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Palynofacies and Paleoenvironmental Studies of TDA-1 Well, Niger Delta Basin, Nigeria

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Palynofacies And Paleoenvironmental Studies of TDA-1 Well, Niger Delta Basin, Nigeria

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Abstract- ***The palynofacies and paleoenvironmental study of TDA-1 well, Niger Delta Basin, Nigeria between intervals of 6160 to 14470 feet (1878 to 4410 meter). The Niger Delta Basin is a crucial geological formation that has significant hydrocarbon reserves and supports diverse ecosystems where three main formations in ascending order are formed including the Paleocene Akata Formation, Eocene Agbada Formation, and Oligocene Benin Formation. Palynological analysis was carried out on the ditch cutting samples obtained from TDA- well of the Niger Delta Basin which was done through maceration (removal of silicate mineral and carbonate), neutralization which involves addition of Potassium Hydroxide (KOH) and distilled water. Then, microscopic analysis for identification of palynofacies. Certain palynomorphs (Spores: Laevigatosporites sp., Verrucatosporites sp., Polypodiaceoisporites sp., and Acrostichum aureum; Pollen: Striatricolporites catatumbus, Psilatricolporites sp., Monocolpites sp. etc.). The palynomacerals types PM-1, PM-2, PM-3, PM-4 identified and percentage of different paleoecological groupings and taxa (freshwater, rainforest, mangrove, savannah and montane) of dominant palynomorphs are were used to determine the paleoenvironment of deposition. The dominant paleoenvironments are freshwater and mangrove. The paleoenvironment of deposition was inferred to be Coastal brackish water environment.***

INTRODUCTION

According to Tyson (1995), a paleofacies is a body of sediment that has a unique collection of palynological organic matter that is assumed to represent a particular set of environmental circumstances or be connected to a particular range of hydrocarbon-generating potential. In general, organic materials recovered from a rock or unconsolidated sediment using the usual palynological processing method of digesting a sample in HCl and/or HF is referred to as palynofacies, or palynological facies, according to Batten and Stead (2005). Coal is oxidized using Schulze solution, which is a solution made of 1 g of potassium chlorate (KClO3) and 10–15 ml of HNO3 (Ediger, 1986). The palynofacies associated with sedimentary deposits containing biological matter may consist of minute particles of charcoal, miospores (small spores and pollen grains), or phytoclasts (fragments of plants). Palynofacies are assemblages of microfossils found in sedimentary rocks. They are primarily made up of palynomorphs, which include pollen, spores, dinoflagellate cysts, and other microscopic organic-walled microfossils. These microfossils can reveal important details about the environments in which sediments are found, the processes involved in depositional processes, and the potential for source rocks. Palynofacies analysis is an effective method for stratigraphic correlation, paleoenvironmental reconstruction, and petroleum exploration. Palynofacies analysis finds use in a variety of geological applications, including paleoclimatology, paleoecology, biostratigraphy, and chronostratigraphy. Additionally, palynofacies analysis has been used in paleoenvironmental reconstruction, such as the identification of marine and non-marine environments, depositional environments, and environmental changes during the geological past (Traverse, 2007).

Palynomorphs are preserved in different ways within sedimentary rocks, depending on their organic and mineral composition, as well as the depositional and diagenetic history. Palynofacies analysis also involves the systematic study of palynomorphs, their preservation and distribution within the rock, as well as their association with other sedimentary components such as clay minerals, organic matter, and carbonate minerals (Visscher and Playford, 1993)

METHODOLOGY

The ditch cutting samples of TDA-1 well were provided by Nigeria Petroleum Development while the sample processing and laboratory analyses were carried out at Limited Crystal Age Limited, Lagos, Nigeria. Palynological and palynofacial processing and analysis were carried out on fifteen (15) ditch cutting samples of the TDA -1 Well between intervals 6160 to 14470 feet (1878 to 4410 m). Standard palynological processing method for maceration of samples was applied. The materials used are weighing balance, and alternate usage of inorganic reagent such as dilute hydrochloric acid (HCl), concentrated hydrofluoric acid (HF), nitric acid (HNO_3), potassium hydroxide (KOH), glass slides, sieve mesh, Norland adhesive and distilled water.

Palynological and palynofacies processing and analysis were carried out on fifteen (15) ditch cutting samples of the TDA -1 Well between intervals 6160 to 14470 feet, in order to establish the age and paleoenvironment of deposition through the use of the diagnostic palynomorphs species and palynomacerals (PM) recovered from the samples.

A. MACERATION

Standard palynological processing method for maceration of samples was applied. This involves weighing of 25 g each of samples and alternate usage of inorganic reagents such as dilute Hydrochloric acid (HCl), concentrated Hydrofluoric acid (HF) and Nitric acid (HNO_3) to macerate the sediments. These reagents remove the carbonate minerals, silicate minerals and help to concentrate the palynomorphs respectively.

B. NEUTRALIZATION

Neutralization of acidic reaction was done with the use of Potassium hydroxide (KOH) and distilled water. Subsequently the palynomorph rich residue was mounted on labelled glass slides with the use of Norland adhesive mounting medium for microscopic analysis. The results of the analyses are hereby presented.

Palynofacies processing was carried out on the samples to produce un-oxidized slides from the residue derived from the HCL-HF-HCL stages.

C. SIEVING

The residue is sieved through 10 micron sieves mesh and mounted on cover slips and glass slides with Norland adhesive without the addition of HNO_3.

D. MICROSCOPIC IDENTIFICATION

The un-oxidized slide is subsequently cleaned for routine microscopic identification of plant organic materials. The particulate organic matter (palynofacies) have been found to be useful in inferring depositional environments (Lukaye, 2008; Oyede, 1991). The Palynomaceral types PM-1, PM-2, PM-3, PM-4 and Structureless Organic Matter (SOM) of Oyede (1991) were identified. Their abundances and size variations were used to interpret the possible paleoenvironment of deposition of the samples in collaboration with recovered sporomorphs and fresh water algae *Botryococcus braunii*.

RESULT OR FINDINGS

The result of palynofacies analysis shows that the diversity is moderate. Pollen and spores are dominant with a single dinoflagellate species.

The spores recorded are *Laevigatosporites* sp., *Verrucatosporites* sp.*, Polypodiaceoisporites* sp., and *Acrostichum aureum*. The pollen taxa recovered include: *Striatricolporites catatumbus,* Charred graminae cuticle*, Zonocostites ramonae, Tilia Americana, Brevicolporites guinetii, Sapotaceae, Psilatricolporites onitshaensis, Retibrevitricolporites obodoensis, Proxapertites* sp, *Stereisporites* sp., *Retitricolporites* sp.*, Praedapollis africanus, Peregrinipollis nigericus, Praedapollis flexibilis, Canthiumidites* sp., *Pachydermites diederixi, Zonocostites diederixi, Retitricolporites irregularis, Proxapertites cursus, Longapertites* sp. The algal cysts recovered is *Botryococcus braunii;* Diatum frustule was recovered in abundance; and the fungal cysts recovered is fungalspore.

The Palynomaceral types PM-1, PM-2, PM-3, PM-4 and Structureless Organic Matter (SOM) of Oyede (1991) were identified. The palynomacerals analysis yielded abundant records of palynomercerals 1 and 2, with low records of palynomacerals 3 and small common records of palynomacerals 4.

Palynomaceral 1 (PM-1) are easily degraded by physical abrasion or high-energy oxidizing environments. Palynomaceral 2 (PM-2) is less dense compared to PM2. Palynomaceral 3 (PM-3) have a cuticular origin and are generally degraded plant material. Palynomaceral 4 (PM-4) are very buoyant, resistant to degradation, and transported over long distances. Unlike PM-1, PM-2, and PM-3, the PM-4 generally indicates brackish water swamp and fluvial marine environment.

Palynofacies characterization

Abundant and poorly sorted; small to medium sized PM-1 and PM-2 with common small sized PM-4 in association with low records of PM-3 characterized the palynofacies assemblage.

***A. Interval*: 6160-8500 feet (1878 – 2591m)**

Ten (10) samples fall within this interval and are characterized by the dominant occurrence of small to medium sized PMI (Type I) and PM2 (Type II) with relatively common records of small lath tooth shaped PM4 (Type IV) palynofacies. Palynomacerals are predominantly black to dark brown in colour suggesting relatively mature to super mature conditions for possible hydrocarbon generation. The admixture suggests a predominantly brackish swamp environment of deposition.

***Interval*: 8500-14470 feet (2591-4410m).**

This section comprises five samples characterized by the increase in small to medium sized PM3 (Type III) in association with common to abundant PM1 (Type I), PM2 (Type II) and PM4 (Type IV) palynofacies. This assemblage suggests deposition of sediments in a predominantly brackish swamp environment of deposition. in a terrestrial (? open forest vegetation) to brackish water paleoenvironment. The palynomacerals are predominantly dark brown in colour suggesting relatively mature conditions for possible hydrocarbon generation.

Paleoenvironmental Interpretation

Based on the criteria, the environment of deposition has been inferred for the sediments encountered in the analysed intervals of TDA-1 well. The freshwater swamp to Mangrove environment has been inferred for the sediments encountered in the analysed interval.

The interval 6160 – 8500ft (1878 – 2591m) was delineated to have been deposited predominantly in a rainforest/brackish water swamp environment. The

interval is characterised by *Monocolpites* sp (Montane), *Brevicolporites guinetii*(Rainforest), *Sapotaceae* (Rainforest), *Laevigastosporites* sp (Freshwater), *Verrucatosporites* sp.(Freshwater), *Botryococcusbraunii* (Freshwater), Acrostichum aureum (Mangrove). There are high occurrences of freshwater swamp taxa (*Laevigastosporites* sp., *Verrucatosporites* sp., *Botryococcusbraunii*) followed by rainforest (*Brevicolporitesguinetii*, *Sapotaceae*) and little representation of mangrove and montane taxa.

The interval 8500 – 14470 ft (2591 – 4410m) was delineated to have sediment deposited in the coastal/freshwater swamp environment. The interval is characterized by increase in the occurrence of freshwater predominant palynomorphs like *Striatricolporites catatumbus , Verrucatosporites* sp., *Laevigastosporites* sp., and one rainforest palynomorphs (*Monocolpites* sp.)

The abundant record of poorly sorted Palynomaceral 1 and 2 indicate the terrestrial/coastal environments of deposition with more freshwater from moderate amounts of *Botryococcus braunii, Verrucatosporites* sp. and *Laevigastosporites* sp. recorded in the interval (Oyede 1991). The predominant paleoecological taxa is Freshwater which is 48.5%, followed by Mangrove which is 22.8% and Savannah which 11% while both Montane and Rainforest paleoecological taxa is less than 10%. The percentage shows predominantly that the paleoenvironment is of brackish coastal water swamp due to dominant of both freshwater (Coastal/Freshwater swamp) mangrove (brackish water swamp) paleoecological taxa.

CONCLUSION

The palynomorphs recovered from the analysis of the samples are used to denote different paleoecological environments like rainforest, montane, mangrove, freshwater swamp and savannah. The paleoecological taxa of predominant palynomorphs and the characteristics of the palynomacerals can also be a pointer to certain paleoenvironmental deposition. The predominant appearance of freshwater palynomorphs (*Botryococcus braunii*, *Striatricolporites catatumbus*, *Verrucatosporites* sp., *Laevigastosporites* sp.) followed by mangrove paleoecological taxa palynomorphs (*Acrostichum aureum, Zonocostites ramonae, Psilatricolporites*), the presence of poorly sorted PM 1 and PM 2 and few PM 4 determines the paleoenvironmental deposition which is Coastal brackish water environment.

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