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Research Article

ICHNOFACIES ANALYTICAL STUDIES USING WELL IN THE NIGER DELTA AS A CASE STUDY

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ABSTRACT

The Research study result reveals that the samples are dominated by the gruziana and Skolithos ichnofacies association. Within the sandstone facies, the finer grains are observed to have higher porosity values due to the presence of micro pore spaces while the coarser grained cross bedded fades are observed to have the highest and best permeability values. This indicates an inverse relationship existing between the porosity and permeability data of the well .It was also revealed that the more bioturbated facies exhibited higher permeability and porosity values compared to their less bioturbated counterparts. Meaning that bioturbation alter a positive effect on the reservoir quality of the well sample and that the entire core section were influenced by both textural and biogenic factors.

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INTRODUCTION

Geologists have acquired extensive experiences studying trace fossils in outcrops with fewer ones having such experience with cores while almost none has been able to comprehensively use ichnofossils in cores to assess the quality of reservoir rocks.

It is intended that this study involving approximately 32ft of conventional cores recovered from the Miocene interval of the parallic Aghada Formation, located in the Southeastern offshore Niger delta would expose intending researchers to the natural features and benefits usually enjoyed when working with cores.

LOCATION OF STUDY AREA: The study area is located in the Southeastern part of the offshore Niger Delta sedimentary basin of Nigeria between latitudes 4° and 4°30'N and longitudes 8° and B°30'E. It is bounded in the east by Cameroon, in the south by Gulf of Guinea and on the north by the Calabar flank (fig I).

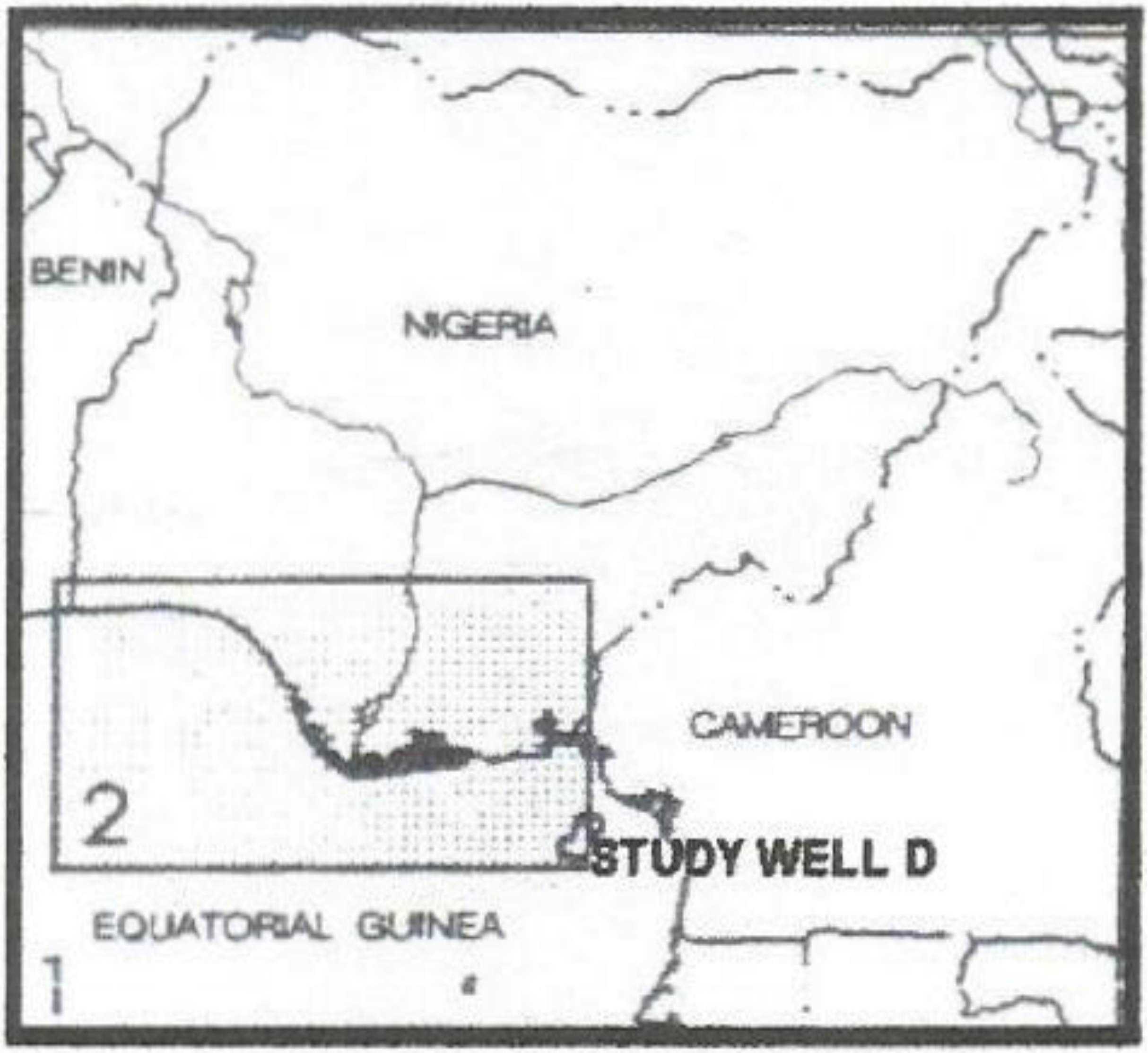

Figure 1: Location map of the study Area

AIMS AND OBJECTIVES:

The objectives of this research work are:

- Carrying out detailed lithofacies and ichnofacies identification of the cure samples
- Studying the biogenic structures and determining their distribution within the cored interval.

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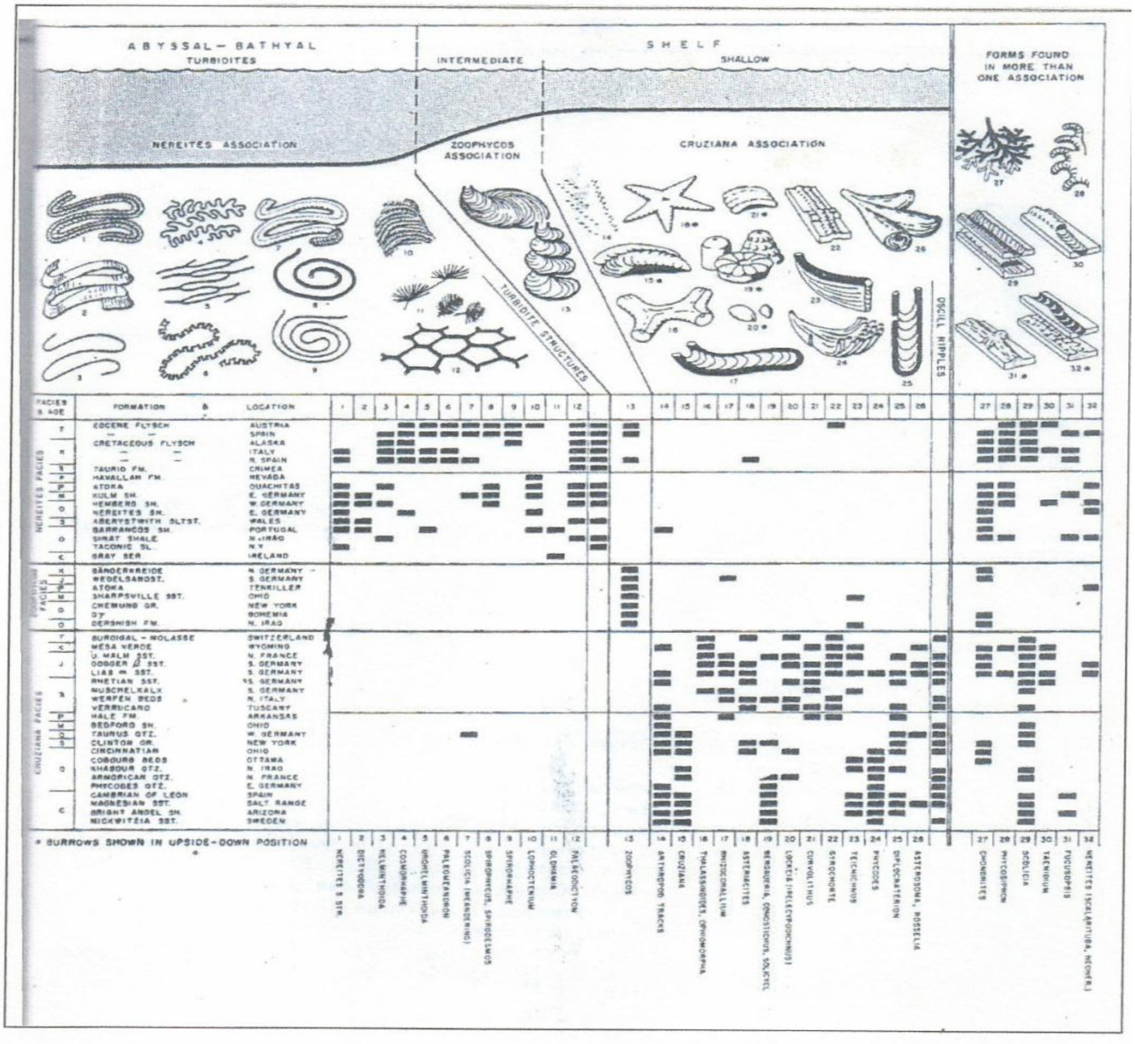

Figure 2: Common associations of trace fossils and their environment significance.

MATERIALS & METHODS OF STUDY

MATERIALS USED IN THE STUDY WORK:

The materials and datasets employed in this study /research work includes as listed below while the analysis were done in core lab.

- Petrophysical data of the proposed study well
- Location map of the study area.
- The study well's core samples
- The core images of the study well.
- The photnmicrograph/ thin section reports of the specific zones of interest.

METHOD OF STUDY:

This study actually started when the cores arrived at the core laboratory and involved four basic stages and other sub stages which includes as follows;

- An initial core handing procedure on arrival at the laboratory
- Gore preparation
- Core analysis
- Retrieved data study. interpretation and final report presentation.

THE INITIAL HANDLING UF THE CURE SAMPLES:

This process involved a careful inspection of the cores to ensure no damages had been done to them during transit. Then laying out of the cores according to their respective depths, in guttering mounted on trolley for easy movement within the laboratory and then photographed under normal and ultra light using high resolution digital camera and finally exposed to core description.

CORE PREPARATIONS:

This process can be divided into three steps which include:The core that been frozen so as to keep them consolidated, were slabbed into two sections (for the sake of increasing its surface area) with thicknesses of 1/3 and 2/3 of the original diameter of the whole core after the optimum slabbing plane was determined through CT scanning with the aid of an electric powered saw. Plugs were then drilled from the 2/3 diameter section using liquid nitrogen as a coolant locations, at intervals of say one foot.

RESULT OBSERVATIONS AND INTERPRETATIONS:

It is observed that the cores have a separating gap dividing them into cores one and two as indicated in the petrophysical plug data

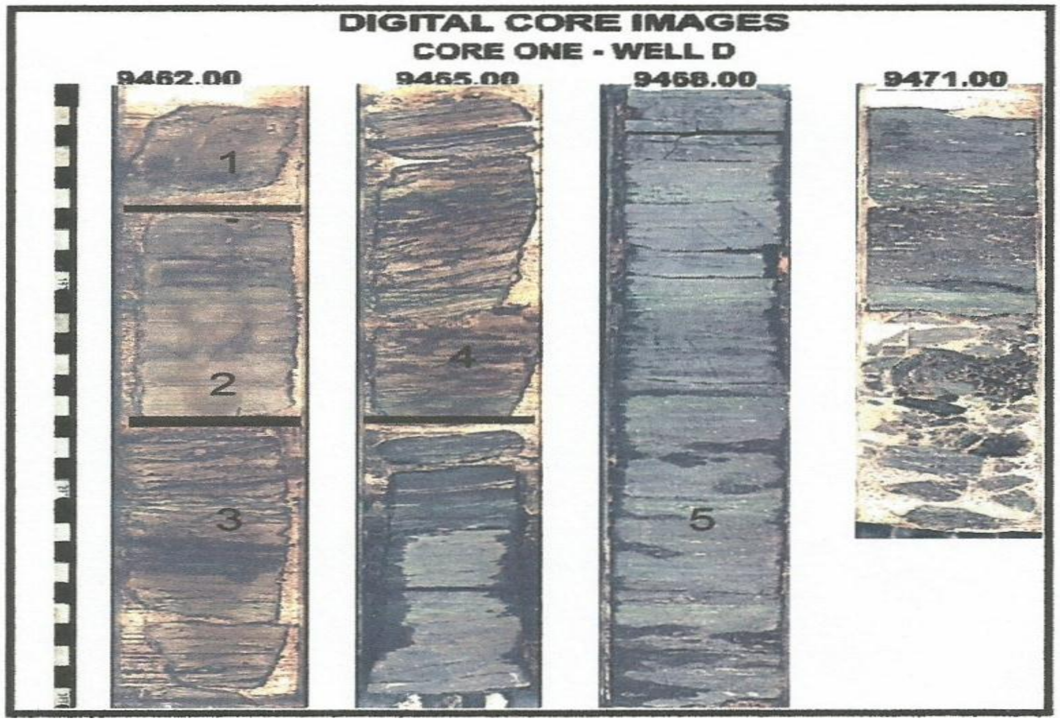

Plate 1: Core one digital image

Plate 1 reveals the major lithofacie succession of core one - an upper cleaner sandstone unit with moderate bioturbation-middle muddy sandstones of low -strong bioturbation with preserved wavy beds overlaying a hummocky bed zone and a lower massive silty shale unit with moderate to strong bioturbation.

It also shows a well defined fining upwards sequence of core two with transition from the -lower coarser, cross bedded sandstones of the estuarine channel through the -middle fore shore-lower shore face deposits to — an upper almost churned muddy sands of the transitions-well bioturbated silty shelf mud

LITHOFACIE CHARACTERISTICS AND INTERPRETATIONS:

Seven main lithofacies were identified overall the cured sequence. These facies were described based on the lithologies. grain size, primary and biogenic structures as observed. This was done based on the classification and nomenclature scheme of Reijers et al, 1993 which follows the terminology proposed in the regional Niger delta study by Core laboratories in 1993.

The lithofacie classification shows that the cored succession has dominance of bioturbated lithofacies (with bioturbated sandstone, bioturbated muddy sandstones and bioturbated sandy mudstone) over unbioturbated ones. Also observed were dominance of sand rich facies over locally significant mud rich facies with a decrease in bioturbation as the sequence progrades from its lower muddy facie through cleaner sandy facies in core one while bioturbation increases from the lower cleaner and cross bedded sandstone facies to its upper muddy facies.

SANDSTONE LITHOFACIES:

This class of facie association includes the cross bedded and laminated sandstone facies.

CROSS BEDDED SANDSTONE LITHOFACIES:

These are dark brown in color and heavily oil stained which makes it difficult to see structures in them properly except when enhanced for brightness and contrast. Examples include those that have been disrupted by bioturbation and some without any evidence of bioturbations.

These facie is mainly of coarser grains with fewer finer grains. They are poorly to locally unconsolidated and generally moderately sorted with the coarser grains at the base and the finer grains towards the top of core two. The coarse grained sections correspond to the estuarine channel deposits while the finer sections correspond to the fore shore deposits.

LAMINATED SANDSTONE LITHOFACIES:

These are distinguished by their well developed parallel/sub parallel laminations. The locally laminated beds tend to grade vertically into units or beds with hurnmocky cross stratification (between depths D4BS and A464 feet's. They show minor to no bioturbation. Trace fossils include Skolithos and bivalve escape traces.

ICHNOFACIES AND INTERPRETATION:

The ichnofacies identified overall the bioturbated cared succession comprise mainly the Cruziana assemblages. In the muddy facies. there was dominance of the Chondrites with local Teichichnus, Planolite and Xcnyenia. While the sandstone facies showed presence of Bivalva escape traces, Arenicolite, Ophiorniorpha. Asterosoma, Rhizocorallium and Skolithos associations suggesting deposits and traces of the range of shore face and channel environs. The presence of Asterosoma in both muddy and sandy facies only indicated that is found wide range of environment.

POROSITY AND VARIATION PATTERN:

The porosity data for the plug samples from well 0 show mainly very good to excellent values ranging from 12-32.3% with an average value of 28.9%. From the graphical plots it is observed that most samples fall within the range of 20-32.8% while only a few fell below 20%. The lower values correspond to the muddy facies.

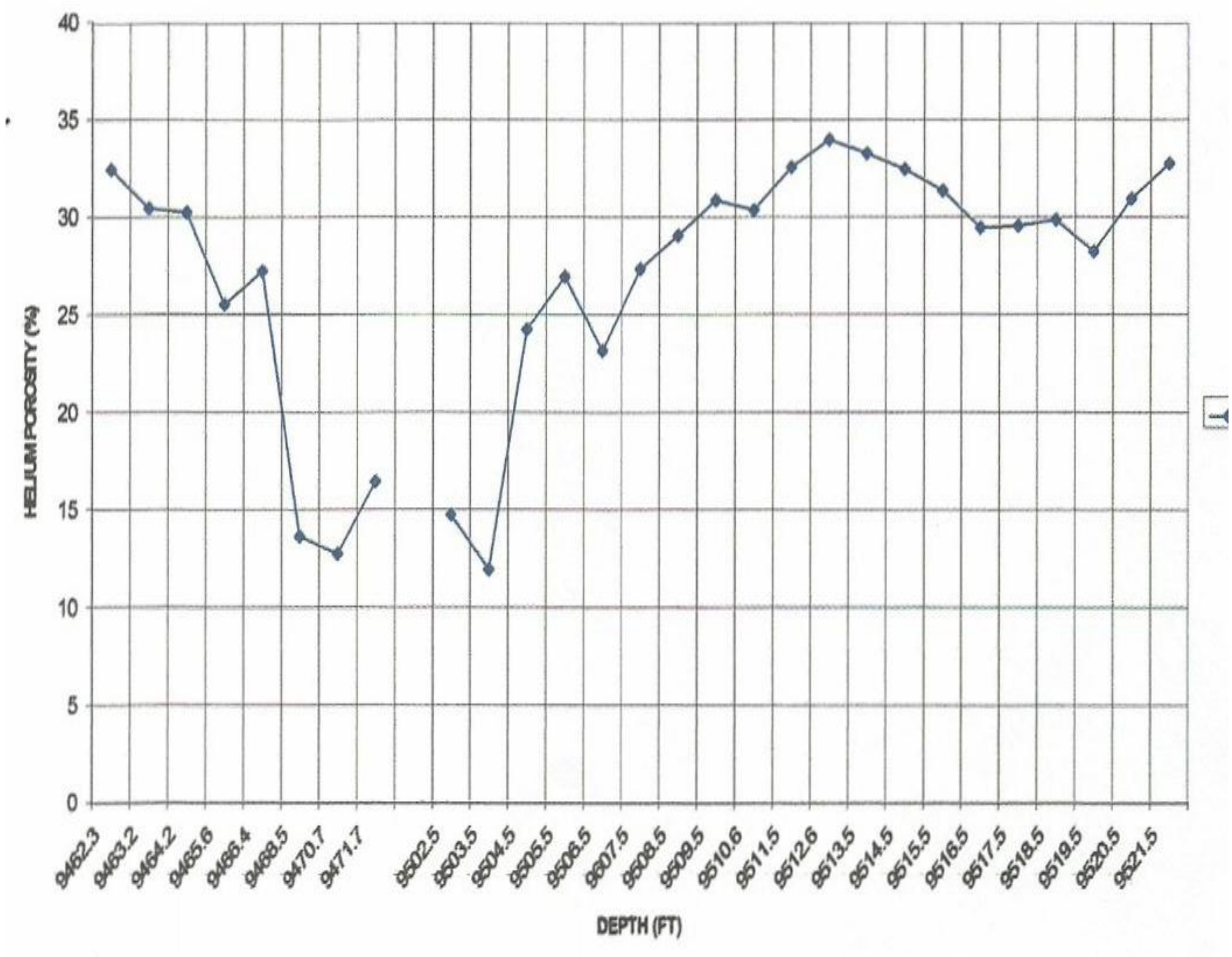

Figure 3: Porosity vs Depth Plots of Well

The graphical pattern shows a direct relationship between lithology. grain size and porosity because the sandstone facies have higher values as against the finer muddy facies. Generally the more bioturbated facies of all the different lithologies showed slightly higher values compared to their rarely-lowly bioturbated counterparts.

LITHOFACIES, ICHNOFACIES AND DEPOSITIONAL ENVIRONMENTS AGAINST POROSITY AND PERMEABILITY:

In integrating porosity and permeability with lithofacies, ichnofacies and depositional environments, it is revealed that there was a significant depositional control on reservoir quality. This is because the highest reservoir quality is seen to be associated with the cleaner sandstone facies within the cross bedded, bioturbated, wavy and hummocky bedded sandstones which is found within the shore face and estuarine depositional environments. While the muddy facies shows reduced reservoir quality due to the lower porosity and permeability values attributed to the presence of clay matrix within their pore spaces and its associated compaction and cementation effect.

Considering the ichnofacies we have that the sandstone facies which represents middle to higher energy deposits typically have little or no bioturbation with less intensity while the finer grained sediments of the lower shore face and lagoon environments have more bioturbation with greater intensity. These deposits with more/intense bioturbation have higher values compared to their lowly to less intensely bioturbated fades. For instance taking a close look at the petrophysical plug data and comparing plug 1 and 2. we have that the plug 1 with more bioturbation has higher porosity and permeability values than plug 2. While also comparing plug 7 and B. we have that the intensely bioturbated plug H sample have higher values and better reservoir quality than plug 7.

THIN SECTION ANALYSIS REPORT:

Thin sections analyses were carried out on plugs 1 from core one and plug 23 from core two. There, both revealed dominance of quartz and feldspar as their framework minerals with detrital clays as their matrix except for plug I which has got some of its detrital clays replaced by siderite clay . Below are the photomicrographs and analysis report for the respective plugs.

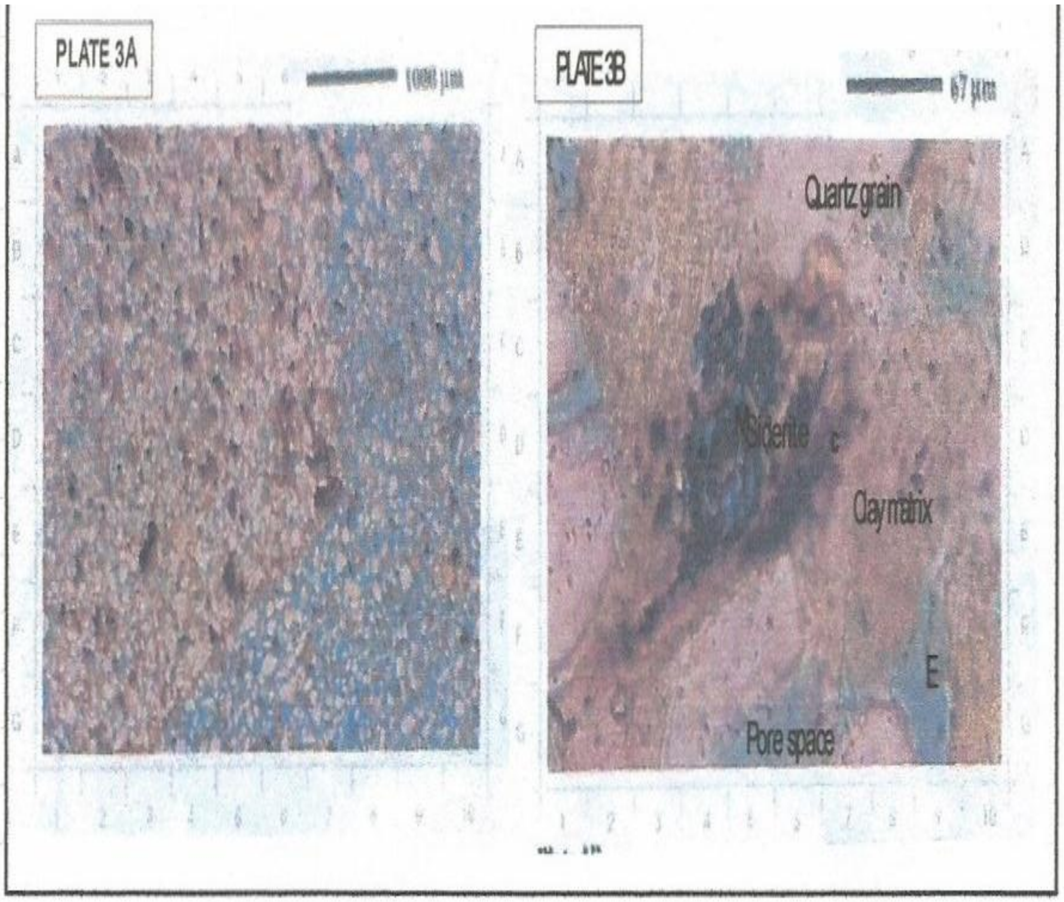

Plate 2: Thin section photomicrographs of plug 1 well D

Plate 2.0 is the photomicrograph of a thin section taken from plug I of depth 9482.30 ft. It has —73% of quartz with-14% of feldspar as framework minerals and-5% detrital clay (burro-fills) as matrix though it seems to have been replaced by siderite clays. Porosity is excellent probably due to the presence of micro pore-spaces while permeability remains good despite the fine grain sizes and siderite patches which may act as minor obstruction.

DISCUSSION OF RESULT

Well D core samples covers approximately 32ft with a gap separating them into core one and core two. Due to their textural trend, petrophysical and biogenic characteristics, a regressive sequence is inferred for core one while a transgressive system is inferred for core two.

The study result reveals that the samples are dominated by the gruziana and Skolithos ichnofacies association. Within the sandstone facies, the finer grains are observed to have higher porosity values due to the presence of micro pore spaces while the coarser grained cross bedded fades are observed to have the highest and best permeability values. This indicates an inverse relationship existing between the porosity and permeability data of well D.

It was also revealed that the more bioturbated facies exhibited higher permeability and porosity values compared to their less bioturbated counterparts. Meaning that bioturbation alter a positive effect on the reservoir quality on well D sample and that the entire core section were influenced by both textural and biogenic factors.

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