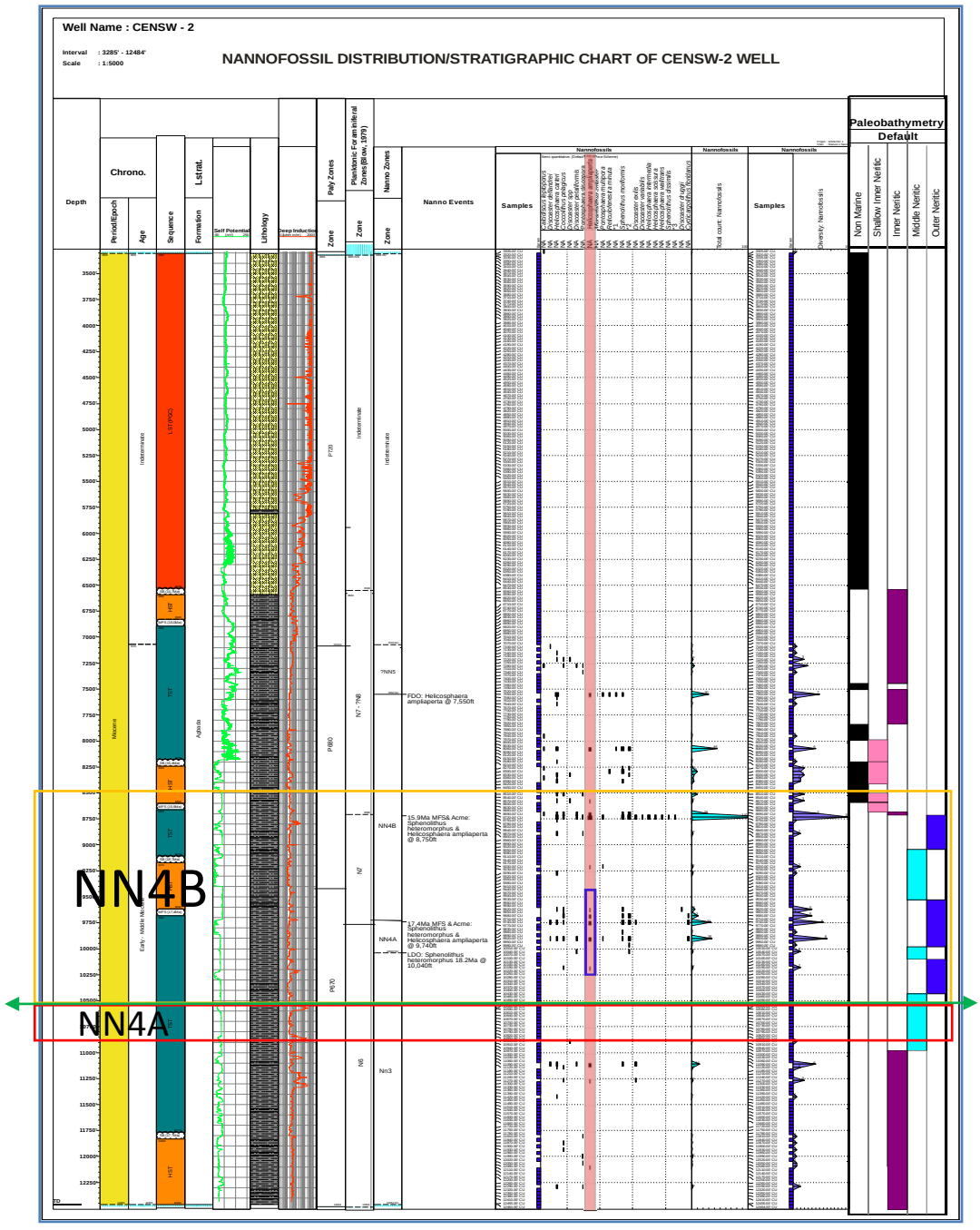


*Figure 6: Nannofossil Distribution Chart of CNSW – 2 Well*

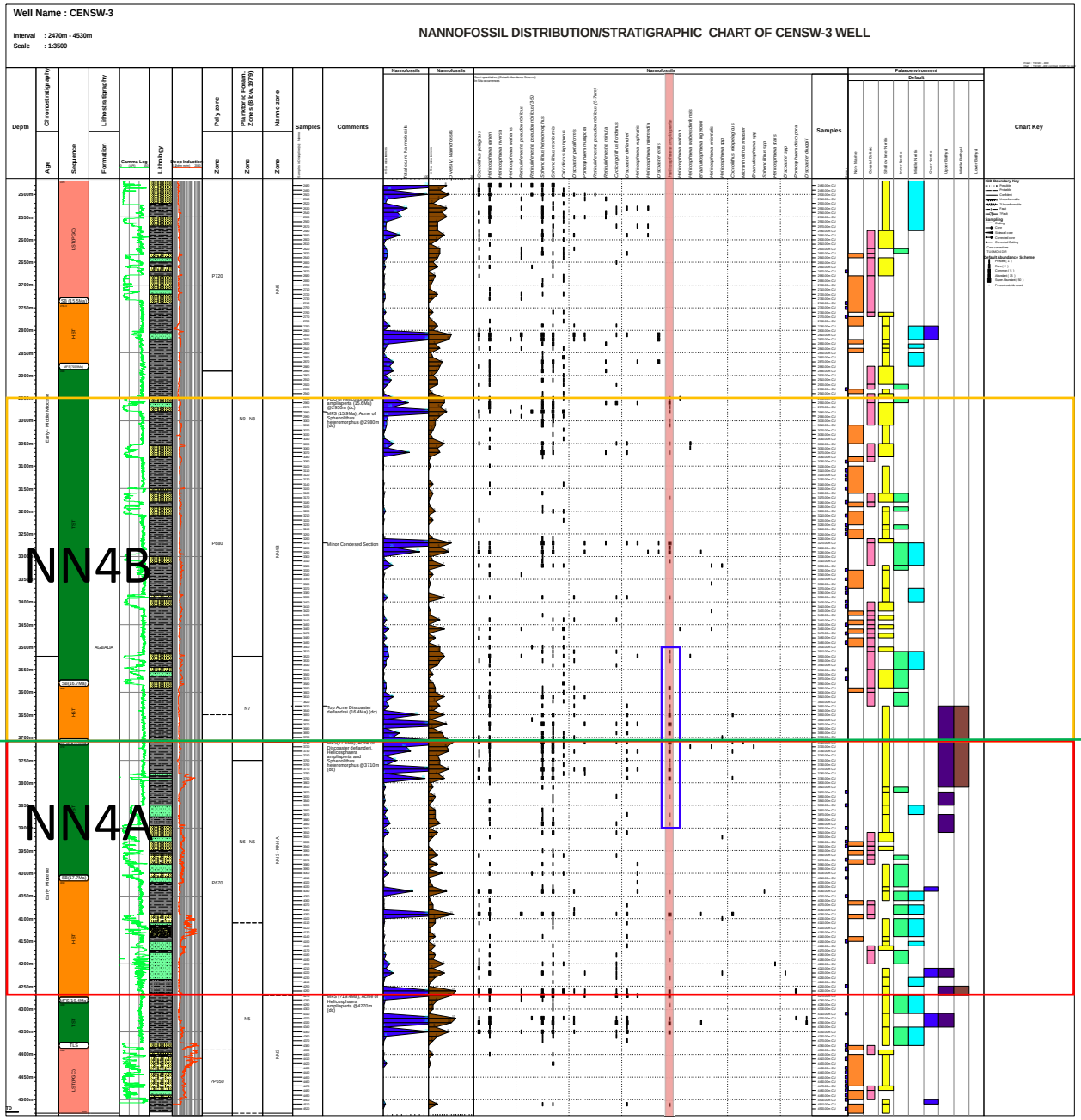


*Figure 7: Nannofossil Distribution Chart of CNSW – 3 Well*

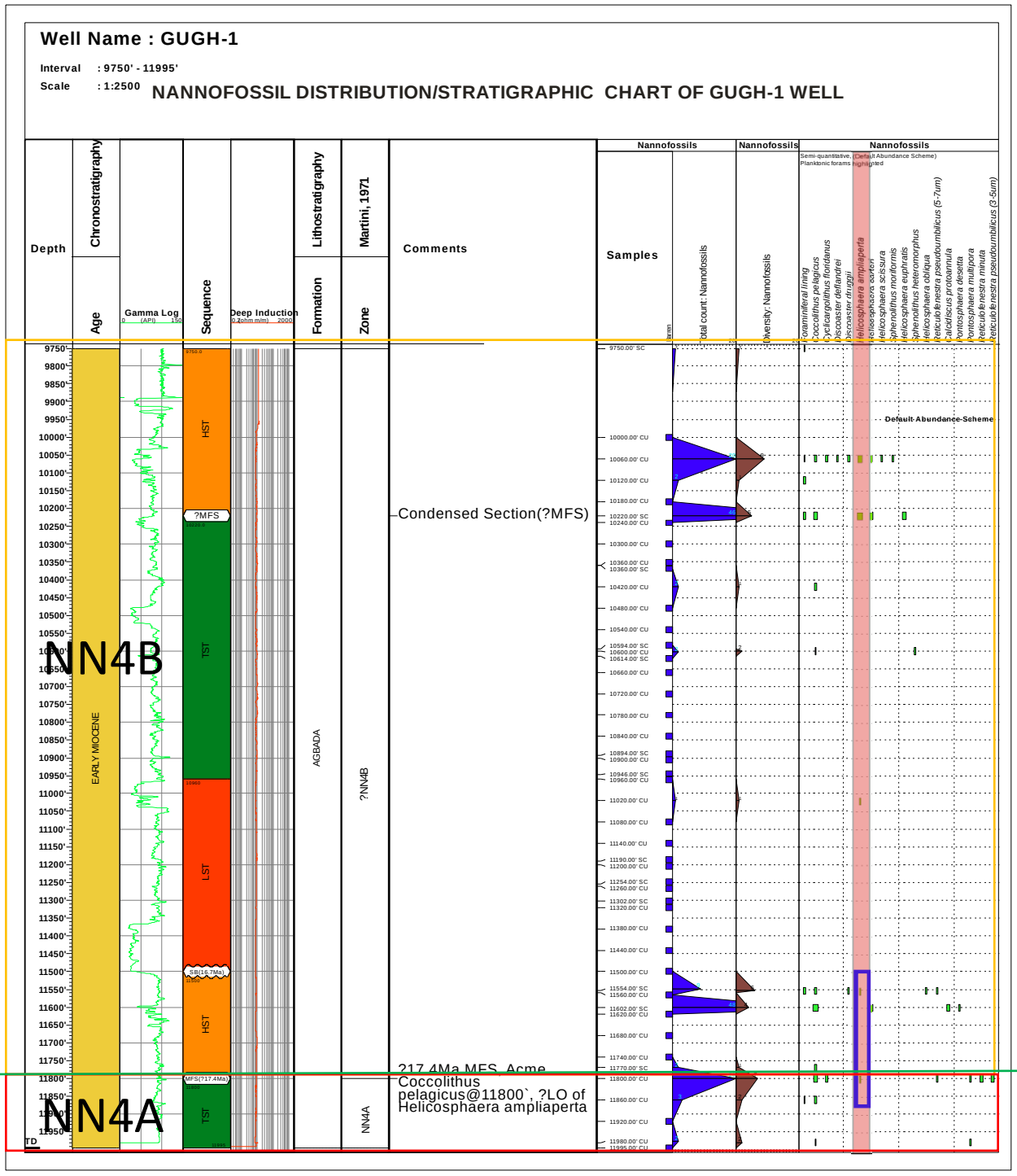


*Figure 8: Nannofossil Distribution Chart of GUGH – 1 Well*

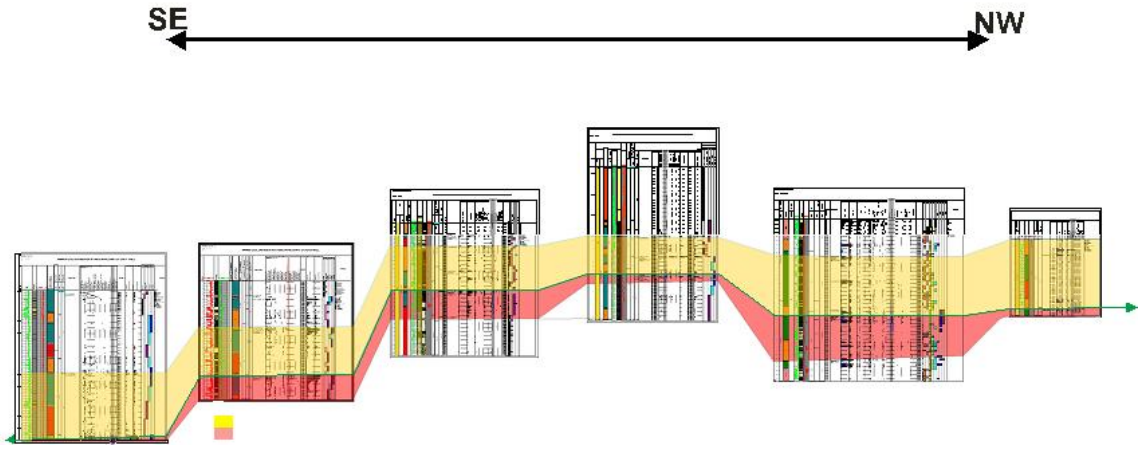


*Figure 9: Stratigraphic Chart of the Wells showing the Acme Event across the Study Area*

The common Nannoplankton species usually associated with this Acme event are *Cyclicargolithus floridanus, Coccolithus pelagicus, Sphenolithus heteromorphus, Sphenolithus moriformis, Discoaster deflandrei and Helicosphaera carteri* (Plate 1).

The Top of the NN4 Nannozone is defined by the FDO/HO of *Helicosphaera ampliaperta* and is dated 15.6Ma [11], while the Base is defined by the FDO/HO of *Sphenolithus belemnos* which is dated 18.3Ma [11]. The alternate bio-datum used to define the Base of the Nannozone by Okada and Bukry [12]; the LDO/LO of *Sphenolithus heteromorphus* is approximately 18.2Ma [11]. These two (Base-defining) bio-events are very close and according to Young [14], the sequence of the events is not clear. However, the difference between their approximated ages (ca. ±0.1Ma) is within acceptable limits and thus justifies their interchangeable use.

From the foregoing, the entire NN4 NannoZone defines a time interval of about 2.39 – 2.40Ma. However, its subdivision and calibration using the Acme occurrence of *Helicosphaera ampliaperta* has further refined the time intervals to about 0.9Ma for NN4A and 1.8Ma for NN4B, thus improving the Time-stratigraphic resolution in the Early to Miocene epoch of the Niger Delta.

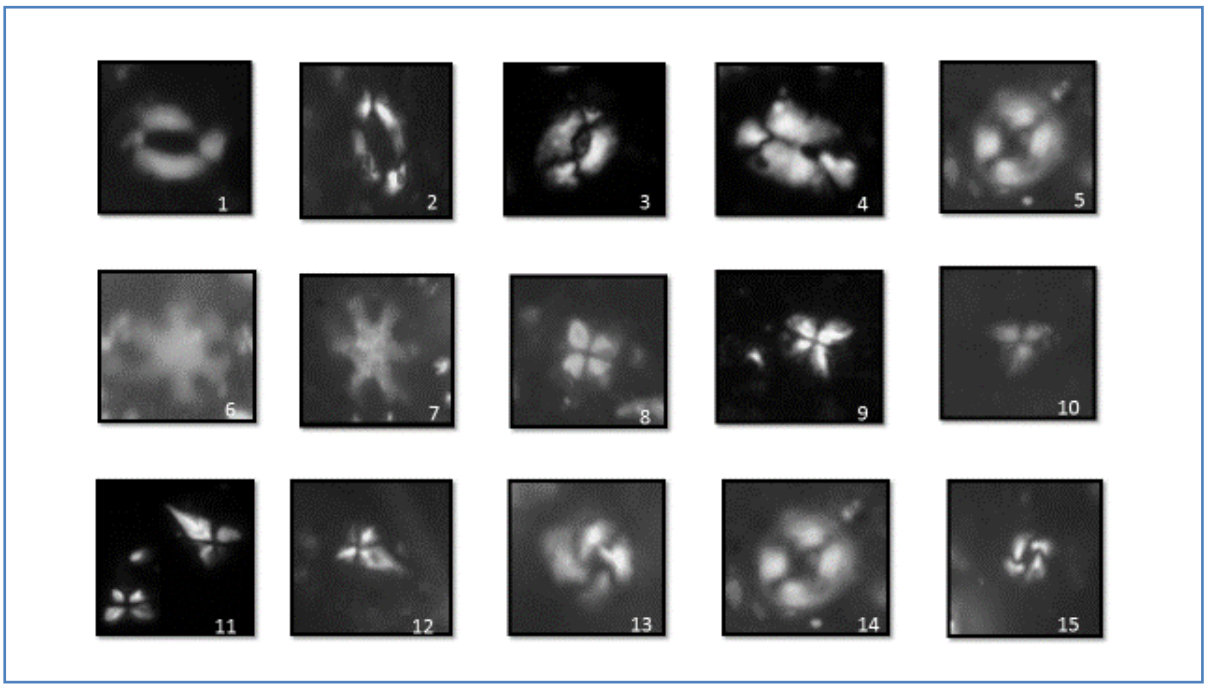


*Plate 1: 1-2 Helicosphaera ampliaperta, 3. Helicosphaera euphartis, 4 Helicosphaera cateri, 5 Coccolithus pelagicus, 6-7 Discoaster deflandrei,8-9 Sphenolithus moriformis,10 Sphenolithus belemnos,11-12 sphenolithus heteromorphus, 14 Cyclicargolithus floridanus, 15 Reticulofenestra pseudoumbilicus.*

**Conclusions**

The Acme occurrence of *Helicosphaera ampliaperta* in the Niger Delta has been used to subdivide NN4 NannoZone into two; the NN4A and NN4B Nanno subzones. The calibration of this bio-datum to Micropaleontological and Palynological Zones as well as the Chronostratigraphic sequences of the Niger Delta indicates that it approximates the 17.4Ma MFS and can thus be used as an indicator of the penetration of this transgressive event in the Delta. This subdivision of the NN4 NannoZone has enabled the Time-stratigraphic refinement of the Zone; reducing the 2.4Ma time interval to shorter/finer components of about 0.9Ma for NN4A subzone and 1.8Ma for NN4B subzone.

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