

PALYNOFACIES INVESTIGATION OF SEDIMENTS FROM ORE-1 WELL AND ITS PALEOENVIRONMENTAL STUDIES, WESTERN NIGER DELTA, NIGERIA

Gana, F.D., Okosun, E.A., Onoduku, U.S. and Alkali, Y.B.

Federal University of Technology, Department of Geology, Minna, Niger State, Nigeria.

Corresponding E-mail: ganafunmilayo@gmail.com

Abstract

Palynofacies investigation of the sediments from 9700 ft - 1350 ft intervals of Ore-1 well, western Niger Delta, Nigeria was carried out. The study is aimed at delineating palynostratigraphic zones and established paleoenvironment of the sections. Forty-three ditch cutting samples were subjected to standard technique of palynofacies analysis using the acid method and the recovered palynomorphs were examined under the CX41Olympus binocular transmitted light microscope. Lithologically the section comprises of fine to medium grained, orange to dark coloured sandstone units and dark shale units. Palynofacies analysis yielded moderately rich palynomacerals and palynomorphs. Palynomacerals recorded show more than 90% of palynomaceral 1 (orange-brown or dark brown structured and unstructured higher plant materials), over 80% of palynomaceral 2 (structureless or structured materials of rootlet relics, stem, leaf and relics of algal and less than 30% of palynomaceral 3 (leaf cuticle and irregular relics of plants) and approximately 4% of palynomaceral 4 (dark blade, tube and needle like shape materials with cellular structure). Palynomorph assemblage of the recovered organic content was less than 5%. Three interval palynostratigraphic range zones of *Verrucatosporitesusmensis* - *Ctenolophoniditescoastatus*, *Pachydermitesdiederixi* - *Spinicolpitesechinatus* and *Grimsdaleapolygonalis*–*Retibrevitricolopitestriangulatus* were recognized. These zones were dated early to late Eocene based on the recovered marker palynomorphs such as *Douladiteslaevigatus*, *Ctenolophoniditescoastatus*, *Psilamonocolpitesmarginatus*, *Retitricolporitesirregularis* and *Sapotaceae*. A coastal-deltaic (lower delta and upper delta plain) environment have been inferred for the studied section of Ore-1 well.

Keyword: *Paleoenvironment, Palynofacies, Palynostratigraphic Zones, Ore-1*

Introduction

Palynofacies studies have become a strong logical tool for paleoenvironmental studies in recent times particularly in unfossiliferous sediments. The term was described by (Combaz, 1964; Powell, 1990, Batten and Stead, 2005) to designate the entire organic matter recovered from sedimentary rocks through a standard palynological preparatory method whose composition reflect a particular environment. These organic contents are palynomorphs, structured and unstructured vegetal materials of plants.

The character of organic matter in sedimentary rocks could provide a guide to which the rock unit is formed, insights into the hydrocarbon type and thermal maturity. Its concept could be used for correlation of reservoirs within an oil bearing field and areas where biomarkers are scarce (Chukwuma *et al.*, 2019). This could aid in improving geological practices and refined biostratigraphy because different environments have different sceneries in which the rock units are laid. Therefore sufficient information on paleoenvironment is needed to reduce risk and cost of exploration. Unfortunately application of palynofacies data in Niger Delta Basin is scarce compare to the use of other microfossils (Foraminiferal and calcareous nanno fossils) in biostratigraphy. Chukwuma *et al.*, (2017)

carried out an extensive research on the Miocene sediments in Ida-6 well, Niger Delta Basin. Based on palynofacies study the authors identified three informal palynozones and deduce an environment of coastal deltaic to the strata penetrated. Chukwuma *et al.*, (2019) further infer a marginal marine environment to Ida-4 well located in the coastal swamp area of eastern Niger Delta Basin.

Study Area

Ore-1 well falls within latitude 4° and 6° N and longitude 3° and 9° E in the onshore part of the western Niger Delta Basin and characterized by the geology of the Paleocene outcrop. Ore-1 well is located precisely on latitude 6° 03' 40" N longitude 5° 35' 44" E, (Figure 1.) The Niger Delta Basin lies in the inland lowlands in the southern part of Nigeria lying between 30 m to 300 m above the sea level. It is fill predominately by the by the complex dregs from Niger, Benue and Cross Rivers (Doust, 1990). Stratigraphically the lithic fill was subdivided into three major lithostratigraphic units that are interpreted based on sand and shale ratio. These lithic fills are also dated based on fossil micro fauna (foraminifera and calcareous nannofossils) but of recent the stratigraphic framework is based on the use of pollen and spores. These are the basal marine prodelta Akata Formation, the middle shallow marine delta front

Agbada Formation and the top continental delta Benin Formation. These formations consists of progradational sequence (Esan, 2002) and a gross upward coarsening deltaic marine, inter lobe and abyssal plain deposits of

about 12,000 m (Weber and Daukoru, 1975). This study conduct palynostratigraphic zonation and paleoenvironment of Ore-1 well of the western, Niger Delta Basin

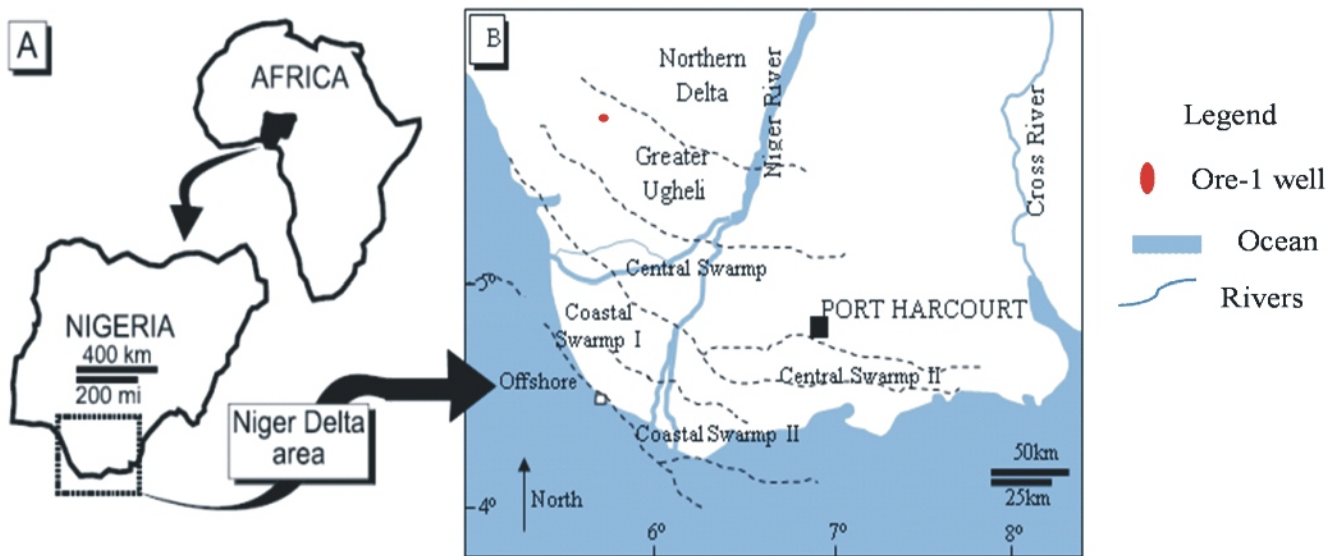


Fig. 1: Location map of Ore-1 well

Materials and Methods

Ditch cuttings and wire line log were obtained from National Petroleum Development Company (NPDC) and other materials provided by Crystal Age Limited Lagos, Nigeria were the analysis was conducted. Lithology description were based on physical examination using hand lens, the sense of touch, feel, Munsell colour chart (1999). This was further aided by wire line log that measure the API units where lower value represent sand and high value indicate shale.

Forty three samples obtained at 15 ft interval between 9700ft -10350ft were subjected to the standard technique of palynofacies analysis using the acid method. Ten grams of each samples were equally ditched into a well clean labelled plastic beakers and treated mildly with 10% hydrochloric acid (HCl) under a fume cupboard for thorough removal of carbonates materials (shell fragments and foraminifera). The process was followed by complete neutralization with cleaned water. This was followed by addition of 40% of hydrofluoric acid (HF) and transferred into a centrifuge to speed up the rate of chemical reaction for complete dissolution of silicates for twenty four hours. After twenty four hours the HF was washed and decanted with water. Samples are then transferred into the Brason Sonifier to further filter any other inorganic materials present. Residue are divided into two, one portion for palynological analysis and the second for

palynofacies analysis. Portion for palynological analysis was stained with nitric acid for clearer identification of palynomorphs while those for palynofacies was not in order to retain the actual colour of the organic content. Two drops of each residue was pipetted into a clean circular cover slide, mix with Loctite (impruv) as a permanent mounting medium and cured in ultraviolet light for about five minutes. Prepared slides for both palynofacies and palynology where observed under the CX41 Olympus Binocular transmitted light microscope and compared with classical works of with classical works of (Germeraad *et al.*, 1968, Van Hoeken- klinkenberge, 1966, Oyede, 1992, Ige *et al.*, 2011).

Results, Interpretations and Discussions

Lithology description of Ore-1 well

Lithologically Ore-1 well comprises of alternations of sand stone, sandy mudstone and shale beds (Figure 2). The lower paralic unit is more shally compare with the upper paralic which is sandier. This description agrees with the works of (Doust and Omotsola, 1990) who stated that the lower unit of Agbada Formation is shalier than the upper part. The sandstone units are orange to dark colours while the shale are dark and fissile. Texturally the sandstone units are fine to medium grained with thin lenses of shale at some intervals..

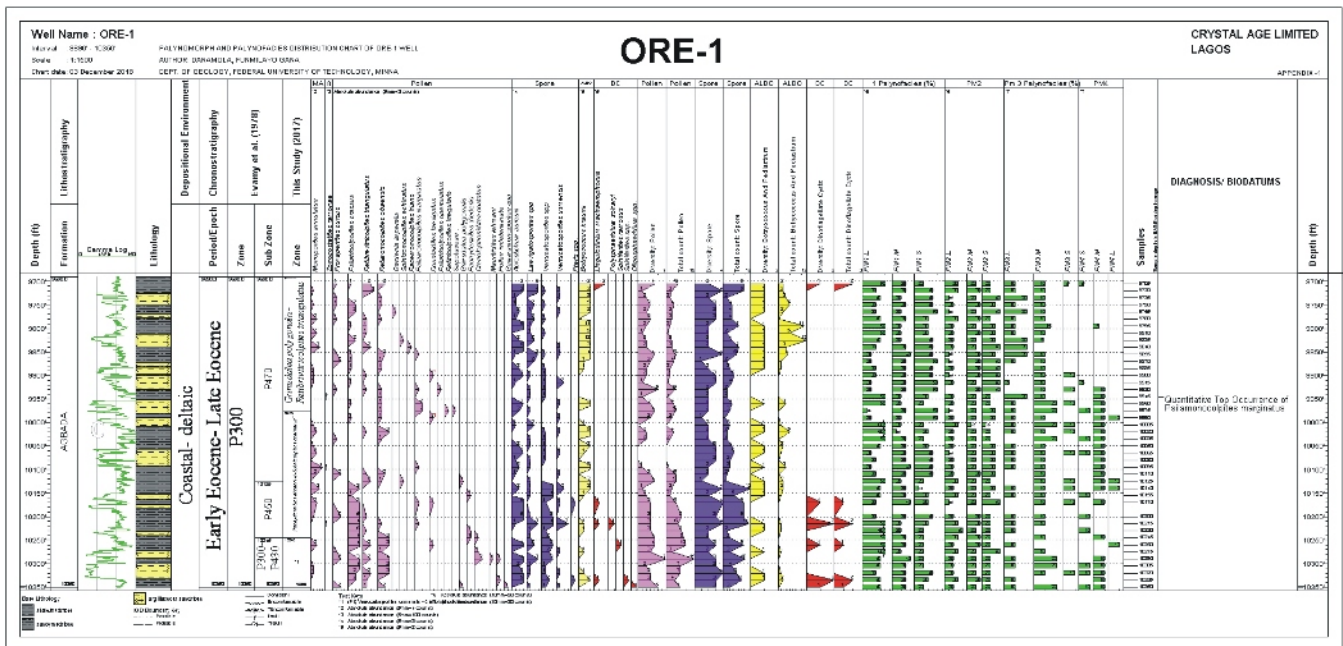


Fig. 2: Lithology, palynofacies and palynomorphs distribution of Ore-1 well

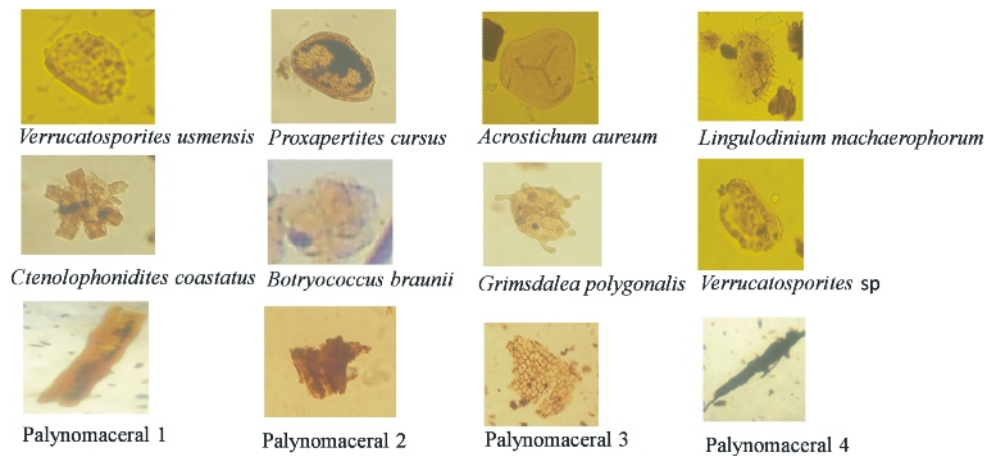


Plate 1: Palynomorphs and palynomacerals recovered from Ore-1 well.

Palynofacies

Palynofacies results is presented in (Figure 1), the chart shows the different palynomorphs and palynomacerals recovered from Ore-1 well at different intervals. Investigation revealed more than 90% of PM1, over 80% of palynomaceral 2, less than 30% of palynomaceral 3 and approximately 4% of palynomaceral 4. Palynomorph assemblage of the recovered organic content was less than 5%(Figure 3). Results further indicate that palynomorphs increases down the well with more of freshwater palynomorphs such as *Verrucatosporites* spp, *Acrostichum* aureum, *Laevigatosporites* spp and *Psilatricolporites* scrossus.

Palynomaceral 1(PM1).

PM1 from the studies have dense appearance, structured

and unstructured with colour ranging from orange brown and dark brown in colour (Plate 1). The palynomaceral are of higher plant materials mainly resinox cortex material, found also within this class are algal remnant of *Botryococcus* spp (Whitaker *et al.*, 1992). Palynomaceral 1 is further defined by the lowest buoyancy compare with PM2, 3 and 4.

Palynomaceral 2(PM2).

These are brownish orange lathy shape remains of plants (stem, leaf, rootlet and relics of algal) known as exinites according to the above authors. Also these PM2 are of higher buoyancy than PM1.

Palynomaceral 3 (PM3).

Palynomaceral of this kind generally appear pale and

skinny with irregular shape (Thomas *et al.*, 2015) and more buoyant than PM2, These authors further specified that PM3 are irregular relics of plant and consist of stomata.

Palynomaceral 4 (PM4).

Palynomaceral 4 from studied interval reveal variable dark equidimensional blade and needle like shape materials with cellular structure and of different origin. Palynomacerals of this kind are regarded as product of forest fires and highly buoyant, resistant and are transported over long distance (Whitaker *et al.*, 1992).

Palynostratigraphiczonations and Palynochronology of Ore-1 well

Three interval range palynostratigraphic zones were established for Ore-1 sediments and dated Early Eocene to Late Eocene based on the occurrence of diagnostic marker species recovered from the well. These are

Verrucatosporitesusmensis – Ctenolophoniditescostatus Zone

Stratigraphic interval: 10 350 ft-1245ft

The interval is defined at the base by the first appearance datum occurrence (FAD) of *Verrucatosporitesusmensis* and at the top by (LAD) *Ctenolophoniditescostatus*. Other palynomorphs defining the zone are *Doaulaiditeslaevigatus*, *Monoporitesannulatus*, *Sapotaceae Acrostichumaureum* and *Gemmamonoporites* sp. The zone correspond with the P300-P430 of (Evamy *et al.*, 1978) (Figure 1) and dated Early to Middle Eocene (Yepresen - Lutetian) based on *Verrucatosporitesusmensis*, *Retimonocolptesobaensis* and *Pachydermitesdiederixi*.

Pachydermitesdiederixi – Spinicolpitesechinatus Zone

Stratigraphic interval: 1245ft-10125ft

The base of this interval is characterized by the FAD of *Pachydermitesdiederixi* and top by LAD of *Spinicolpitesechinatus*. The zone is rich in *Psilamonocolpitescrassus*, other diagnostics palynomorphs within the zones are *Lingulodinummachaerophorum* and *Ctenolophoniditescoastatus* *Psilamonocolpitesmarginatus* and *Pteris* spp. The age of Middle –Late Eocene (Bartonia-Priabonian) is assigned to this interval due to the presence of *Psilamonocolpitesmarginatus* a pollen use to define the top of P450.

Grimsdaleapolygonalis – Retibrevitricolpites triangulatus Zone

Stratigraphic interval: 10125ft-9700ft

Characteristics: The interval is characterized by FAD of *Grimsdaleapolygonalis* and LAD *Retibrevitricolpites triangulatus*. Other characteristic palynomorph found within the interval are *Gardenia imperelis*, *Retimonocolpitesobaensis* and *Laevigatosporites* spp. The zones match with the P470 subzones of (Evamy *et al.*, 1978) and dated Late Eocene (Bartonia) (Figure 1) due to the occurrence *Grimsdaleapolygonalis*.

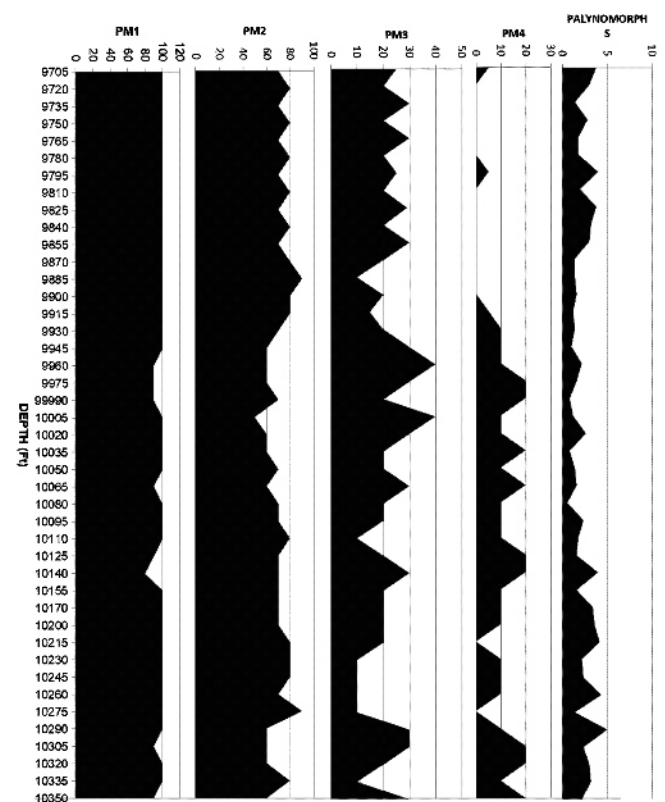


Fig. 3: Percentage palynomaceral plot for Ore-1 well

Conclusion

Ore-1 well reveal a typical Early Eocene to Late Eocene palynofacies signature of the Niger Delta Basin. Based on recovered palynomorphs three interval range zones of *Verrucatosporitesusmensis – Ctenolophoniditescostatus* zone, *Pachydermitesdiederixi – Spinicolpitesechinatus* zone and *Grimsdaleapolygonalis - Retibrevitricolpites triangulatus* were delineated. A coastal - deltaic (lower-upper delta plain) environment have been suggested for the strata penetrated by Ore-1 well.

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