

**THE PALYNOSTRATIGRAPHY, PALYNOFACIES AND THERMAL
MATURITY OF X AND Y WELLS, NIGER DELTA. NIGERIA.**

BY

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CERTIFICATION

This research by Mr. OGUNLEYE Segun Oyewole (SCP 11/12/H/3153) has been read and approved as meeting part of the requirement for the award of M.Sc. degree in Applied Geology (Sedimentary/-Petroleum Geology), of the Department of Geology, Obafemi Awolowo University, Ile Ife, Nigeria.

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DEDICATION

This thesis is dedicated to the Almighty God, the Alpha and Omega.

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ABSTRACT

A palynostratigraphic investigation was carried out on ditch cuttings from Wells X and Y, located within the shallow offshore, Niger Delta. This was with a view to establishing the age as well as attempting the zonation of sections and determining the paleoenvironment and maturity of the sediments penetrated.

Sixty (60) samples composited from each of Well X (interval 2105 – 3305 m) and Well Y (interval 1000 – 2220 m) were employed for the study. The samples were prepared for palynological and palynofacies studies using standard extraction technique involving Hydrochloric acid (HCl) and Hydrofluoric acid (HF) treatment. The organic extracts were wet-sieved using 5 μ m and 10 μ m polypropylene mesh sieve. Recovered palynomorphs and particulate organic matter were mounted on the glass slide and analysed using a transmitted light LeitzOrtholux II biological microscope.

The lithological description of the analysed sections of both wells revealed a clastic sequence composed of alternating sand and shale sequences with accessory shell fragments, carbonaceous detritus, ferruginous materials, mica flakes, pyrites and glauconite. Moderately abundant and diverse pollen and spores, fresh water algae and dinoflagellates were recovered from the studied section of both wells. One floral zone (P800) and three (3) subzones (P860, P850 – P840 and P830) were delineated in both wells based on the recognition of the base continuous occurrence of *Nymphaeaepollis clarus* and the quantitative base occurrence of *Cyperaceaepollis* sp. These bioevents as well as the associated palynomorph assemblage indicated a Late Miocene age for the analysed section of both wells. The organic facies analysis

revealed three palynofacies types pointing to three possible paleoenvironments which were the proximal, marginal and distal shelf environment laid down under anoxic, suboxic and oxic condition. On this basis a coastal to marginal marine environment was proposed for the sequence penetrated by the two wells. The thermal maturity deduced from the optical examination of the organic matter revealed that Well X organic matters were immature while those of Well Y were immature to slightly mature (TAI between - 2 and + 2 and SCI between 3 and 5). A strong correlation occurred between the two wells studied based on their microfloral and palynofacies contents as well as the thermal maturity.

The study concluded that palynoflora and palynofacies analysis played an important role in the hydrocarbon exploration technique, especially in the determination of age, paleoenvironment and thermal maturity of the penetrated strata.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The Niger Delta is a major hydrocarbon producing basin in Nigeria where intensive exploration and exploitation activities have been on since early 1960's owing to the discovery of commercial oil in Oloibiri-1well in 1956 (Reijers *et al.*, 1996). Since then, exploration and production activities have moved from the near shore into the shallow-water offshore and presently into the deep-water. This region has been described as the seat of oil and gas production in the country and placing the country as one of the top ten leading oil producing nations in the world (Egberongbe *et al.*, 2006).

The last two decades witnessed a tremendous increase in the demand for petroleum products both for export and domestic consumption and for industrial purposes. This increase in demand on a worldwide basis has been the major driving force behind the high cost of crude oil. The present demand for petroleum coupled with the recent political unrest in some of the major petroleum producing areas of the world such as Iraq has contributed to the high cost of petroleum products. Though the outset of global recession which crippled the world's economy since mid 2008 resulted in a significant crash in price, the cost of the product still remains a major factor in the world economy (Bankole, 2010).

With demand not showing any sign of reduction, the search for petroleum in new frontiers and the reassessment of the ageing fields is the preoccupation for petroleum geologists and engineers around the world. Improvements in seismic data acquisition (including 3D seismic

data) and processing over the last decades have led to the discovery of several giant oil reservoirs in many petroleum provinces around the world. The huge cost of seismic data acquisition and personnel hiring for interpretation is a major factor. Besides, the science of petroleum exploration and production is multi-tool based, with each tool complementing the other.

Among these important tools is biostratigraphy which is a branch of stratigraphy that focuses on correlating and assigning relative ages to rock strata by using the fossil assemblages contained within them. Biostratigraphic studies in the oil industry relied on the microfossils. The biostratigraphic value of these microfossils lies in their abundance, short stratigraphic ranges, microscopic size and their easy preservation in sediments. The main groups of microfossils used in oil exploration include foraminifera, calcareous nannoplankton and palynomorphs. Calcareous nannoplankton and most foraminifera are marine organisms and make use of calcium carbonate for their test and are therefore found in a marine environment or an environment with marine influence. Palynomorphs on the other hand, have both the terrestrially - derived and marine components. They are therefore common and abundant in both continental and marine deposits. They can be treated statistically to reveal the degree of correlation in onshore and offshore sediments.

Palynology is the study of organic walled microfossils of 5 to 500 micrometers in size while palynofacies is an aspect of palynology that studies floral component of particulate organic matter in a sediment sample recovered by palynological processing techniques (Combaz, 1964). Aside, the general usefulness of microfossils, palynomorphs and palynofacies colouration provides information on the thermal maturity and type of organic matter in the rock, which is of high importance in assessing hydrocarbon potentials.

Due to the aforementioned features of palynomorphs and palynofacies, they have found their usefulness in petroleum exploration essentially as a stratigraphic tool in depositional settings such as continental, coastal, marginal marine and fully marine environments. When integrated with other tools including wireline logs and seismic stratigraphy, they are useful mainly for chronostratigraphic correlation, palaeoenvironmental studies, and evaluation of potential source, reservoir and sealing rocks (Copestake, 1993).

In other basins in the world palynostratigraphy, palynofacies and hydrocarbon predictability of source rock using palynomorphs and its colouration have moderately been put to use. Unfortunately, up till now, few works have been published on the applied palynological studies in the Niger Delta, especially in the aspect of stratigraphic values, thermal maturity and palynofacies.

1.2 PREVIOUS WORKS

One of the earliest geological studies on Tertiary rocks of the Southern Nigeria was done by Parkinson (1903). He studied four provinces: the Central province, the Asaba province, the Calabar province and the Ijebu province. The rocks found were divided into four main units: Alluvium of river and lower terrace (youngest), Benin sands, Ijebu beds and Lignite series. Since then, numerous research works have been conducted on the evolution, megatectonic settings and tectonics of the Niger Delta. These includes the works Reyment (1965), Adegoke (1969), Murat (1972), Merki (1972), Weber and Daukoru (1975), Evamy *et al.* (1978), Ogbe (1982), Ejedawe *et al.* (1984) and Knox and Omatsola (1989).

Reyment (1965) undertook the first detailed studies of the stratigraphy of the Southern Nigeria Sedimentary Basin and proposed many lithostratigraphic units in the region. This

include: Imo Formation, Ameki Formation and Ogwashi – Asaba Formation and Benin Formation.

Adegoke (1969) studied the Eocene stratigraphy of Southern Nigeria and indicated that the sedimentation in the Cretaceous and Tertiary periods were partly cut off from the Niger Delta to the west by a ridge of crystalline basement rocks named the Okitipupa ridge.

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