PS Integrated Subsurface Evaluation of 'Doyin' Field, Shallow Offshore Niger Delta, Nigeria*

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Abstract

The Niger Delta basin is ranked among the world's prolific hydrocarbon provinces. The structures, stratigraphy, and traps could be very subtle and complex and are therefore, difficult to map accurately. The degree of reliability and precision of the mapping can be greatly enhanced by integrating seismic data with well logs for hydrocarbon exploration and field development studies. Seismic data and well logs were integrated to delineate the subsurface geometry, stratigraphic framework, and hydrocarbon trapping potential of 'Doyin' Field, offshore Niger Delta, Nigeria. The objectives of this study is to utilize seismic data to image subsurface geology for hydrocarbon exploration and estimate the amount of hydrocarbon resources in place. Seven reservoirs were correlated, mapped, and analyzed for their varying petrophysical parameters using wireline logs. Seismic attribute analysis was used to enhance the quality of interpretation in all reservoirs mapped. Structure contour maps were generated in time and depth domain for the reservoirs and closures were delineated. This study also utilizes the various seismic attributes to investigate structural and stratigraphic elements within the study area to delineate lithology and hydrocarbon. The trapping mechanism is mainly fault dependent and the accumulations are mainly on the hanging wall of an antithetic fault. Structural style is dominated by two parallel structure-building normal faults trending through the entire field. Hydrocarbon discovery in this field is estimated at 13.70 BCF for gas and 22.12 MMBO for oil.

Selected References

Doust, H., and E. Omatsola, 1990, Niger Delta, *in* J.D. Edwards and P.A. Santogrossi (eds.), Divergent/Passive Margin Basins: American Association of Petroleum Geologists Memoir 48, p. 239-248.

Tuttle, M.L.W., R.R. Charpentier, and M.E. Brownfield, 1999, The Niger Delta Petroleum System: Niger Delta Province, Nigeria, Cameroon, and Equatorial Guinea, Africa: United States Geological Survey, Open-File Report 99-50-H, 64 p.

INTEGRATED SUBSURFACE EVALUATION OF 'DOYIN' FIELD, SHALLOW OFFSHORE NIGER DELTA, NIGERIA.

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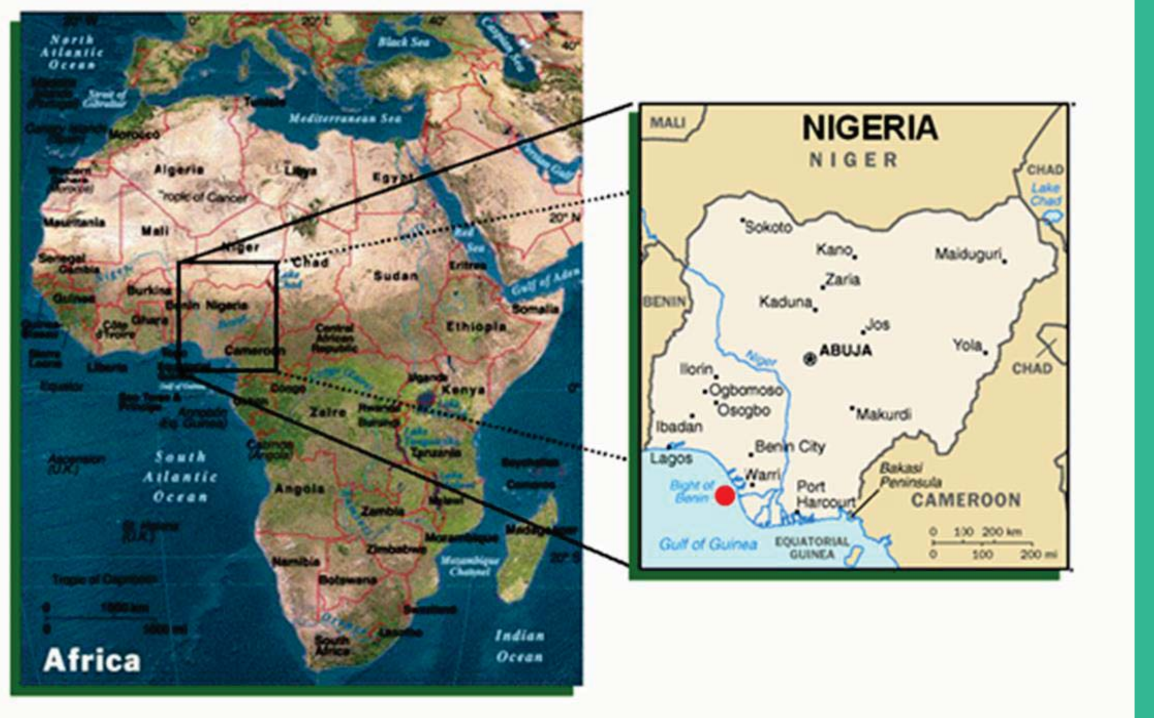
RESEARCH QUESTIONS

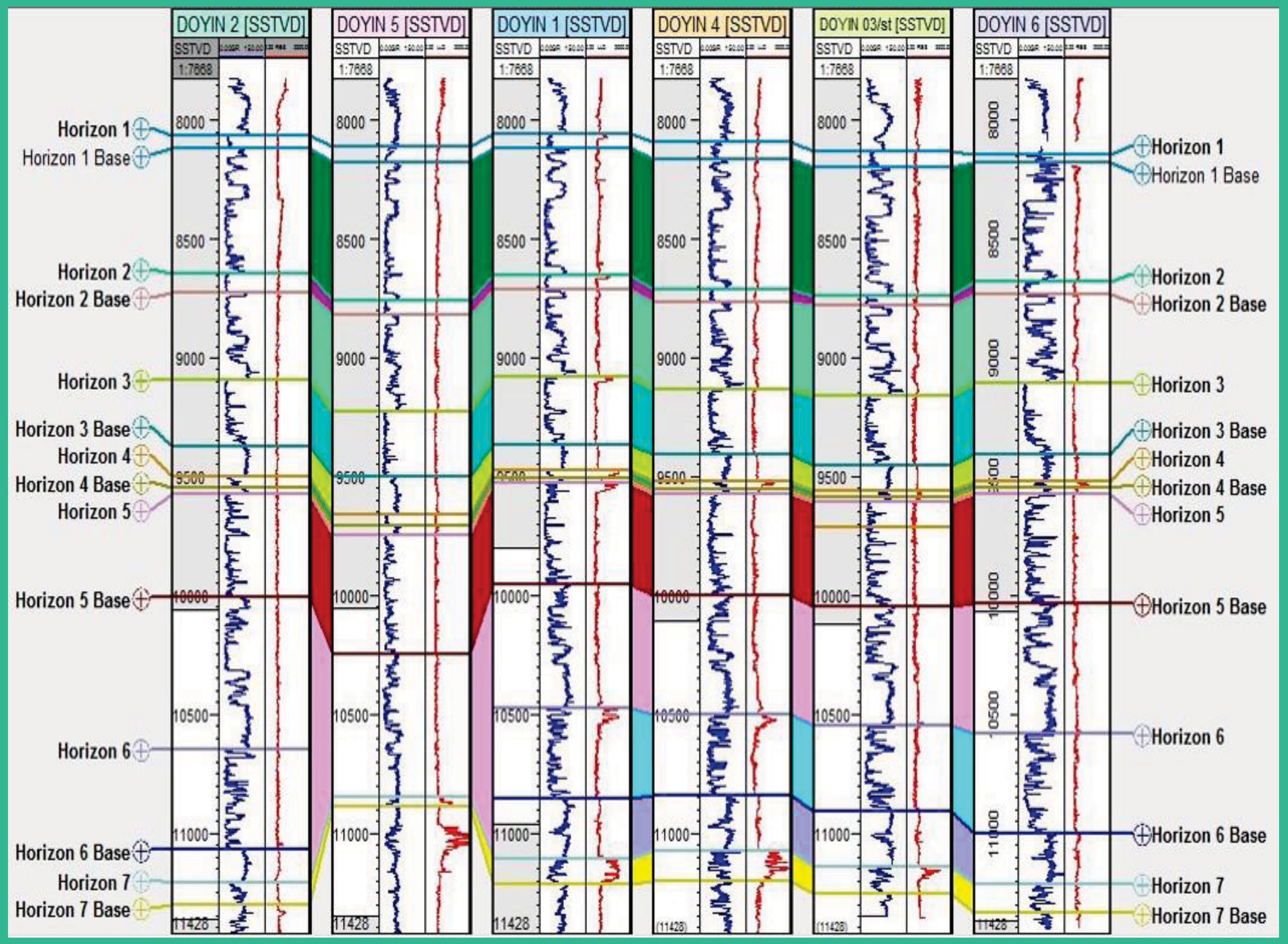
- What are the structural framework and hydrocarbon trapping mechanisms in 'Doyin' field?
- What is the relationship between seismic amplitudes and reservoir properties in 'Doyin' field?
- Where are the potential drill well locations?
- What are the chances for future exploration opportunities?

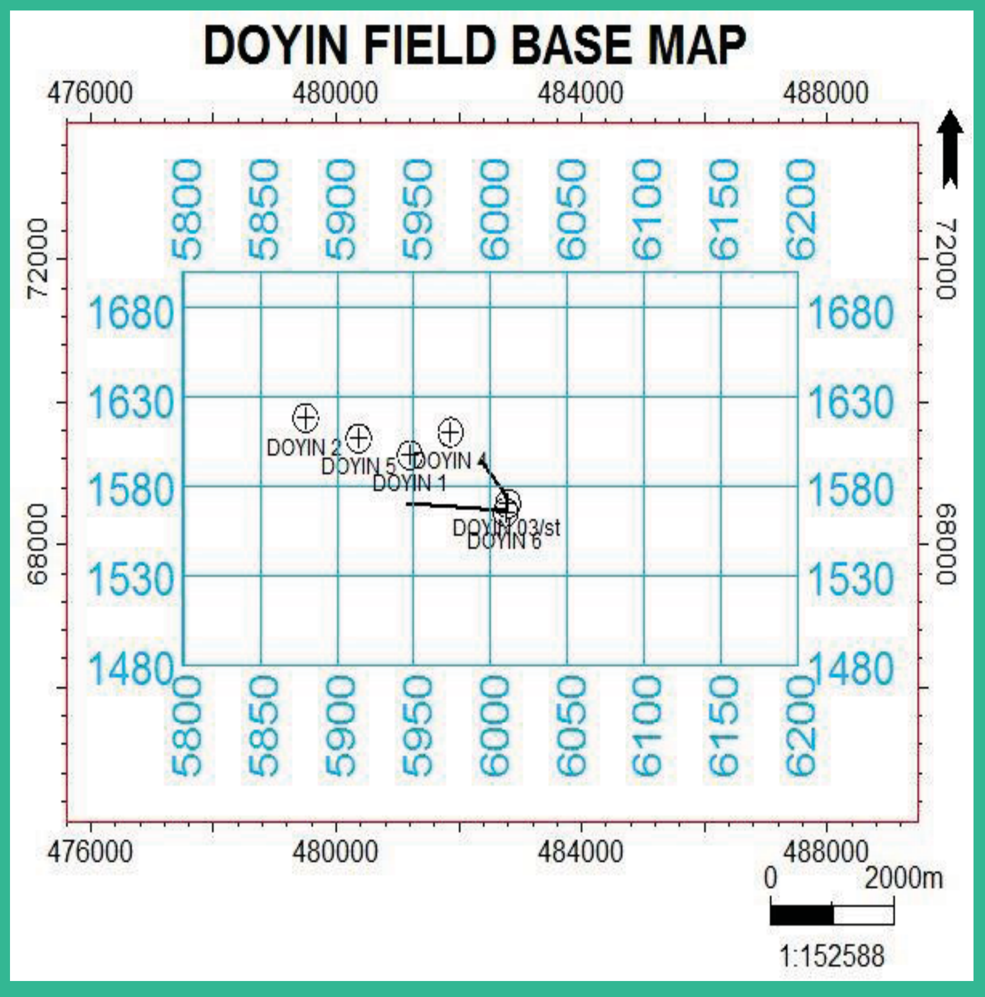
LOCATION OF STUDY AREA

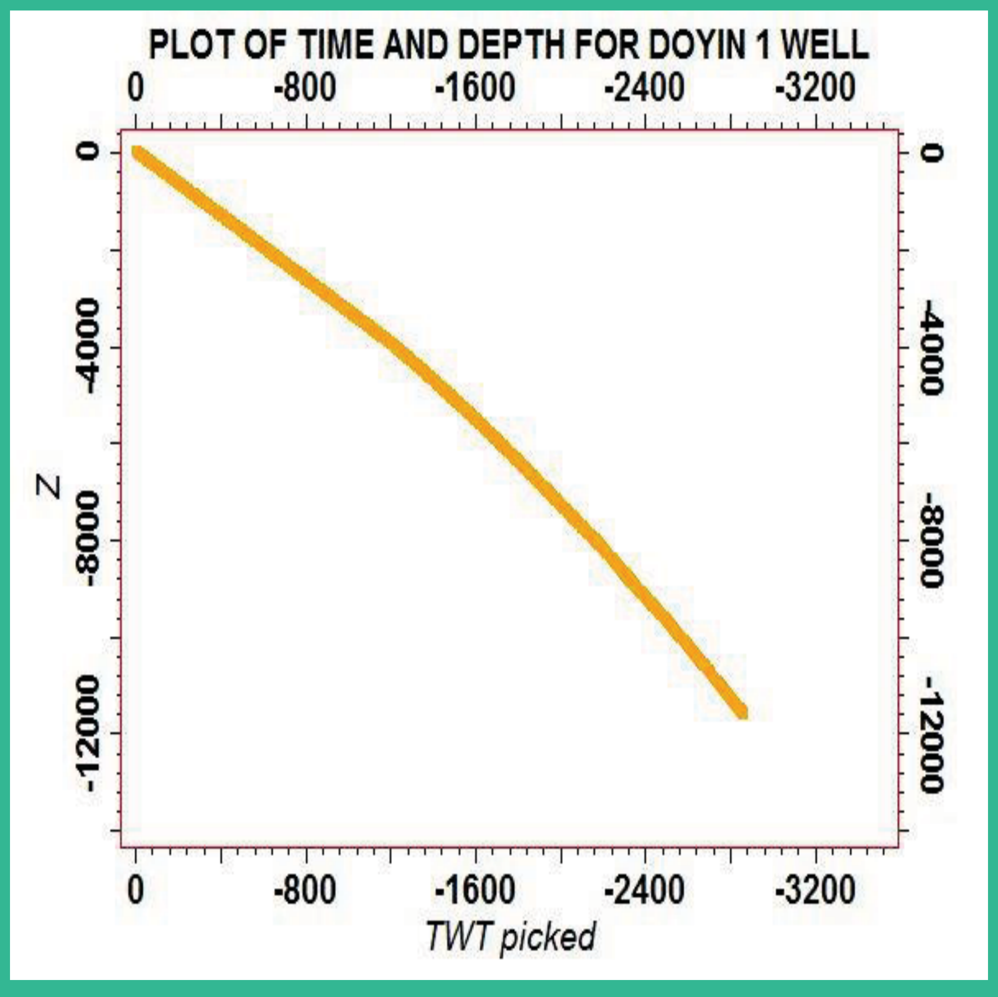


METHODOLOGY

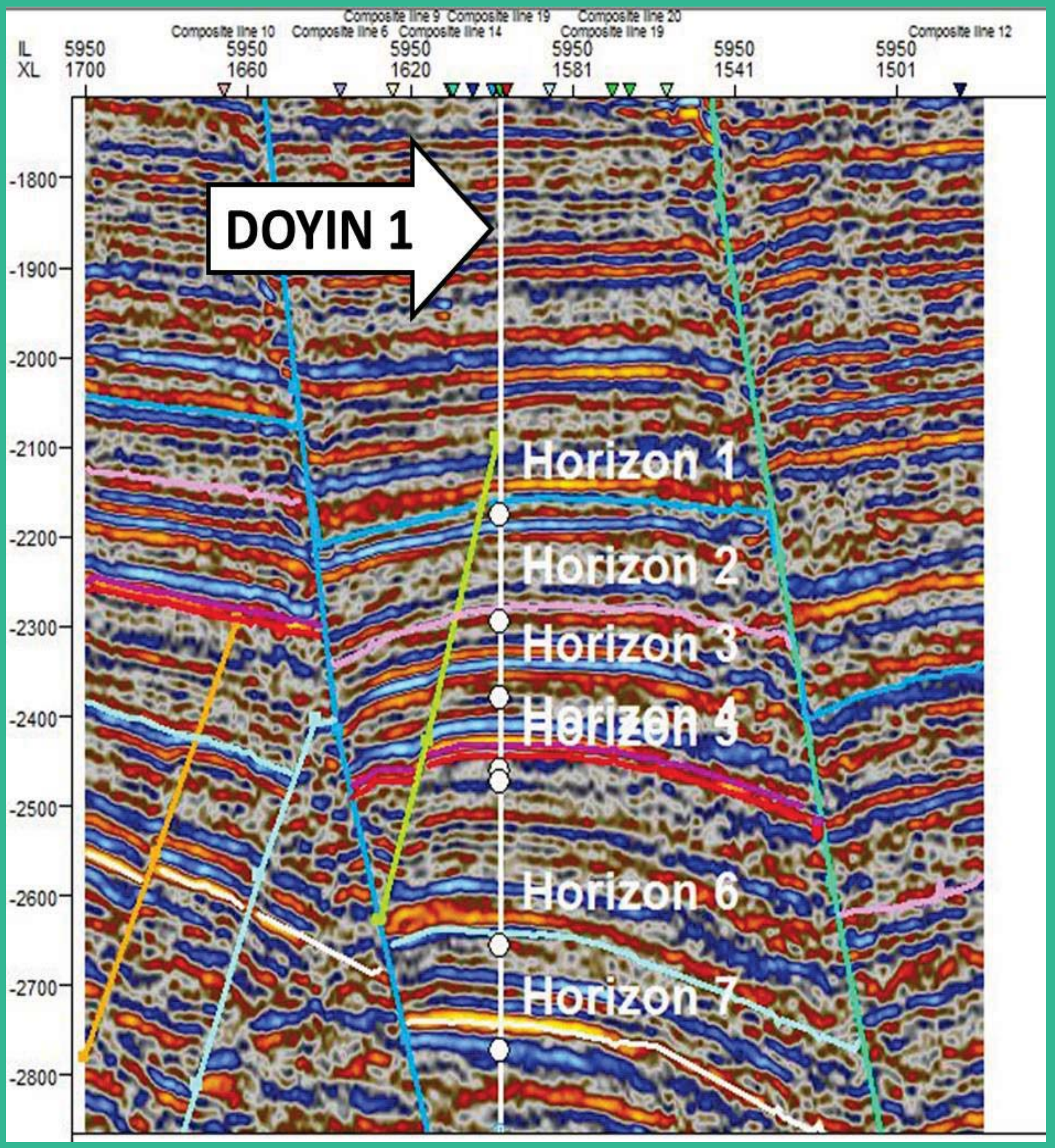
- Well – to – well correlation to identify lithofacies and delineate hydrocarbon reservoirs
- Petrophysical analysis of hydrocarbon reservoirs
- Seismic to well tie
- Seismic data interpretation and amplitude extraction
- Map generation and volumetrics

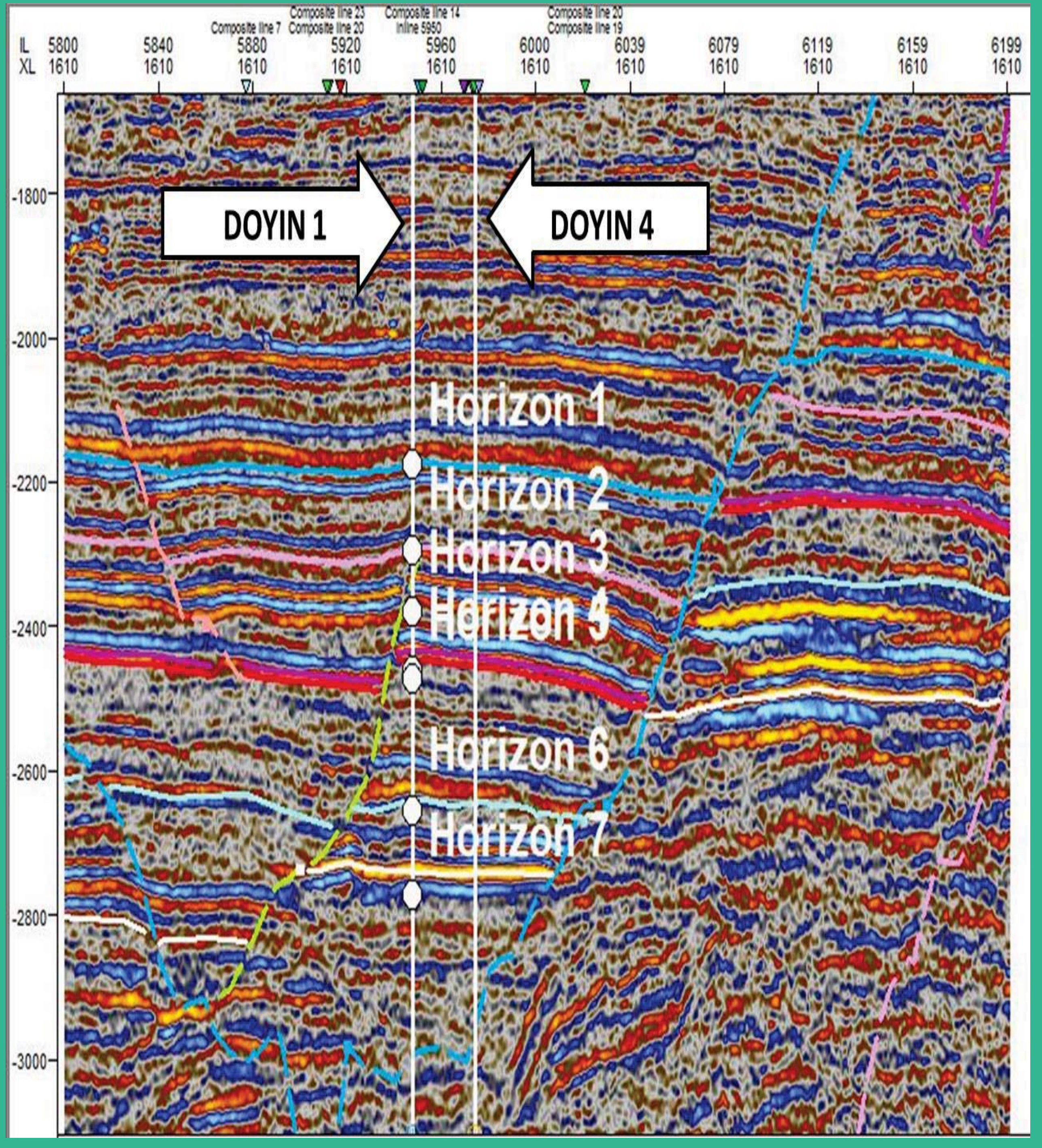






SEISMIC LINES





This research is supported by Degeconek Nigerial Limited

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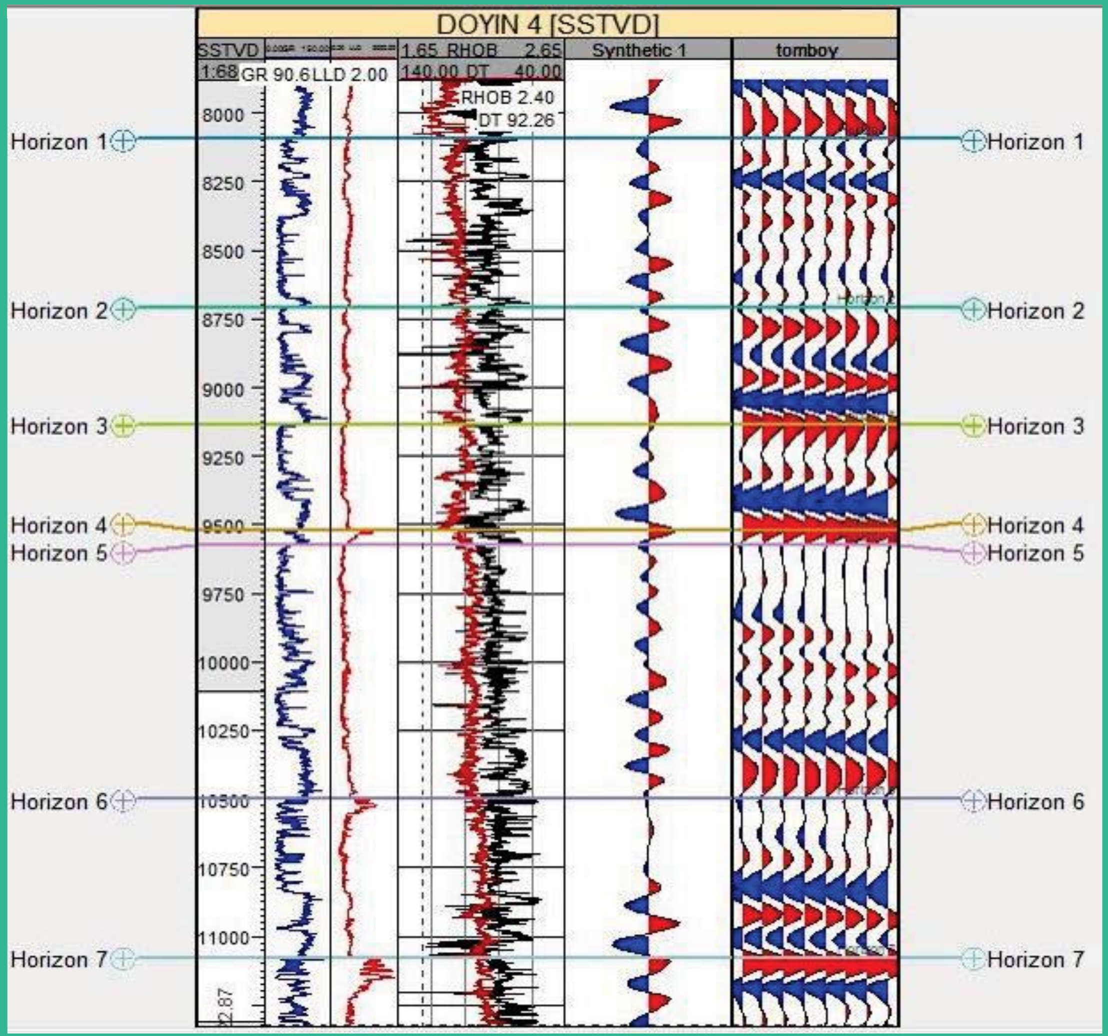
SYNTHETIC SEISMOGRAM



PETROPHYSICAL PARAMETERS

EQUATIONS

Porosity: $\Phi = (\rho ma - \rho b) / (\rho ma - \rho f)$
(derived from density log)
ρma = Formation matrix(2.65gcc)
ρf = Desisty of Fluid (1.0 gcc)
ρb = Values derived from density log

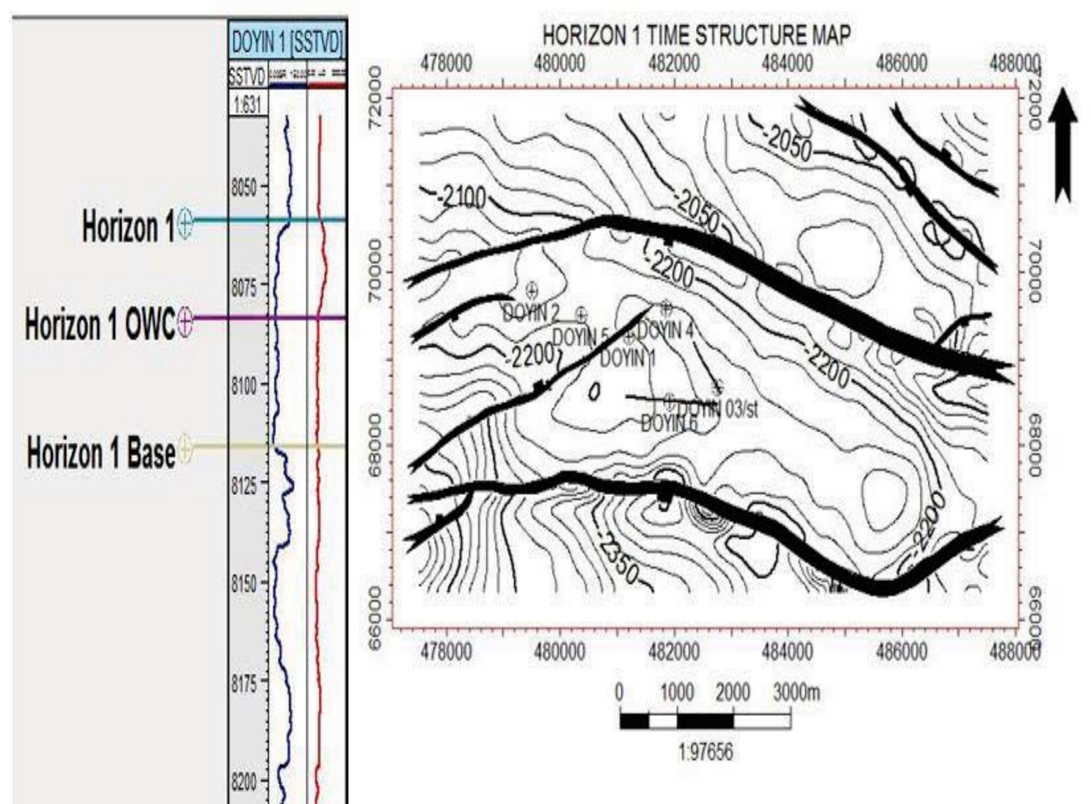
$I_{GR} = (GRlog - GRmin) / (GRmax - Grmin)$
$Vsh = 0.083(2^{3.7\,IGR} - 1)$

Resistivity of water : $Rw = (Rt * \Phi m)/a$
Water saturation : $Sw = [a*Rw/Rt*\Phi^{m}]^{1/n}$
Gas saturation $Sg = 1 - So - Sw$
Oil Saturation $So = 1 - Sg - Sw$

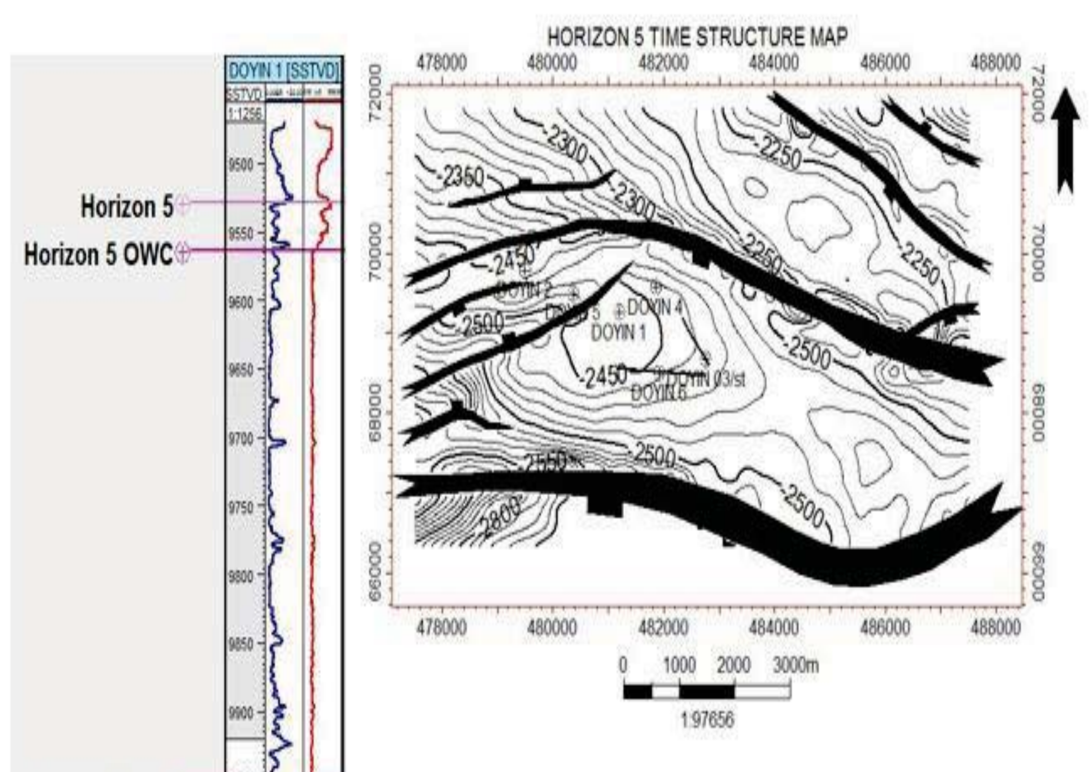
NTG = Net Sand/Gross Sand

Reservoir	Porosity Φ	Sw	Sg	So	NTG
Horizon 1	0.28	0.46	-	0.54	0.94
Horizon 2	0.28	0.44	-	0.56	0.95
Horizon 3	0.27	0.31	-	0.69	0.86
Horizon 4	0.23	0.14	-	0.86	0.75
Horizon 5	0.23	0.19	-	0.81	0.80
Horizon 6 (Gas)	0.24	0.24	0.40	-	0.75
Horizon 6 (Oil)	0.24	0.24	-	0.36	0.75
Horizon 7	0.26	0.31	-	0.69	0.79

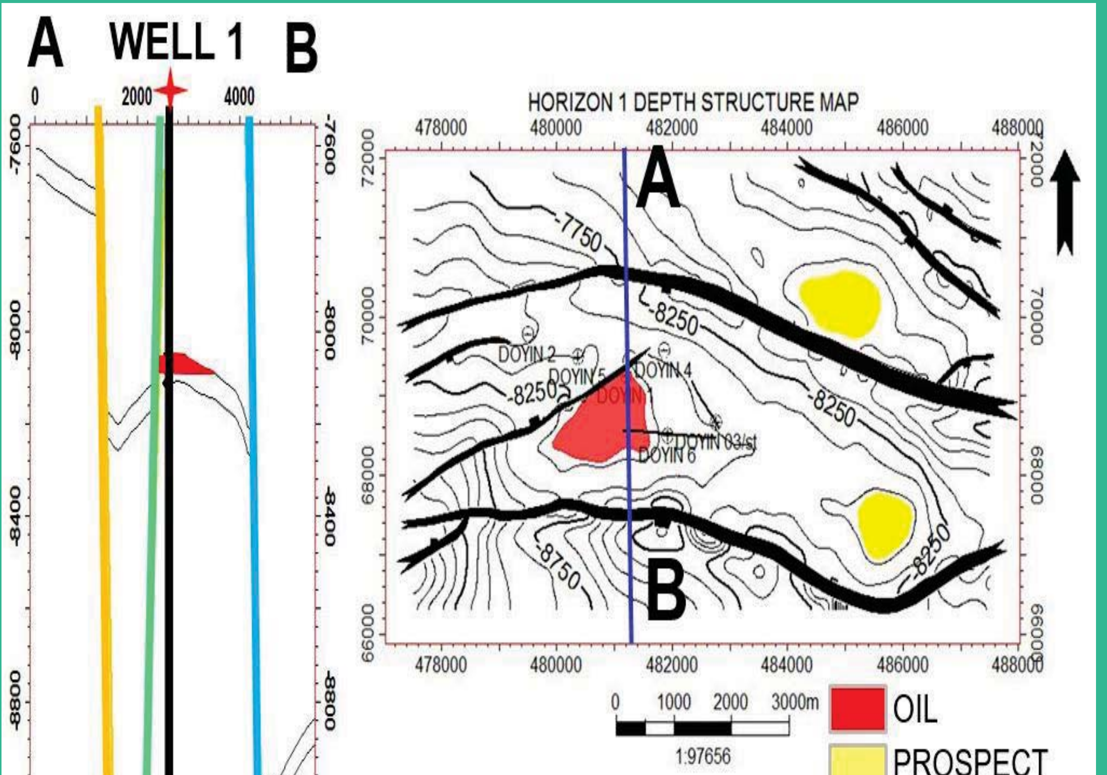
MAPS



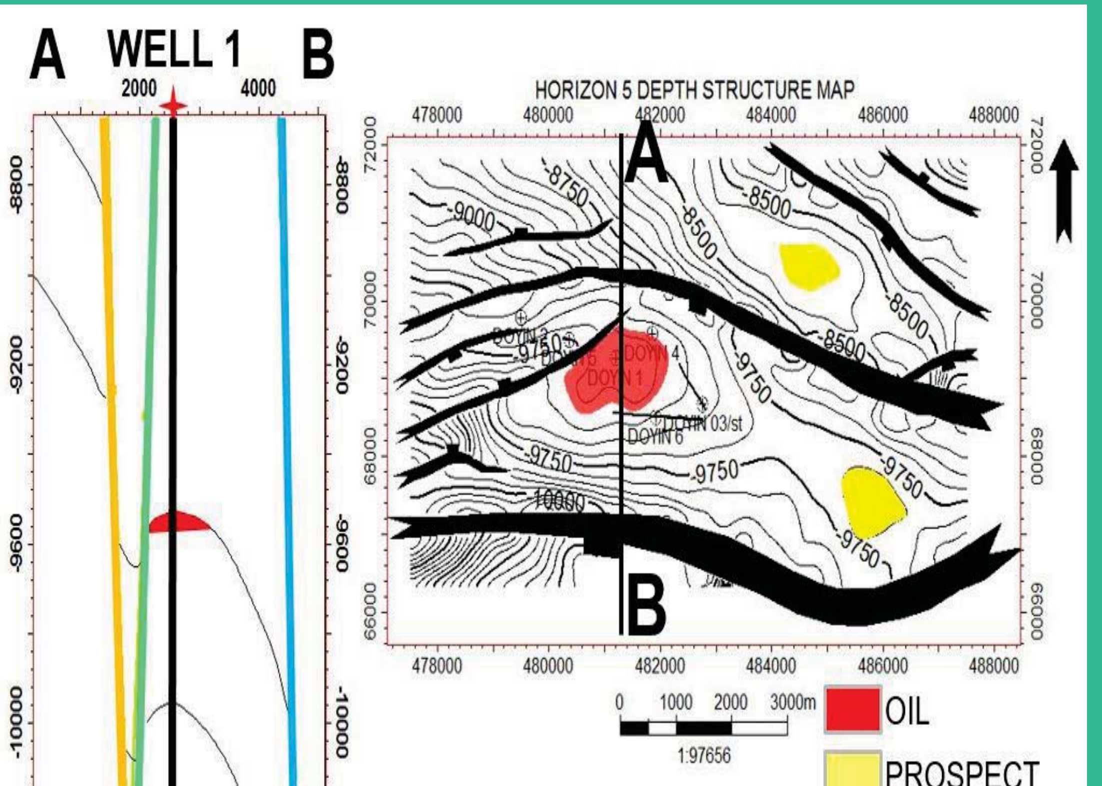
HORIZON 1 WELL SECTION AND TIME STRUCTURE MAP



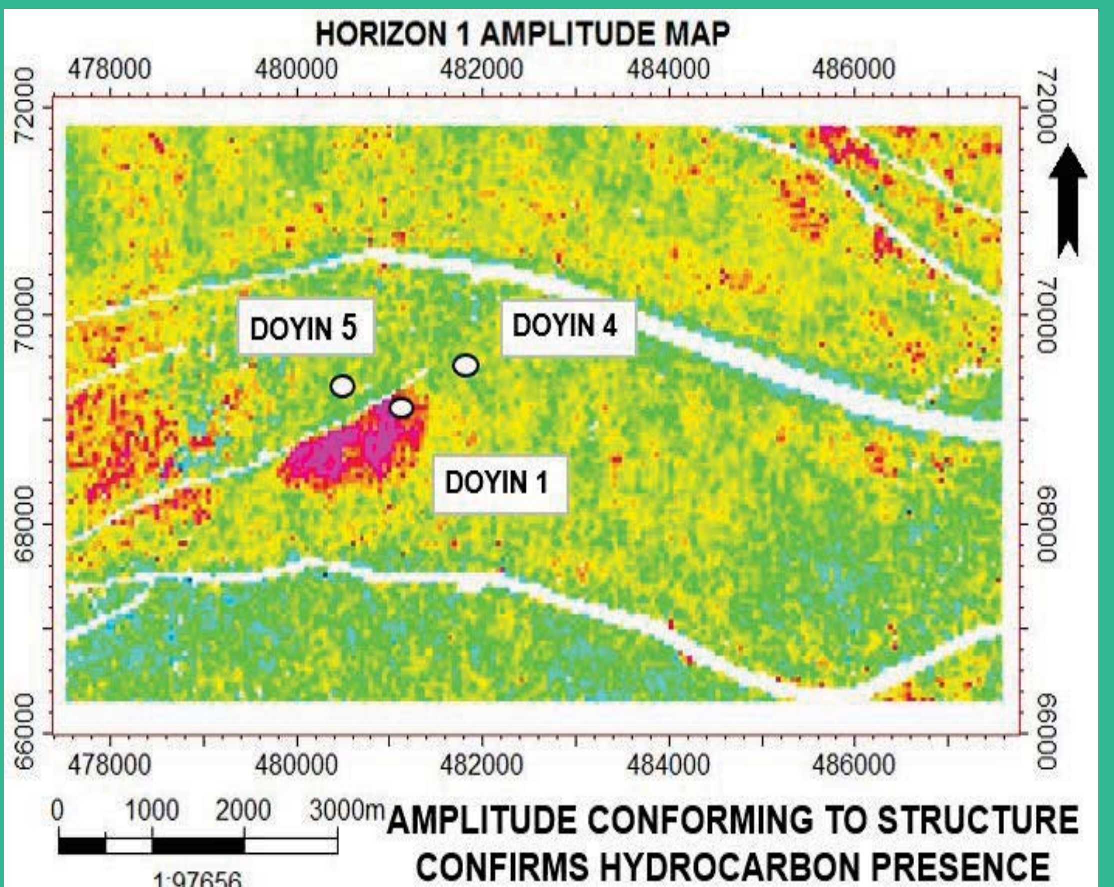
HORIZON 5 WELL SECTION AND TIME STRUCTURE MAP



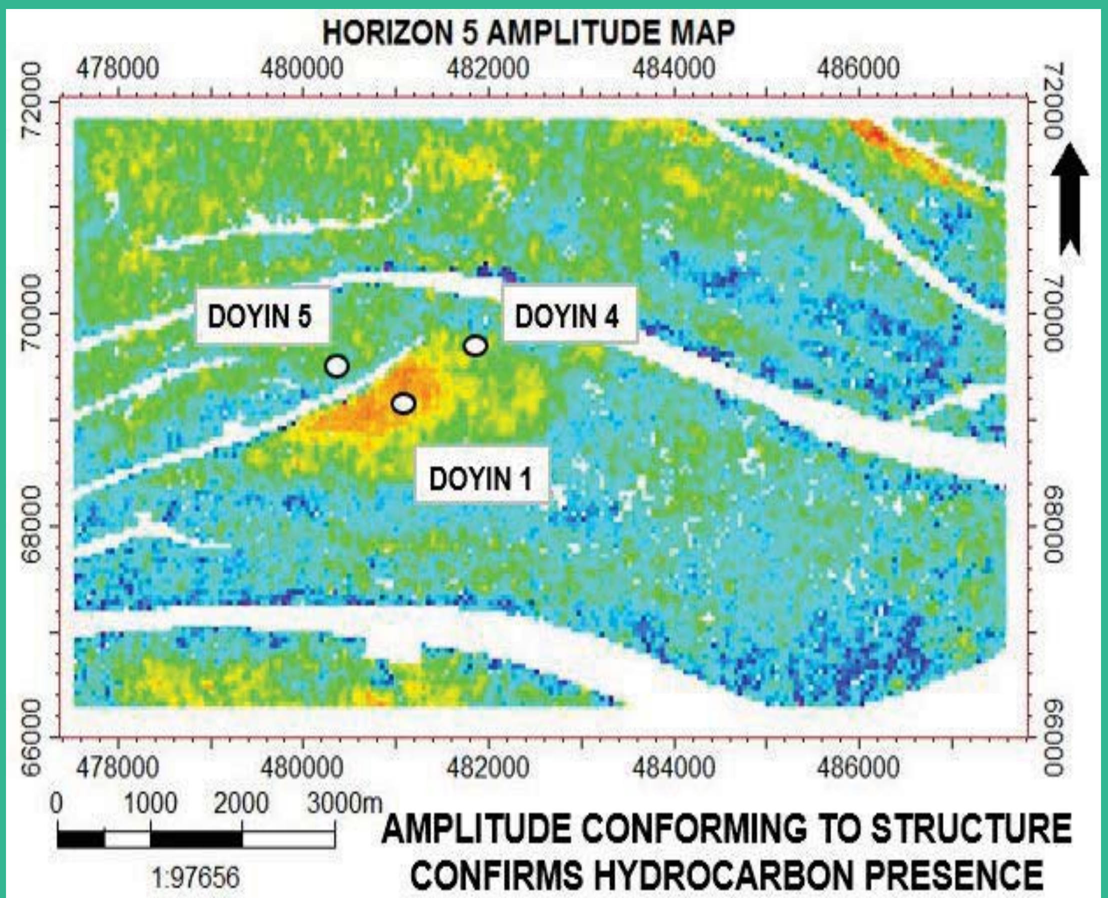
HORIZON 1 DEPTH STRUCTURE MAP AND PROFILE SECTION ALONG A - B



HORIZON 5 DEPTH STRUCTURE MAP AND PROFILE SECTION ALONG A – B



AMPLITUDE CONFORMING TO STRUCTURE CONFIRMS HYDROCARBON PRESENCE



AMPLITUDE CONFORMING TO STRUCTURE CONFIRMS HYDROCARBON PRESENCE

VOLUMETRICS

EQUATIONS

$STOIIP = (6.29 * GRV * NTG * \phi * S_o)/Bo$
$GIIP = (35.31 * GRV * NTG * \phi * S_g)/Bg$

STOIIP: Stock Tank Oil Initially In Place
GIIP: Gas Initially In Place
6.29: Conversion Factor from m^3 to bbl
35.31: Conversion Factor from m^3 to scf
GRV: Gross Rock Volume
NTG: Net To Gross
ϕ: Porosity
S_o : Oil Saturation
S_g : Gas Saturation
Bo : Formation Volume Factor (oil)
Bg : Formation Volume Factor (gas)
EUR oil = STOIIP*Recovery Factor
EUR gas= GIIP*Recovery Factor
EUR: Estimated Ultimate Recovery

Reserve	Constant	Volume	NTG	Φ	Sg	So	Bo (Bg)	STOIIP	GIIP	Avg. RF.	EUR GAS	EUR OIL
	bbl/m^3 (Scf/m^3)	'000 m^3					Rb/stb (Rb/scf)	MMBO	BCF		BCF	MMBO
Horizon 1	6.29	14,700	0.94	0.28	-	0.54	1.3	10.11	-	0.35	-	3.54
Horizon 2	6.29	11,840	0.95	0.28	-	0.56	1.3	8.53	-	0.35	-	2.99
Horizon 3	6.29	7,121	0.86	0.27	-	0.69	1.3	5.52	-	0.35	-	1.93
Horizon 4	6.29	30,360	0.75	0.23	-	0.86	1.3	21.79	-	0.35	-	7.63
Horizon 5	6.29	8,520	0.80	0.23	-	0.81	1.3	6.14	-	0.35	-	2.15
Horizon 6 (gas)	(35.31)	30,793	0.75	0.24	0.40	-	0.004	-	19.57	0.70	13.70	-
Horizon 6 (oil)	6.29	5,832	0.75	0.24	-	0.36	1.3	1.83	-	0.35	-	0.64
Horizon 7	6.29	13,520	0.79	0.26	-	0.69	1.3	9.27	-	0.35	-	3.24
TOTAL								63.19	19.57		13.70	22.12

RESULTS

- Hydrocarbon trapping mechanism is structural traps
- Amplitudes conforming to structure in all reservoirs mapped is an indication of structural closure and presence of hydrocarbon
- Potential drill well locations are on the crest of the structure with 'DOYIN 1' well
- Chances of prospects are low since they are only closures with non amplitude conformity

REFERENCES

- Doust, H., and Omatsola, E., (1990). Niger Delta structures and geology.
- Michele L. W. Tuttle, Ronald R. Charpentier, and Michael E. Brownfield. (1999). The Niger Delta Petroleum System

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