3D Structural Interpretation and Volumetric Analysis of Reservoir 'X' over Dara Field, Onshore Niger Delta.

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ABSTRACT

3D seismic and well log data have been utilized for the evaluation of subsurface geology and hydrocarbon potential of an oil field onshore Niger Delta. A network of faults and horizons were identified and mapped based on prospectivity using geophysical software and volumetric computations done manually. Time and depth structure maps of the fourth reservoir shows that the structure harboring hydrocarbon is a fault dependent anticlinal structure. An amplitude map of the top of the reservoir complements the structural maps. The lateral extent of the reservoir was estimated from depth structure map and the thickness of the pay zone from a combination of depth map and well logs. The generated well log panel depicts the general stratigraphy and interrelationship between reservoirs and non-reservoirs rock units.

The reservoir has an average porosity of 24%, water saturation 21%, hydrocarbon saturation 79%, and net to gross sand thickness 0.65. Having a recovery factor of 40% and 60% for oil and gas, it was deduced that the oil and gas reserves are 4,531, 895 STB and 2,702,086,391 SCF, respectively. This analysis has shown that the reservoir is prolific and harbors hydrocarbon in commercial quantities.

(Keywords: reservoir, amplitude map, anticlinal structure, horizon)

INTRODUCTION

3D seismic methodology has revolutionized the oil and gas industry (Nestvold, 1996). The method is used for exploration, field development, and production. Its ability to properly image subsurface structures and stratigraphy makes it one of the best methods in the rejuvenation of mature oil fields, thereby increasing oil production (Brown; 2007).

Complementary to seismic data is Geophysical wireline logs which give insight into basinal stratigraphy and reservoir vertical compartmentalization. This article integrates 3D seismic data and well logs for the determination of structure and reserves of an oil field in Niger Delta.

STUDY LOCATION

The area of investigation lies onshore Niger Delta (Figures 1 and 2). Wells drilled in the area penetrated two lithostratigraphic units which include the Benin and Agbada Formations (Short and Stauble, 1967). The Akata Formation that is mainly shale was not penetrated. The lithology of the Benin Formation is mainly sands with few shale intercalations, whilst that of Agbada is composed of alternating sand and shale layers.

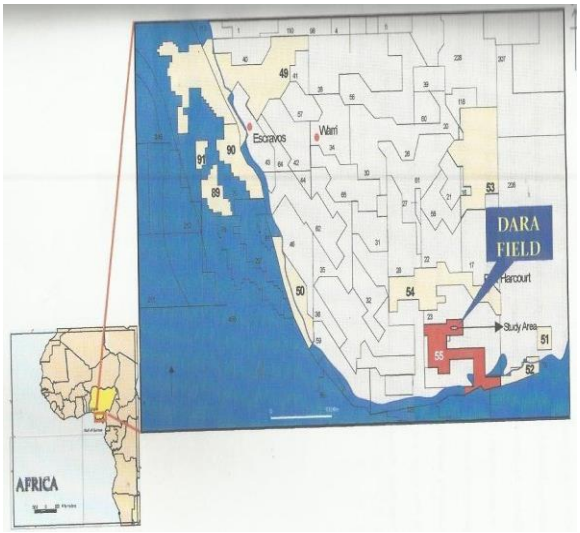


Figure 1: Location Map.

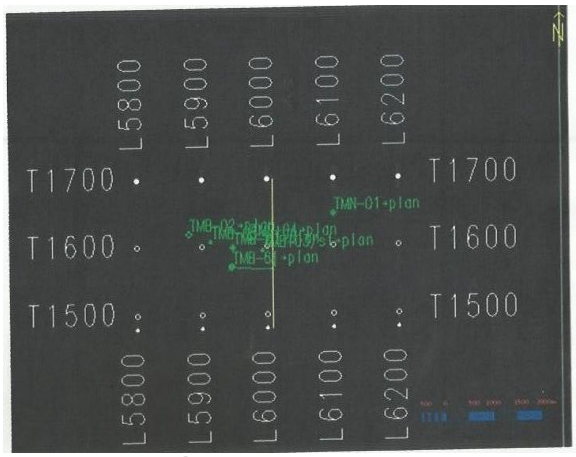
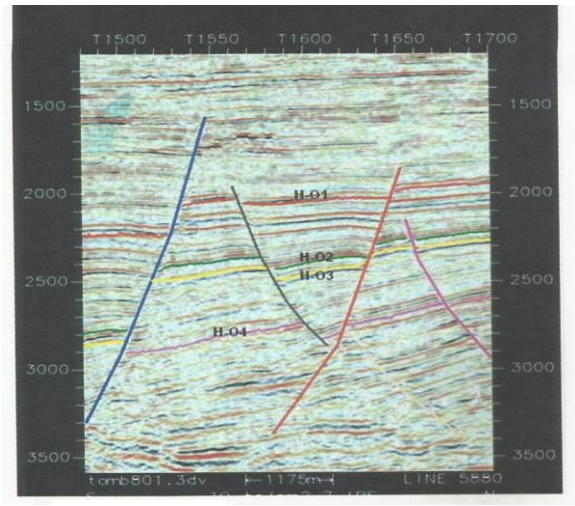


Figure 2: Base Map.

METHODOLOGY

The digital data base for this study comprised 3D seismic sections, a suite of Geophysical wireline logs from six wells and velocity check shot survey data. The interpretational procedure involved the following:

i. Well log correlation and integration with seismic data;
ii. Seismic structural and attribute analysis (Figure 3)
iii. Petrophysical parameters evaluation, and
iv. Computation of oil and gas reserves. The above outlined procedures (i-ii) were accomplished using open-works software; while (iii) and (iv) procedures were done manually.



F Fault

Figure 3: Typical Interpreted Seismic Section of Inline 5880.

RESULTS AND DISCUSSION

Well Log Correlation and Seismic Structural Interpretation

Figure 4 depicts lithostratigraphic correlation panel trending SE to NW. The subsurface geology is that of alternating sand and shale layers with shale layers increasing in thickness with depth. The mapped horizons at depths of 2286m, 2774m, 2896m and 3338m have also been indicated on the panel. A typical interpreted seismic section is also shown in Figure 3. The depth structure map of horizon 04 (Figure 5) is characterized by major and minor growth faults.

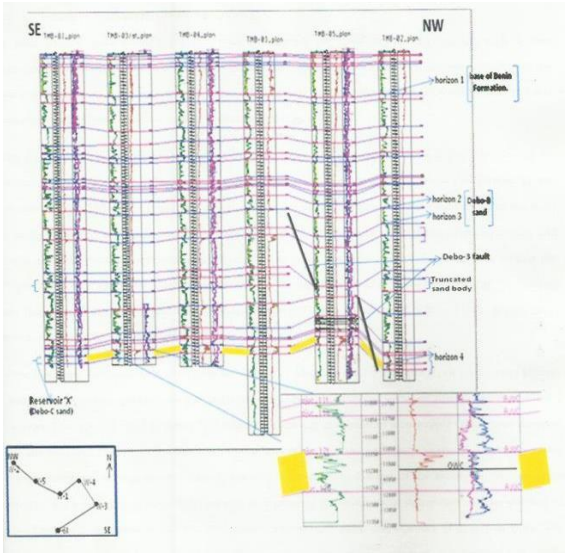


Figure 4: Well Log Correlation Panel.

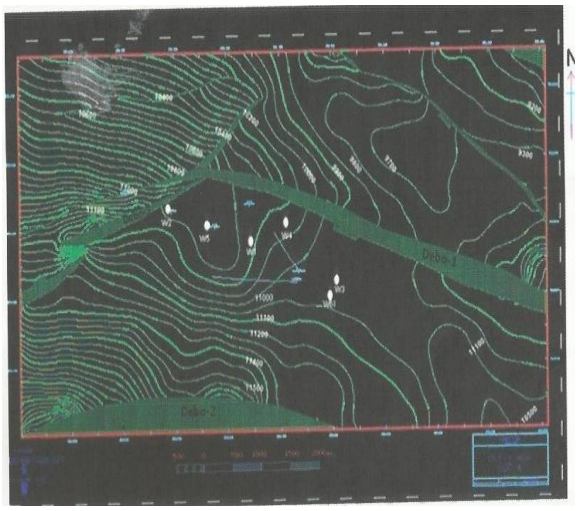


Figure 5: Depth Structure Map of Horizon 04.

The major faults trend in west to southeast and east to west directions with appreciable throw. The minor faults trend in southwest to northeast with throw towards northwest. The structure harboring hydrocarbons in the area is a fault dependent anticline. Most of the wells are located within this region of structural closure because of probable thick sediment accumulation.

Seismic Attribute Analysis

Figure 6 shows the amplitude map of horizon 04. It is similar to the depth structure map and the contours are expressed in amplitude scale. The region of downthrown block where the wells are located is characterized by high amplitude. The upthrown block of the major fault has favorable closure and similar amplitude strength like that of the downthrown thus making it a prospective zone for the localization/ drilling of development wells.

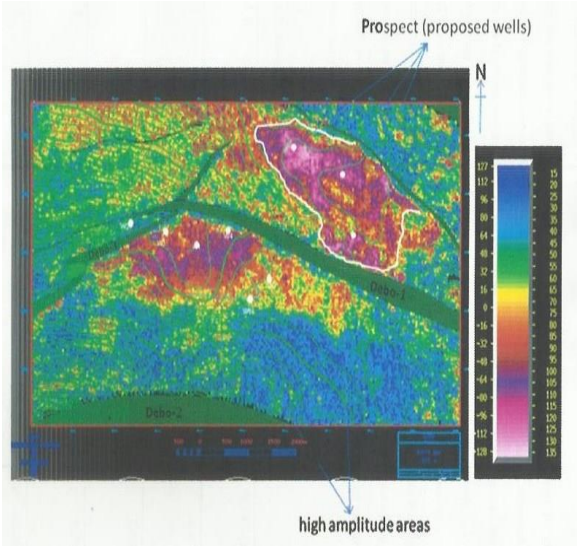


Figure 6: Amplitude Map of Horizon 04.

Reserve Estimation

Figure 7 shows the depth structure map of horizon 04 upon which the various fluids (gas, oil and water) have been superimposed. There is segregation of the fluid types within the structure. A line of section A and A^1 within the structure gives a two dimensional picture of the distribution of gas, oil and water within the reservoir (Figure 8).

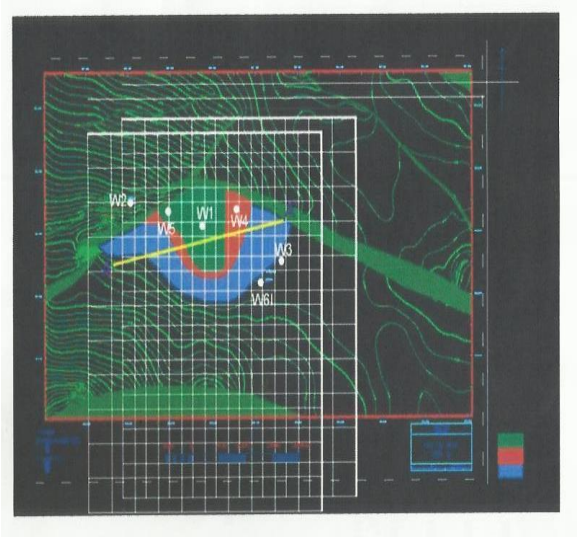


Figure 7: Depth Structure Map of Horizon 04 showing Contacts and Square Grid.

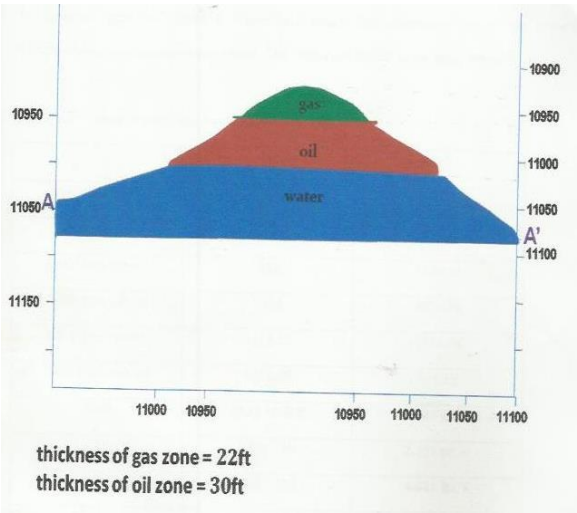


Figure 8: Cross Section A to A^1 showing the Distribution of Fluids.

The reservoir of interest has average porosity of 24%, hydrocarbon saturation 79%, water saturation 21% and a net to gross thickness of 0.65. Integration of depth structure and well log data reveal that the reservoir has oil and gas reserves of 4,531, 895 STB and 2,702, 086, 391 SCF, respectively.

CONCLUSIONS

1. Well log correlation panel shows the general geology of the study area which is composed of alternating sands and shale layers.

2. Seismic and well log data have been used for evaluation of stratigraphy and hydrocarbon potential of the field.

3. The structure harboring oil as deduced from 3D seismic data is a faulted rollover anticline characterized by fault dependent closures.

4. Amplitude map complements the structural map by further highlighting the most prospective zones within the structure.

5. Prospective zones for the drilling of development wells (Figure 6) designated A, B and C have been identified and mapped.

6. The reservoir of interest has porosity of 24%, water saturation 21%, hydrocarbon saturation 79% and net to gross thickness of 0.65. It also has oil and gas reserves of 4,531, 895 STB and 2,702,086,391 SCF, respectively.

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