



Detection of Overpressure in X Field in the Niger Delta (Central Swamp Onshore Niger Delta basin) Using Well-log and Repeat Formation Tester Data

By

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ABSTRACT

Well-log and Repeat Formation Tester (RFT) data were used for the detection of overpressure in X Field in the Niger Delta, using sonic, gamma ray, density and calliper logs and RFT data. ROKDOC software was used for the analysis of these data. And the result compared with the RFT log data. The result shows that the onset of overpressure was observed in Wells A and B depth below 7700ft and in Well C at a depth below 7150ft respectively. The formation pressure gradient ranges from 0.836 psi/ft to 0.934 psi/ft for Well A, from 0.830 psi/ft to 0.928 psi/ft for Well B, and from 0.830 psi/ft to 0.967 psi/ft for Well C. Overpressures in the study area are as a result of compaction disequilibrium and secondary mechanism. That is the point at which fluids are no longer being expelled effectively due to low permeability as the rock attempts to compact. The results of the present study would be useful in assessing seal effectiveness, mapping of hydrocarbon migration pathways, trap configuration, basin geometry, basin modelling, and safe and economic drilling.

Keywords: Overpressure, disequilibrium compaction, shale, pore pressure detection, fracture pressure.

INTRODUCTION

Overpressure is a major concern in exploration and production of oil and gas. Pore pressure prediction has been a vital concern to the oil and gas industry for many decades. As the oil and gas industry explores for deeper targets, it has been noted that most sedimentary basins exhibit overpressures^{1, 2}. Overpressured formations are characterized by (though not limited to) the following properties when compared with a normally pressured section at the same depth: (1) Higher porosities (2) Lower bulk densities (3) Lower effective stresses (4) Higher temperatures (5) Lower interval velocities (6) Higher Poisson's ratios (7) Velocity reversals^{3, 4}.

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¹ Fertl, W. H. 1976. Abnormal formation pressures: Elsevier Scientific Publishing Company, 382

² Zizhen, W. and Ruihe, W. 2015. Pore pressure prediction using geophysical methods in carbonate reservoirs:

Current status, challenges and way ahead. Journal of Natural Gas Science and Engineering, Vol. 27: 986-993.

³ Dutta, N. C. 2002. Geopressure prediction using seismic data: Current status and road ahead. *Geophysics*, Vol. 67: 2012-2014.

⁴ Uko, E. D., Emudianughe, J. and Tamunobereton-ari, I. (2013). Overpressure prediction in the north-west Niger Delta using porosity data. *Journal of Applied Geology and Geophysics*, Vol.1 No 3: 42-50.

Overpressure poses a major threat to the success of exploration and production of hydrocarbons. Rapid processes of deposition and sedimentation that builds up tertiary basins have resulted into under-compaction at depths⁵. It is commonly accepted that compaction results majorly due to vertical stress induced by deposition or tectonic activities. Rapid burial rate gives sediments less time to dewater. Lithologically, fine grained sediments reduce the permeability thus impeding dewatering.

This fluid retention is most favoured by the presence of low permeability rocks such as shales, evaporates, and well cemented carbonates often referred to as seals. This seal prevents the escape of pore fluids at rates sufficient enough to compensate for the rate of increase in vertical stress induced by the overlying beds, and thus the pore fluid pressure begins to carry a large part of the load, and thereby increase the pore fluid pressure⁶. Pressure compartments are characterized by their distinct pressure regimes which affect the maturation, migration and trapping history of hydrocarbons^{7,8}. An understanding of the rock/fluid characteristics of the subsurface formation is of critical importance in the evolution of oil and gas fields. The aim of this work is to detect Overpressure in X Field Central Swamp Onshore Niger Delta basin in the Niger Delta using Well-log and Repeat Formation Tester Data.

GEOLOGIC SETTING OF THE STUDY AREA IN THE NIGER DELTA

The Niger Delta is situated at the West African margin of the Gulf of Guinea. The study area is located in Central Swamp Onshore Niger Delta basin. 4° 49'60" N and 6° 0' 0" E. (Figure 1).

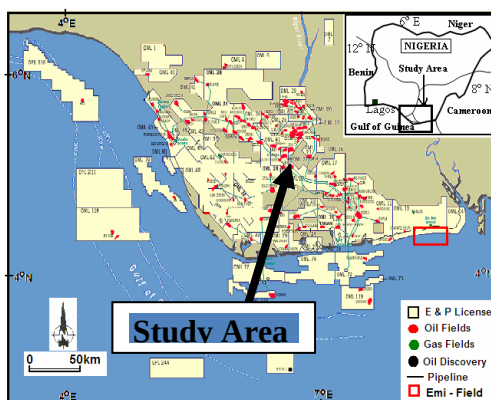


Figure 1: Map of X field in the Niger Delta

⁵ Osborne, M.J., and Swarbrick, R.E.1997. Mechanism for generating overpressure in sedimentary basins: A revaluation. *American Association of Petroleum Geologists Bulletin*, Vol. 81: 1023-1041.

⁶ Nwozor, K. K., Omudu, M. L., Ozumba, B. M., Egbuachor, C. J., Onwuemesi, A. G., Anike, O. L. 2013. Quantitative evidence of secondary mechanism of overpressure generation: Insight from parts of Onshore Niger Delta, Nigeria. *Petroleum technology development journal*, Vol. 3 No.1: 64-83.

⁷ Hunt, J.M. 1990. Generation and migration of petroleum from abnormally pressured fluid compartments: *American Association of Petroleum Geologists Bulletin*, Vol. 72: 1-12.

⁸ Tissot, B.P., Pelet, R. and Ungerer, P.H. 1987. Thermal history of sedimentary basins maturation indices and kinetics of oil and gas migration, *American Association of Petroleum Geologists Bulletin*, Vol.71: 1445-1466.

The stratigraphic sequence of the Niger Delta basin has been described by^{9, 10}. The Delta is composed of three major structural Formations: Akata, Agbada and Benin Formations (Figure 2). The Benin Formation is the upper alluvial coastal plain depositional environment of the Niger Delta Complex. It consists of coarse grained sand stones, gravel lignite streaks and wood fragments with minor intercalation of shales.

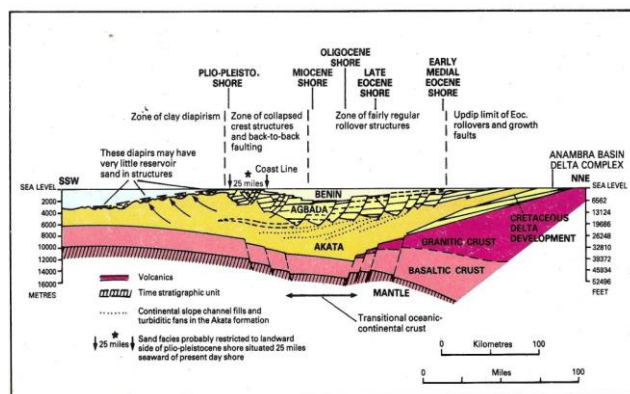


Figure 2: Akata, Agbada and Benin Formations

The Agbada Formation underlies the Benin Formation. It was laid down in paralic brackish to marine fluviatile, coastal environments. It is made up mainly of alternating sandstone, silt and shale. The Akata shales are mobile, under-compacted and typically overpressured. They are considered to be the main source rock of the Niger delta with the upper part considered mature source rock¹¹.

METHODOLOGY

Gamma Ray (GR), Resistivity (Resis), Density (Rho), Sonic (V_p) and Caliper (Cal) Logs. data for this work were obtained from Shell Petroleum Development Company (SPDC). ROKDOC software was used to carry out the interpretation of the sourced data. Quality control checks were carried out on the data. Correct log units and scales were set in the ROKDOC project before loading the data set. Density (Rho) unit in g/cm^3 , Resistivity (Resis) unit in ohmm, Sonic (V_p) unit in m/s, Caliper (Cal) unit in inches and Gamma ray (GR) unit in API. Depth discrepancies, correct scaling, spikes and gaps were also observed the coordinate system and the reference elevations were checked and accurately set in ROKDOC to map the project in a correct geographic location in space. Overburden stress and Shale Volume was determined using GR logs. Normal Compaction trend (NCT) of Shale and Relationship between V_p -Rho crossplot was established¹².

⁹ Short, K.C., and Stauble, A.J. 1967. Outline of geology of Niger Delta: *American Association of Petroleum Geologists Bulletin*, Vol. 51: 761-779.

¹⁰ Avbovbo, A.A. (1978). Tertiary Lithostratigraphy of Niger Delta. *American Association of Petroleum Geologists Bulletin*, Vol. 62: 295-300

¹¹ Ekweozor, C. M. and Daukoru, E.M. 1984. Petroleum source bed evaluation of Tertiary Niger Delta. *American Association of Petroleum Geologists Bulletin*, Vol. 70: 48-55

¹² Hoesni, M. J. 2004. *Origins of overpressures in Malay basin and its influence on petroleum system. PHD. Thesis*, Durham University.

Shales are preferred lithology for pore pressure interpretation because sandstones have different compaction properties and cannot be used directly for pore pressure interpretation. Overburden stress was generated for well A, NCT was generated for well A and V_p -Rho crossplot for well A was carried out.

The volume of shale was calculated from the GR log using the equation:

$$V_{(sh)} = \frac{GR_{log} - GR_{min}}{(GR_{max} - GR_{min})} \quad (1)$$

Where V_{sh} = Volume of shale; GR_{log} = Gamma ray reading of formation; GR_{min} = Minimum Gamma ray (Clean sand); GR_{max} = Maximum gamma ray (Shale). The Volume of Sand was calculated using the equation: $V_{sand} = 1 - V_{shale}$. A shale cutoff of 0.65 (a shale limit set in Rokdoc) was applied to the V_{shale} to make a lithologic discrimination between sand and shale sequence, such that interval with volume of shale less than 0.65 is class as sand and intervals with Volume of shale greater than 0.65 is grouped as shale.

Since pressures are predicted in shale, the velocity reading within the clean shale intervals were picked out (termed V_p shale trend), from which the normal compaction trend is established. The observed velocity in shale (V_p shale trend) and the velocity of a normally compacted shale (the result of fitting a line of best fit to the shallow section assumed to be normally compacted) are inputs in Eaton model equation. Using Rho log, the bulk density log is used in the calculation of the overburden stress.

The exponential equation was used to calculate the Rho fit:

$$Rho_{zml} = (Rho_{matrix} - Rho_{Top}) \cdot \exp(-b \cdot zml) \quad (2)$$

Where: $Rho_{(zml)}$ = density at depth z below mudline; $Rho_{(Matrix)}$ = matrix density, $Rho_{(Top)}$ = density at mudline (seabed) and b is the compaction coefficient.

RFT data are measured data at reservoir intervals to which the results of the prediction are compared. RFT points were represented as a green triangle on the pressure view interface (Figure 10, 11 and 12), which serves as landmark markers confirming the accuracy or not of our prediction. If the predictions correlate well with the RFT points, it is an indication that the results of the prediction at other points where there is no RFT data can be trusted.

Acoustic sonic velocity is inputted into the equation of the two methods using ROKDOC to establish the relationship. It is crucial to establish a relationship between velocities and pore pressure using offset well data. This is because, it enables us to test how reliably well, the acoustic parameter can be used to determine the formation pressure and to derive the calibration parameters as well required in the methods used.

Equation 2 is the founding equation based on¹³, theoretical soil mechanics, upon which the two models^{14, 15} were based.

A derivation Eaton and Bowers relationship from Terzhagi relationship is as shown:

$$\sigma = S - P \quad (3)$$

EATONS MODEL

$$\sigma = \sigma_N \left(\frac{v}{v_n} \right)^3 \quad (4)$$

Then

$$P_p = (S_v - P_n) \left(\frac{\Delta V_{p_{obs}}}{\Delta V_{p_{norm}}} \right)^3 \quad (5)$$

BOWERS MODEL

$$V_p = V_{ml} + A \sigma_e^B \quad (6)$$

$$\sigma = \left(\frac{V_p - V_{ml}}{A} \right)^{\frac{1}{B}} \quad (7)$$

$$P_p = S_v - \left(\frac{V_p - V_{ml}}{A} \right)^{\frac{1}{B}} \quad (8)$$

where: σ = effective stress; S = overburden stress; P = pore pressure; σ_n = Effective Stress of a normal compaction; v_n = Velocity of normally compacted formation, v = Observed velocity; P_p = formation pore pressure gradient; P_n = hydrostatic pore pressure gradient (normally 0.45 psi/ft or 1.03Mpa/km, dependent on water gradient salinity); $V_{p_{obs}}$ = velocity observed; $V_{p_{norm}}$ = velocity on normal trend; V_p = the compressional velocity at a given depth; V_{ml} = the compressional velocity in the mudline (i.e. the sea floor or the ground surface); A and B are the parameters calibrated with offset velocity versus effective stress; σ_e = effective stress.

The result of Eaton equation and Bowers equation was called Eaton model and Bowers model in the final prediction. This was come about by putting the various parameters in the equation for

¹³ Terzaghi, K., 1943. *Theoretical soil mechanics*: John Wiley and Sons, Inc.

¹⁴ Eaton, B.A. 1975. The equation for geopressure prediction from well logs. *Society Petroleum*. 50-63.

¹⁵ Bowers, G. L. 1995. Pore pressure estimation from velocity data: Accounting for overpressure mechanisms besides undercompaction: *Society of petroleum Engineer Drilling and Completions*, 1-19.

each well and the results of that exercise was plotted against depth to get the blue line and the red line termed Bowers and Eaton model.

The detected pore pressure was applied in¹⁶ equation of fracture pressure prediction to determine the minimum stress at which a formation will fracture.

$$F_p = K (S_v - P_p) + P_p \quad (9)$$

where S_v = Lithostatic stress; P_p = Pore Pressure; K = Stress ratio; F_p = Fracture pressure. The fracture pressure is the black line in (Figures 10, 11 and 12).

Repeat formation tester (RFT)

The repeat formation tester (RFT) tool was designed to measure formation pressure quickly and accurately. It measures pressure at specific points on the borehole wall. Repeat formation test tool measures the following pressures.

- A. The hydrostatic pressure of the fluids in the well, it produces two readings.
 - B. The pore pressure of the formation.
 - C. The pressure transient induced by the withdrawal of 2 small samples
- Beside the valuable information which can be gained, RFT also save rig time¹⁷.

Repeat Formation Tester Data for Well A, B and C

MD = Measured Depth, TVDkb = True Vertical Depth below rig floor

TWT = Two way Time, TVDss = True Vertical Depth subsea

PType = Pressure Type, PForm = Pressure Form

Figure 3,4 and 5 represents the plot of RFT pressure against depth for well A, B and C.

¹⁶ Matthews, W.R., Kelly, J. 1967. How to predict formation pressure and fracture gradient. *Oil and Gas Journal*. Vol.780 No.65: 92-106.

¹⁷ Serra, O.1986.Advanced interpretation of wireline logs. Princeton Junction, NJ: Schlumberger.

Table 1: RFT data for well A

Pressure	MD
3226.56	7479.25
3263	7577.4
4557	8360
5433	9758.75
5432	9822.6
4684.9	10050.85
4766.04	10090.11
4756.04	10119.19

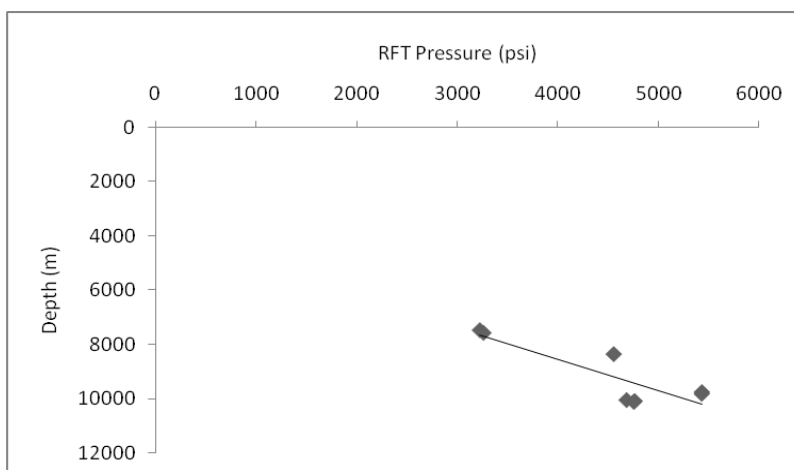


Figure 3: A plot of Pressure – Depth for well A

Table 2: RFT Data for Well B

MD	TVDkb	TVDss	Pressure
7707.97	7707.97	7660	3315
9481.97	9481.97	9434	4359.1
9481.97	9481.97	9434	4359.1
11023.97	11023.97	10976	5321.8
11023.97	11023.97	10976	5316.8
11033.97	11033.97	10986	5400
11867.97	11867.97	11820	6275.6
11877.97	11877.97	11830	6370.8

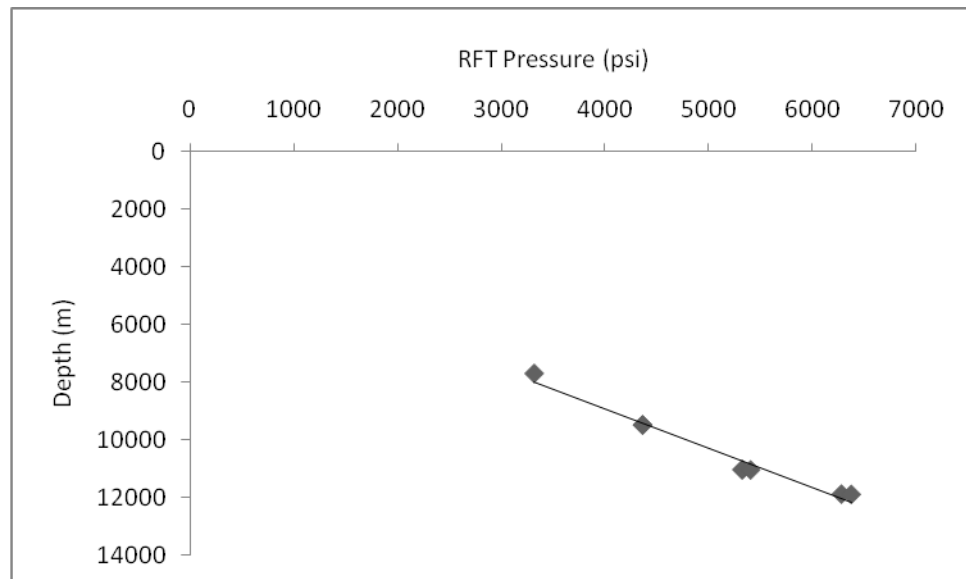


Figure 4: A plot of Pressure - Depth for well B

RFT Data for Well C

MD	TVDkb	TVDss	Pressure
8512.01	8512.01	8320.82	4922.57
8518.04	8518.04	8326.85	4920.1
8519.05	8519.05	8327.86	4922.72
8525.08	8525.08	8333.89	4925.68
8631.09	8631.09	8439.9	5043.44
8646.02	8646.02	8454.83	5046.4
8665.04	8665.04	8473.85	5050.98
8666.01	8666.01	8474.82	5166.53
8934.04	8934.04	8742.85	5680.7
8950.06	8950.06	8758.87	5760.14
8951.08	8951.08	8759.89	5760.98
9034.19	9034.19	8843	5762.23
9069.07	9069.07	8877.88	5760
9170.1	9170.1	8978.91	4779.16
9220.05	9220.05	9028.86	4869.17
9670	9670	9478.81	6084.83
9676	9676	9484.81	6085.17
9824	9824	9632.81	6105.73
9831	9831	9639.81	6106.77
9847	9847	9655.81	6109.51
9888	9888	9696.81	6117.54
9903	9903	9711.81	6120.7
9938	9938	9746.81	6128.48
9972	9972	9780.81	6135.96
9987	9987	9795.81	6137.75

10005	10005	9813.81	6141.75
10026	10026	9834.81	6151.84
10044	10044	9852.81	6160.41
10062	10062	9870.81	6167.17
10260	10260	10068.81	6268.9
10272	10272	10080.81	6274
10287	10287	10095.81	6278.3
10542	10542	10350.81	6385.94
10568	10568	10376.81	6396.53
10581	10581	10389.81	6401.2
11154	11154	10962.81	8536.7
11158	11158	10966.81	8551.24

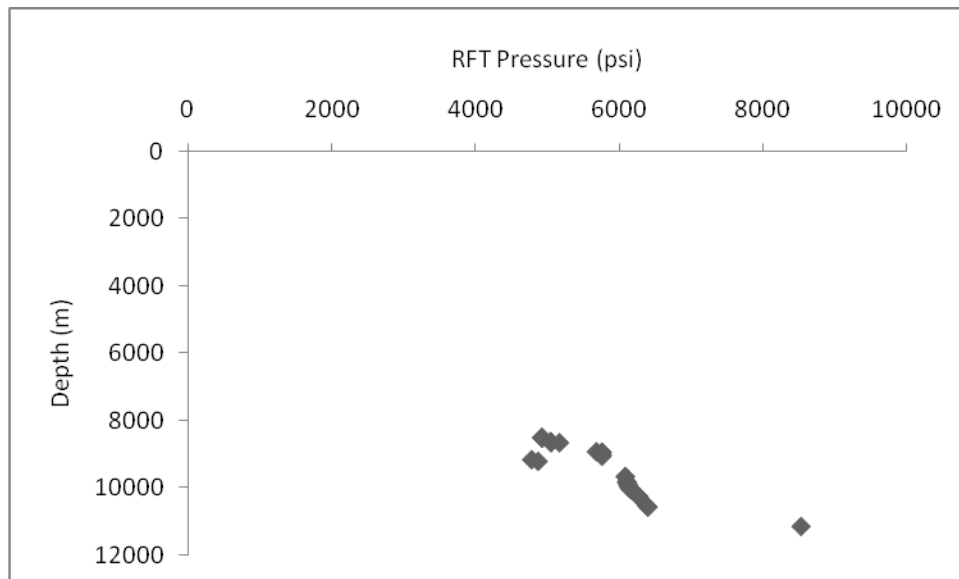


Figure 5: A plot of Pressure versus Depth for well C

From (Figure 10, 11 and 12) RFT Data were used for the detection of overpressure by comparing its data with pressure data from Eatons and Bowers model to see if they matched.

RESULTS AND DISCUSSION

A view of all Logs used for well A is displayed in (Figure 6). From Figure 7, the grey line on the right represents overburden pressure of a fixed gradient, while the black line is the estimated

overburden gradient from density log with the error margin in dotted line. To the left-hand side is the density log (Rho) and the Rho fit. The following logs were used for the detection of overpressure. (Figure 8) Showing sonic velocity generated NCT. (Figure 9) V_p – Rho crossplot (Coloured by depth).

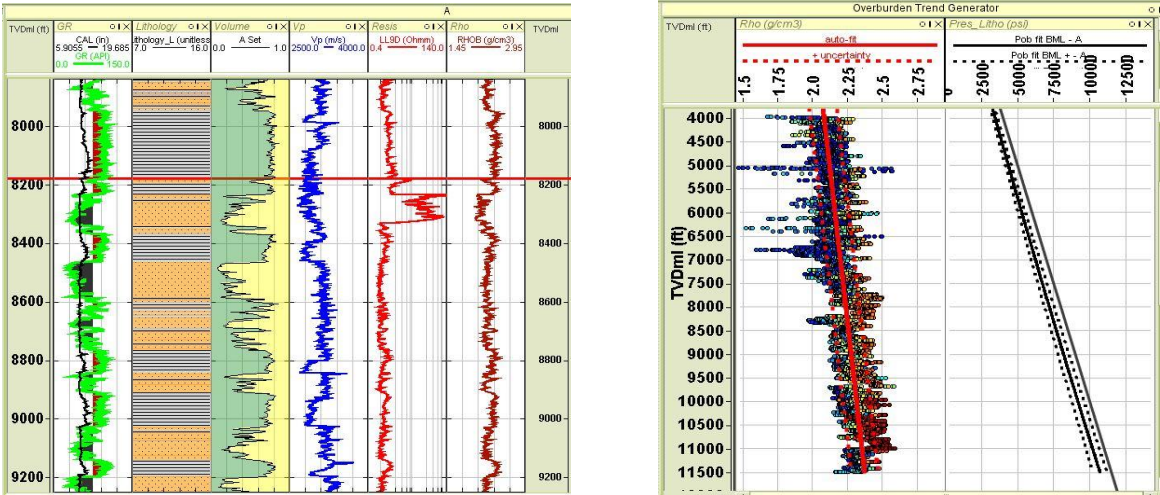


Figure 6: A view of Well logs use for this work. Figure 7: Sample of Overburden stress generated from density log.

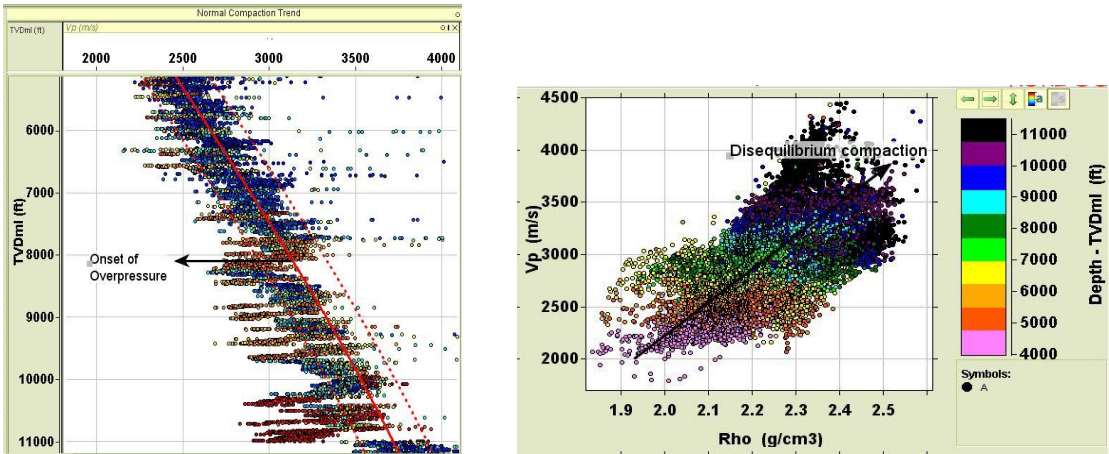
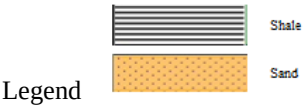


Figure 8: Showing sonic velocity generated NCT Figure 9: V_p – Rho crossplot (Coloured by depth)

Velocity–density crossplot for the wells analyzed plot a typical compaction disequilibrium curve for Well A. The lithology log derived from GR log showed a typical sand dominated Benin Formation for Well A and Well B, while Well C present an evidence of unloading with continuous reduction in velocity as density remains constant. The overburden gradient derived from the density log plotted parallel to the line of a fixed gradient of 1.0 psi/ft and it ranges from 0.836 psi/ft to 0.934 psi/ft for Well A, 0.830 psi/ft to 0.928 psi/ft for Well B, and 0.830 psi/ft to 0.967 psi/ft for Well C. The onset of overpressure was observed at 7,700 ft, 7,700 ft, and 7150 ft respectively for Well A, B, and C which correspond with the first Agbada shale Formation. Bowers loading model and Eaton model used for detection of overpressure at the interval shown to have undergone compaction disequilibrium gave a good match with the measured pressure where available, but under predict at the intervals suspected to be undergoing unloading. A maximum velocity (V_{max}) of 3393 m/s was observed at depth (d_{max}) 10148 ft (TVD), before the unloading process started. The result of the prediction showed that Well A and B increase from hydrostatic pressure gradient (0.433 psi/ft) to about 0.6 psi/ft (mild over pressured), while Well C increases from hydrostatic to about 0.66 psi/ft to a depth of 10148 ft, before unloading result in a change of the gradient which increases to pressure gradient of about 0.72 psi/ft (hard overpressure). (Figure 10, 11 and 12), represents the final prediction of pressure–depth profile of Well A, B and C

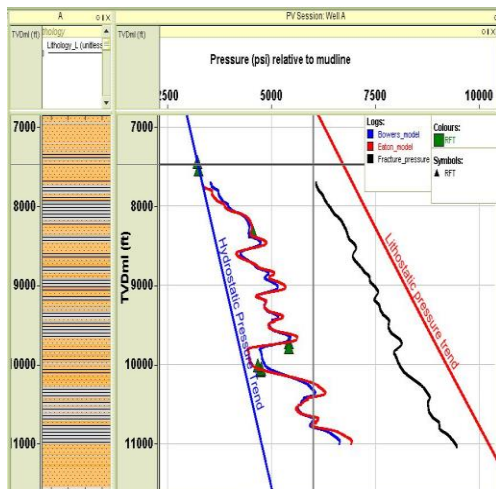


Figure 10: Pressure-Depth Profile Well A Final Prediction.

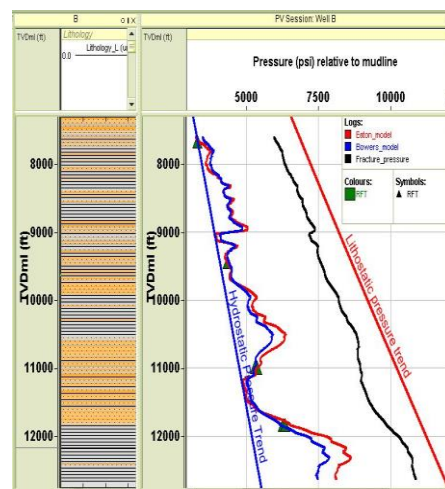


Figure 11: Pressure-Depth Profile Well B Final Prediction

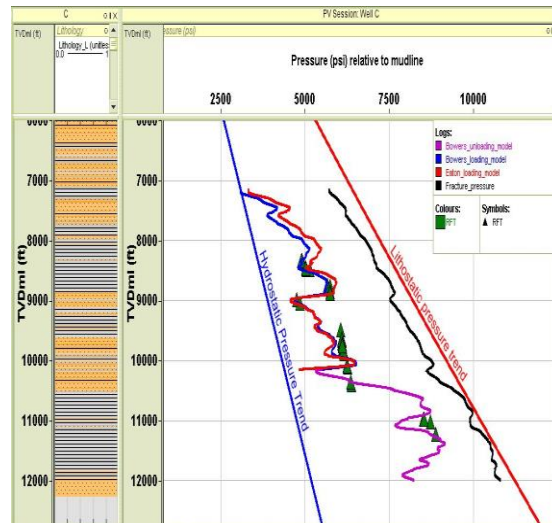


Figure 12: Pressure-Depth Profile Well C Final Prediction

Table 1: Pressure results for well A (Where TVD_{ml} is the Depth in feet and EATON and BOWERS are the pressure derived from their Model).

TV Dml (ft.)	Eato n (psi)	Bowe rs (psi)	TV Dml (ft.)	Eato n (psi)	Bowe rs (psi)	TV Dml (ft.)	Eato n (psi)	Bow ers (psi)	TV Dml (ft.)	Eato n (psi)	Bow ers (psi)	TV Dml (ft.)	Ea ton (ps i)	Bow ers (psi)
7700.31	3341.487	3354.71	7723.31	3350.949	3365.302	7746.81	3373.904	3385.735	7770.31	3424.747	3622.986	7793.81	3540.165	3703.973
7700.81	3341.362	3354.719	7723.81	3351.531	3365.812	7747.31	3373.58	3385.634	7770.81	3426.667	3624.329	7794.31	3542.742	3705.797
7701.31	3341.24	3354.735	7724.31	3352.129	3366.323	7747.81	3373.184	3385.527	7771.31	3428.625	3625.702	7794.81	3545.23	3707.561
7701.81	3341.133	3354.76	7724.81	3352.746	3366.833	7748.31	3372.716	3385.355	7771.81	3430.632	3627.11	7795.31	3547.669	3709.296
7702.31	3341.041	3354.794	7725.31	3353.379	3367.344	7748.81	3372.172	3385.13	7772.31	3432.693	3628.556	7795.81	3550.061	3711.001
7702.81	3340.963	3354.833	7725.81	3354.03	3367.864	7749.31	3371.555	3384.856	7772.81	3434.79	3630.024	7796.31	3552.415	3712.679
7703.31	3340.9	3354.878	7726.31	3354.698	3368.399	7749.81	3370.907	3384.561	7773.31	3436.921	3631.511	7796.81	3554.693	3714.307
7703.81	3340.851	3354.932	7726.81	3355.384	3368.947	7750.31	3370.286	3384.288	7773.81	3439.071	3633.012	7797.31	3556.881	3715.873
7704.31	3340.817	3354.995	7727.31	3356.086	3369.508	7750.81	3369.775	3384.086	7774.31	3441.237	3634.522	7797.81	3558.989	3717.384
7704.81	3340.798	3355.07	7727.81	3356.806	3370.08	7751.31	3369.42	3383.979	7774.81	3443.409	3636.039	7798.31	3561.019	3718.839
7705.31	3340.794	3355.155	7728.31	3357.543	3370.659	7751.81	3369.161	3383.926	7775.31	3445.593	3637.567	7798.81	3562.968	3720.242
7705.81	3340.804	3355.25	7728.81	3358.298	3371.245	7752.31	3368.915	3383.874	7775.81	3447.776	3639.098	7799.31	3564.831	3721.589
7706.31	3340.829	3355.359	7729.31	3359.071	3371.839	7752.81	3368.675	3383.822	7776.31	3449.951	3640.625	7799.81	3566.587	3722.866
7706.81	3340.869	3355.481	7729.81	3359.861	3372.445	7753.31	3368.495	3383.806	7776.81	3452.104	3642.137	7800.31	3568.23	3724.209
7707.31	3340.923	3355.615	7730.31	3360.669	3373.064	7753.81	3368.421	3383.853	7777.31	3454.238	3643.637	7800.81	3569.77	3725.265
7707.81	3340.993	3355.758	7730.81	3361.494	3373.697	7754.31	3368.528	3384.012	7777.81	3456.375	3645.14	7801.31	3571.23	3726.293
7708.31	3341.078	3355.907	7731.31	3362.337	3374.347	7754.81	3368.951	3384.369	7778.31	3458.525	3646.653	7801.81	3572.61	3727.328
7708.81	3341.179	3356.065	7731.81	3363.197	3375.016	7755.31	3369.737	3384.956	7778.81	3460.699	3648.184	7802.31	3573.918	3728.315
7709.31	3341.294	3356.235	7732.31	3364.074	3375.71	7755.81	3370.892	3385.777	7779.31	3462.899	3649.733	7802.81	3575.177	3729.268
7709.81	3341.425	3356.418	7732.81	3364.992	3376.437	7756.31	3371.876	3386.486	7779.81	3465.121	3651.297	7803.31	3576.41	3730.204
7710.31	3341.571	3356.612	7733.31	3366.012	3377.226	7756.81	3373.079	3387.334	7780.31	3467.37	3652.879	7803.81	3577.615	3731.118
7710.81	3341.732	3356.82	7733.81	3367.033	3378.005	7757.31	3374.912	3388.587	7780.81	3469.644	3654.478	7804.31	3578.8	3732.015
7711.31	3341.909	3357.042	7734.31	3367.939	3378.704	7757.81	3376.9	3389.94	7781.31	3471.946	3656.097	7804.81	3579.952	3732.89
7711.81	3342.101	3357.277	7734.81	3368.732	3379.33	7758.31	3378.963	3391.342	7781.81	3474.283	3657.743	7805.31	3581.068	3733.741
7712.31	3342.308	3357.526	7735.31	3369.438	3379.904	7758.81	3381.038	3392.752	7782.31	3476.667	3659.423	7805.81	3582.132	3734.559
7712.81	3342.531	3357.783	7735.81	3370.095	3380.451	7759.31	3383.103	3394.158	7782.81	3479.102	3661.134	7806.31	3583.132	3735.334
7713.31	3342.77	3358.048	7736.31	3370.726	3380.985	7759.81	3385.158	3395.56	7783.31	3481.579	3662.871	7806.81	3584.06	3736.059
7713.81	3343.025	3358.319	7736.81	3371.329	3381.5	7760.31	3387.199	3396.957	7783.81	3484.083	3664.626	7807.31	3584.923	3736.739
7714.31	3343.296	3358.593	7737.31	3371.894	3381.988	7760.81	3389.22	3398.343	7784.31	3486.615	3666.403	7807.81	3585.729	3737.382
7714.81	3343.583	3358.871	7737.81	3372.416	3382.448	7761.31	3391.208	3399.706	7784.81	3489.189	3668.21	7808.31	3586.48	3737.994
7715.31	3343.887	3359.156	7738.31	3372.872	3382.862	7761.81	3393.161	3601.046	7785.31	3491.821	3670.059	7808.81	3587.181	3738.574
7715.81	3344.206	3359.449	7738.81	3373.24	3383.217	7762.31	3395.084	3602.367	7785.81	3494.5	3671.94	7809.31	3587.832	3739.117
7716.31	3344.542	3359.749	7739.31	3373.537	3383.53	7762.81	3396.985	3603.673	7786.31	3497.215	3673.848	7809.81	3588.443	3739.633
7716.81	3344.894	3360.058	7739.81	3373.769	3383.811	7763.31	3398.876	3604.971	7786.81	3499.934	3675.773	7810.31	3589.012	3740.131
7717.31	3345.261	3360.38	7740.31	3373.966	3384.074	7763.81	3400.757	3606.26	7787.31	3502.718	3677.717	7810.81	3589.527	3740.598
7717.81	3345.643	3360.713	7740.81	3374.153	3384.335	7764.31	3402.619	3607.537	7787.81	3505.528	3679.694	7811.31	3590.009	3741.045
7718.31	3346.046	3361.057	7741.31	3374.334	3384.593	7764.81	3404.465	3608.806	7788.31	3508.383	3681.702	7811.81	3590.463	3741.474
7718.81	3346.463	3361.412	7741.81	3374.501	3384.841	7765.31	3406.296	3610.068	7788.81	3511.299	3683.747	7812.31	3590.885	3741.879
7719.31	3346.896	3361.78	7742.31	3374.636	3385.063	7765.81	3408.109	3611.32	7789.31	3514.252	3685.814	7812.81	3591.268	3742.26
7719.81	3347.345	3362.162	7742.81	3374.722	3385.249	7766.31	3409.912	3612.571	7789.81	3517.222	3687.889	7813.31	3591.611	3742.616
7720.31	3347.811	3362.559	7743.31	3374.76	3385.4	7766.81	3411.712	3613.827	7790.31	3520.201	3689.972	7813.81	3591.92	3742.95
7720.81	3348.293	3362.973	7743.81	3374.762	3385.527	7767.31	3413.514	3615.089	7790.81	3523.174	3692.051	7814.31	3592.19	3743.26
7721.31	3348.791	3363.402	7744.31	3374.713	3385.617	7767.81	3415.329	3616.366	7791.31	3526.125	3694.115	7814.81	3592.418	3743.541
7721.81	3349.306	3363.846	7744.81	3374.63	3385.685	7768.31	3417.171	3617.662	7791.81	3529.042	3696.159	7815.31	3592.605	3743.792
7722.31	3349.837	3364.309	7745.31	3374.518	3385.736	7768.81	3419.043	3618.981	7792.31	3531.911	3698.171	7815.81	3592.754	3744.015
7722.81	3350.385	3364.796	7745.81	3374.365	3385.768	7769.31	3420.936	3620.312	7792.81	3534.73	3700.15	7816.31	3592.864	3744.211
7723.31	3350.949	3365.302	7746.31	3374.165	3385.772	7769.81	3422.842	3621.651	7793.31	3537.487	3702.088	7816.81	3592.933	3744.381

CONCLUSION

High drilling non-productive time (pipe-stuck, lost circulation, kick and blowout) calls for a critical re-evaluation of the methods and practices in detecting geopressure. Despite the advances and widespread campaign for accurate pore pressure prediction and detection. The onset of overpressure was observed at 7,700 ft, 7,700 ft, and 7150 ft for Wells A, B, and C respectively. The result of the prediction showed that Well A and B increase from hydrostatic pressure gradient (0.433 psi/ft) to about 0.6 psi/ft (mild over pressured), while Well C increases from hydrostatic to about 0.66 psi/ft to a depth of 10148 ft, before unloading result in a change of the gradient which increases to pressure gradient of about 0.72 psi/ft (hard overpressure). The results

of the present study would be useful in assessing seal effectiveness, mapping of hydrocarbon migration pathways, trap configuration, basin geometry, basin modelling, and safe and economic drilling. Overpressures in Niger delta basin are because of compaction disequilibrium and secondary mechanism. The use of seismic method to predict pre-drill overpressure, will give a more accurate result.

ACKNOWLEDGEMENT

The researchers are grateful to Shell Petroleum Development Company of Nigeria (SPDC) for providing data to actualize this research.