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Research Article

STRUCTURAL INTERPRETATION AND HYDROCARBON POTENTIAL OF OBUA FIELD, NIGER DELTA, SOUTHERN NIGERIA

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ABSTRACT

Structural Interpretation and Hydrocarbon Potential of OBUA field was carried out to examine the principal structures responsible for hydrocarbon entrapment and also indicate favourable areas in which exploration can be concentrated in the field.The research methodology involved delineation of lithologies and identification of reservoirs,fault and horizon mapping, well- to- seismic tie of the hydrocarbon reservoirs, time to depth conversion,determination of petrophysical parameters and prospect evaluation.Sand and shale are the two key lithological units present in the studied area. Two hydrocarbon bearing reservoirs (A and D) were outlined. Well-to-seismic tie revealed that the hydrocarbon bearing reservoirs encountered tied properly with the trough in the seismic. Two horizons and twelve faults were mapped. These faults include eleven synthetic and one antithetic fault.Three growth faults were also interpreted. Depth structural maps revealed that the principal structures responsible for hydrocarbon entrapment in OBUA field are fault assisted closures and rollover anticlines. The result of the petrophysical evaluation showed that the average porosity value for reservoir A is 0.225 while that of reservoir D is 0.219. The average permeability (k) values range from 1462.695 to 1448.062md. Water saturation (Sw) average values are 0.381 and 0.424 for both reservoirs. Net-to-Gross average values range from 0.625 to 0.597. Two prospects were identified at the central part of the field. The results of this study suggest more developmental prospects in the central part of the field.

Keywords: Lithologies, Reservoirs, ProspectEvaluation, Rollover Anticlines, Faults.

INTRODUCTION

The knowledge of the structural architecture of a reservoir aids in delineating prospective locations suitable for economically exploitable accumulations in a field. Structural traps are formed as aneffect of changes in the structure of the subsurface owing to processes like folding and faulting.Theyare the most important type of trap because the majority of the world's petroleum reserves are discovered in structural traps[1]. Structural traps are classified into three:the anticline trap, the fault trap and the salt dome trap.This work therefore aimed at producing a regional structural interpretation as well as evaluating the hydrocarbon potential of OBUA Field.

Several workers have carried out research on the structure and hydrocarbon potential of the Niger Delta basin. They include; [3],[4], [6], [8] among others.

Geologic Setting and Stratigraphy:

The OBUA field is locatedwithin southwest of Central swamp Depobelt of Niger Delta Basin (fig.1).Niger Delta is situated in the southern part of Nigeria between the longitude 4^0–9^0E and latitude 4^0-6^0N (Fig.2). The basin is surrounded to the east by the Calabar Flank [5], to the west by the Benin

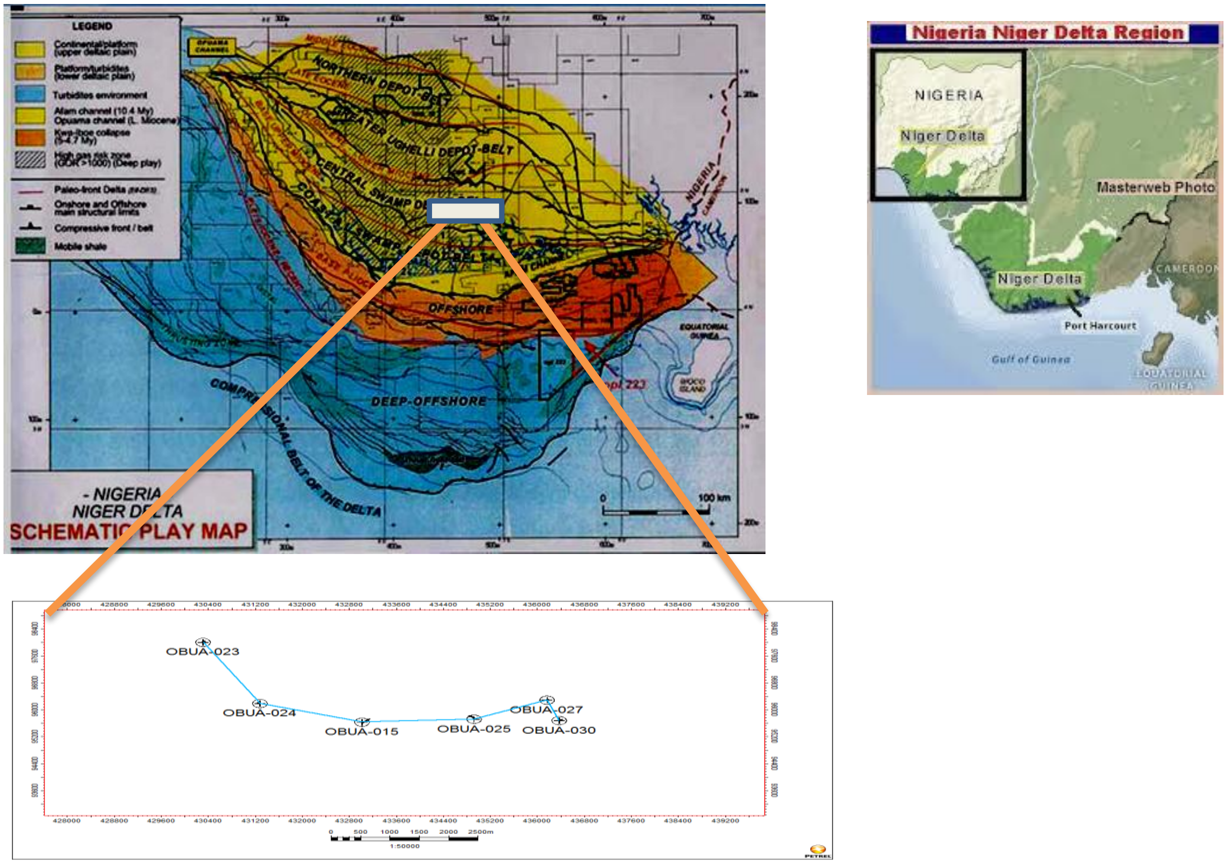

Figure 1: Location map of Niger Delta showing the study areaand the inset of map of Nigeria

Basin, to the south by the gulf of Guinea and to the north by the older (Cretaceous) tectonic structures such as Anambra Basin, Abakalilki Anticlinorium and Afikpo Syncline. The delta has progradedsouthwestward from the Eocene to the present thereby establishing active portion of the delta at each stage of development [2]. Niger Delta Basin comprises of three basic formations. They include the basal Paleocene to Recent pro-delta facies of Akata Formation, Eocene to Recent paralic facies of the Agbada

Formation and the Oligocene to Recent fluvial facies of Benin Formation [7].These three formations were deposited on the sedimentation cycles otherwise known as depobelt, which encompass the Niger Delta. The depobelts are classified into five. They include Northern depobelt, Greater Ugheli, Central swamp, Coastal swamp, and Offshoredepobelt (Fig.1).

MATERIALS AND METHODS

The data used in this research include; base map, wireline logs, 3D Seismic Section, and Checkshot. These data were provided by Shell Petroleum Development Company with permission of the Department of Petroleum Resources (DPR), Port Harcourt.

All data used in this research were checked for quality to avoid interpretation difficulties before being loaded into geosciences workstation.

The methods adopted in this research include delineation of lithologies and identification of reservoirs from log signatures of gamma ray and resistivity logs.Faults were recognised on the basis of discontinuities in reflections. The checkshot data was used for the well- to- seismic tie of the hydrocarbon reservoirs. Horizons were mapped and used to generate the time structure maps which were later converted to depth structure maps using checkshot. These time and depth contour maps of productive reservoir formations were constructed using time read directly from the tops of particular horizons and average velocities derived from internal velocities. Petrophysical evaluation was carried out from the relevant wireline logs. Finally, the prospective zones in OBUA field were delineated using depth structure map and petrophysical results obtained.

RESULTS AND DISCUSSION

Lithologic Analysis/Reservoir Identification:

The two mainlithologies present in OBUA field as revealed by well logs are sand and shale. The interval coloured yellow denotes sand while the interval coloured black signifies shale (fig.2).

Stratigraphic correlation of six wells in OBUA field led to a division of the sand bodies into two sections. They are sand A and D correspondingly.

Two reservoirs were recognized in the field. The top and base of the reservoirs are shown in well correlation panel. The deeper reservoir is found to be thicker and cleaner than the reservoir encountered at shallow level. Reservoir A thins towards the eastern part of the field (fig.3)

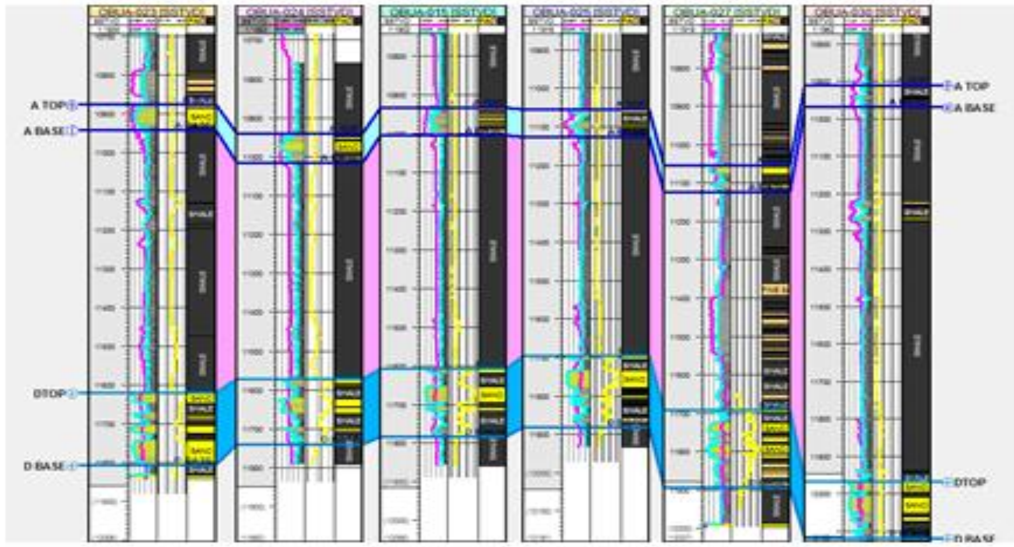

Figure 2: Well Correlation Panel

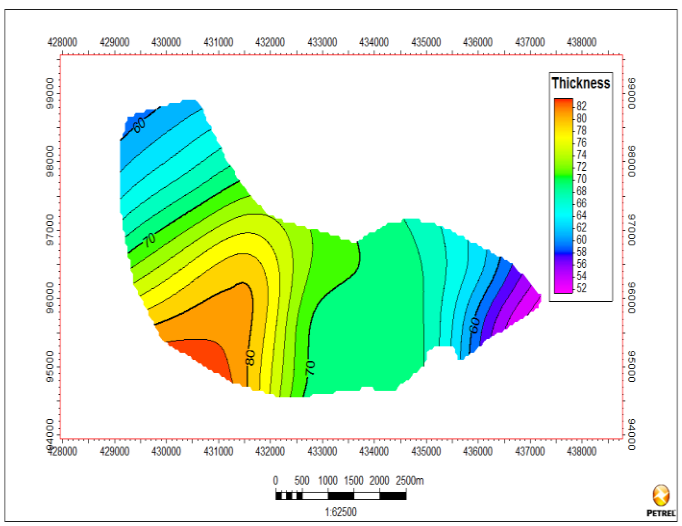

Figure 3: Isopach map showing the thinning of reservoir A eastward

Fault and Horizon Mapping:

Twelve faults labelled F1 – F12 are interpreted. Figures 4 and 5 show the various positions and orientations of the faults. Two types of faults were identified in OBUA field. They are synthetic and antithetic faults. The synthetic faults are labelled F1, F3, F4, F5, F6, F7, F8, F9, F10, F11 and F12. These faults trend in the Northeast–Southwest direction. The antithetic fault which is labelled F2 trends in the Northwest-Southeast direction. A total of three growth faults coded F1, F3 and F6 were mapped in the field. These growth faults cut across the field. The presence of these faults shows the possibility of hydrocarbon accumulation in OBUA field (Weber and Daukora 1975).

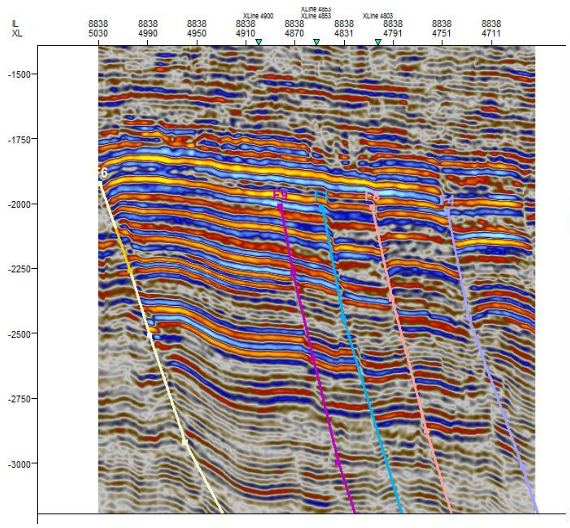

Figure 4: Fault interpretation on inline 8838

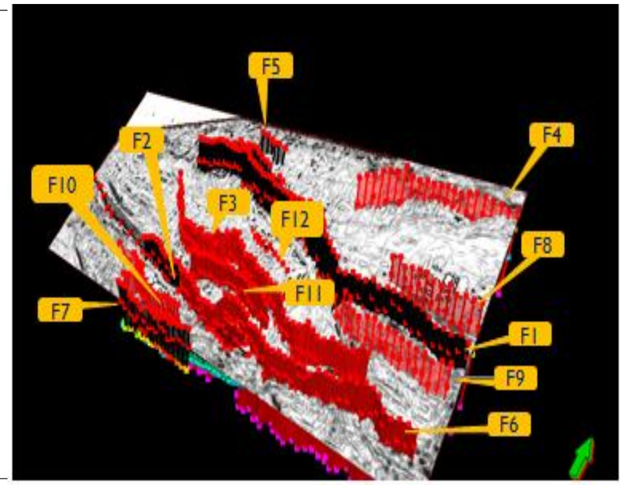

Figure 5: 3-D view of identified faults on OBUA field

Well-to-seismic tie:

Well-to-seismic tie revealed that the hydrocarbon reservoirs encountered tied properly with the trough in the seismic (figs.6a and 6b).

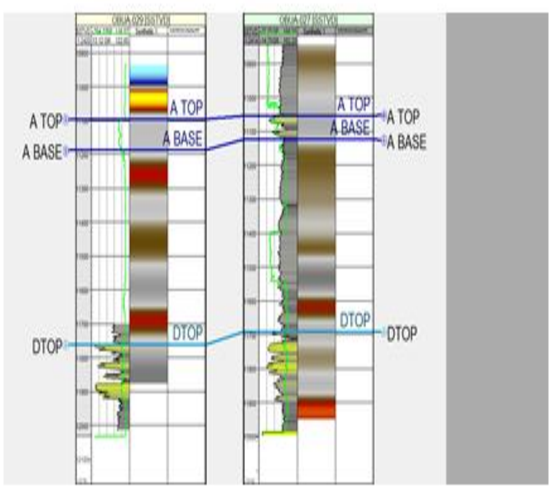

Figure 6a: Well-to-seismic tie

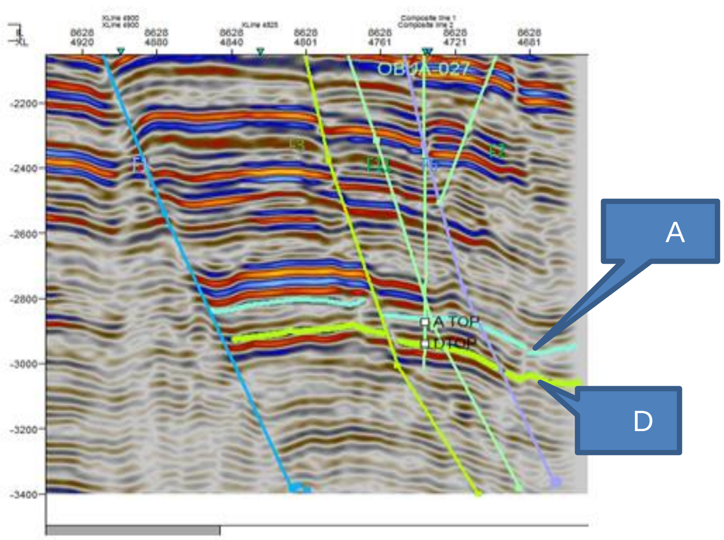

Figure 6b: Well tying on seismic inline 8628

Two horizons (A and D) were also delineated in the study area (Fig.6b).

Time and Depth contour maps:

The time range of horizon A is 2750 and 2850ms while that of horizon D falls within 2900 and 3000ms. The depth equivalent of horizon A is between 10950 and 11400ft. The depth range of horizon D is 11500 and 12250ft.

The time structural maps of both horizon A and D as shown in figures 7a and 7b revealed the presence of anticlinal structures which close on the major faults across the field.

Analysis of the depth structural map of horizon A shows that around OBUA-015, the contours have good closure which is on structural high. One prospect was also delineated. This prospect is labelled P1 (Fig.8a).

Another good closure was observed in horizon D between OBUA-024 and OBUA-015. New prospect was identified and labelled P2 (Fig.8b).

The trapping mechanisms in OBUA field as observed in both time and depth structural maps are anticlines and fault assisted closures.

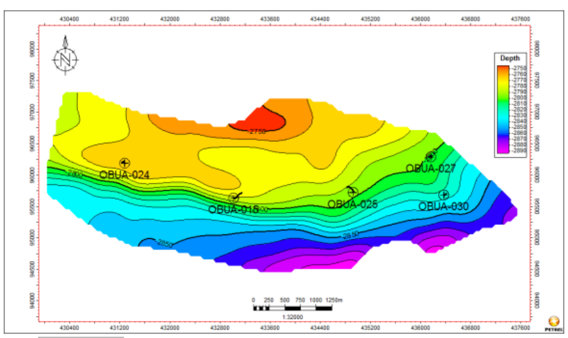

Figure 7a: Time map for horizon A

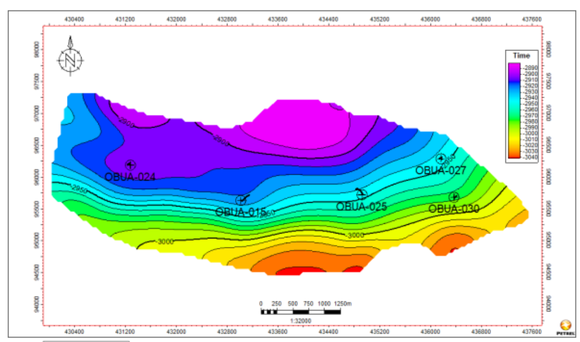

Figure 7b: Time map for Reservoir D

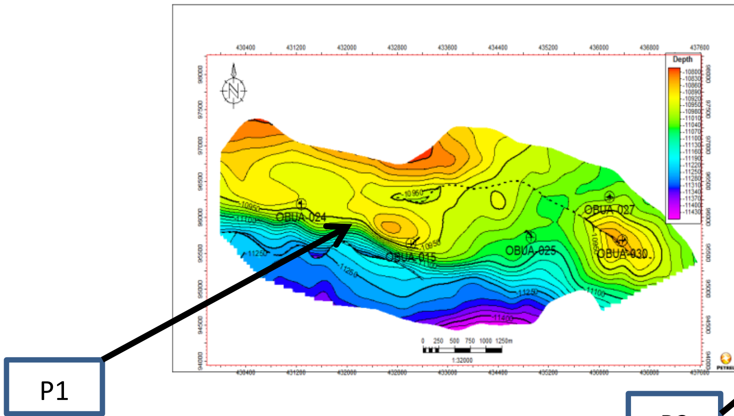

Figure 8a: Depth map for Reservoir A

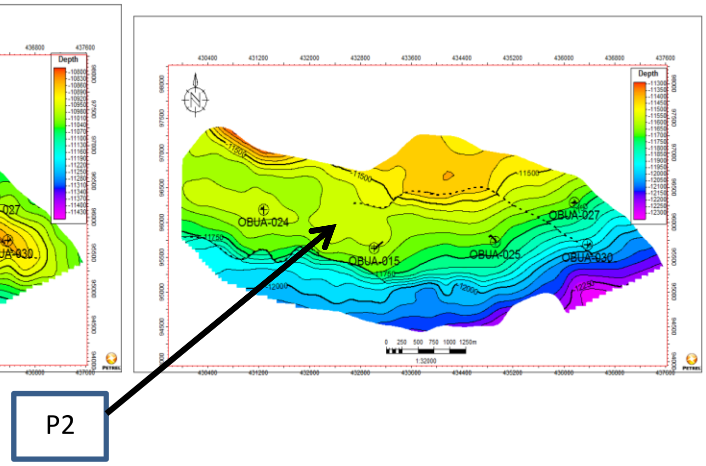

Figure 8b: Depth map for Reservoir D

Petrophysical Evaluation:

Hydrocarbon potentials of the outlined reservoir sands were discovered in their petrophysical properties. The result of the petrophysical analysis shows that the average porosity value for reservoir A is 0.225 while that of reservoir D is 0.219. The average permeability (k) values range from 1462.695 to 1448.062md. Water saturation (Sw) average values are 0.381 and 0.424. Net-to-Gross average values range from 0.625 to 0.597. The porosity value as observed in the two reservoirs across the field is very good in rating while the permeability values are ranked excellent. Table 1 shows the results of petrophysical analysis in OBUA field.

	A					D			
WELL	POROT	K	SW	NTG		POROT	K	SW	NTG
015	0.246974	1706.025	0.334576	0.714286		0.224446	1520.714	0.412358	0.542373
024	0.204171	1217.406	0.42003	0.790123		0.184513	1126.323	0.57298	0.454545
023	0.219821	1385.506	0.383727	0.878788		0.251804	1849.649	0.350312	0.691099
025	0.210954	1307.192	0.412913	0.397059		0.210595	1311.186	0.415362	0.488506
027	0.252177	1807.545	0.337634	0.612903		0.246879	1729.787	0.341654	0.744444
030	0.215449	1352.495	0.397268	0.358491		0.196859	1150.716	0.452094	0.6625
AVGS	0.224924	1462.695	0.381025	0.625275		0.219183	1448.062	0.424127	0.597245
AH	0.0569					0.0738			
AVG THICK		65.66666667					161.8333333		
STOIIP		38.42754581				STOIIP	43.16100561		

Table1: Summary of petrophysical evaluation

SUMMARY AND CONCLUSIONS

In this study, sand and shale are observed to be the two key lithological unitsexisting in the studied area. Two hydrocarbon bearing reservoirs (A and D) have been described from well log analysis. Well-to-seismic tie revealed that the hydrocarbon bearing reservoirs encountered in the wells tied properly with the trough in the seismic. Two horizons were recognized and twelve faults were mapped across the field.

Both time and depth structural maps revealed that the principal structures accountable for hydrocarbon entrapment in OBUA field are fault assisted closures and rollover anticlines. Two prospects were identified in both reservoirs at the central part of the field.From the result of the petrophysicalanalysis, it can be construedthat both the porosities and permeabilities of the reservoirs delineated are adequate to be adjudicated a producible reservoir.The results of this study suggest more developmental prospects in the central part of the field.

ACKNOWLEDGEMENTS

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