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FAULT ANALYSIS USING WELL LOGS IN THE NIGER DELTA, NIGERIA

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ABSTRACT

A Fault present is analyzed between two wells A-2 and A-1 in the Niger Delta. Two stratigraphic horizons were used to determine the presence, size and stratigraphic positions of the faults. These horizons are tops of 4800 and 5000 Sands. In Well A-2, the separation between the tops of 4800 and 5000 Sands horizons is 221ft (67m). The difference between the tops of 4800 and 5000 Sands horizons in Well A-1 is 210ft (64m). Between the two horizons, Well A-1 is short by 11ft (3ft). This shortage indicates the presence of a fault. The fault size is 25ft at 4930ft in Well A-1.

KEYWORDS: Correlation, Fault, Horizon, Shale-Resistivity-Marker, Sand

INTRODUCTION

The Niger Delta is the only hydrocarbon producing basin in Nigeria (Figure 1), producing from Agbada Formation.The objective of this paper is to determine if fault is present in two wells 5664ft (1726 m) apart on the Northern Depobelt, and to determine the size and the position of the fault. Four steps were followed in the analysis. These are lithology analysis, sand and shale correlations and fault analysis. The SP and GR logs were used for lithology analysis. The SP log measures the potential difference between the surface and the borehole, it differentiates between permeable and impermeable beds. The GR log differentiates sand and shale based on the presence of radioactivity. There are two major sands used as drives for the sand correlation. These are 4800 Sand and 5000 Sand. Six Shale Resistivity Markers (SRM) markers are detected using ILD log and these serves as basis for the shale correlation. These are SRM 1, SRM 2, SRM 3, SRM 4, SRM 5 and SRM 6. SRM 5 is only detected in Well A-2. It is faulted out in Well A-1. The size of the fault is 25ft at 4930ft in Well 1.

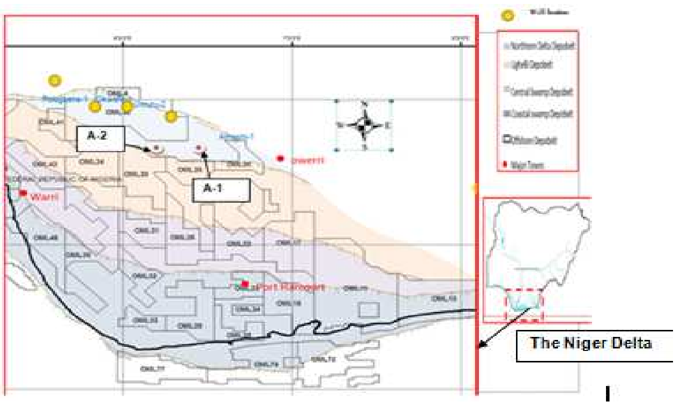


Figure 1: Oil Mining License of the Niger Delta and Location of Wells A-2 and A-1 (Shell Petroleum and Development Company, Nigeria, 2012)

Geology of the Niger Delta

The Niger Delta is made up of three formations in ascending order, Figure 3. These are Akata Formation, a predominantly shale formation. Akata Formation is recognized on Gamma Ray log by high gamma ray readings. The Agbada Formation consists of sands and shales intercalation. Agbada Formation is recognized on gamma ray log by high (shale) and low (sand) API readings. The Agbada Formation is the main hydrocarbon producers because it consists of structures (growth faults, rollover anticlines, etc) capable of traping hydrocarbon (oil and gas). The Benin Formation succeed the Agbada Formation at the top. Benin Formation is mainly sands recognized on Gamma ray log by low gamma ray reading.

Data

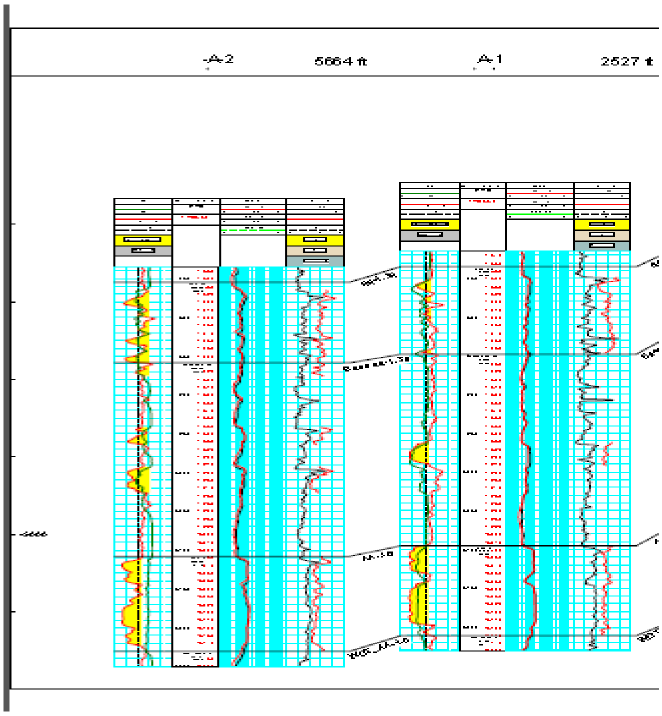
The data used for the analysis comprises of two onshore wells A-2 and A-1, Figure 1 and 2. Well A-2 is separated horizontally from Well A-1 by 5664ft (1726m). Well log used for the analysis are Gamma ray (GR), Spontaneous Potential (SP) and Deep Induction (ILD) logs.

Methodology

The methodology adopted for the analysis are in four steps. The first step is lithologic analysis, the second step is sand correlation, the third step is shale correlation and the last step is fault analysis.

Lithologic Analysis

The objective of lithologic analysis is to separate sands and shales. The tool used for the analysis are GR and SP logs. The GR recognizes sands and shales in the borehole because it measures radioactivity. Shale has very high radioactive materials because it has very high concentrations of organic matter. Sand on the other hand has less organic matter and therefore has less concentration of radioactivity. On the GR log reading, graduated in API, there are flunctuations between sands and shales sections. The sands are coloured in yellow, Figure 2.



Vertical Scale is 1.5 in. = 10ft

Figure 2: Log Correlation Panel and Raw Data Used for Fault Analysis in Well A-2 and Well A-1 (Department of Petroleum Resources, Nigerian National Petroleum Resources)

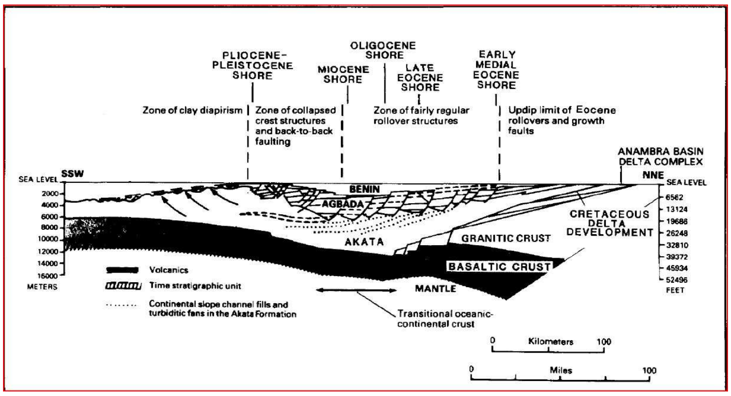


Figure 3: The Structure of the Niger Delta (After Ablewhite *et al.*1986)

Sand Correlation

Sands are correlated from Well A-2 to Well A-1 using major sands as a drive. Two major sands were used as the drive, 4800 Sand and 5000 Sand (Figure 4 and Table 1). The GR and SP log pattern could aid in the correlation. The two sands have high degree of correlation in the two wells.

Shale Correlation

Figure 4 shows detail correlation of the two wells usings sands correlation complemented with Shale Resistivity Marker (SRM). The SRM method is a shale pattern recognition. The SRM is labelled 1 to 6.

Fault Analysis

Table 1 shows that the sepation between the tops of 4800 Sand and 5000 Sand in Wells A-2 and A-1 respectively are 221ft and 210ft. This indicates that Well A-1 is short by 11ft (Table 2). Then there is a correlation problem (Tearpock and Bischke 1991, El-Mowafy and Marfurt 2008)

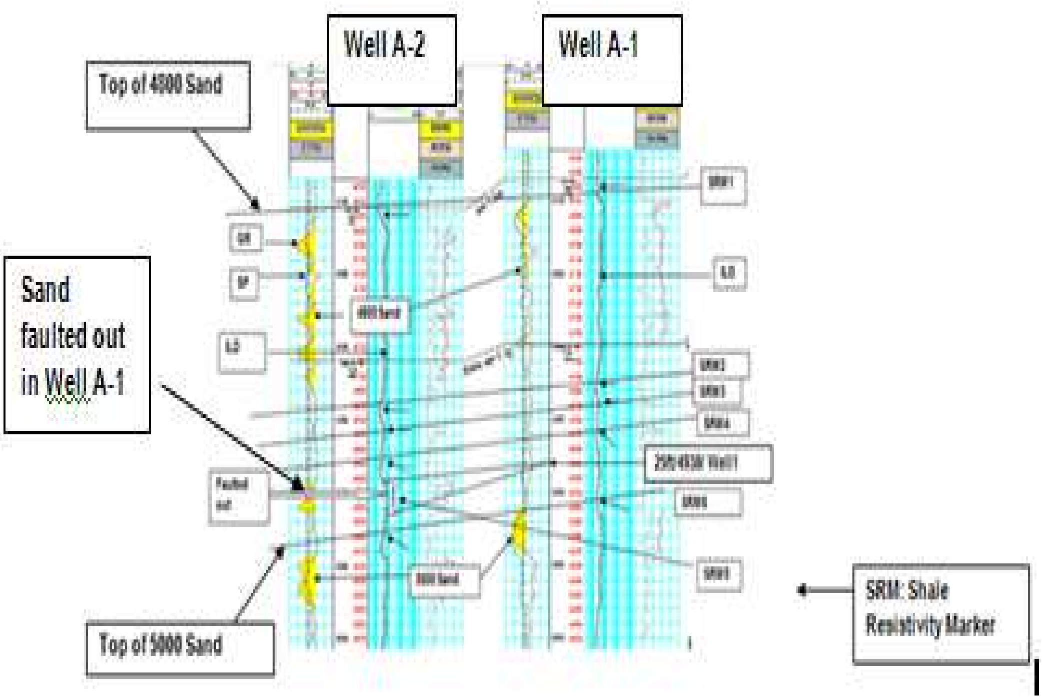


Figure 4: Correlation of Well of A-2 and Well A-1 Using Sand and Shale Resistivity Markers and Faulted Section

RESULTS AND DISCUSSIONS

The lithologies identified are sand and shale. The sands are 4800 and 5000 Sands located at these depths in each well.

The Shale Resistivity markers are SRM-1, SRM-2, SRM-3, SRM-4, SRM-5 and SRM-6. SRM-5 is missing in Well A-1, this indicates the presence of a fault. Using the sand and shale correlations, the size of the fault was determined as 25ft at a depth of 4930ft in Well A-1 (Figure 4).

Table 1: Separation Between the Top of 4800 Sand and 5000 Sand in the Two Wells

<table>
<tr><th></th><th colspan="3">Well A-2</th><th colspan="3">Well A-1</th></tr>
<tr><th></th><th>Top (ft)</th><th>Diff. (ft)</th><th>Diff. (m)</th><th>Top (ft)</th><th>Diff. (ft)</th><th>Diff. (m)</th></tr>
<tr><td>4800 Sand</td><td>4689</td><td rowspan="2">221</td><td rowspan="2">67</td><td>4670</td><td rowspan="2">210</td><td rowspan="2">64</td></tr>
<tr><td>5000 Sand</td><td>4910</td><td>4880</td></tr>
</table>

CONCLUSIONS

Two sand tops were used to identify the presence of a fault between Wells A-2 and A-1. The differences in the tops at Well A-2 and A-1 indicated the presence of an 11ft fault. The size of the fault in Well A-1 is 25ft at depth of 4930ft.

REFERENCES

1. Ablewhite P., K. Akindolire, A. A. Avbovbo, k. Benaboud, S. Brun, J. R. Desparmet, J.
2. Donegan, Y. Esan, A. Gimenez, A. Guindy, D. Henry, G. Isleib, J. Logar, J. Loiseau, A.
3. Martinez, C. Pallot, A. Paul, T. Pilenko, W. Sadras, T. Sodeke, M. Soussi, B. Sowobi, D.
4. Storey, J. Suau, J. Vinet, D. Vu Hoang, G. Weller, A. Weller, A. Whiteman, S. Whittaker,
5. M. Wren, (1985) Well Evaluation Conference, Nigeria. P. 1-290.
6. El-Mowafy H. and K. J. Marfurt (2008), Structural Interpretation of the Middle Frio
7. Formation Using 3D Seismic and Well Logs: An Example from the Texas Gulf Coast of the United States, The leading edge, v. 27, no. 7.
8. Tearpock D. J. and R. E. Bischke (1991), Applied Subsurface Geological Mapping, Prentice-Hall, Inc. 1991 edition