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Anticlinal Structure of the Reservoir Characterization and Formation Evaluation of a "Cobalt Field", Southern Niger Delta Using Well Log Data

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ABSTRACT: Six wells Cobalt-1, Cobalt-2, Cobalt-3, Cobalt-4, Cobalt-5 and Cobalt-6 were investigated on the cobalt's field of the Niger Delta. A detailed petrophysical analysis on all the wells were carried out using SchlumbergeTechlog software of well log data in order to determine their petrophysical parameters. Quantitative and qualitative petrophysical data interpretations were employed in the analysis. Five reservoir sand bodies were delineated for each well and well two was interpreted as water. Reservoir thickness varies from 7 – 120 m. The reservoir rock properties were interpreted as a good quality reservoir rock which has been established from high average porosity (19 – 32 %). Hydrocarbon saturation zones varies in terms of quality reservoir are detected through intervals having $S_{w\ <60\ \%}$. Cobalt's field in the Niger Delta contains adequate amounts of hydrocarbon accumulation.

KEYWORDS: Reservoir, Petrophysical parameters, Hydrocarbon saturation, Well log, Niger Delta.

I. INTRODUCTION

Formation evaluation is the application of scientific principles, engineering concepts and technological innovations in the exploration and prospecting of hydrocarbon resources in geological formations in an environmentally sustainable and responsible manner. It evaluates the systematic data acquisition, processing and interpretation both qualitatively and quantitatively while applying scientific and engineering principles.

The global demand for petroleum products in the world has witnessed a sudden increase in developing countries. Therefore, this calls for greater exploration activity and the subsequent discovery of new accumulations to meet up with the demand. Petroleum is the world's major source of energy and a key factor in the continued development of the world's economy (Viorel, 2018; Valery et al., 2020).

Petroleum system is a fluid system composed of various geological elements such as source rock, reservoir, trap and seal (Jiaet al., 2024). Hydrocarbons are accumulated below the earth's surface in deposits known as reservoirs. Reservoirs are subsurface rocks that have enough porosity to house commercial volumes of hydrocarbons, sufficient permeability to be able to deliver the hydrocarbons to the wells and hydrocarbon volumes to be an economic resource (Fred and Shiraji, 2013). After an oil well has been drilled, the data collected requires to be interpreted in order to harness any hydrocarbons that may have been discovered.

This evaluation means identifying the hydrocarbon bearing zones (gas bearing zone, oil bearing zone and water bearing zone) and non-hydrocarbon bearing like shale, delineating reservoir thickness and evaluating the petrophysical parameters of the reservoir. In evaluating a reservoir, the parameters that are considered includes porosity, permeability, and water saturation, bulk volume of water and hydrocarbon saturation.

The Niger Delta province of Nigeria accumulated with commercial quantities of oil and gas. The accumulation of oil and gas in the pore spaces of reservoir rock, typically sedimentary rocks, is the source of oil and gas production. Oil is produced in the sandstone and unconsolidated sand of Agbada formation. This formation is characterized by alternating sands and shales. The formation's sand is primarily hydrocarbon reservoir, with shale serving as lateral and vertical seals. The previous works from Etu-Efeotor (1997) and Selley (1997) investigated that the gross reservoir properties in the oil bearing reservoir of the Niger Delta is a function of the sand or shale ratio and sealing potential of the faults.

This paper aims at interpreting the lithological subsurface and hydrocarbon prospects using well log data of cobalt field in the Niger Delta. This is achieved by (i) identifying the tops and bottoms of the sand reservoirs (ii) delineating the structural cross section of the wells using GR and RES logs (iii) estimating the petrophysical parameters (flag name, gross, net,net-to-gross, etc,).

LOCATION AND STRATIGRAPHIC SETTING OF THE STUDY AREA

The Niger Delta is a prograding depositional complex within the Cenozoic formation of Southern Nigeria. It is located on the Gulf of Guinea on the west coast of central Africa between latitude 30°N and 60°N and longitude 50°E and 80°E. It occurs at the southern extreme of Benue trough, extends from Calabar flanks and it opens to the Atlantic Ocean in the South.

The Niger Delta is divided into three formations, representing prograding depositional facies that are associated mostly on the basis of sand-shale ratios. The Akata formation contains mainly shale's deposited on a shallow marine shelf and usually over pressured, with soft and under-compacted plastic shales. Exploration rarely gets to it because of the absence of commercial oil deposits. The Agbada formation is made up of alternations of sands and shale's. The sands are mostly encountered at the upper parts while shales are found mostly at the lower parts. The Agbada formation is thickest at the center of the Delta and goes up to 1500 ft (457m), this is the seat of most oil reservoirs and center of over pressures. The Benin formation which is a fresh water bearing sand with occasional ignite and clay, and going up to 7500 ft (2286m) deep with no over pressure.

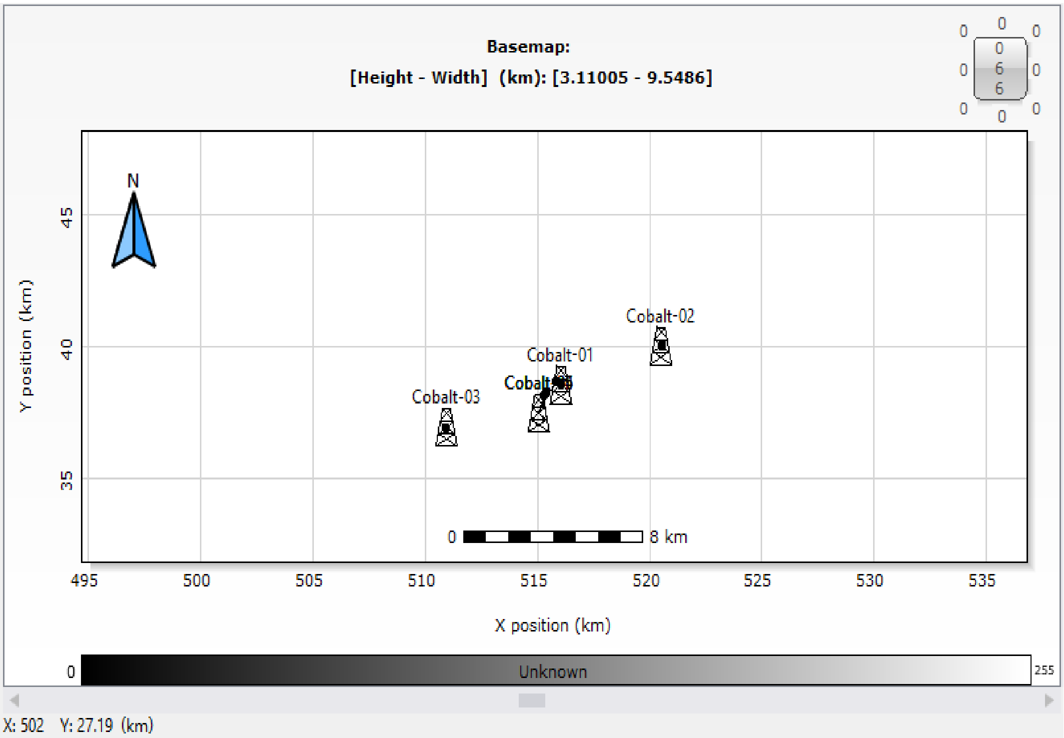

Figure 1: Base Map of the Study

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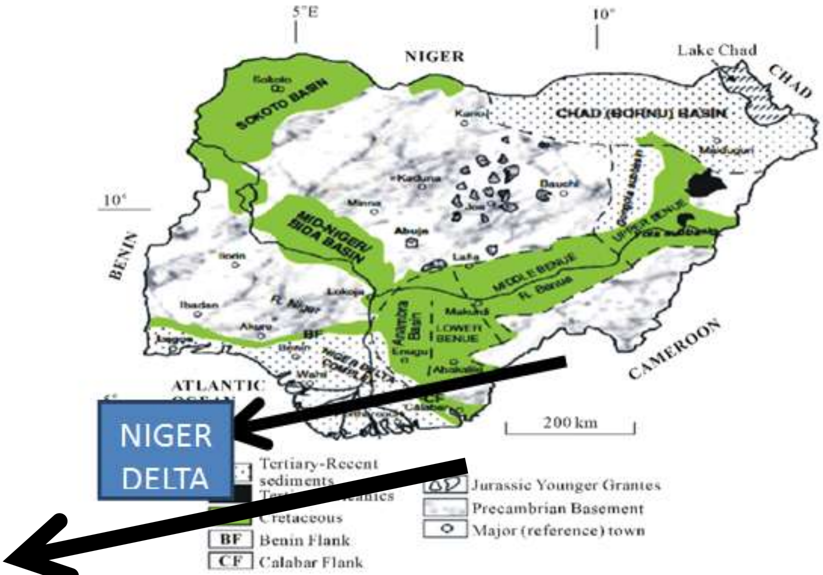


Figure 2: Geology Map of the Study

II. MATERIALS AND METHODOLOGY

MATERIALS

The materials used involve well logs primarily composed of Gamma ray, Resistivity, Density and Neutrons from the six wells. The method involves interpreting wire log data using SchlumbergeTechlog software for the identification of hydrocarbon bearing reservoirs and computing the petrophysical parameters of the reservoir.

PETROPHYSICAL INTERPRETATION

Petrophysical interpretation is divided into two; (i) qualitative assessment/log interpretation and (ii) quantitative assessment/log interpretation.

Qualitative log interpretation: Qualitative log interpretation is based on the visual observation of the logs to determine the lithology and hydrocarbon bearing zones. Permeable zones (sand) were differentiated from non-permeable zones (shale) using GR log. Based on this, tops and bottoms of the sand reservoirs were delineated in all the six wells. The zones of interest for the petrophysical interpretation were identified in terms of clean zones with hydrocarbon saturation (low GR and high resistivity). The porosity logs (density and neutron logs) were applied for the identification of the various fluid types. The gas zones were identified from crossover of the porosity logs. Oil zones were identified based on high resistivity and water zones were corresponding with very low resistivity.

Quantitative log interpretation: Quantitative log interpretation involves the use of empirical formular to estimate the reservoir properties such as volume of shale, porosity, water saturation, permeability and hydrocarbon saturation, etc,. Calculations of such reservoir properties will aid to determine if a reservoir can be obtained. The gamma ray was applied to determine the gamma ray index using the formular (Asquith and Gibson, 1982).

$$I_{GR} = \frac{GR_{log} - GR_{min}}{GR_{max} - GR_{min}}$$

1

where;

I_{GR} = gamma ray index

GR_{log} = gamma ray reading of the formation

GR_{min} = minimum gamma ray (clean sand)

GR_{max} = maximum gamma ray (shale)

Having calculated the gamma ray index, the volume of shale (V_{sh}) was then obtained using (Dresser, 1979);

$$V_{sh} = 0.83\ (2^{3.7/GR} - 1)$$

2

Porosity (∅) is defined as the percentage of voids to the total volume of rock. The formation density log was used to determine formation porosity. The formation porosity was determined by substituting the bulk density readings obtained from the density log within each reservoir into the formular (Asquith and Gibson, 1982);

$$\emptyset = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho f}$$

3

where∅ is the porosity, ρ_{ma} = 2.65gm/cc is the density matrix (sandstone), ρ_f=1.0gm/cc (fluid density), ρ_b is the formation bulk density.

Resistivity of formation water (R_w) is usually estimated in a clean water bearing zone using the equation.

$$R_w = \frac{R_o}{F} \quad (4)$$

Water saturation was estimated from Archie equation using

$$S_w = n\sqrt{\frac{a}{\emptyset^m} \times \frac{R_w}{R_t}} \quad (5)$$

$R_{0=R_t}$

Note, $S_{w=\sqrt{\frac{R_0}{R_t}}}$

where a is the tortuosity factor, m is cementation exponent, S_w is the water saturation, R_o is the resistivity of formation at 100% water saturation and R_t is the true formation resistivity.

Permeability is the ability of the reservoir rock to allow petroleum fluids to flow through its interconnected pores. It is measured in darcies or millidarcies. The permeability of each reservoir that was identified, was derived from (Tixier, 1949).

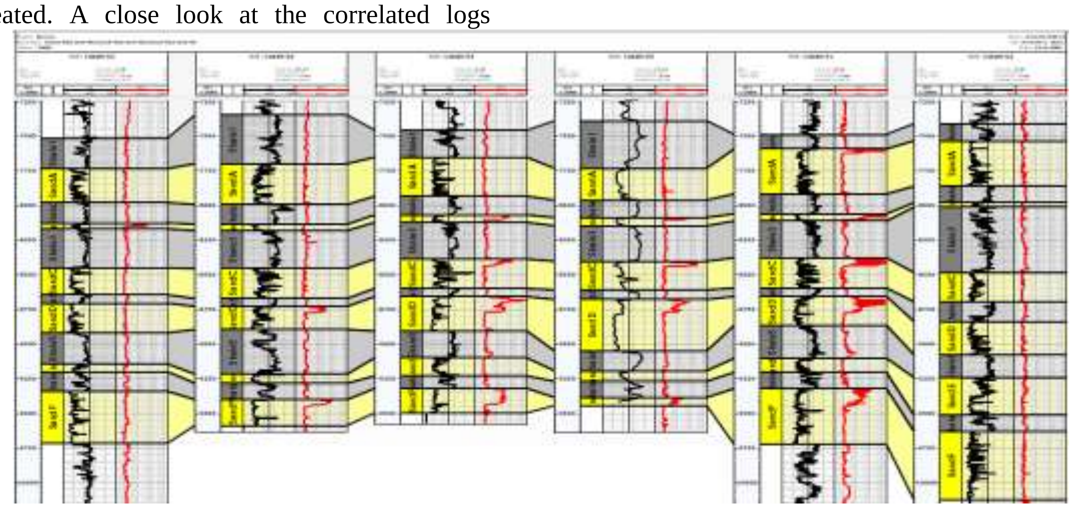
$$K = \frac{250 \times \emptyset^3}{S_{wirr}} \text{ (for oil)} \quad (6)$$

$$K = \frac{79 \times \emptyset^3}{S_{wirr}} \text{(for gas)} \quad (7)$$

where K is the permeability constant, $\emptyset$ is the porosity and S_{wirr} is the irreducible water saturation.

III. RESULTS AND DISCUSSION

A total of six reservoir sands were delineated. A close look at the correlated logs indicates that there are six sand bodies for each well and were labeled; sand A, sand B, sand C, sand D, sand E and sand F as shown in figure 3 (structural cross -section). The quantitative and qualitative analyses were done for the six exploration wells with their respective depth ranges for Cobalt well 1, Cobalt well 2, Cobalt well 3, Cobalt well 4, Cobalt well 5 and Cobalt well 6. The reservoirs petrophysical parameters have been computed from the six wells of Cobalt field. The logs used in this study include gamma ray, resistivity, neutron and density logs. The lithologic units within the area of interest were correlated to identify their lateral and vertical extent using a combination of gamma ray and resistivity logs (in figure 3). Gamma ray value less than 80API indicates sand unit while values above 80API indicates shale unit. Shale bed was used as a reference datum for the correlation. The suite of borehole logs was loaded and analysed using the SLB Techlog Software. The various lithologies within the wells across the Cobalt field were mapped first using lithologic log (gamma ray log). Lithology was identified by defining shale baseline using a cutoff value of 80API, which is constant line separating shale from sand. Low gamma ray is an indication of sand, while high, that is, positive inflection of log curve is an indication of shalyness. Electrical logs were used to indicate the fluid type that occurred in a reservoir while porosity logs were used for porosity calculation. Petrophysical parameters such as porosity, permeability, volume of shale, water saturation, hydrocarbon saturation, and irreducible water saturation were computed and the results presented below.



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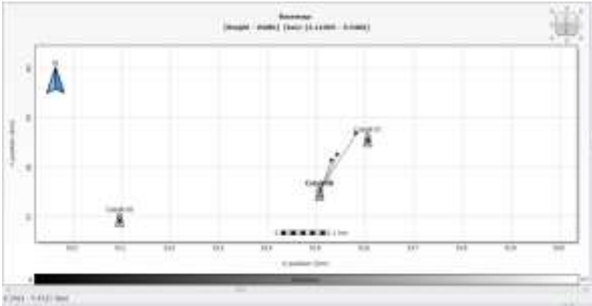

Figure 3: Structural cross-section

Well 1 (Cobalt-1): Sand A

In figure 4, the top and bottom of the reservoir at the depth range of 7592.15 – 7916.854 ft (TVDSS) with a reservoir contact of 7623.65 ft (TVDSS) of oil-water contact as shown in table 1 of petrophysical summary, has a gross thickness of 31.5 m and net sand thickness of 16.5 m. The net – to- gross (pay) is 52%.

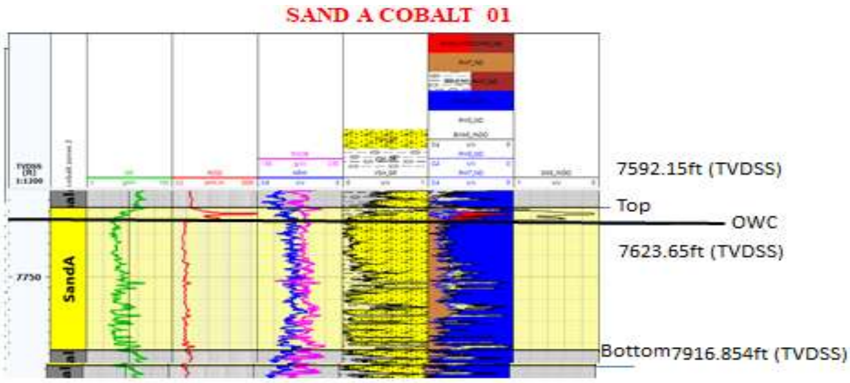

Figure 4: Well 1 (Cobalt-1): Sand A

Table 1: Petrophysical summary for sand A

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_01	Sand A	RES	7592.15	7916.854	324.704	271.704	0.837	0.298	0.966	OIL	OWC	7623.65
Cobalt_01	Sand A	PAY	7592.15	7623.65	31.5	16.5	0.524	0.302	0.447			

Well 1 (Cobalt-1): Sand B

In figure 5, the top and bottom of the reservoir at the depth range of 8060.379 – 8112.436 ft (TVDSS) with a reservoir contact of 8100.55 ft (TVDSS) of gas-water contact as shown in table 2 of petrophysical summary, has a gross thickness of 40.171 m and net sand thickness of 28 m. The net to gross (pay) is 69%.

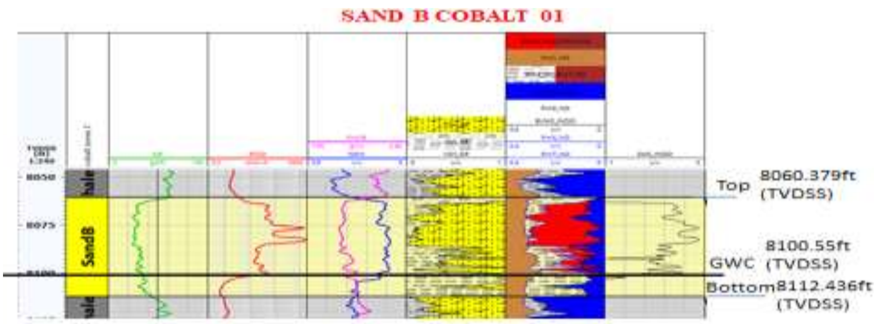

Figure 5: Well 1 (Cobalt-1): Sand B

Table 2: Petrophysical summary for sand B

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_01	Sand B	RES	8060.379	8112.436	52.186	28.621	0.55	0.266	0.295	GAS	GWC	8100.55
Cobalt_01	Sand B	PAY	8060.379	8100.55	40.171	28	0.6970	0.267	0.283			

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Well 1 (Cobalt-1): Sand C

In figure 6, the top and bottom of the reservoir at the depth range of 8377.271 – 8595.528 ft (TVDSS) with a reservoir contact of 8433.54 ft (TVDSS) of gas-water contact as shown in table 3 of petrophysical summary, has a gross thickness of 56.269 m and net sand thickness of 44.5 m. The net to gross (pay) is 79%.

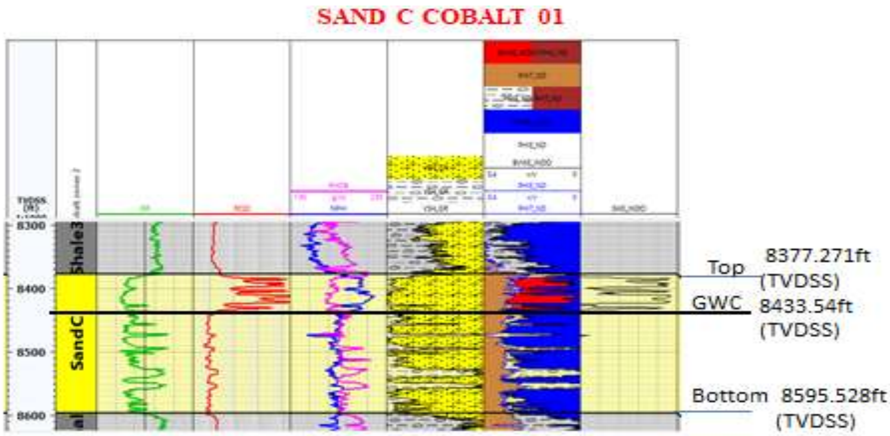

Figure 6: Well 1 (Cobalt-1): Sand C

Table 3: **Petrophysical summary for sand C**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_01	Sand C	RES	8377.271	8595.528	218.257	183.028	0.839	0.264	0.828	GAS	GWC	8433.54
Cobalt_01	Sand C	PAY	8377.271	8433.54	56.269	44.5	0.7908	0.276	0.333			

Well 1 (Cobalt-1): Sand D

The top and bottom of the reservoir in figure 7 at the depth range of 8656.532 – 8864.932 ft (TVDSS) with a reservoir of 8771.21 ft (TVDSS) of oil –water contact as shown in table 4 of petrophysical summary, has gross thickness of 114.678 m and net sand thickness of 73 m. The net to gross (pay) is 63%.

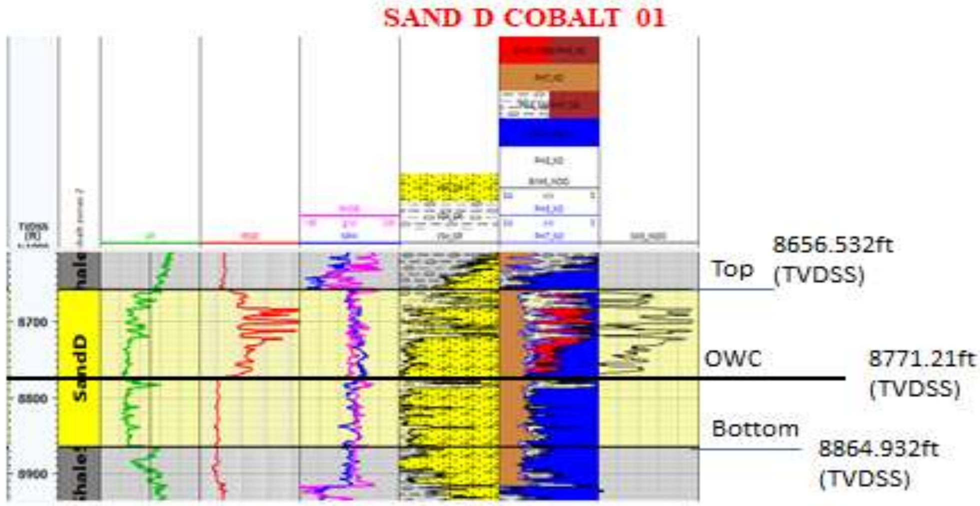

Figure 7: Well 1 (Cobalt-1): Sand D

Table 4: **Petrophysical summary for sand D**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_01	Sand D	RES	8656.532	8864.932	208.399	165.468	0.794	0.25	0.762	OIL	OWC	8771.21
Cobalt_01	Sand D	PAY	8656.532	8771.21	114.678	73	0.6365	0.244	0.45			

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Well 1 (Cobalt-1): Sand F

In figure 8, the top and bottom of the reservoir at the depth range of 9321.693 – 9725.325 ft (TVDSS) with a reservoir contact of 9485.17 ft (TVDSS) of oil-water contact as shown in table 5 of petrophysical summary, has gross thickness of 163.477 m and net sand thickness of 86.5 m. The net to gross (pay) is 52%.

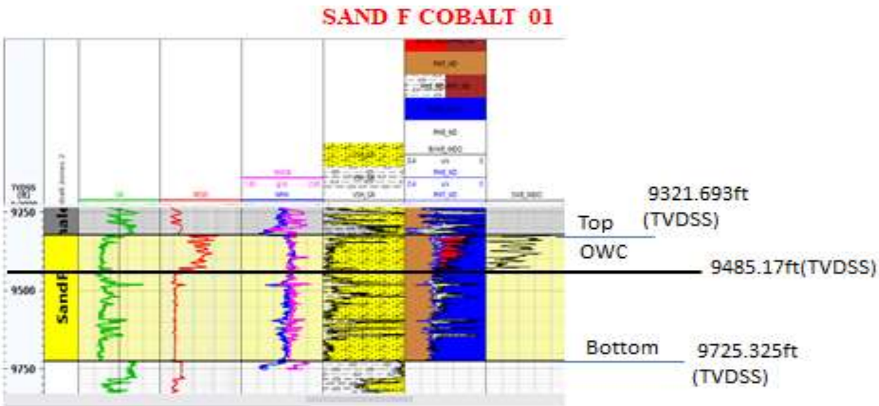

Figure 8: Well 1 (Cobalt-1): Sand F

Table 5: **Petrophysical summary for sand F**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_01	Sand F	RES	9321.693	9725.325	403.632	360.807	0.894	0.236	0.901	OIL	OWC	9485.17
Cobalt_01	Sand F	PAY	9321.693	9485.17	163.477	86.5	0.529	0.228	0.59			

Well 3 (Cobalt-3): Sand B

The top and bottom of the reservoir in figure 9 shows the depth range of 8126.453 – 8168.478 ft (TVDSS) with a reservoir contact of 8150.58 ft (TVDSS) of gas-water contact as shown in table 6 of petrophysical summary, has a gross thickness of 24.127 m and net sand thickness of 14 m. The net to gross (pay) is 58%.

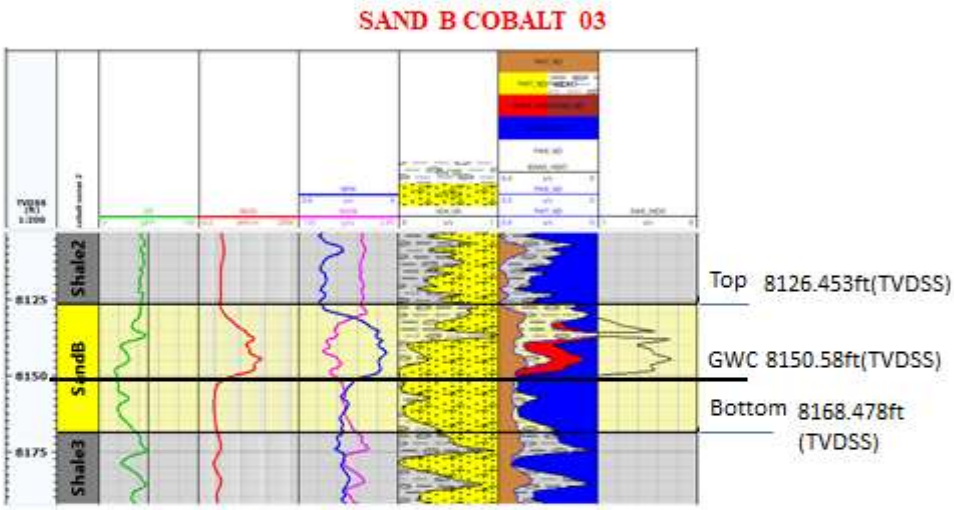

Figure 9: Well 3 (Cobalt-3): Sand B

Table 6: **Petrophysical summary for sand B**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_03	Sand B	RES	8126.453	8168.478	42.024	33.524	0.798	0.264	0.806	GAS	GWC	8150.58
Cobalt_03	Sand B	PAY	8126.453	8150.58	24.127	14	0.5802	0.238	0.494			

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Well 4 (Cobalt-4): Sand B

In figure 10, the top and bottom of the reservoir at the depth range of 8068.161 – 8122.387 ft (TVDSS) with a reservoir contact of 8101.55 ft (TVDSS) of gas-water contact as shown in table 7 of petrophysical summary, has a gross thickness of 33.389 m and net sand thickness of 25.509 m. The net to gross (pay) is 76%.

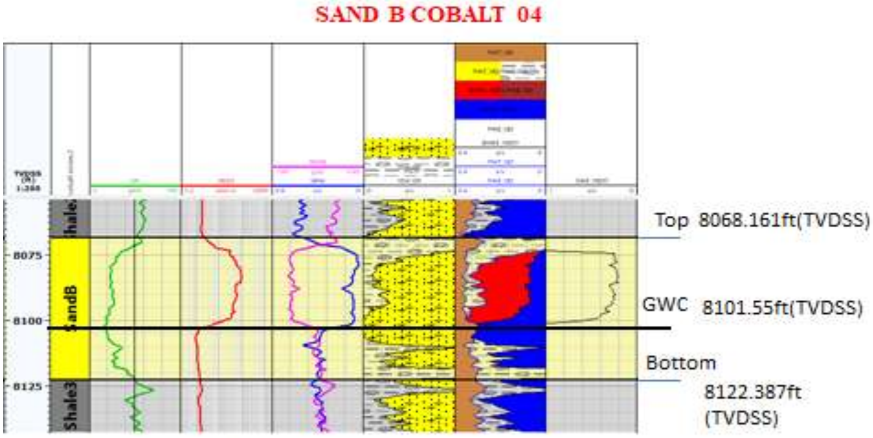

Figure 10: Well 4 (Cobalt-4): Sand B

Table 7: **Petrophysical summary for sand B**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_04	Sand B	RES	8068.161	8122.387	54.226	40.326	0.744	0.285	0.541	GAS	GWC	8101.55
Cobalt_04	Sand B	PAY	8068.161	8101.55	33.389	25.509	0.7639	0.296	0.301			

Well 4 (Cobalt-4): Sand C

In figure 11, the top and bottom of the reservoir at the depth range of 8377.27 – 8598.748 ft (TVDSS) with a reservoir contact of 8441.02 ft (TVDSS) of gas-water contact as shown in table 8 of petrophysical summary, has a gross thickness of 63.749 m and net sand thickness of 41.437 m. The net to gross (pay) is 65%.

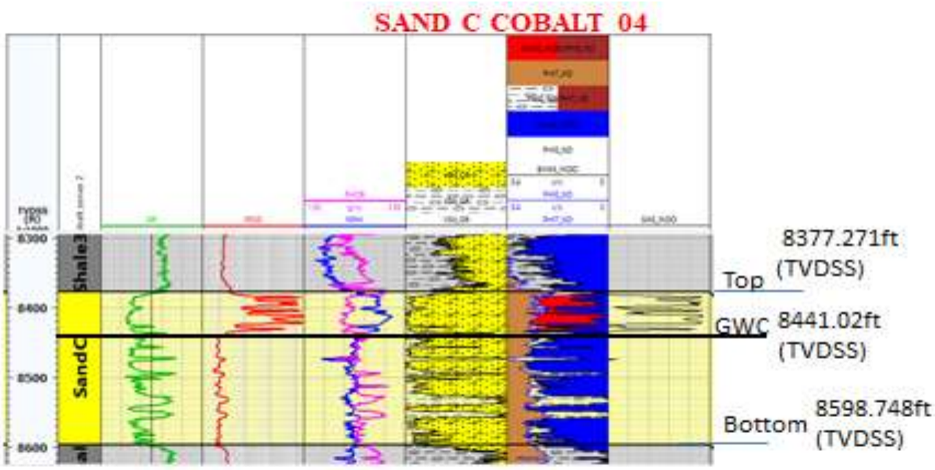

Figure 11: Well 4 (Cobalt-4): Sand C

Table 8: **Petrophysical summary for sand C**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_04	Sand C	RES	8377.271	8598.748	221.477	179.867	0.812	0.271	0.852	GAS	GWC	8441.02
Cobalt_04	Sand C	PAY	8377.271	8441.02	63.749	41.437	0.6500	0.287	0.399			

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Well 4 (Cobalt-4): Sand D

In figure 12, the top and bottom of the reservoir at the depth range of 9314.29 – 9582.04 ft (TVDSS) with a reservoir contact of 9434.7 ft (TVDSS) of gas-water contact and oil-water contact as shown in table 9 of petrophysical summary, has a gross thickness 120.41 m and net sand thickness of 82.279 m. The net to gross (pay) is 68%.

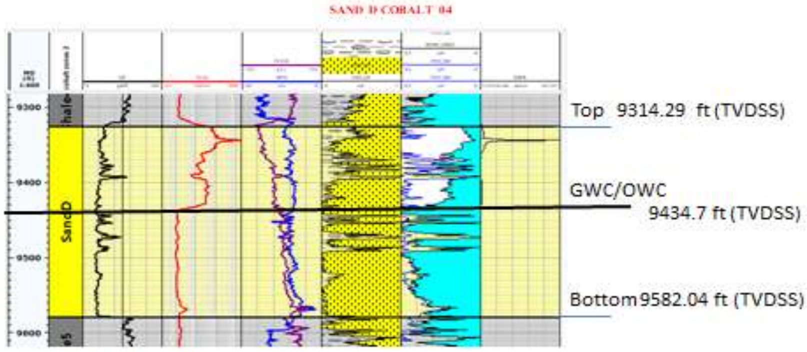

Figure 12: Well 4 (Cobalt-4): Sand D

Table 9: **Petrophysical summary for sand D**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (TVDSS)
Cobalt-04	SandD	RES	9314.29	9582.04	267.75	208.07	0.84	0.259	0.703	GAS/OIL	GWC/OWC	9434.7
Cobalt-04	SandD	PAY	9314.29	9434.7	120.41	82.279	0.6833	0.291	0.332			

Well 4 (Cobalt-4): Sand F

In figure 13, the top and bottom of the reservoir at the depth range of 9320.422 – 9496.89 ft (TVDSS) with a reservoir contact of 9440.21 ft (TVDSS) of gas-water contact as shown in table 10 of petrophysical summary, has a gross thickness of 119.823 m and net sand thickness of 103.823 m. The net to gross (pay) is 86 %.

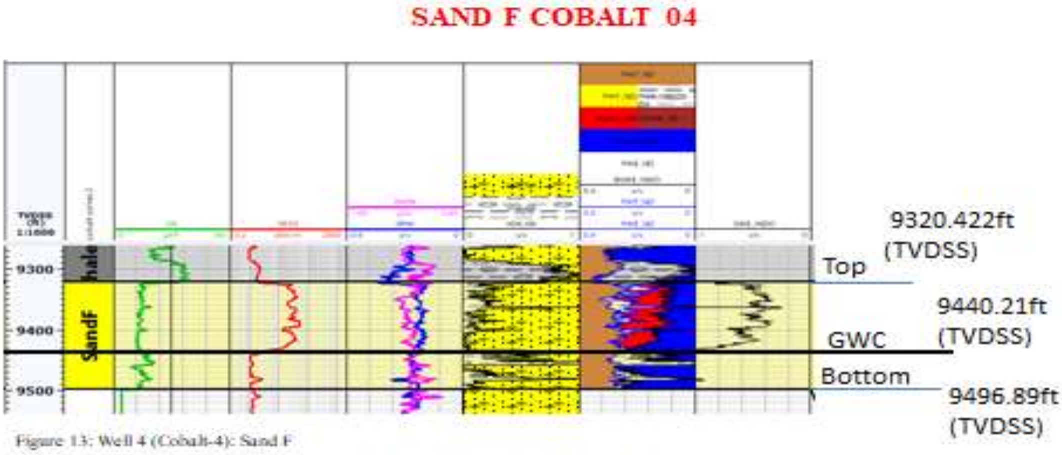

Figure 13: Well 4 (Cobalt-4): Sand F

Table 10: **Petrophysical summary for sand F**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_04	Sand F	RES	9320.422	9496.89	176.468	150.235	0.851	0.226	0.654	GAS	GWC	9440.21
Cobalt_04	Sand F	PAY	9320.422	9440.21	119.788	103.823	0.8667	0.23	0.509			

Well 5 (Cobalt-5): Sand B

In figure 14, the top and bottom of the reservoir at the depth range of 8087.14 – 8146.608 ft (TVDSS) with a reservoir contact of 8105.28 ft (TVDSS) of gas-water contact as shown in table 11 of petrophysical summary, has a gross thickness is

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18.14 m and net sand thickness of 7.052 m. The net to gross (pay) is 38 %.

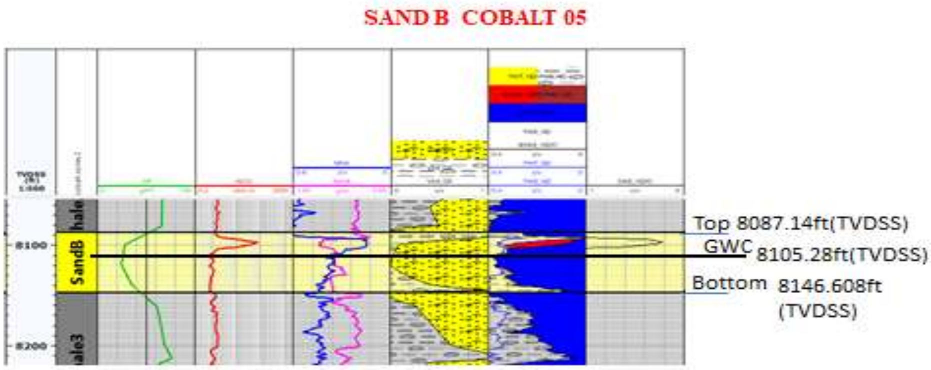

Figure 14: Well 5 (Cobalt-5): Sand B

Table 11: **Petrophysical summary for sand B**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobal t_05	Sand B	RES	8087.14	8146.608	59.46 8	45.15	0.759	0.324	0.915	GAS	GWC	8105.28
Cobal t_05	Sand B	PAY	8087.14	8105.28	18.14	7.052	0.388 7	0.291	0.393			

Well 5 (Cobalt-5): Sand C

In figure 15, the top and bottom of the reservoir at the depth range of 8403.03 – 8609.396 ft (TVDSS) with a reservoir contact of 8440.26 ft (TVDSS) gas-water contact as shown in table 12 of petrophysical summary, has a gross thickness of 37.23 m and net sand thickness of 28.697 m. The net to gross is 77 %.

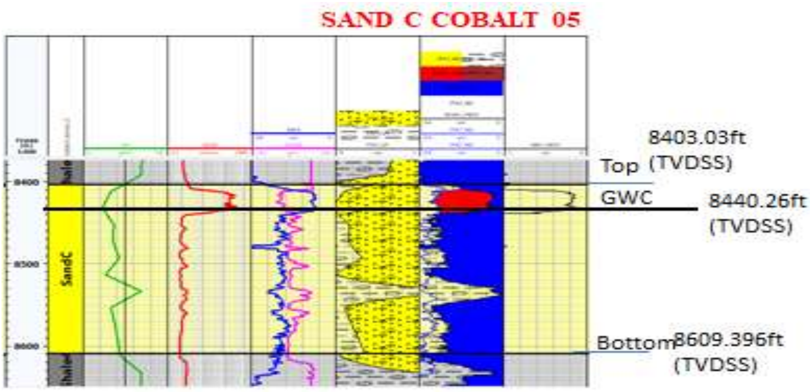

Figure 15: Well 5 (Cobalt-5): Sand C

Table 12: **Petrophysical summary for sand C**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosit y	Av_Water Saturation	Fluid Type	Conta ct Type	Contact (MD)
Cobal t_05	Sand C	RES	8403.03	8609.396	206.365	183.339	0.888	0.301	0.877	GAS	GWC	8440.26
Cobal t_05	Sand C	PAY	8403.03	8440.26	37.23	28.697	0.770 8	0.301	0.255			

Well 5 (Cobalt-5): Sand D

In figure 16, the top and bottom of the reservoir at the depth range of 9135.36 – 9523.54 ft (TVDSS) with a reservoir contact of 9237.36 ft (TVDSS) of oil-water contact as shown in table 13 of petrophysical summary, has a gross thickness is 102 m and net sand thickness of 80.77 m. The net to gross (pay) is 79%.

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SAND D COBALT 05

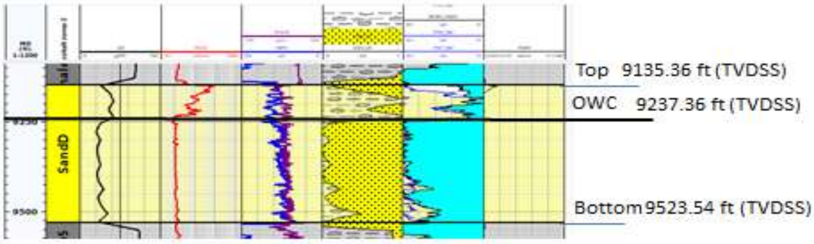

Figure 16: Well 5 (Cobalt-5): Sand D

Table 13: **Petrophysical summary for sand D**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (TVDSS)
Cobalt-05	SandD	RES	9135.36	9523.54	388.18	286.704	0.772	0.264	0.954	OIL	OWC	9237.36
Cobalt-05	SandD	PAY	9135.36	9237.36	102	80.77	0.7918	0.258	0.311			

Well 5 (Cobalt-5): Sand F

The top and bottom of the reservoir at the depth range of 9385.35 – 9444.622 ft (TVDSS) with a gas-down two in figure 17 of sand F. Gas down to (GDT) in sand F Cobalt 05 indicates the depth at which gas is present in sand F reservoir, signifying the lower limit of gas bearing zone.

SAND F COBALT 05

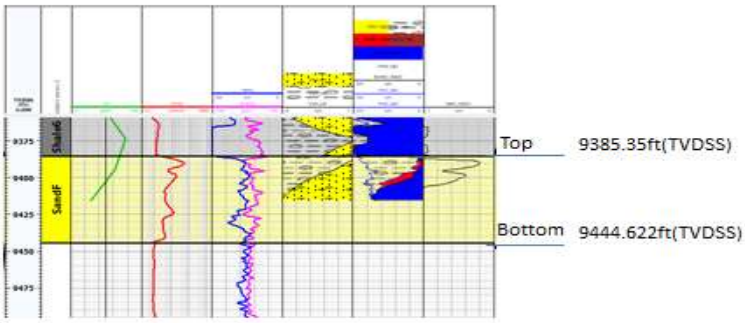

Figure 17: Well 5 (Cobalt-5): Sand F

Table 14: **Petrophysical summary for sand F**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_05	Sand F	RES	9385.35	9444.622	59.272	17.299	0.292	0.24	0.864	GAS	GDT	
Cobalt_05	Sand F	PAY	9385.35	9444.622	59.272	7.014	0.118	0.395	0.594			

Well 6 (Cobalt-6): Sand D

In figure 18, the top and bottom of the reservoir at the depth range of 8728.38 – 8894.938 ft (TVDSS) with a reservoir contact of 8776.17 ft (TVDSS) of gas-water contact as shown in table 15 of petrophysical summary, has a gross thickness of 47.79 m and net sand thickness of 29.924 m. The net to gross is 62 %.

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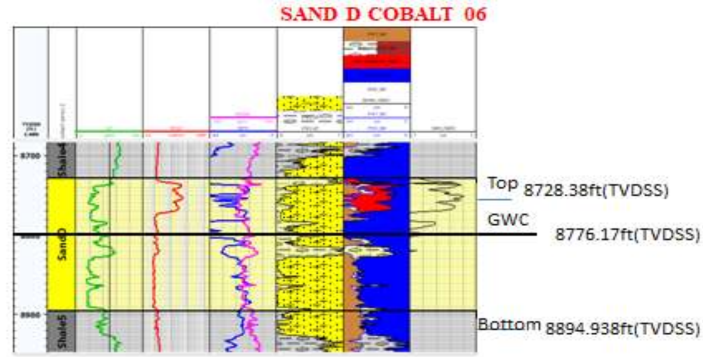

Figure 18: Well 6 (Cobalt-6): Sand D

Table 15: **Petrophysical summary for sand D**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_06	Sand D	RES	8728.38	8894.938	166.558	124.164	0.745	0.305	0.856	GAS	GWC	8776.17
Cobalt_06	Sand D	PAY	8728.38	8776.17	47.79	29.924	0.6262	0.317	0.429			

Well 6 (Cobalt-6): Sand F

In figure 19, the top and bottom of the reservoir at the depth range of 9401.359 – 9587.877 ft (TVDSS) with a reservoir contact of 9450.2 ft (TVDSS) of oil-water contact as shown in table 16 of petrophysical summary, has a gross thickness is 48.841 m and net sand thickness of 33.491 m. The net to gross is 68 %.

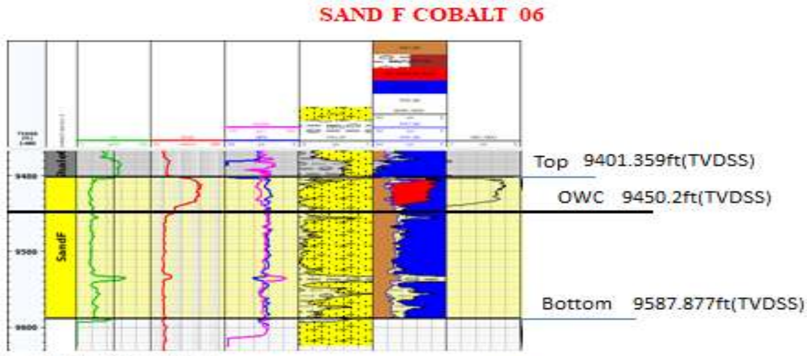

Figure 19: Well 6 (Cobalt-6): Sand F

Table 16: **Petrophysical summary for sand F**

Well	Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Porosity	Av_Water Saturation	Fluid Type	Contact Type	Contact (MD)
Cobalt_06	Sand F	RES	9401.359	9587.877	186.518	159.566	0.855	0.251	0.84	OIL	OWC	9450.2
Cobalt_06	Sand F	PAY	9401.359	9450.2	48.841	33.491	0.6857	0.29	0.342			

IV. CONCLUSION

The correlated logs (GR and RES) of the structural cross-section shows an anticline structure of hydrocarbon. The net productive zones of the cobalt field have been delineated using well logs. Reservoir thickness varies from 7 – 120 m. The petrophysical values such as hydrocarbon saturation and porosity in the six reservoirs were computed. The reservoir rock properties were analysed as a good quality reservoir rock. The results from the net to gross indicates that all the delineated reservoirs within the six wells, well 1, 3,4,5 and 6 are producible since the net to gross values ranged from good to excellent and moderate hydrocarbon saturation while well 2 interpreted water with absence of gas and oil.

The computed petrophysical summary tables indicates that porosity and permeability values from the hydrocarbon bearing reservoirs are good enough for commercial hydrocarbon accumulation in the Niger Delta.

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REFERENCES

[1]. Asquith, G. and Gibson, C. (1982). Basic well log analysis for Geologists. American Association of Petroleum Geology. Tulsa, Methods of Exploration ser. no. 216.

[2]. Dresser Atlas,(1979). Log interpretation fundamentals. Dresser Industries Inc.

[3]. Efu- Efeotor, J. (1997). Fundamentals of Petroleum Geology. Africana – FEP Publishers, Onitsha, 111-123.

[4]. Fred Aminzadeh and Shiraji N. Dasgupta (2013). Developments in Petroleum Science.

[5]. Jia Chengzao, Pang Xiongqi and Song Yan (2013). Basic principles of the whole petroleum system. 51(4): 780 – 794

[6]. Selley, R.C. (1997). African Basins (Sedimentary Basins of the World). Vol (3), Elsevier Science B.V, Amsterdam

[7]. Tixier, M.P. (1949). Evaluation of permeability from electric log resistivity gradients. Oil and Gas Journal, Volume (8), pp. 75-90

[8]. Valery, F.A., Yuri, V.T., Valery, V.B. and Saltanat, Y. (2020).Prospects of Development of the Oil Industry in the Global Economy and in the Regional Economics.International Journal of Energy Economics and Policy, 10(1): 265-279.

[9]. Viorel, P. (2018). Petroleum Strategic Resource for World Economy.StudiaUniversitatis“ VasileGoldis” Arad. Economics Series, 28(2): 70-85.