

Sequence Stratigraphic Analysis of Olay Field, Niger Delta, and Implications for Hydrocarbon Prospect.

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ABSTRACT

The clastic sedimentary succession in the Olay Field were analyzed using sequence stratigraphic principles that involve use of parasequence stacking pattern to interpret system tracts, sequences, and depositional environments. The dataset include 50km² 3D seismic data, checkshot data for six wells and suites of well logs from 5 wells.

Five sequences were delineated and named sequences 1 to 5 from bottom to top. The sequences comprise of lowstand systems tract (LST), transgressive systems tract (TST) and highstand systems tract (HST) with exception of sequence 5 which is progradational in all the wells.

Analysis of the sequences and individual systems tracts reveal that hydrocarbon are hosted mainly within lowstand systems tracts and transgressive systems tracts reservoirs. Traps within the field are mainly structural and shales within the transgressive systems tract are laterally extensive and offer sealing potential for the traps.

(Keywords: Niger Delta, sequences, systems tracts, reservoirs, traps, seals)

INTRODUCTION

Sequence stratigraphy concepts have been used in the Niger Delta and are found to be applicable to the siliclastic successions in the Niger Delta petroleum province. The Formation and sedimentation in the Niger Delta have been greatly influenced by tectonics and sea level changes.

Stacher (1995) produced chronostratigraphic and sequence stratigraphic framework for the Niger Delta. Also, Ejadawe *et al.*, (2004) used 2D seismic grid of 500 x 500m and 500 well data to examine the regional sequence stratigraphy and sand fairways as controls on hydrocarbon occurrence in the Niger Delta. Ozumba *et al.* (2005) re-evaluated Opuama channel using sequence stratigraphy. Optimization of the Usari field was achieved by the use of sequence stratigraphic analyses (Ajayi *et al.*, 2006). Giwa *et al.*,(2005) and Durogbitan and Gwarthorpe, (2008) emphasized the importance of sequence stratigraphy in petroleum exploration in the Niger delta. The present study combines a three-dimensional seismic image with well log data to analyze the stratigraphic successions within the Olay field and develop a sequence stratigraphic framework for the field.

The objectives of the study include identification of key stratigraphic surfaces, depositional sequences and delineation of the different systems tracts and determination of dominant trapping mechanisms in the study area. Also, systems tracts that serve as hydrocarbon reservoirs will be identified and environment of deposition determined using electrofacies association.

The study area is located in a portion of the Western Niger Delta petroleum province of Nigeria (Figure 1). The need for this study is reinforced by the fact that only six (6) wells have been drilled in the Olay field and these wells are restricted to western and central parts of the study area, this is less than 25km² of the 50km² Olay Field.

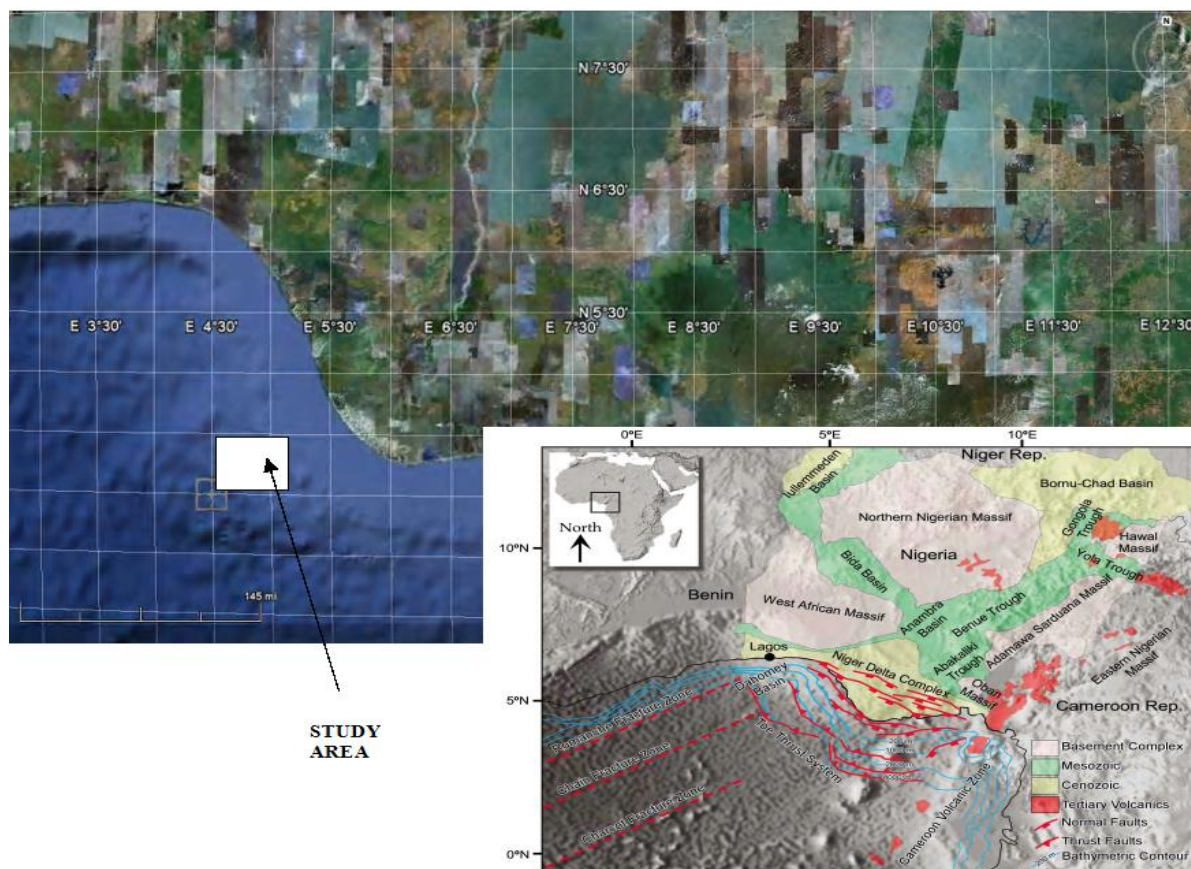


Figure 1: Location Map of the Study Area. Inset: Map of Africa and Nigeria showing the Niger Delta. Adapted from Corredor *et al.* (2005).

Geology and Tectonic Setting

The Niger Delta is situated in the gulf of Guinea and extends throughout the Niger Delta province. The delta has prograded southwestwards forming depobelts that represent the most active portion of the delta at each stage of its development (Doust and Omatsola, 1990).

The Niger Delta is one of the most prolific deltaic hydrocarbon provinces in the world. While it is widely believed that the Niger Delta contains only one identified petroleum system (Stacher, 1995, Reijers *et al.*, 1997), Haack *et al.*, (2000) submitted that the Niger Delta is actually made up of three distinct petroleum systems.

These are: Lower Cretaceous (lacustrine), Upper Cretaceous – Lower Paleocene (marine), Tertiary (deltaic).

However, it is generally believed that the principal source of oil and gas in the Niger Delta is the Tertiary deltaic petroleum systems consisting of types II, II-III, and III kerogens (Doust and Omatsola, 1990, Michelle *et al.*, 1999, Haack *et al.*, 2000). Short and Stauble (1967), Doust and Omatsola (1990), Reijers *et al.*, (1997) provided information on the depositional cycles in Southern Nigeria (Figure 2).

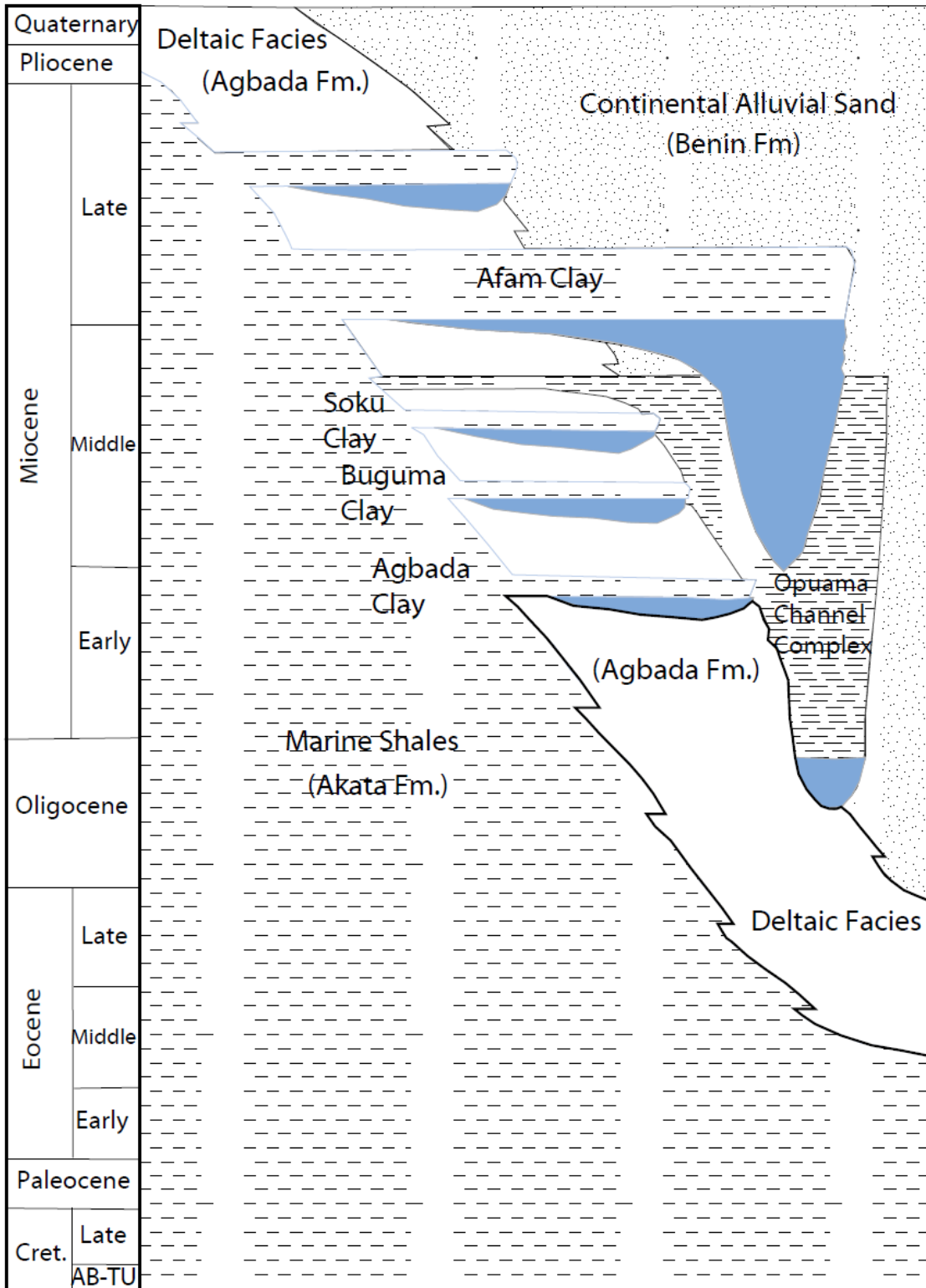


Figure 2: Stratigraphy of the Niger Delta (Doust and Omatsola 1990).

METHODOLOGY

The data used for this study were supplied by Chevron Nigeria Limited.

The dataset include: 50Km² 3D seismic data, deviation surveys for two wells, check shot data for six wells, and suites of well logs for five wells.

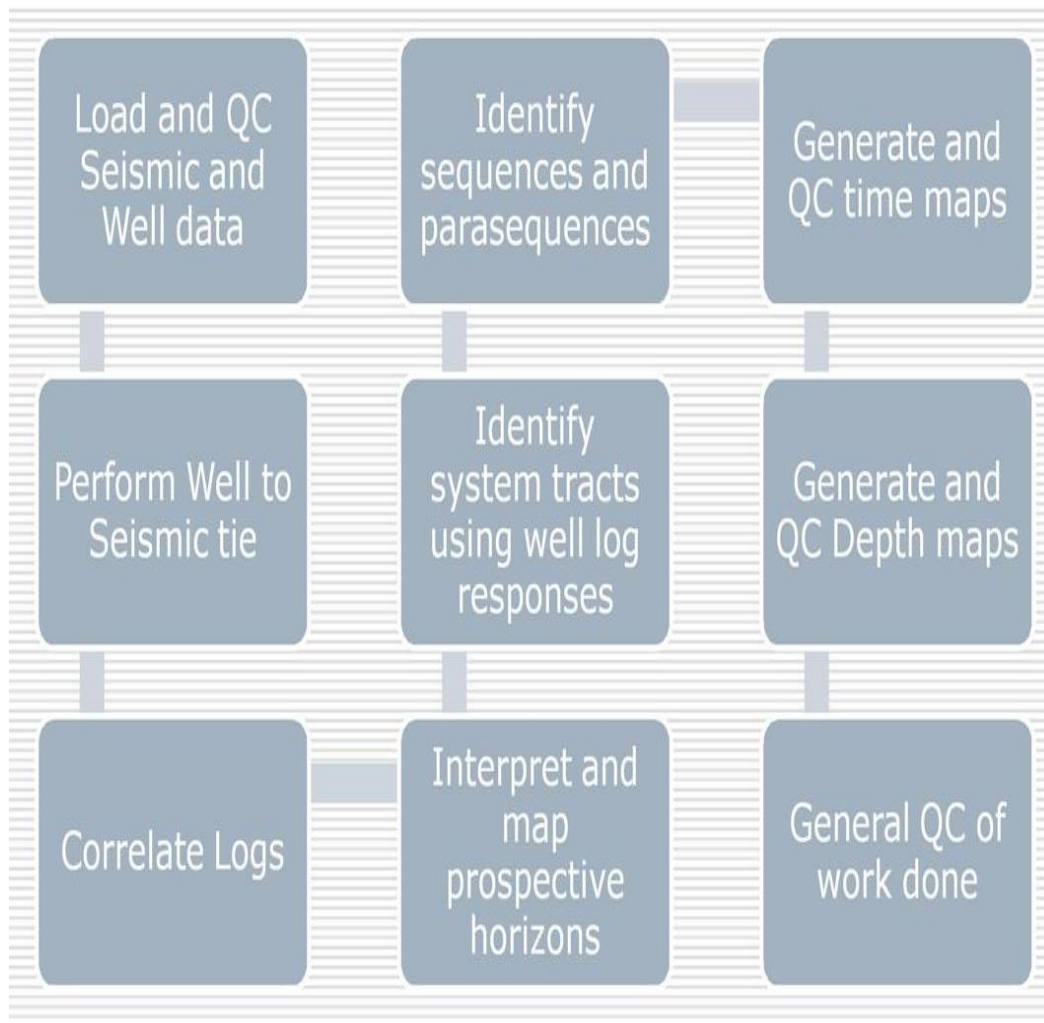
For the purpose of this study the field is referred to as Olay field and wells are named Sh 01, Sh 02, Sh 03, Sh 04, Sh 05, and Sh 06 (not actual names for proprietary reasons).

The three dimensional (3-D) seismic reflection data used for this work contain inlines and crosslines. Well log data include gamma ray,

caliper, resistivity, spontaneous potential, bulk density and sonic. However, not all the wells have all the log types enumerated above. For example well Sh 01 has caliper, gamma ray, resistivity, neutron porosity and spontaneous potential logs, while Sh 02 has gamma ray, resistivity, spontaneous potential and sonic logs.

Wells Sh 04, Sh 05, and Sh 06 have all the logs earlier mentioned and also include bulk density log. In addition, wells Sh 01, Sh 04, Sh 05, and Sh 06 have water saturation logs.

The workflow used in this study is presented in the chart below:



Schlumberger Petrel software was used for the analysis of seismic and well data. The 3D seismic data was loaded in SEG Y format. Inlines, crossline and time slices were generated and quality control performed on them. Well header information file containing co-ordinates was loaded into petrel software before well logs were loaded in order to display the wells within their proper co-ordinates. Deviation surveys were also imported into the Petrel software. The deviation survey measures the deviation of the wells from vertical.

Well log data were imported after proper quality control was carried out on the data. A base map (Figure 3) of the study area was generated after loading the various data types enumerated above. Posamentier and George (1994) identified the first step in sequence stratigraphic interpretation as determination of the general paleogeographic setting for the database in question.

Determination of physiographic setting for this dataset was accomplished using 2-D and 3-D seismic data. These data provide continuous imaging of the subsurface in a way not possible with other forms of data because they enable the interpretation of the overall geologic and tectonic setting of the basin (Vail *et al.*, 1977). The 2-D seismic data afforded a cross sectional view of the seismic data (Figure 4).

The second step is to interpret depositional systems and facies using all available data. Different parasequence stacking patterns (coarsening upward, fining upward, blocky, symmetrical and serrated patterns) noticed were analyzed in relationship with those below and above individual parasequences to determine depositional systems. These range of patterns compares with those described by, Selly (1988), Serra and Abbott (1982), Rider (1986) and Cant (1992).

The third step is to subdivide the stratigraphic succession through the identification of maximum flooding surfaces and sequence boundaries (Loutit *et al.*, 1988, Van Wagoner *et al.*, 1990, Posamentier and George, 1994). Gamma ray logs were examined for highest peaks that could signify flooding surfaces, maximum flooding surfaces and sequence boundaries were identified afterwards.

Checkshot data was used for well log to seismic tie, this was necessary in order to be able to locate and mark information from the well data in the form of geologic tops on the time (seismic) section. Well logs were used to identify different lithofacies present within the study area. Gamma ray (GR) logs were used as the primary tools for lithology identification and delineations.

A range of 0 API to 150 API was used for GR logs and 0 ohm m²/m to 200 ohm m²/m for resistivity. Also, a scale of 0 g/cm³ to 60 g/cm³ was used for bulk density while 1.5 neutron porosity unit (p.u) to 2.6 p.u was used for neutron porosity. Intervals interpreted to be sandstone were colored yellow just as intervals interpreted to be shale were colored grey. In addition, log signatures of individual wells were compared with those proposed by Neal *et al.* (1993) and Posamentier and George (1994) to interpret systems tracts.

Lithology interpretation was done for all the wells and through careful study of log patterns, parasequences and systems tracts were established. Well correlation for the Olay field was done after lithology interpretation based on well logs.

RESULTS AND DISCUSSION

Five different maximum flooding surfaces (Figure 5) were defined in the study area and sequence boundaries were picked at the points of maximum basinward shift in facies within a coarsening upward sequence. They are usually located between two maximum flooding surfaces (Van wagoner *et al.*, 1990).

Parasequences, sequence boundaries and maximum flooding surfaces were used as inputs to determine the various sequences in the Olay field. Five sequences were recognized from the stacking patterns and systems tracts in the well logs. While all the five sequences are represented in all wells from wells Sh 01 to well Sh 06, the same cannot be said of the systems tracts. Lowstand systems tracts are the most occurring in all sequence indicating they are well preserved. As a matter of fact, sequence 5 in all wells appears to be entirely composed of the lowstand systems tract.

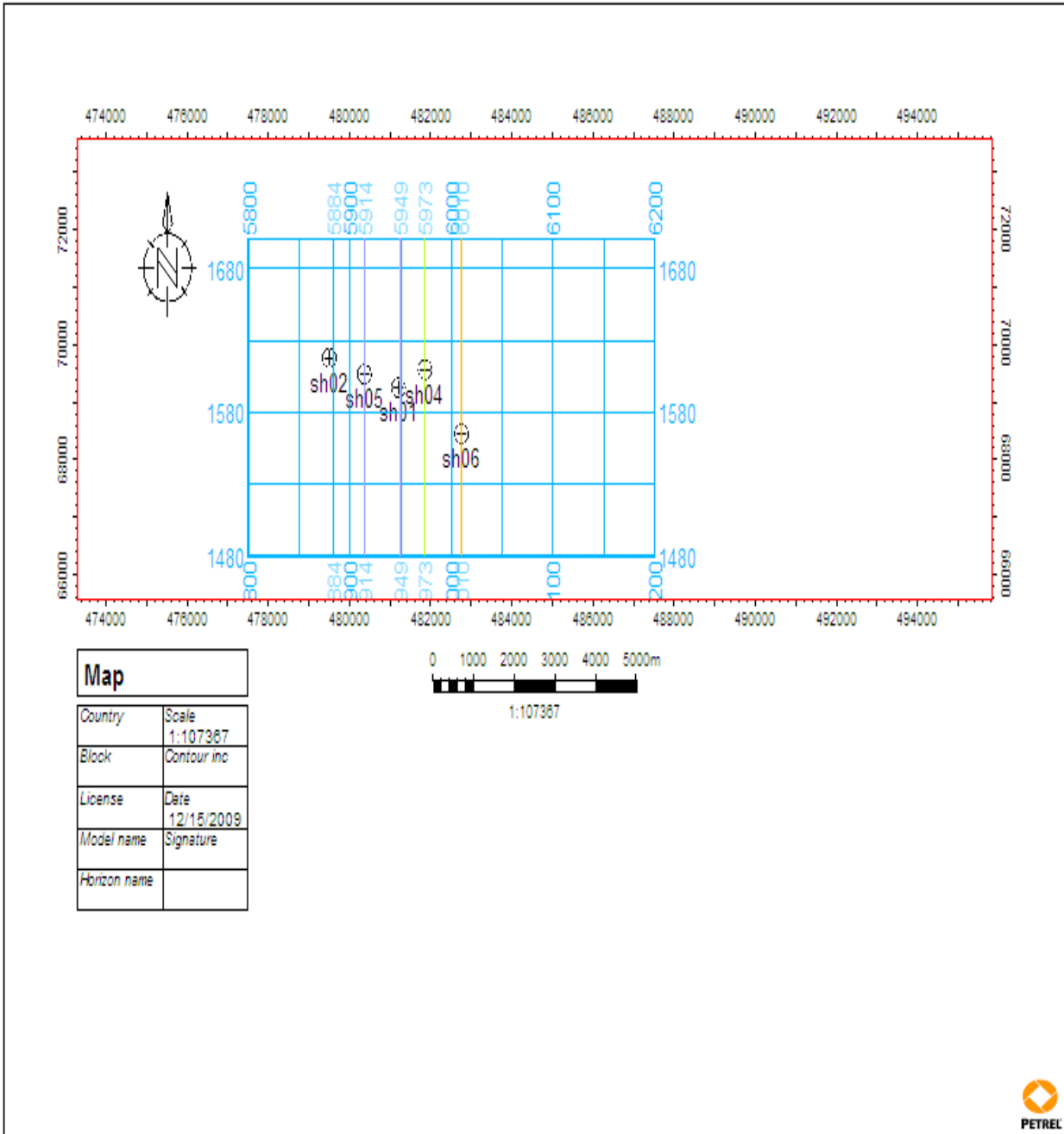


Figure 3: Base Map of the Study Area Showing Wells and Seismic Lines Intersecting Them.

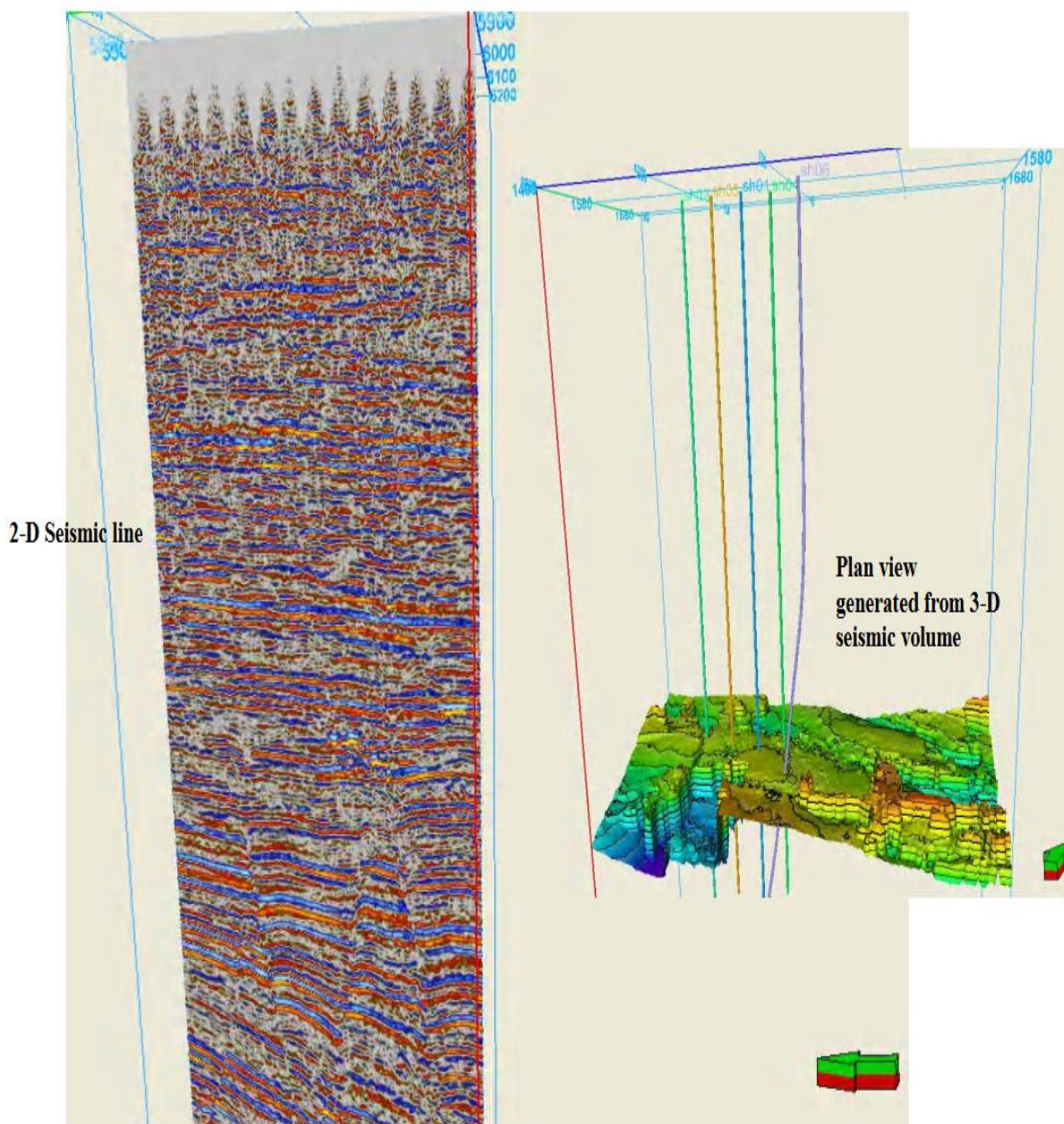


Figure 4: The Use of 2-D and 3-D Seismic Data for Paleo-Physiography Determination.

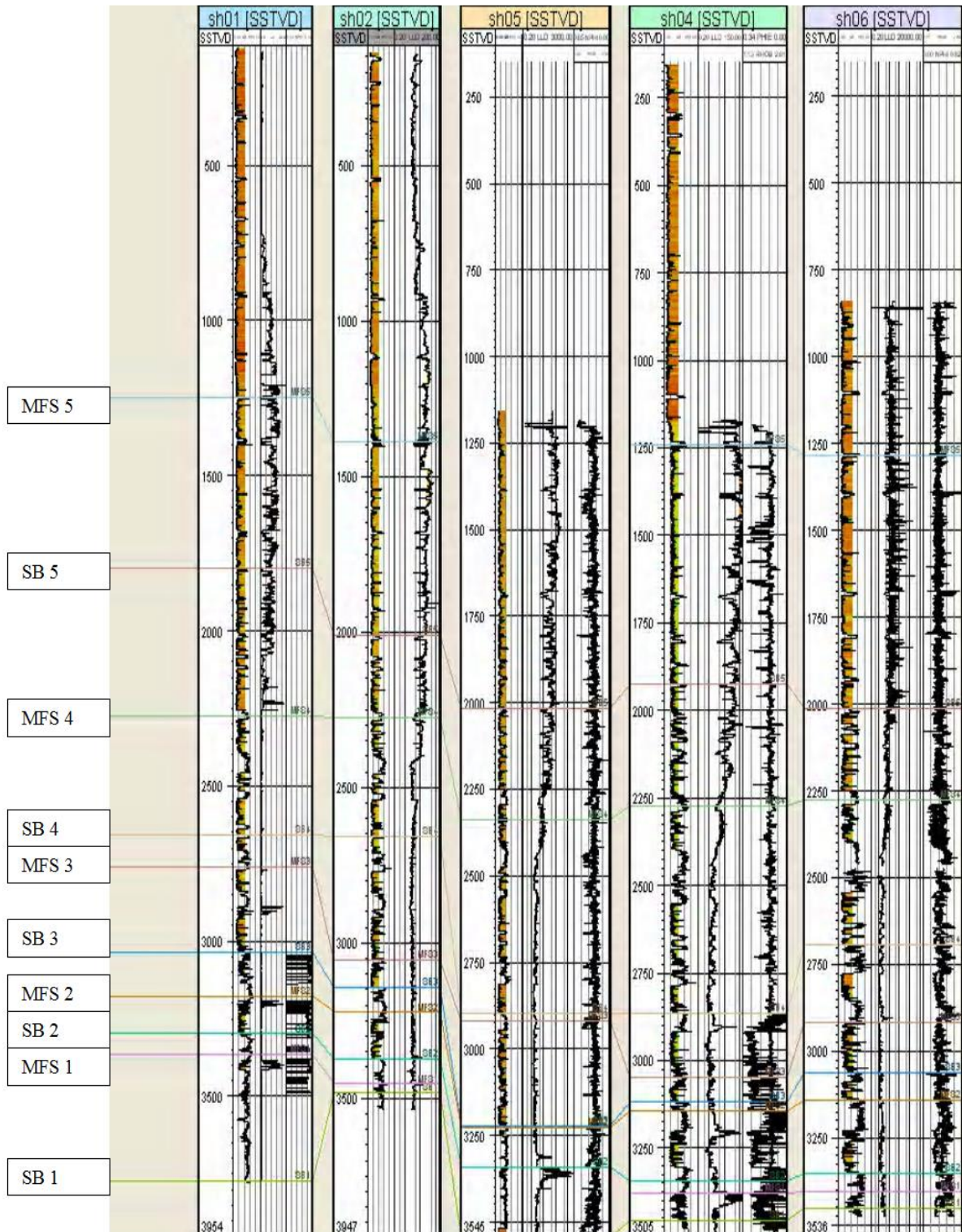


Figure 5: MFS and SB Interpreted on Well Section.

Well Correlation

Wells in the Olay field were correlated using well logs, especially the gamma ray logs (Rider, 1986). Systems tracts and sequences were also correlated across the wells. The result of this process is shown in Figure 6.

Correlation across all the wells using available well data, sequences and systems tracts shows that sequence 1 is represented in all wells, however, with varying degree of representation of the different system tracts that make up the sequence. Generally, sequence 1 in wells Sh 02, Sh 04 and Sh 06 is of relatively shorter depth interval compared to intervals in wells Sh 01 and Sh 05. Interestingly, wells Sh 01 and Sh 05 are located more or less in the central part of the study area while the other wells are drilled towards the flanks. Wells Sh 01 and Sh 05 appear to have penetrated an incised channel.

This may be responsible for the difference in thickness seen in sequence 1. Characteristics of the other sequences above sequence 1 appear to confirm this assumption. Sequence 1 in all wells contains the main hydrocarbon bearing sand.

Lowstand systems tracts of sequence 2 are well preserved in all wells, but there is a lesser degree of preservation of transgressive systems and highstand systems tracts as they are almost completely eroded in well Sh 05 for example and they are generally smaller in size than the LST in the other wells except in well Sh 06.

A correlation of sequence 3 across the study area shows that the highstand systems tracts increase towards the flanks of the field as evidenced in the sizes of the HST in wells Sh 02, Sh 04 and Sh 06 (wells drilled towards the flanks) and wells Sh 01 and Sh 05 (wells drilled in the central part of the field).

Sequence 4 correlated across the field seems to be fairly well distributed among all systems tracts, although local variations are seen for example in well Sh 04 where the TST is a little smaller than LST and HST and well Sh 05 where both TST and HST have been eroded or where there has been sediment bypass and consequent non deposition (Posamentia and George, 1994).

Progradational patterns in sequence 5 is repeated in all wells from the flanks to the middle of the study area. Log signatures and characteristics within this sequence in all the wells are basically the same. From the resistivity log, it can be seen that deposits of this sequence are of fresh water environment (Owoyemi and Willis, 2006, Magbagbeola and Willis, 2007). Time and depth structural maps incorporating fault framework were generated for horizons mapped (Figures 7 and 8), horizons mapped across seismic sections are based on sequence boundaries determined from well logs.

Fault Mapping and Interpretation

Fault mapping was done after generating contrasts in seismic volume attributes on time slice and moving the time slice to intersect the different horizons. There is a major fault (F 1) that runs across the study area almost dividing the field into two parts, North and South (Figure 9).

There are other faults interpreted in the study area beside the major growth fault, they are labeled F 2, F 3, F 4, F 5 and F 6 respectively (Figure 9). Although fault F 2 is also a growth fault with an antithetic fault associated with it and seems to run across the field from East to West, it does not possess the characteristics of dividing the field into two halves. While the major growth faults generally trend from East to West, antithetic faults trend from northeast to southwest.

Other minor faults like F 4 and F 5 trend parallel to the growth faults. As evidenced in this field, rapid sedimentation resulting in growth faulting and formation of rollover anticline structures seem to provide more and more accommodation with even more deformation as resultant effect (Selly, 1988, Doust and Omatsola, 1990, Reijers *et al.*, 1997, Haack *et al.*, 2000, Corredor *et al.*, 2005, Owoyemi *et al.*, 2006).

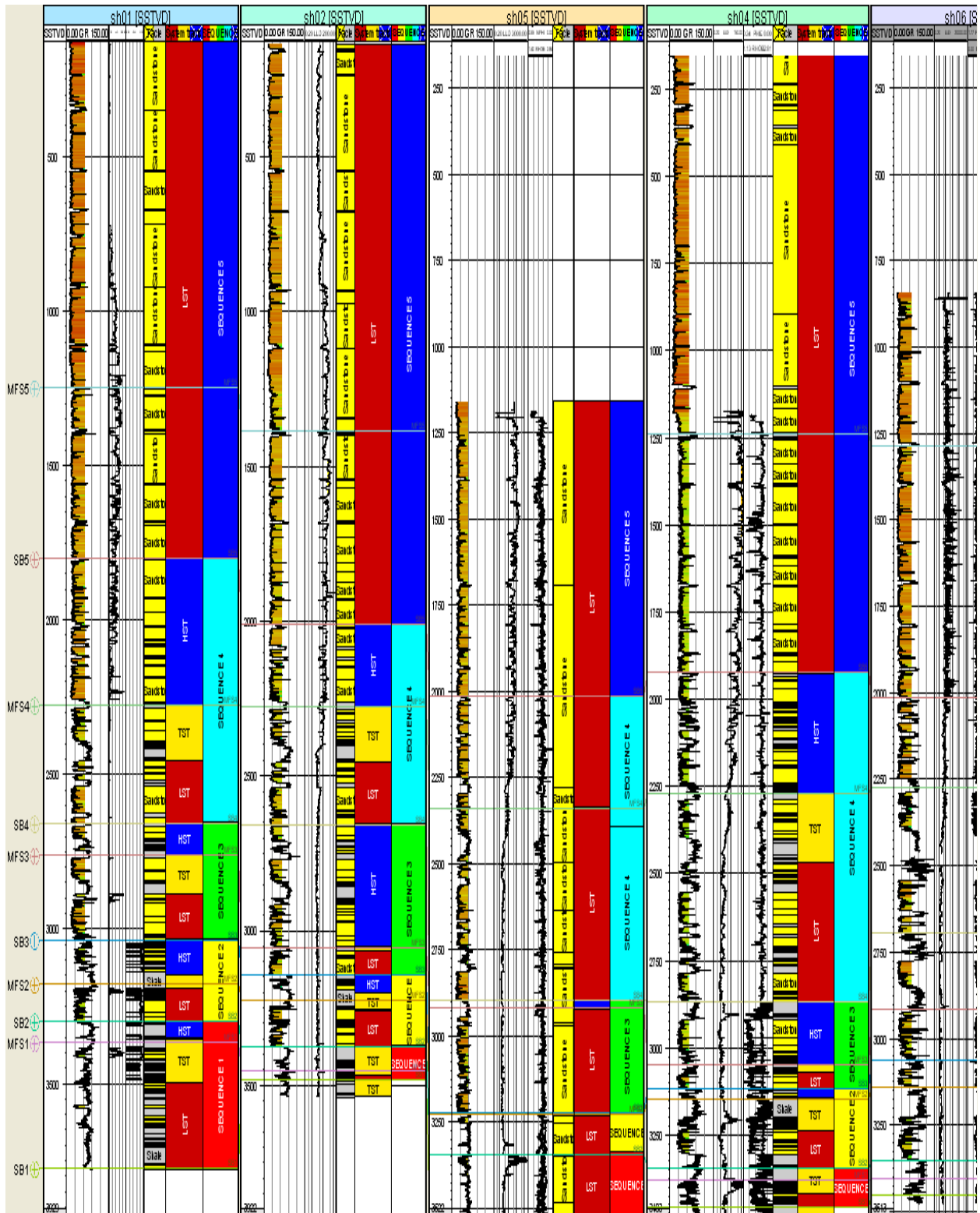


Figure 6: Correlation Panel showing Wells Sh 01, Sh, 02, Sh 04, and Sh 05. Systems Tracts and Sequences are also highlighted.

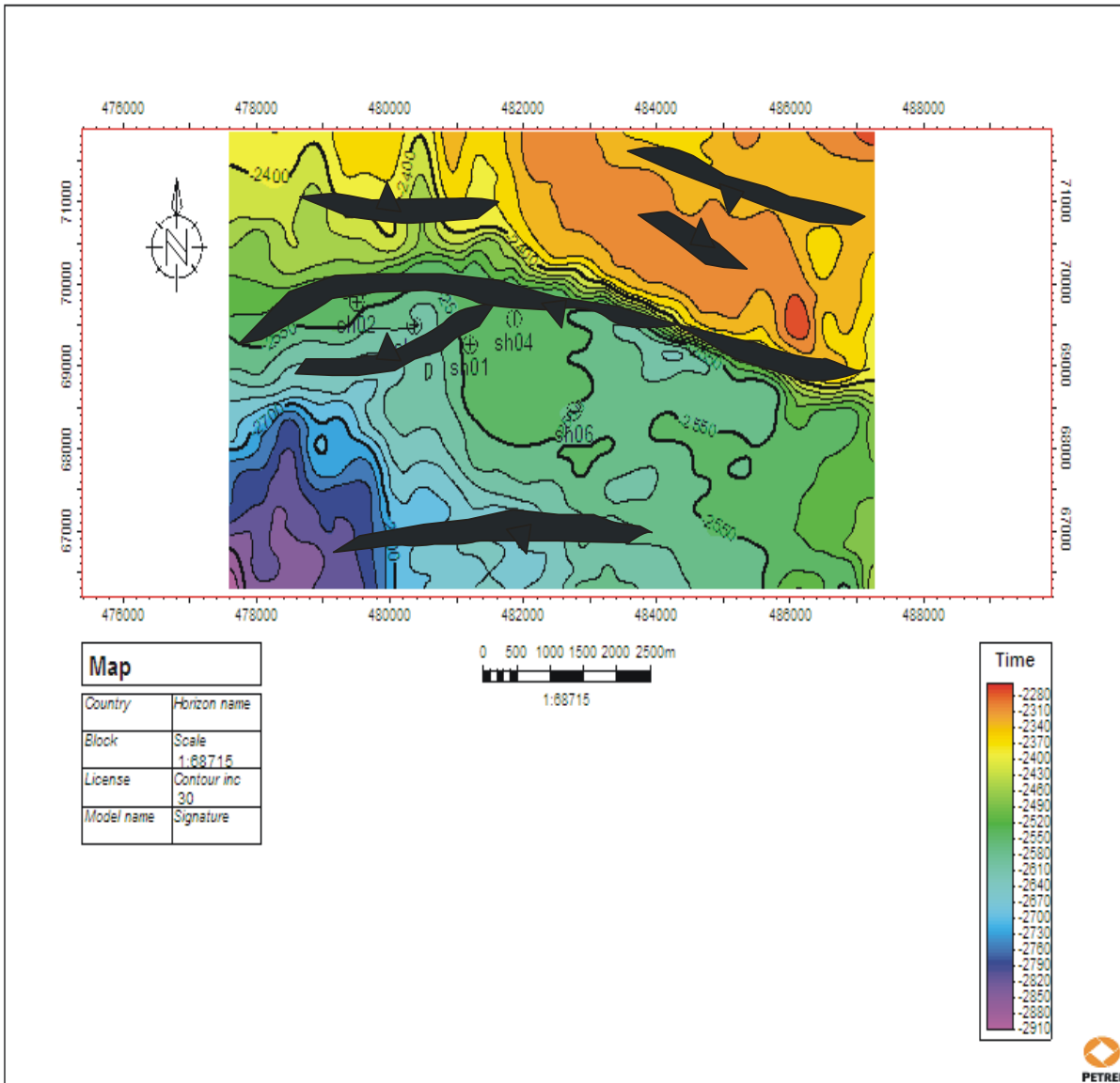


Figure 7: Time structural map of SB 2/Horizon 2 with fault framework incorporated.

The structural high in the NE part of the study area makes it a probable area of interest. Anticlinal structure associated with this portion and the fact that the anticline has a structural closure is a strong point. Moreover this area has not been tested, in the sense that no well has been drilled in it. Although the bigger anticlinal structure seems to be faulted, the remarkable thing is that the fault is entirely located within the structure which means whatever hydrocarbon is within the structure would still be retained in it.

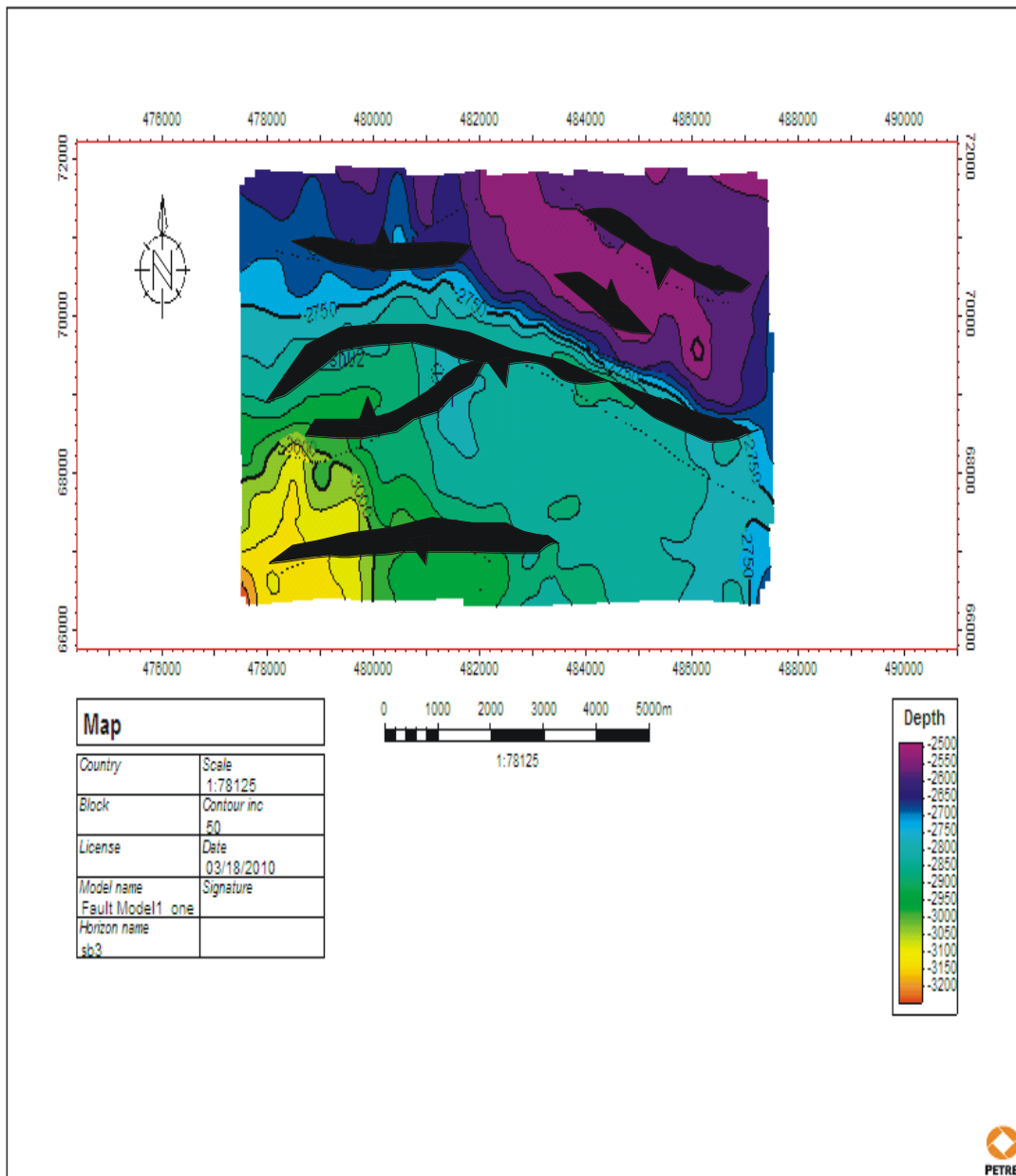


Figure 8: Depth Map of SB 2/ Horizon 2.

No wells have been drilled in the NEtern portion of the study area, and from the structural closure as seen in the anticline, that portion of the Olay field seems to be highly prospective.

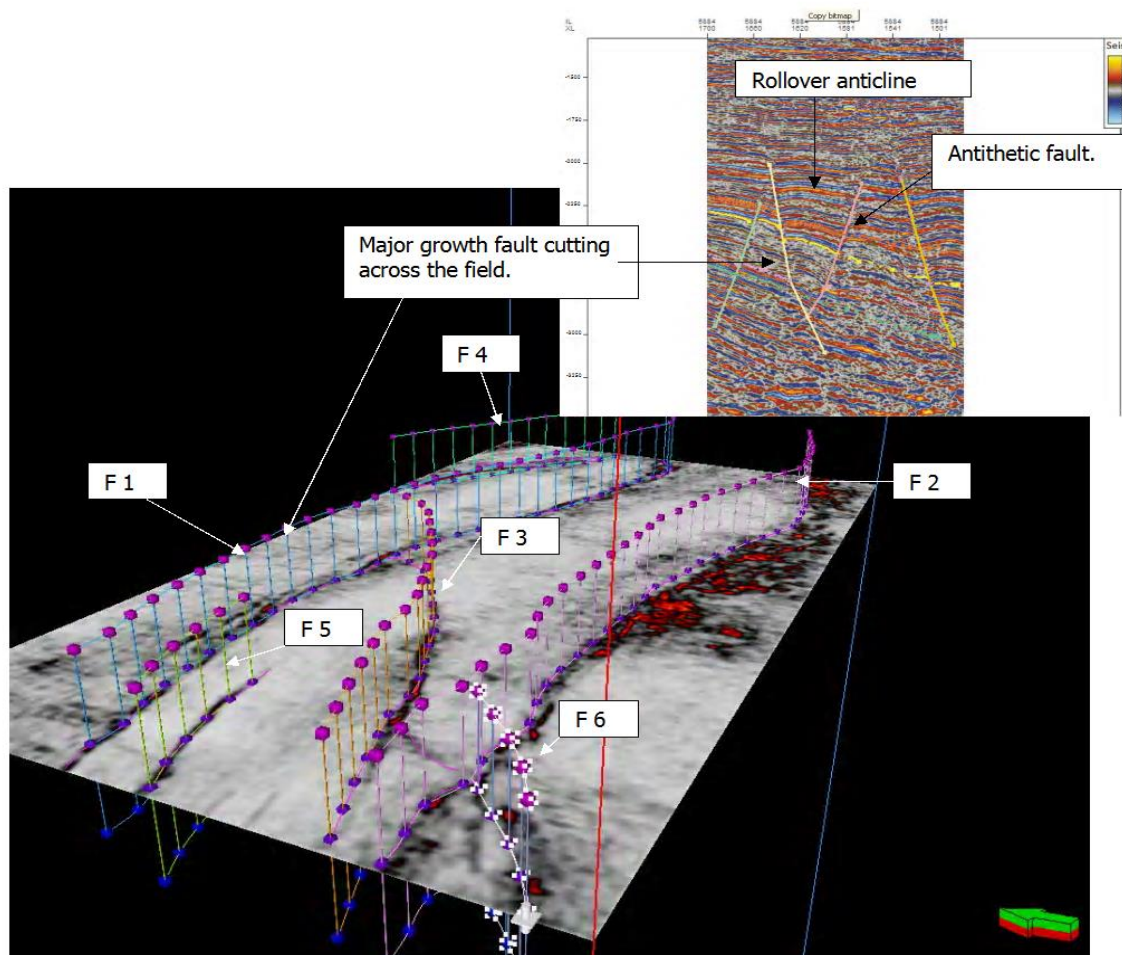


Figure 9: Fault Interpretation.

Depositional Environment

Depositional environments were interpreted after comparing log signatures within sequences, parasequences and parasequence sets and their stacking patterns with the stacking patterns and depositional environments proposed by Van Wagoner *et al.* (1990), Neal *et al.* (1993), Posamentier and George (1994) and Chris Kendall (2005) within the background of previous works done by Adeogba *et al.* (2005), Magbagbeola and Willis (2007), Durogbitan and Gwarthorpe (2008) on some Niger Delta fields.

Stacking patterns of parasequences and parasequence sets were used to deduce the depositional systems of the different sedimentary succession in the Olay field. The blocky gamma

ray well log patterns at the upper parts of the field are interpreted to be fluvial channel fills, this is consistent with the results of Magbagbeola and Willis (2007). Also, the signatures of resistivity logs within these intervals confirm a fluvial environment of deposition.

Prograding, coarsening upwards, parasequence patterns located in the lower parts of the wells are interpreted to be shoreface deposits within shallow marine environments. Serrated fining upward parasequence and parasequence sets infer a storm dominated shelf setting. As a whole, the stratigraphic successions within the field is a progradational succession of clastic sediments, although there are fining upward sequences of fine grained sediments deposited during periods of relative sea level rise and landward movement of the shoreline.

It also does appear that some fluvial/delta plain deposits are preserved as seen in the occasional and intermittent increase of the gamma ray values especially in the upper parts of the well sections. The fact that well Sh 05 is made up almost entirely of lowstand systems tract deposits and parasequence stacking patterns that are progradational suggests that the sedimentary successions penetrated within the well are of channel fill depositional environment. This is further supported by the central position of well Sh 05 within the field.

Deposits within sequence 5 in all the wells with their progradational parasequences and parasequence sets stacking pattern and resistivity values show that they were deposited in fluvio deltaic environment. They are most probably river mouth bar or delta front deposits.

Hydrocarbon Potential

Analysis of sequences and individual systems tracts reveal that hydrocarbons are hosted mainly within lowstand systems tract and transgressive systems tract reservoirs. Below is a table of hydrocarbon occurrences with their associated systems tracts based on well log data interpretation. It is obvious from Table 1 that the lowstand systems tracts (LST) are the main hydrocarbon hosts. This trend is observed in the other wells as well. However, there is an exception to this generalization, the reservoir located in sequence 1 falls within the transgressive systems tract (TST); it has similar resistivity, water saturation and neutron porosity values with the immediate overlying LST reservoir.

Table 1: Hydrocarbon Occurrence and Associated Systems Tracts from Well Sh 01.

Depth Interval (m)	Resistivity Ohm m/m²	Water saturation	Neutron porosity (p.u)	Systems Tract
2470 – 2477	4 – 18	0.3 – 0.5	20	LST
2652 – 2655	5 – 26	0.2 – 0.5	25	LST
2782 – 2788	5 – 50	0.2 – 0.5	35	LST
2901 – 2928	5 – 170	0.05 – 0.1	50	LST
3207 – 3210	5 – 135	0.1 – 0.5	56	LST
3215 – 3226	6 – 173	0.08 – 0.5	60	LST
3399 – 3432	6 – 155	0.1 – 0.5	60	TST

Traps within the Olay field are mainly structural as evidenced in the occurrences of anticlinal structures and faults. Wells drilled so far in the field have been restricted to the northwestern part of the study area and they are located close to fault zones. Bonvier *et al.* (1989) and Koledoye *et al.* (2004) have shown that faults can constitute seals for hydrocarbon reservoirs. Reservoir sands interpreted from well logs, mapped and correlated across the wells are found to continue throughout the field.

Moreover, shales of the transgressive systems tract are also found to be laterally extensive creating the needed sealing facies for the hydrocarbon bearing sand intervals. With similar structures; faults and anticlines located within the continuum, it is highly probable that the northeastern part of the study area holds some promising quantity of hydrocarbon also.

In addition, there are occurrences of stratigraphic traps in the form of incised channel fills within the Olay field, Well Sh 05 is interpreted to have been drilled through an incised channel because of the nature of the sedimentary successions within the well and its relationship with other wells around it.

CONCLUSIONS AND RECOMMENDATIONS

The clastic sedimentary successions in the Olay field were analysed using sequence stratigraphic principles that involve the use of parasequence stacking patterns to interpret systems tracts, sequences and depositional environment.

Geological structures were interpreted based on seismic reflection profile; these structures include growth faults, antithetic faults and rollover anticlines.

Well log patterns were critically examined to determine parasequences and parasequence sets stacking patterns. Series of forestepping and basinward progradational coarsening upward sequences were interpreted as well as successions of backstepping, landward and retrogradational fining upward units. A total of 5 sequences were interpreted and named successively as sequences 1 to 5 from bottom to top. All the sequences are made up of lowstand systems tracts (LST), transgressive systems tracts (TST) and highstand systems tracts (HST). The only exception is sequence 5 which is entirely

a progradational unit in all wells. Also, Well Sh 05 is almost exclusively made up of lowstand systems tract deposits in the sequences.

Flooding surfaces were defined mainly by highest gamma ray and lowest resistivity values. Maximum flooding surfaces were marked after careful observation of the character of flooding surfaces and consideration of neutron porosity and bulk density values of individual flooding surfaces. 5 maximum flooding surfaces were defined within the study area, MFS were mapped independently on well logs and seismic volume.

Hydrocarbon bearing sands interpreted from well logs were found to be laterally continuous in the Olay field. With the presence of such structures as growth faults and rollover anticlines throughout the field, it is highly probable that these sands contain hydrocarbon also in the yet to be assessed (especially northeastern) parts of the Olay field. Seismic reflections with characteristically high amplitude across the northeastern part of the study area also support this position. Depositional systems in the Olay field include incised channel fill, shoreface deposits and fluvial/delta plain deposits within marine and fresh water environments.

RECOMMENDATIONS

Appraisal wells can be drilled to an average depth of 2500 m in the following locations. A) X: 486000, Y: 70800. B) X: 482400, Y: 72600. C) X: 484600, Y: 72800. With Location A it will be possible to assess the eastern limit of the anticlinal structure in horizon 2 while at location B the western limit of the same structure could be assessed.

ACKNOWLEDGEMENT

Authors are grateful to the Department of Petroleum Resources and Chevron Nigeria Limited for the provision of the data used for this work. Thanks are also due to ExxonMobil for provision of the facility, Unilorin ExxonMobil workstation room used for this work. Schlumberger Nigeria is specially acknowledged for the provision of the Petrel software used for this study. Tosin Rotimi, Taye Adeoye, Akinjolare, Niyi Aladesuslu are also thankfully acknowledged for their technical support.

REFERENCES

1. Adeogba, A.A., T.R. Mchargue, and S.A. Graham. 2005. "Transient Fan Architecture and Depositional Controls from Near-Surface 3-D Seismic Data: Niger Delta Continental Slope". *AAPG Bulletin*. 89(6): 753–780.
2. Ajayi, O.K., A.O. Adeniji, R.E. Hill, J.P. Linscott, I.O. Uka, W.R. Brock, E.E. Udoh, F.A. Babatunde, and P.A. Ononiwu. 2006. "Field Depletion Optimization through Integrated Approach to Field Study: Usari Intermediate Reservoirs, Offshore Nigeria". *NAPE Bulletin*. 19(1):59-61.
3. Bouvier, J.D., D.F. Kluesner, C.C. Onyekwe, and R.C. Van Der Pal. 1989. "Three Dimensional Seismic Interpretation and Fault Sealing Investigations, Nun River Field, Nigeria". *AAPG Bulletin*. 73:1397-1414.
4. Cant, D.J. 1992. "Subsurface Facies Analysis". In: *Facies Models: Response to Sea Level Change*. Walker, R.G. and N.P. James, (eds.), Geological Association of Canada, GeoText. 1, 27–45.
5. Corredor, F., J.W. Shaw, and F. Bilotti. 2005. "Structural Styles in the Deep Water Fold and Thrust Belt of the Niger Delta". *AAPG Bulletin*. 89: 753-770.
6. Doust, H. and E. Omatsola. 1990. "Niger Delta". In: *Divergent/passive Margin Basins*. Edwards, J. D. and P.A. Santogrossi, (eds.). *AAPG Memoir*. 48, 239-248.
7. Durogbitan, A.A. and R.L. Gwathorpe. 2008. "Sequence Stratigraphic Analysis of Middle Miocene Paralic Deposits (Agbada Formation), Ewan and Oloye Fields, Central Niger Delta". *AAPG Annual Convention, Extended Abstracts*. 50.
8. Ejedawe, J.E., B. Lehner, S. Meyer, F. Olugbemiro, L. Fullarton, O. Agwunobi, J. Agbo, and J. Calvache. 2004. "Regional Sequence Stratigraphy and Sand Fairways as Controls on Hydrocarbon Occurrence in the Niger Delta". In: *Application of 3-D Structural Interpretation and Seismic Attribute Analysis to Hydrocarbon Prospecting over X – Field, Niger Delta*. Rotimi, O.J., A.A. Ameloko and O.T. Adeoye (eds). 2010. *International Journal of Basic & Applied Sciences*, 10 (4).
9. Giwa, G.O., A.C. Oyede, and E.A. Okosun. 2005. "Emerging Trends in the Application of Biostratigraphy to Petroleum Exploration and Production". *NAPE Bulletin*. 18(1):12-27.
10. Haack, R.C., P. Sundararaman, J.O. Diejomahor, H. Xiao, N.J. Gant, E.D. May, and K. Kelsch. 2000. "Niger Delta Petroleum Systems, Nigeria". In: *Petroleum Systems of South Atlantic Margins*. Mello, M.R. and B.J. Katz, (eds.). *AAPG Memoir* 73, 213-231.
11. Koledoye, A. and E. May. 2003. "A New Process-Based Methodology for Analysis of Shale Smears along Normal Faults in the Niger Delta". *NAPE Bulletin*. 17(1): 48-60.
12. Loutit, T.S., J. Hardenbol, P.R. Vail, and G.R. Baum. 1988. "Condensed Sections: The Key to Age-Dating and Correlation of Continental Margin Sequences". In: *Sea Level Changes—An Integrated Approach*. Wilgus, C. K., B. S. Hastings, C.G. Kendall, C. St., H.W. Posamentier, C. A. Ross, and J.C. Van Wagoner, (eds.). SEPM Special Publication. 42:183–213.
13. Magbagbeola, O.A. and B.J. Willis. 2007. "Sequence Stratigraphy and Syndeformational Deformation of the Agbada Formation, Robertkiri Field, Niger Delta, Nigeria". *AAPG Bulletin*. 91(7): 945-958.
14. Michele, L.W., R.R. Charpentier, and M.E. Brownfield. 1999. "The Niger Delta Petroleum System: Niger Delta Province, Nigeria, Cameroon, and Equatorial Guinea, Africa". USGS, 70p.
15. Neal, J., D. Risch, and P.R. VAIL. 1993. "Sequence Stratigraphy-A Global Theory for Local Success. Oilfield Review". ORS 93/0193, 51-62.
16. Owoyemi, A.O. and B.J. Willis. 2006. "Depositional Pattern across Syndeformational Normal Fault, Niger Delta, Nigeria". *Journal of Sedimentary Research*. 76:346-363.
17. Ozumba, M.B., D.A. Omene, and C. Otoghile. 2005. "The Opuam Channel Area 3D Prospectivity Review, Impact of High Resolution Sequence Stratigraphy". *NAPE Bulletin*. 19(1): 1-11.
18. Posamentier, H.W. and P.A. George 1994. "Siliciclastic Sequence Stratigraphy: Concepts and Application". *AAPG Short Course*. 10, 89 p.
19. Reijers, T.J.A., S.W. Petters, and C.S. Nwajide. 1997. "The Niger Delta Basin". In: *African Basins. Sedimentary Basins of the World*. Selly, R.C. (ed.). Elsevier Science: Amsterdam, The Netherlands. 3:151-172.
20. Rider, W.H. 1986. *The Geological Interpretation of Well Logs*. Blackie and Sons, Ltd.. Glasgow, UK. 175.
21. Shelly, R.C. 1988. *Applied Sedimentology*. Academic Press: Harcourt Brace Jovanovich Publishers: London, UK. 443.

22. Serra, O. and H. T. Abbott. 1982. "The Contribution of Loggin Sedimentology and Stratigraphy". *SPE Journal*. 22(1):117–131.
23. Short, K.C. and A.J. Stauble. 1967. "Outline of Geology of Niger Delta". *AAPG Bulletin*. 51:761-779.
24. Stacher, P. 1995. "Present Understanding of the Niger Delta Hydrocarbon Habitat". In: *Geology of Deltas*. Oti, M.N. and G. Postma (eds). A.A. Balkema: Rotterdam, The Netherlands. 257-267.
25. Vail, P.R., R.M. JR. Mitchum, and S. Thompson. 1977. "Seismic Stratigraphy and Global Changes of Sea Level, Part Four: Global Cycles of Relative Changes of Sea Level". *AAPG Memoir*. 26:83–98.
26. Van Wagoner, J.C., R.M. JR. Mitchum, K.M. Campion, and V.D. Rahmanian, 1990. "Siliciclastic Sequence Stratigraphy in Well Logs, Core, and Outcrops: Concepts for High-Resolution Correlation of Time and Facies". *AAPG in Exploration Series*. 7: 55.

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SUGGESTED CITATION

Osetoba, O.A. and O.J. Ojo. 2014. "Sequence Stratigraphic Analysis of Olay Field, Niger Delta, and Implications for Hydrocarbon Prospect". *Pacific Journal of Science and Technology*. 15(1):375-391.

 [Pacific Journal of Science and Technology](http://www.akamaiuniversity.us/PJST.htm)