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## **FACIES CHARACTERISATION OF WELL A, FIELD Y, NORTH-EASTERN NIGER DELTA**

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### **ABSTRACT**

The facies characteristics of well A in the field Y were studied using wireline log signatures and data derived from them and cores. The lithostratigraphy, facies types which helped in the interpretation of the depositional environments and their characteristics were read from the wireline logs. The logs were environmentally corrected and normalized. The core data analysis helped in confirming the properties of the various facies types and the effective establishment of the facies boundaries.

**Keywords:** Facies, wireline logs, characteristics, depositional environment.

### **INTRODUCTION**

Adequate knowledge and understanding of facies types in sedimentary basin analysis will help in hydrocarbon exploration and exploitation. This study examines some of the basic facies types in a sedimentary basin. Their appearance or signature in wireline logs, their characteristics in terms of porosity and permeability which are derived from both the wireline log data and core data.

### **Location**

The Y field is the field under study and is located within concession OML58 block in the north-eastern Niger Delta (Fig 1). Geographically, the field lies between longitude 6° 30' and 7°00'E and Latitude 5°00' and 5°30'N. Well A is located within field Y as indicated in Fig 1. The well was drilled by Elf Petroleum Nigeria limited. Initially, the well was producing at maximum capacity, but the productivity was reduced after sometime. This necessitated this research.

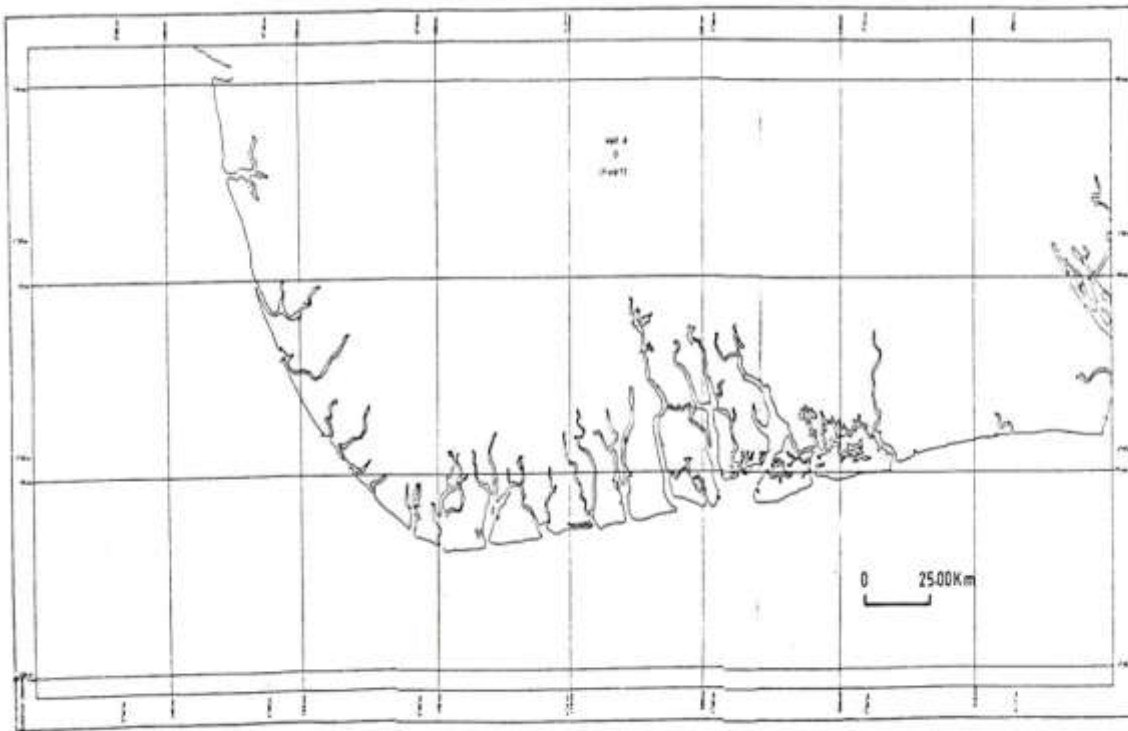


Fig 1: The Geographical Location of the study well relative to the coastline of Niger Delta (Elf,1997)

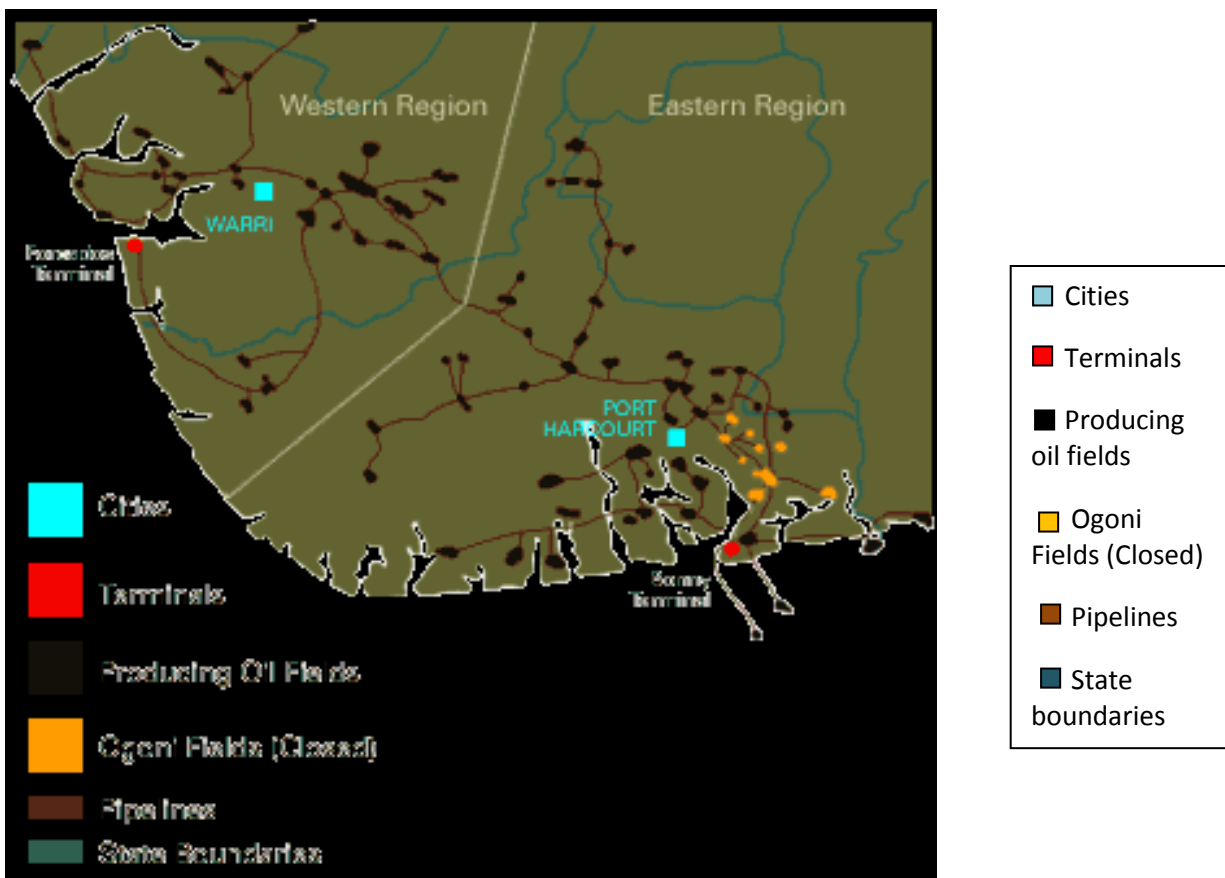


Fig 2: A Map of Niger Delta showing oil fields and pipelines (Source; Urhobo Historical Society,2008)

**MATERIALS & METHODS**

The materials that were available for this work include: wire line logs and conventional cores. The wire line logs include gamma ray (GR), neutron logs, sonic, density, Self potential (Sp), resistivity I (LLD, LLS & MSFL) and calliper logs. Cores were provided from one meter intervals of 3236-3237, 3245-3246 and 3253-3254. The base map showing location of the oil field Y, and the position of well A was drawn to scale of 1:25.00. These materials were provided by Elf Petroleum Nigeria Limited with the permission of the Department of Petroleum Resources (DPR), Lagos.

**Interpretation of Facies and Depositional Environment**

The facies and depositional environment of the sequence cross-cut by well A are discussed in the light of the knowledge of the depositional facies so recognised from gamma ray logs. The gamma ray log is best used for facies delineation because their curves give greater variety of shapes, showing greater detail and have more characteristics than other logs (Schlumberger, 1989). The gamma ray log is complemented by the Sp-log as well as resistivity logs.

Studies of modern depositional environment show that they deposit sediment with characteristic vertical profile of grain size. Gamma and Sp-logs often show 3-basic motifs, bell, funnel, boxcar or blocky motifs.(Fig 3). No log motif is specific to a particular sedimentary environment but by combining an analysis of log profiles with the composition of well samples, and interpretation of the environment can be attempted as well as prediction of the reservoir geometry and trend (Selley, 1998).

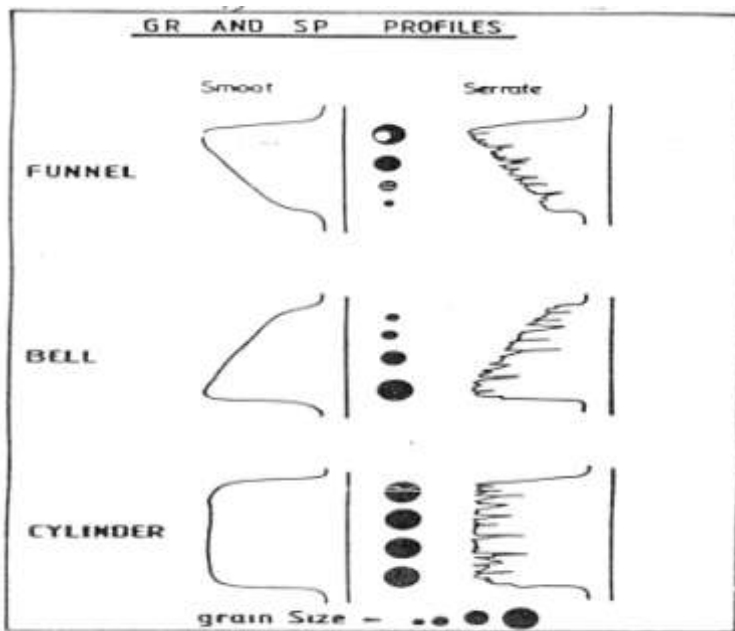


Fig 10: Gamma Ray and S-P Log Profiles Showing the Basic Shapes of Facies (After Shell 1982)

**Fig 3: Gamma Ray and SP Log Profiles Showing the Basic Shapes of Facies (After Shell, 1982)**

Moore (1949) described facies as "any areally restricted part of a designated stratigraphical unit which exhibit characters significantly different from those of other part of the unit". Moore's definition summarized every other meaning of facies, (Selley,1998).

The Well Evaluation Conference, WEC (1985) show that the funnel shaped gamma ray curve indicate an upward coarsening barrier bar sand, the cylindrical shaped gamma ray curve indicate a massive, featureless, non-graded sand normally associated with channel fills and the bell shaped gamma ray signature indicates an upward finning fluvial deposited sand (Fig 4). This in combination with the Sp log responses enabled the delineation of the different facies types (fig 5).

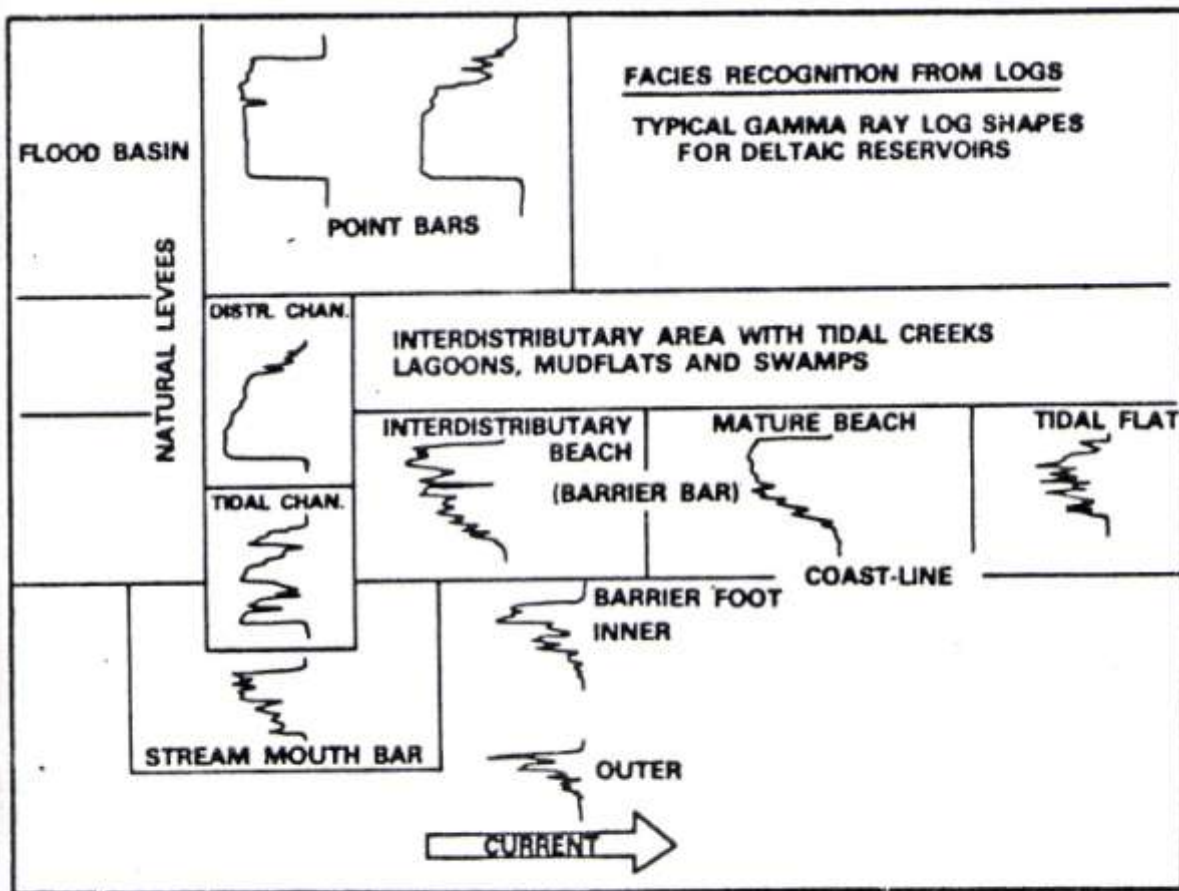


Fig. 1 1. Electrofacies classification for deltaic environments from Gamma Ray logs. (After WEC, 1985)

Fig 3: Electrofacies classification for deltaic environments from Gamma Ray Logs (After WEC, 1985)

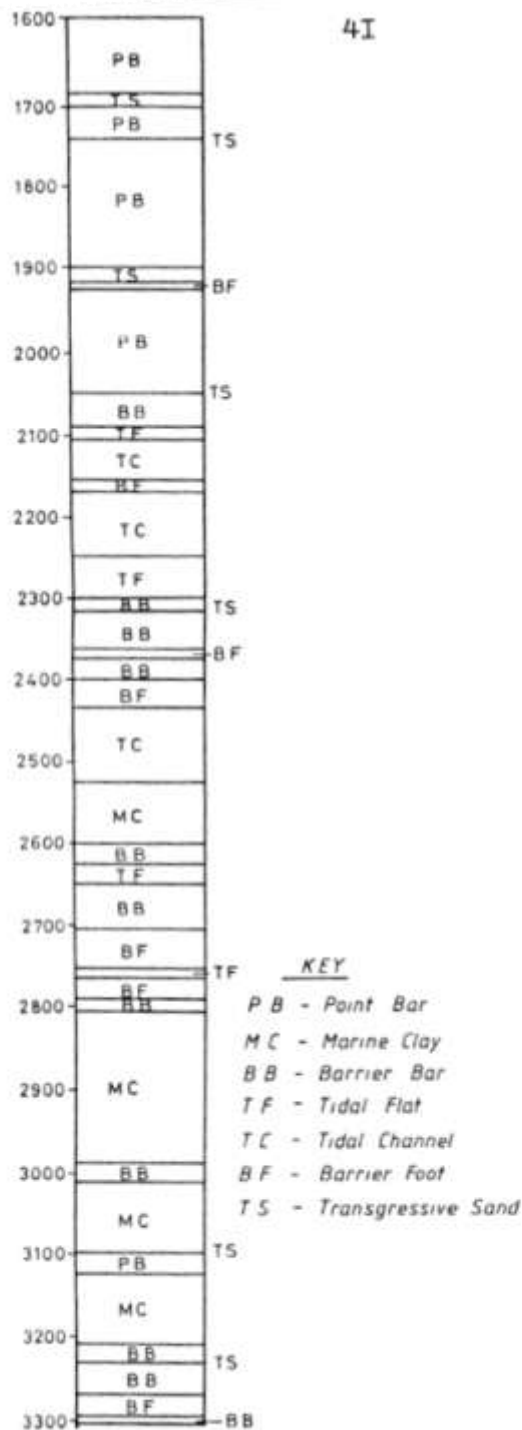


Fig 9 The Different Types of Facies Interpreted from Gamma Ray Logs of Well - A

**Fig 5. The Different Types of Facies Interpreted from Gamma Ray Logs of Well-A**

The gamma ray log signatures complimented with those of Sp-log as well as resistivity readings were also used to establish the lithology. The observed sequence in well A, consists of sand bodies with shale breaks on the upper part and intercalation of sand and shale bodies suggesting that logging started from the transition zone between the Benin

and the Agbada Formation (figs.6). This stratigraphic sequence is typical of Agbada Formation in the Niger Delta, which is the productive zone and has been the target of all drillings in the Niger Delta.

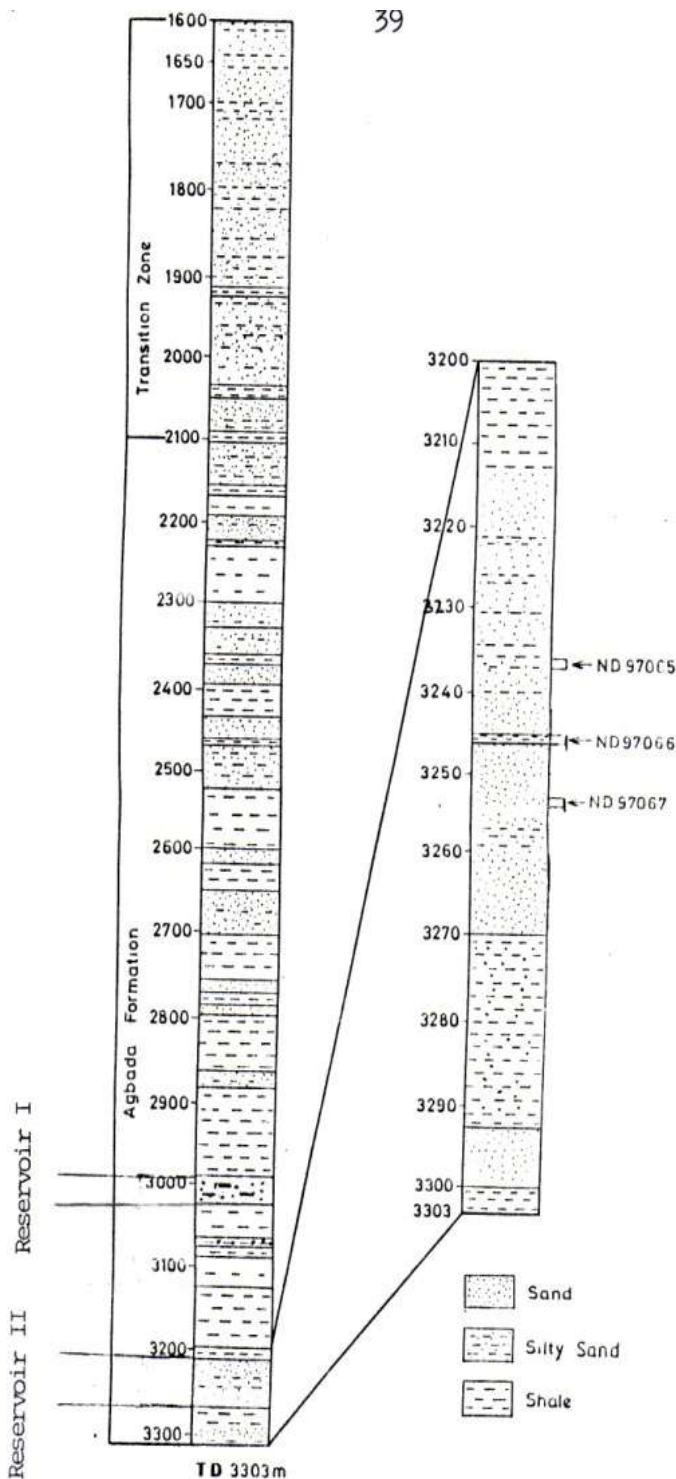


Fig 8 Depth Profile of the Well - A. Showing the Sampled Intervals

Fig 6. Depth Profile of Well-A. Showing the sampled intervals

Based on the wireline log signatures 7 basic facies types were delineated; they are point bar, barrier bar, barrier foot, marine clay, Tidal channel, Tidal flat and Transgressive sand facies (Fig 6). These facies types are deposited in different depositional environment. Depositional environments are characterised by the facies types they contain. Thus, facies could be defined as a geographical unit with a particular set of physical, chemical and biological variables (Shell, 1982).

Depositional systems are divided into 3 major types which are; Deltaic-fluvial environment, Marine environment and Deep sea environment. The seven facies types found in this environment cut across these 3 major depositional systems. Point bar, Tidal channel and Tidal flats are found in Deltaic fluvial environment. Transgressive sand facies which are found in the Transgressive marine shelf are part of the marine environment. While barrier bar, barrier foot, and marine clay facies are found in the deep sea environments.

### **Characteristics of the Facies**

In well A, two commercially viable reservoir horizons were selected for study. This was judged from the wireline logs such as gamma ray, resistivity and calliper logs which indicated invaded zones and the length of these zones extends from 2988m-3025m for reservoir I and 3212.55m-5270m for reservoir II (Fig 6).

The Fluvial channel which is a subdivision of the Deltaic-Fluvial environment commonly consists of well sorted sands and thus obvious potential reservoirs for hydrocarbon. They result from meandering streams that create Point bar facies.

For effective characterisation of the marine and deep sea environment facies depositional facies, the work was concentrated on two horizons where sidewall cores of 1 meter which is the standard were available. These are horizons I and II corresponding to depth intervals of 3236-3237 (ND95065) and 3253-3254 (ND95067) respectively (Fig 6). Well log responses of reservoir II are depicted in Fig 7, in which we have Marine clay (MC), Barrier bar (BB), Transgressive sand (TS), and Barrier foot (BF) facies.

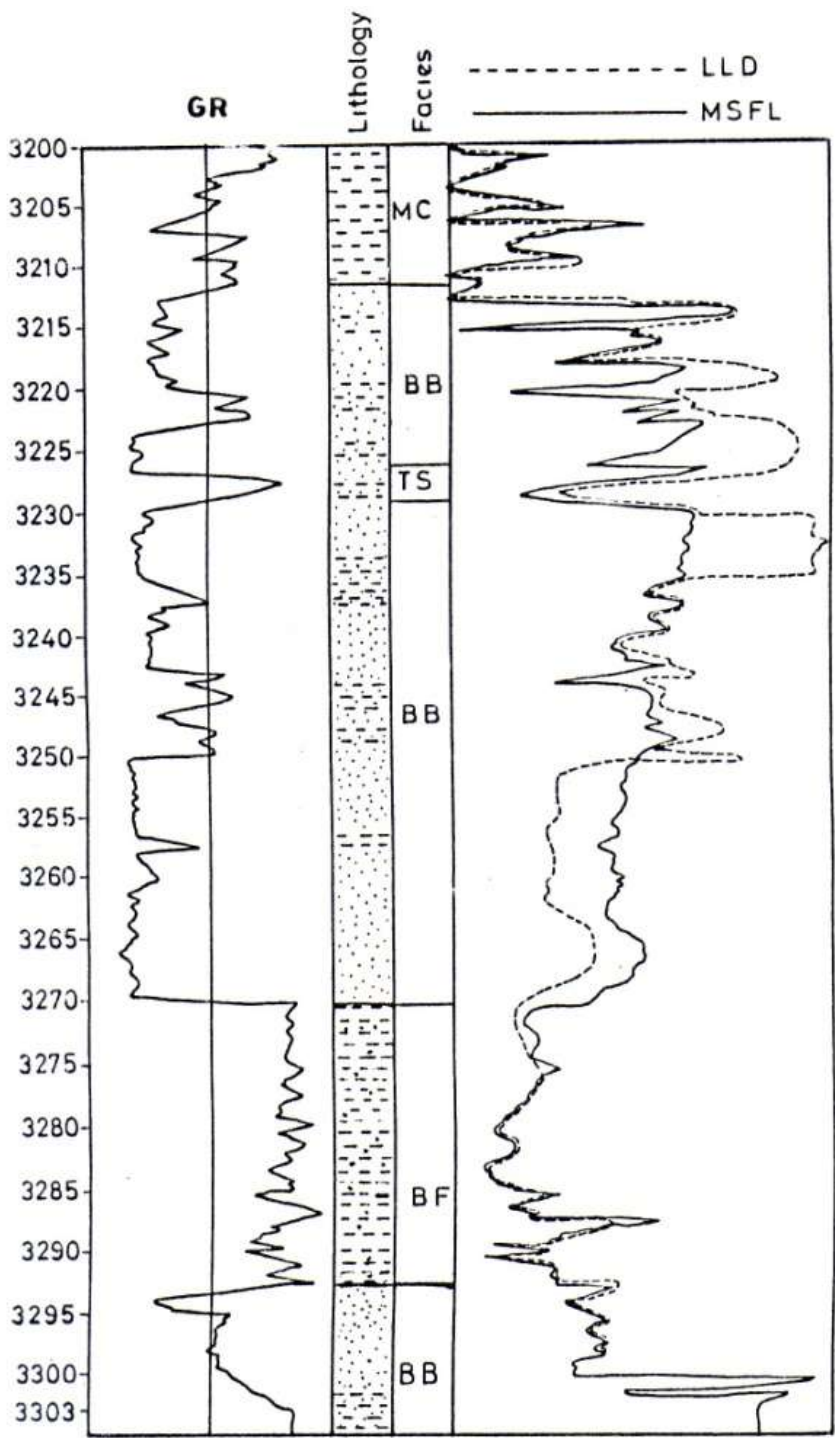


Fig.13: Log Responses of Well - A at Depth Interval of 3200 - 3303m, Showing Lithology and Facies .

**Fig 7: Log Responses of Well-A at Depth Interval of 3200-3303m, Showing Lithology and Facies Types**

Marine clays are usually found in the Basin plain unit of the Deep Sea Environment. They are usually silty and sandy indicating the quiet nature of this environment. Marine clay facies are of great importance with respect to hydrocarbon accumulation because they form the seal over the top of reservoirs as in fig 5.



Barrier bars are characteristics of the Inner Fan Channel environment which is also a subunit of the Deep Sea Environment. This form the sedimentary offlap cycle in the Niger Delta complex. They are characterised by upward coarsening sequence which is an indication of increasing grain size upward (Fig 7). The environment is formed by processes such as long shore currents and wave action. Deposits in the Inner Fan Environment are coarse and clean enough to be regarded as potential reservoir beds (Coleman & Prior,1980).

The Transgressive marine shelf environment subunit which is a part of the Deltaic-Fluvial environment is characterised by Transgressive sand facies and is inferred by the high gamma ray radiation emitted due to high percentage of potassium rich glauconite (Schlumberger,1989). The sands in this type of environment are derived from reworking and winnowing of eroded beds.

The Basin floor fan system as recognised in the well is a relatively small, sand rich submarine fan depositional system at or near the base of a slope. On an irregular continental margin, it is restricted to the vicinity of intraslope basins or to the mouths of submarine canyons. The sand-rich sediment is eroded from non-marine, shelf-edge deposit during the early phase of relative sea-level fall (Hallam,1981).

The clean well sorted nature of the Barrier bars is evidenced in the good porosity values from both the wireline logs and core data as depicted by the porosity Vs depth cross-plots for both horizons

GOCON (1988) states that a porosity of one percent is equivalent to a total volume of 77.58 barrels of void space per acre foot of bulk volume. They also indicate that the minimum porosity for a hydrocarbon bearing rock to be of commercial and economic importance is 10-20%. The average porosities from both the wireline logs and core data for the barrier bar within the depth interval of 3236m-3237m and 3253m-3254m is 20.5% and 23.7% respectively while the average porosities for the two horizons from the wireline logs data is 24.7% and 23.4% which is within a barrier bar facies confirming that barrier bars are very important to hydrocarbon exploration and the recognition of this facies type will enhance the success of petroleum exploration efforts.

**Evaluation Parameters from core analysis (Table 1)**

ND97065

		Permeability					
Nos	Depth	Horizontal md	Vertical md	Total k md	Porosity Helium %	Sw	Fluid Indicated
1	3236	334	37.9	371.9	17.4	0.27	Hc
2	3236.25	2020	2050	4070	22.3	0.3	Hc
3	336.5	2550	3160	5710	21.3	0.36	Hc
4	3237	8730	3960	12690	21.2	0.35	Hc
Average		3408.5	2301.975	5710.475	20.55	0.32	

ND97067

		Permeability					
Nos	Depth	Horizontal md	Vertical md	Total k md	Porosity Helium %	Sw	Fluid Indicated
5	3253	4950	3780	87309	25	0.66	H <sub>2</sub> O
6	3253.25	5750	5500	11260	23.7	0.5	Hc=H <sub>2</sub> O
7	3253.5	5000	4110	9110	22.9	0.63	H <sub>2</sub> O
8	3253.75	6510	9210	15720	24.5	0.25	Hc
9	3254	4580	9160	13740	22.5	0.19	Hc
Average		5358	6352	27427.8	23.72	0.446	

**Table 2.1;Evaluation Parameters from Wireline Logs (corresponding to ND97350 & ND97065 respectively)**

Depth	Ø N	ØN correct ed	ØD	ØN -D	F	Swi rr	k	Rt	Rw a	S w	Fluid Indicat ed	Sp- Log valu es
3236	21	24	23.97	23.99	13.3	8.2	2388.1	45	3.45	0.27	Hc	-1
3236.25	22	25	22.2	23.61	13.8	8.3	2168.7	40	2.96	0.31	Hc	-1
3236..50	23	26	24	25.03	12.2	7.8	3164.4	55	4.57	0.36	Hc	-1
3236.75	22	25	26.3	25.6	11.6	7.6	3699.75	80	6.99	0.34	Hc	-1
3237	21	24	26.9	25.44	11.6	7.6	3237	100	8.53	0.35	Hc	-1
<b>Average</b>				24.7			2931.6					

Depth	Ø N	ØN correct ed	ØD	ØN -D	F	Swi rr	k	R t	Rw a	S w	Fluid Indicat ed	Sp- Log valu es
3263	16	19	26.3 2	22.9 5	14. 7	8.6	1786 .4	1 0	0.5	0.6 8	H <sub>2</sub> O	0
3253.2 5	14	18	26.3	22.5	15. 3	8.7	1599 .9	1 1	0.7	0.5	Hc=H <sub>2</sub> O	0
3253.5	18	21	26.9	24.1	13. 2	8.1	2497 .1	1 2	0.9	0.6 3	H <sub>2</sub> O	0
3253.7 5	17	20	26.9	23.7	13. 7	8.3	2209 .4	1 2	0.9	0.2 5	Hc	0
3254	17. 6	20.5	29.9	23.7	13. 7	8.3	2209 .4	1 2	0.9 3	0.5 6	H <sub>2</sub> O	0
<b>Avera ge</b>				23.4			2060 .4					

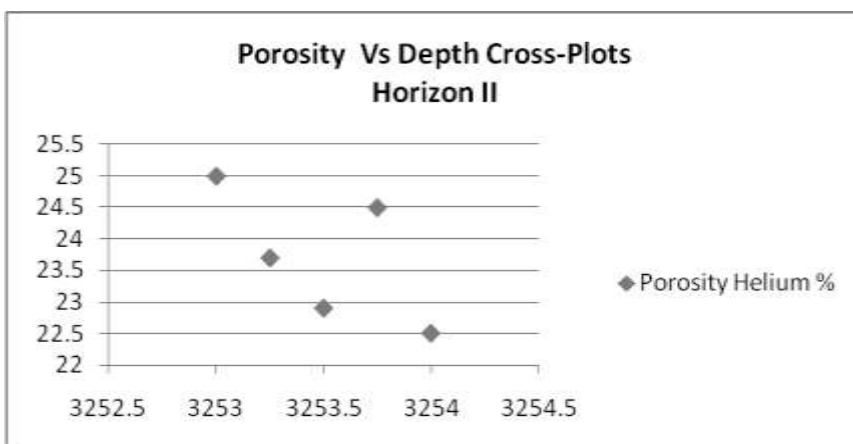
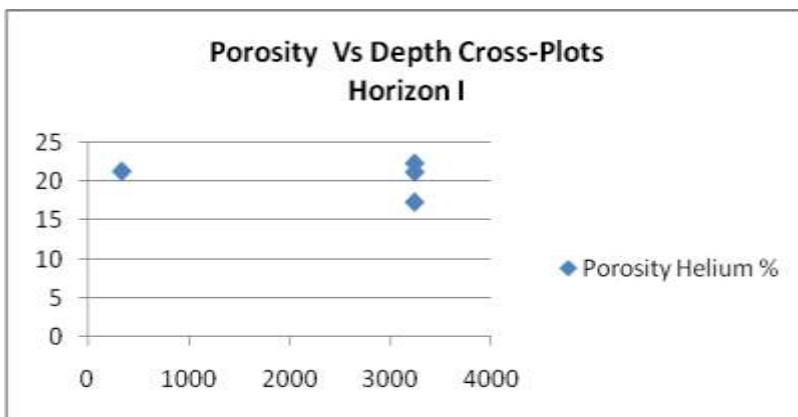


Fig 8. Porosity Vs Depth Cross-Plots

## **CONCLUSION**

Facies is a Latin word meaning face, figure, appearance, aspect, look or condition and thus signify an abstract idea. Primary goal of facies analysis is to produce a facies model which is in effect a hypothesis about the environment signified by the rocks and fossils under study. In this work we have tried to characterize some of the basic facies types that are very important to petroleum exploration using well A in the Y field, in north-eastern Niger Delta as a case, invariably this will help to enrich the understanding of facies characterisation for the purpose of petroleum exploration.

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