Formation Temperature Distribution of the Turonian-Maastrichtian Fika Shale Formation from Wireline Logs, in Part of Borno Basin, Northeastern Nigeria

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ABSTRACT---- ***The distribution of Formation Temperature of the Fika Shale Formation within part of Borno basin from five wireline logs was investigated. The area under studied covered about 20 by 40 kilometre square of the total land mass of the basin. The Fika shale sequence were identified at 865m to 1795m in Kinasar well, 640m to 1990m in Krumta, 980m to 1620m in Masu, 700m to 2710m in Tuma, 710m to 2220m in Wadi. The plot of the entire Formation Temperature of the study area reveals remarkable steep variations in temperature with increased range from 68^0C to 128^0C starting from the southern eastern region to the north western region. This is possibly due to substantial temperature enhancing effects of the underlying basement complex. Interestingly, it was also observed that the minimal temperature variation occurred approximately 2^0C/ meter across the field and this also lays credence to the fact that the notable subsurface geothermal variation may be recent events initiated by the near- surface magmatic intrusive events which may have had adverse effects on the overlying sedimentary cover. Furthermore, it was deduced that the probability of hydrocarbon accumulation is better in the south eastern region than the north western region although the steep temperature variation of 2^0C/ meter within some part of the study area may perhaps reduce this possibility.***

Keywords---- wireline, sequence, basement, intrusive, geothermal and magmatic

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1. INTRODUCTION

The Nigerian sector (Borno Basin) of the Chad Basin is known to provide possible source rocks, reservoir beds and structural and stratigraphic environment required for the formation, exploration and exploitation of hydrocarbon. However, there has been no successful record of commercial discovery of Hydrocarbon within the Borno Basin contrary to the success recorded in the Chad Basin by other neighboring countries that are part of this Chad Basin system despite the huge Capital that has been invested by Federal government of Nigeria. Currently, over 730 square kilometers of data been acquired and interpreted by IDSL, a subsidiary of NNPC, in partnership with BGP of China with little to show for it despite the huge resources deplored by the federal government of Nigeria thus there is a need to critically re assess the potential of the basin by looking at various hydrocarbon indices that may explain or proffer solution to lack of discovery of commercial quantities of hydrocarbon within the basin (Ilozobhie, et al. 2014) and one of such indices is the Formation Temperature. The Formation Temperature is the temperature of the unperturbed formation within a basin. A critical understanding of the variation of Formation Temperature within an identified source rock formation as conceived in this research will go a long way to give an idea about the maturation of the source rock and in general, the hydrocarbon prospect of the Basin.

Generally,any prospective hydrocarbon basin must have a good quality source rock, good reservoir and seal lithologies, favourable regional pathways and trapping mechanisms Ayoola et al (1982) Ajayi and Ajakaiye (1983) Cratchley et al (1984) and Ilozobhie, et.al (2015). It is an established fact that the Fika Shale is one of the major source rock within the basin, while the reservoirs are provided by Gombe Sandstone and the Bima Sandstone facies of the basin. Also, the intrusive sills are known to be good seal for hydrocarbons while the aquifers within the Chad Formation can act as a conduit for hydrocarbon to the surface. Nwankwo and Ekine,(2009) and Ilozobhie et. al (2009). Thus the thrust of this study shall investigate the Formation Temperature distribution within the Turonian- Maastrichtian Fika Shale, in order to ascertain their effect on the hydrocarbon potential of the basin.

2. MATERIALS AND METHOD

2.1 Location of study Area

The study area lies within an approximate location of latitude 12^0 09'N and $12^0$26'N and longitudes $15^0$12'E and $15^0$24'E and it covered an area of about 20 by 40 kilometer square of the total land mass of the entire basin (Fig. 1.0). In the concessional map of the basin, it is located in the oil prospecting lease (OPL) 721, 722, 732 and 733. The altitude of the basin dropped from 350m at the western margin to about 300m along a distance of roughly 240km indicating a gentle slope towards lake Chad. The area of study is situated onshore and accessibility is by road and air.

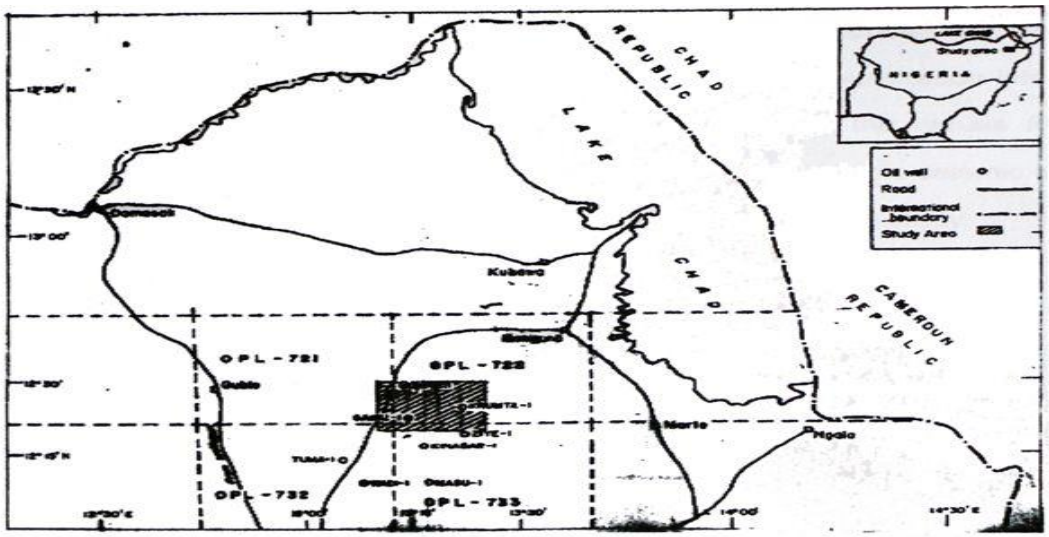

Fig. 1.0: Location map of Bornu Basin. Shaded section represent area covered in the study

2.2 The Fika Shales of Borno Basin

The Fika Shale is mainly dark to blue black shale overlying the Gongila Formation. These are completely marine shales consisting of blue black shales occasionally, gypsiferous with thin limestone intercalation. The thickness varies from about 1000m in the NorthWestern margin to about 500m in the NorthEastern margin. Volcanic intrusive which occurs as diorites sills are present at several horizon of the formation (Okosun,1995).The unit is diachronous, dating from Turonian to Maastrichtian in age. The relative abundance of arenaceous benthic foraminifera within the Fika shale point to the prevalent of near shore environment. The Source of Marine water during the period is believed to be through the Tran Sahara sea way (Avbovbo et. al, 1986).

2.3 Acquisition

Soft copies of digital well data were supplied for this work. The soft copies of the well data given are Kinasar-1 ($12^0$19'N $13^0$17'E), Tuma-1 ($12^0$15'N $13^0$05'E), Wadi-1 ($12^0$09'N $13^0$09'E), Masu-1 ($12^0$10'N $13^0$18'E), Gaibu-1 ($12^0$23N $13^0$14'E), Krumta-1(12^0 26'N 13^0 23'E). This data were plotted by a developed visual basic plotter manager to facilitate the demarcation of bed boundaries and formations identification. Table (1.0) shows the wireline logs and the depth of investigation.

2.4 Identification of the Fika Shale

In this study, the gamma ray log signatures were utilized to delineate the sediments bed boundaries for the various formations (sandstone, shale and siltstone) encountered. Deductions from the electric logs show that this formation consists primarily of shale with minor limestone and subordinate amount of intercalated sand extending from 865m to 1795m. Kinasar well reveals the Fika shale member from 865m to 1250m to be a shaly sequence with intercalations of sand (865m – 975m and 1045m – 1250m). This strata is recognized by high Gamma ray values (except in the intercalated areas), high sonic travel time for shale zone but moderately low area of sands. A thick sequence of shale occurs between 1250m to 1450m. It is recognized by high Gamma ray value and relatively high resistivity and high sonic travel time. Toward the end of the Fika Shale Formation (1450m to 1850m) there is a gradual increase in resistivity values with high gamma values with high sonic travel time compared to earlier zone. The log characteristics above indicate unconsolidated shale.

The Fika Shale was identified in the Krumta well within the depth range from 640m to 1990m by the high Gamma ray values with high sonic travel time. The Intercalation sequence ranges from 640m to 1110m. Most of the remaining

section of the Fika shale depicts shaly sequence throughout ranging from 1110m to 1990m as reflected by high values of gamma ray, Resistivity and Sonic logs. The depth range of the Fika sequence identified within Masu, Tuma and Wadi ranges within 980m to 1620m, 700m to 2710m and 710m to 2220m respectively.

Table 1.0: Well location and wirelines log used for the study

Well	Drilling depth Range (m)	Type of log		
		Lithology	Resistivity	Porosity
Kinasar-1	45-4665	CAL. & GR	SN & ILD	ΔT & RHOB
Krumta-1	15-2950	CAL. & GR	SN & ILD	ΔT & RHOB
Masu-1	1996-3104	CAL. & GR	MSFL & ILD	ΔT & RHOB
Tuma – 1	33-3628	CAL. & GR	SN & ILD	ΔT & RHOB
Wadi -1	539-3225	CAL. & GR	SN & ILD	ΔT & RHOB

Key:

CAL. = Caliper log
SP = Spontaneous Potential Log
GR = Gamma Ray Log
SN = Short Normal Log
MSFL = Microspherical Focus Log
ILD = Deep Induction Resistivity Log
ΔT = Sonic Log
RHOB = Density Log

2.4 Computation of Formation Temperature

The computed formation temperature within each of the interested formation from each well was computed using the Borehole Temperature (BHT) values as displayed on the well header after which the BHT values were corrected. Several correction methods have been proposed by many authors (Kutasov and Eppelbaum, 2003 and Onuoha and Ekine, 1999). In this study the BHT drilling effects were corrected by using an AAPG gradient correction factors (Table 2.0). The approach allows corrections to be made on individual recorded BHT data. The corrected BHT values were converted to the Formation Temperature using the Schlumberger correction chart (GEN- 6). Table (3.0 to 8.0) shows the computed formation temperature for Fika shale at various coordinates and depths, this was done for the remaining four wells. Since all the given well data are from vertical well, the position of each of the well were posted on the corresponding depth point using the coordinate of such point to generates maps that shows the distribution of Formation Temperature within each well. Most importantly, in order to have an ideal about the variation of the Formation Temperature within the study the computed values were posted on the situation map using the coordinates of each depth points and are contoured using available contour software.

Table 2.0: Additions for correction of logged Bottom Hole Temperatures to True Formation Temperatures based on API method (Neglia, 1979).

Depth (m)	**Added temperature quotient (°C)**
500	4.0
1000	7.5
1500	11.0
2000	14.0
2500	16.0
3000	17.5
3500	18.0
4000	18.0
4500	17.0
5000	15.0
5500	11.0
6000	4.5

Table 3: Computed Formation Temperature values with coordinates and depth in Kinasar well

Depth (m)	Latitude	Longitude	Formation Temperature within Fika Formation
865	$12^0\ 16^1\ 22"$	$15^0\ 20^1\ 32"$	60
915	$12^0\ 16^1 24"$	$15^0\ 20^1\ 33"$	62
965	$12^0\ 16^1\ 25"$	$15^0\ 20^1\ 34"$	59
1015	$12^0\ 16^1\ 27"$	$15^0\ 20^1\ 35"$	63
1065	$12^0\ 16^1\ 29"$	$15^0\ 20^1\ 37"$	66
1115	$12^0\ 16^1\ 30"$	$15^0\ 20^1\ 38"$	67
1165	$12^0\ 16^1\ 31"$	$15^0\ 20^1\ 39"$	66
1215	$12^0\ 16^1\ 35"$	$15^0\ 20^1\ 42"$	69
1265	$12^0\ 16^1\ 42"$	$15^0\ 20^1\ 43"$	72
1315	$12^0\ 16^1\ 43"$	$15^0\ 20^1\ 46"$	74
1365	$12^0\ 16^1\ 44"$	$15^0\ 20^1\ 47"$	79
1415	$12^0\ 16^1\ 45"$	$15^0\ 20^1\ 49"$	81
1465	$12^0\ 16^1\ 47"$	$15^0\ 20^1\ 53"$	84
1515	$12^0\ 16^1\ 48"$	$15^0\ 20^1\ 55"$	86
1565	$12^0\ 16^1\ 49"$	$15^0\ 20^1\ 57"$	87
1615	$12^0\ 16^1\ 51"$	$15^0\ 20^1\ 58"$	90
1665	$12^0\ 16^1\ 52"$	$15^0\ 20^1\ 59"$	90
1715	$12^0\ 16^1 52"$	$15^0\ 21^1\ 01"$	91
1765	$12^0\ 16\ 56"$	$15^0\ 21^1\ 03"$	90
1795	$12^0\ 16^1\ 57"$	$15^0\ 21^1\ 04"$	90

Table 4: The Formation Temperature values with depth in Krumta well

Depth(m)	Latitude	Longitude	Formation Temperature within Fika Formation
640	$12^0\ 16^1\ 16"$	$15^0\ 19^1\ 52"$	65
690	$12^0\ 16^1\ 19"$	$15^0\ 19^1\ 56"$	66
740	$12^0\ 16^1\ 20"$	$15^0\ 20^1\ 03"$	59
790	$12^0\ 15^1\ 22"$	$15^0\ 20^1\ 05"$	59
840	$12^0\ 16^1\ 23"$	$15^0\ 20^1\ 08"$	62
890	$12^0\ 16^1\ 25"$	$15^0\ 20^1\ 10"$	66
940	$12^0\ 16^1\ 26"$	$15^0\ 20^1\ 13"$	66
990	$12^0\ 16^1\ 27"$	$15^0\ 20^1\ 17"$	67
1040	$12^0\ 16^1\ 29"$	$15^0\ 20^1\ 20"$	68
1090	$12^0\ 16^1\ 32"$	$15^0\ 20^1\ 23"$	70
1140	$12^0\ 16^1\ 36"$	$15^0\ 20^1\ 26"$	74
1190	$12^0\ 16^1\ 38"$	$15^0\ 20^1\ 29"$	78
1240	$12^0\ 16^1\ 41"$	$15^0\ 20^1\ 31"$	78
1290	$12^0\ 16^1\ 44"$	$15^0\ 20^1\ 32"$	78
1340	$12^0\ 16^1\ 45"$	$15^0\ 20^1\ 36"$	80
1390	$12^0\ 16^1\ 48"$	$15^0\ 20^1\ 38"$	81
1440	$12^0\ 16^1\ 49"$	$15^0\ 20^1\ 40"$	81
1490	$12^0\ 16^1\ 50"$	$15^0\ 20^1\ 44"$	82
1540	$12^0\ 16'\ 54"$	$15^0\ 20^1\ 47"$	88
1590	$12^0\ 16^1\ 55"$	$15^0\ 20^1\ 50"$	88
1640	$12^0\ 16^1\ 56"$	$15^0\ 20^1\ 52"$	88
1690	$12^0\ 16^1\ 58"$	$15^0\ 20^1\ 55"$	87
1740	$12^0\ 16'\ 59"$	$15^0\ 20^1\ 58"$	85
1790	$12^0\ 17^1 03"$	$15^0\ 21^1\ 04"$	90
1840	$12^0\ 17^1 05"$	$15^0\ 21^1\ 05"$	90
1890	$12^0\ 17^1 05"$	$15^0\ 21^1\ 07"$	90
1940	$12^0\ 17^1 07"$	$15^0\ 21^1\ 10"$	90
1990	$12^0\ 17^1 09"$	$15^0\ 21^1\ 03"$	90

Table 5: The Formation Temperature values with depth in Masu well

Depth(m)	Latitude	Longitude	Formation Temperature within Fika Formation
980	$12^0\ 16^1\ 27^{"}$	$15^0\ 20^1\ 24^{"}$	58
1030	$12^0\ 16^1\ 30^{"}$	$15^0\ 20^1\ 27^{"}$	59
1080	$12^0\ 16^1\ 33^{"}$	$15^0\ 20^1\ 29^{"}$	63
1130	$12^0\ 16^1\ 36^{"}$	$15^0\ 20^1\ 30^{"}$	62
1180	$12^0\ 16^1\ 39^{"}$	$15^0\ 20^1\ 32^{"}$	66
1230	$12^0\ 16^1\ 42^{"}$	$15^0\ 20^1\ 36^{"}$	69
1280	$12^0\ 16^1\ 43^{"}$	$15^0\ 20^1\ 38^{"}$	72
1330	$12^0\ 16^1\ 46^{"}$	$15^0\ 20^1\ 40^{"}$	74
1380	$12^0\ 16^1\ 49^{"}$	$15^0\ 20^1\ 42^{"}$	79
1430	$12^0\ 16^1\ 50^{"}$	$15^0\ 20^1\ 44^{"}$	85
1480	$12^0\ 16^1\ 52^{"}$	$15^0\ 20^1\ 48^{"}$	87
1530	$12^0\ 16^1\ 53^{"}$	$15^0\ 20^1\ 51^{"}$	90
1580	$12^0\ 16^1\ 54^{"}$	$15^0\ 20^1\ 52^{"}$	90
1620	$12^0\ 16^1\ 54^{"}$	$15^0\ 20^1\ 55^{"}$	90

Table 6: The Formation Temperature values with depth in Tuma well

Depth(m)	Latitude	Longitude	Formation Temperature within Fika Formation
700	12^0 16^1 23”	15^0 19^1 56”	60
750	12^0 16^1 27”	15^0 19^1 58”	60
800	12^0 16^1 29”	15^0 20^1 00”	62
850	12^0 16^1 32”	15^0 20^1 03”	61
900	12^0 16^1 34”	15^0 20^1 06”	63
950	12^0 16^1 35”	15^0 20^1 06”	66
1000	12^0 16^1 37”	15^0 20^1 08”	67
1050	12^0 16^1 39”	15^0 20^1 09”	67
1100	12^0 16^1 40”	15^0 20^1 12”	69
1150	12^0 16^1 43”	15^0 20^1 15”	69
1200	12^0 16^1 44”	15^0 20^1 18”	70
1250	12^0 16^1 46”	15^0 20^1 22”	72
1300	12^0 16^1 47”	15^0 20^1 23”	69
1350	12^0 16^1 48”	15^0 20^1 26”	69
1400	12^0 16^1 52”	15^0 20^1 27”	70
1450	12^0 16^1 53”	15^0 20^1 29”	75
1500	12^0 16^1 55”	15^0 20^1 32”	75
1550	12^0 16^1 56”	15^0 20^1 35”	75
1600	12^0 16^1 58”	15^0 20^1 38”	75
1650	12^0 17^1 02”	15^0 20^1 40”	74
1700	12^0 17^1 04”	15^0 20^1 43”	75
1750	12^0 17^1 07”	15^0 20^1 47”	75
1800	12^0 17^1 10”	15^0 20^1 49”	75
1850	12^0 17^1 14”	15^0 20^1 53”	75
1900	12^0 17^1 16”	15^0 20^1 56”	76
1950	12^0 17^1 19”	15^0 21^1 01”	77
2000	12^0 17^1 22”	15^0 21^1 03”	79
2050	12^0 17^1 25”	15^0 21^1 06”	79
2100	12^0 17^1 26”	15^0 21^1 08”	79
2150	12^0 17^1 28”	15^0 21^1 08”	79
2200	12^0 17^1 30”	15^0 21^1 11”	79
2250	12^0 17^1 32”	15^0 21^1 13”	79
2300	12^0 17^1 34”	15^0 21^1 15”	79
2350	12^0 17^1 36”	15^0 21^1 17”	82
2400	12^0 17^1 38”	15^0 21^1 19”	82
2450	12^0 17^1 41”	15^0 21^1 21”	83
2500	12^0 17^1 44”	15^0 21^1 23”	86
2550	12^0 17^1 47”	15^0 21^1 26”	89
2600	12^0 17^1 48”	15^0 21^1 28”	90
2650	12^0 17^1 48”	15^0 21^1 28”	87
2700	12^0 17^1 51”	15^0 21^1 31”	90
2710	12^0 17^1 51”	15^0 21^1 31”	90

Table 7: The Formation Temperature values with depth in Wadi well

Depth(m)	Latitude	Longitude	Formation Temperature within Fika Formation
710	12^0 16^1 22”	15^0 19^1 53”	62
760	12^0 16^1 23”	15^0 19^1 55”	62
810	12^0 16^1 24”	15^0 19^1 56”	63
860	12^0 16^1 26”	15^0 19^1 59”	61
910	12^0 16^1 27”	15^0 20^1 03”	65
960	12^0 16^1 29”	15^0 20^1 06”	65
1010	12^0 16^1 32”	15^0 20^1 09”	65
1060	12^0 16^1 36”	15^0 20^1 12”	67
1110	12^0 16^1 39”	15^0 20^1 15”	66
1160	12^0 16^1 41”	15^0 20^1 18”	64
1210	12^0 16^1 44”	15^0 20^1 20”	66
1260	12^0 16^1 47”	15^0 20^1 23”	68
1310	12^0 16^1 48”	15^0 20^1 25”	72
1360	12^0 16^1 50”	15^0 20^1 27”	73
1410	12^0 16^1 52”	15^0 20^1 28”	76
1460	12^0 16^1 53”	15^0 20^1 30”	76
1510	12^0 16^1 56”	15^0 20^1 33”	78
1560	12^0 16^1 58”	15^0 20^1 36”	80
1610	12^0 16^1 59”	15^0 20^1 38”	85
1660	12^0 17^1 02”	15^0 20^1 41”	84
1710	12^0 17^1 07”	15^0 20^1 42”	85
1760	12^0 17^1 09”	15^0 20^1 44”	85
1810	12^0 17^1 13”	15^0 20^1 46”	87
1860	12^0 17^1 12”	15^0 20^1 46”	87
1910	12^0 17^1 15”	15^0 20^1 49”	78
1960	12^0 17^1 17”	15^0 20^1 52”	79
2010	12^0 17^1 19”	15^0 20^1 54”	78
2060	12^0 17^1 22”	15^0 20^1 58”	78
2110	12^0 17^1 24”	15^0 21^1 02”	78
2160	12^0 17^1 27”	15^0 21^1 06”	79
2210	12^0 17^1 30”	15^0 21^1 10”	78
2220	12^0 17^1 30”	15^0 21^1 11”	78

Table 8:The Formation Temperature values with depth in Ziye well

Depth(m)	Latitude	Longitude	Formation Temperature within Fika Formation
790	12^0 16^1 20”	15^0 19^1 58”	65
840	12^0 16^1 23”	15^0 19^1 59”	65
890	12^0 16^1 24”	15^0 20^1 02”	65
940	12^0 16^1 27”	15^0 20^1 04”	72
990	12^0 16^1 30”	15^0 20^1 07”	68
1040	12^0 16^1 32”	15^0 20^1 09”	76
1090	12^0 16^1 34”	15^0 20^1 11”	77
1140	12^0 16^1 38”	15^0 20^1 14”	82
1190	12^0 16^1 40”	15^0 20^1 17”	82
1240	12^0 16^1 43”	15^0 20^1 19”	86
1290	12^0 16^1 46”	15^0 20^1 22”	88
1340	12^0 16^1 49”	15^0 20^1 24”	88
1390	12^0 16^1 52”	15^0 20^1 27”	90

3. RESULTS AND DISCUSSION

3.1 Kinasar Well

The Formation Temperature (FT) within this field ranges within 30^0C to 76^0C (Fig. 2.0) the temperature variation is gentle toward the South Eastern region, with the North – Eastern part of the well is much steeper, having high Formation temperature ranging between 64^0C to 76^0C, the North Western part displace temperature range between 44^0C to 58^0C. The distribution of the temperature is along the South Western - North Eastern direction with the central part showing a range between 54^0C to 62^0C.

3.2 Krumta Well

The outward steepy spreading of the temperature values from the westward side of the study area is clearly seen on this map likely indicating rapid variation in geothermal. The North – Eastern part showing relatively high Formation Temperature from 85^0C to 100^0C (Fig. 3.0). The North Western part ranges from 50^0C to 90^0C. The central part shows

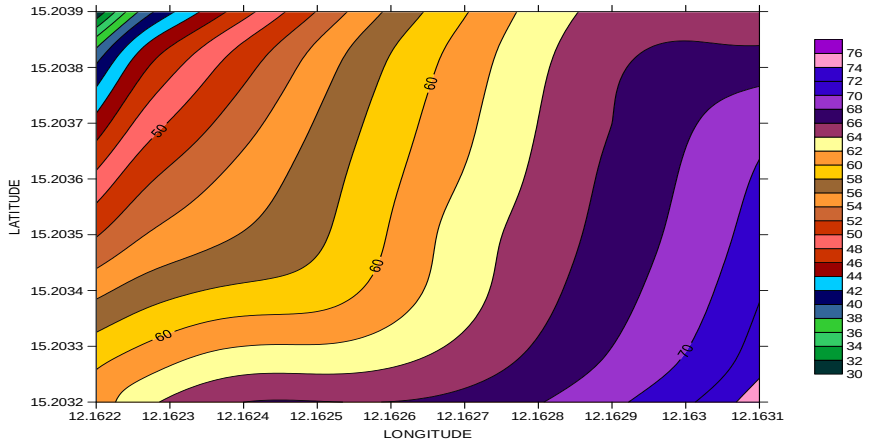

Fig. 2.0: Formation temperature map within Fika Formation in Kinasar well

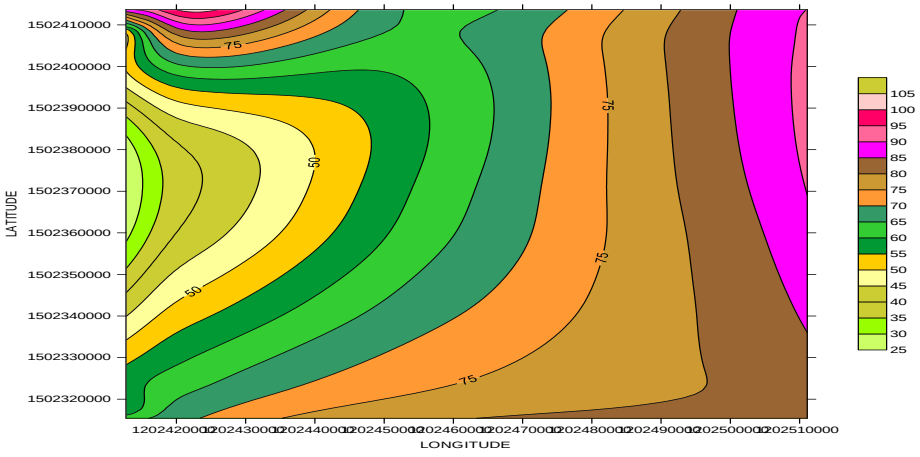

Fig.3.0: Formation temperature map within fika formation in Krumta well

relatively low temperature distribution from 55^0C to 70^0C.The distribution still maintain the North Eastern – South Western pattern.

3.3 Masu Well

The Temperature of the Formation ranging within 56^0C to 108^0C.The well exhibit evenly distribution of temperature within the South central region (Fig.4.0). The Upper part (North Eastern) shows high formation Temperature values ranging within 86^0C to 108^0C. The direction the Temperature is trending is still South Western North Eastern direction.

3.4 Tuma Well

The Formation Temperature ranges from 80^0C to 195^0C trending South Western - North Eastern direction with the Central region having Formation Temperature ranging from 120^0C to 130^0C and the North Eastern part temperature values between 160^0C to 165^0C while the South Eastern part depicts high temperature values within 175^0C to 195^0C (Fig.5.0)

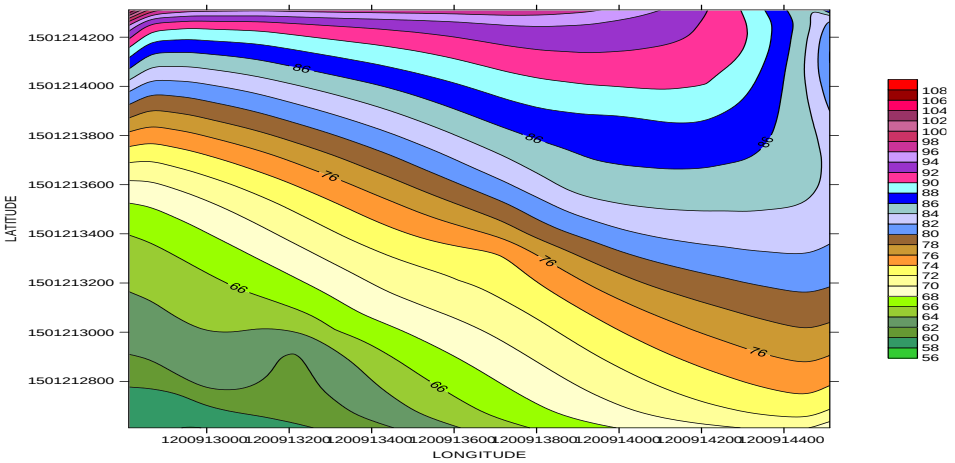

Fig.4.0: Formation temperature map within fika formation in Masu well

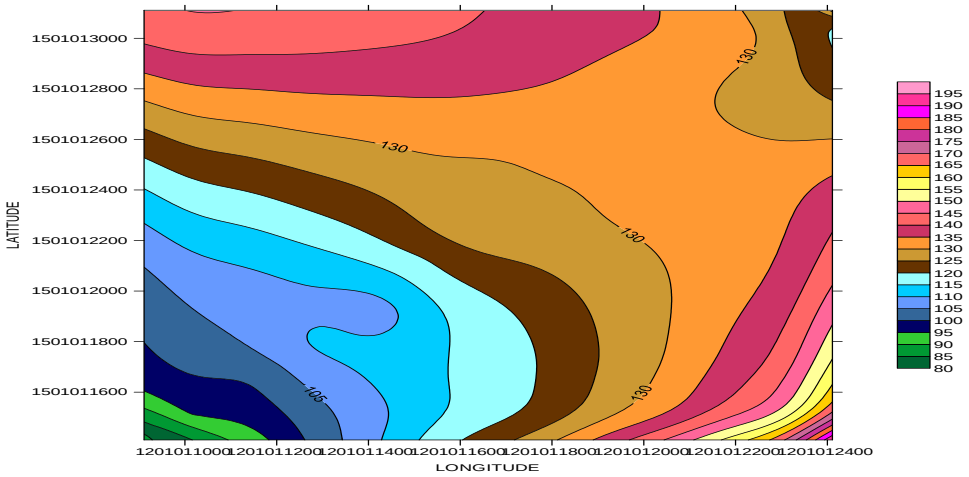

Fig. 5.0: Formation temperature map within fika formation in Tuma well

3.5 Wadi Well

There is a progressive build up of the formation temperature in the South Western – North Eastern direction with the Southern part clearly showing this build up (Fig.6.0). The South Eastern part shows high temperature values between 160^0C to 210^0C while the central portion has relatively low temperature values from 120^0C to 145^0C.

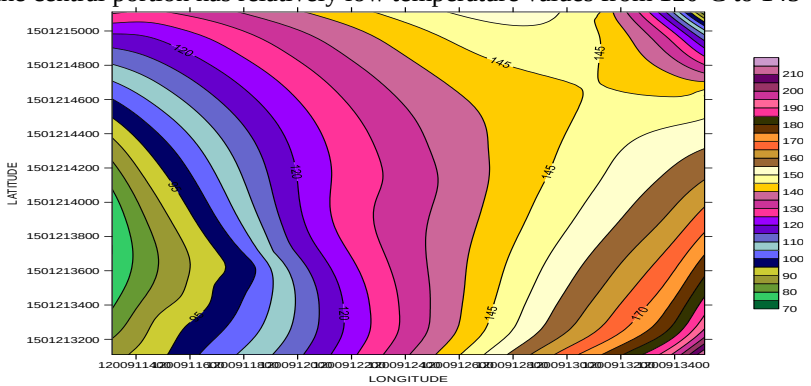

Fig.6.0: Formation temperature map within Fika formation in Wadi well

3.6 Formation Temperature analysis within the study area

A critical investigation of the map of all the wellbore temperatures shows remarkable steep variations in temperature with increased range from 68^0C to 128^0C starting from the southern eastern region to the north western region (Fig.7.0). This is possibly due to substantial temperature enhancing effects of the underlying basement complex. Interestingly, it was also observed that the minimal temperature variation occurred with approximately 2^0C/ meter across the field and this also lays credence to the fact that the notable subsurface geothermal variation may be recent events initiated by the near- surface magmatic events which may have had adverse effects on the overlying sedimentary cover.

The north east to south west region showed diagonally uniform cross sectional temperatures ranging from 90^0C to 102^0C. This suggests that possible hydrocarbon potential occurrences in this field may have better prospects from the central region with an average temperature of 98^0C to the south eastern region with the least temperature of 68^0C as long as favourable sedimentary covers exist. Furthermore, it is suggested that the probability of hydrocarbon is better in the south eastern region than the north western region although the steep temperature variation of 2^0C/ meter may perhaps reduce this possibility.

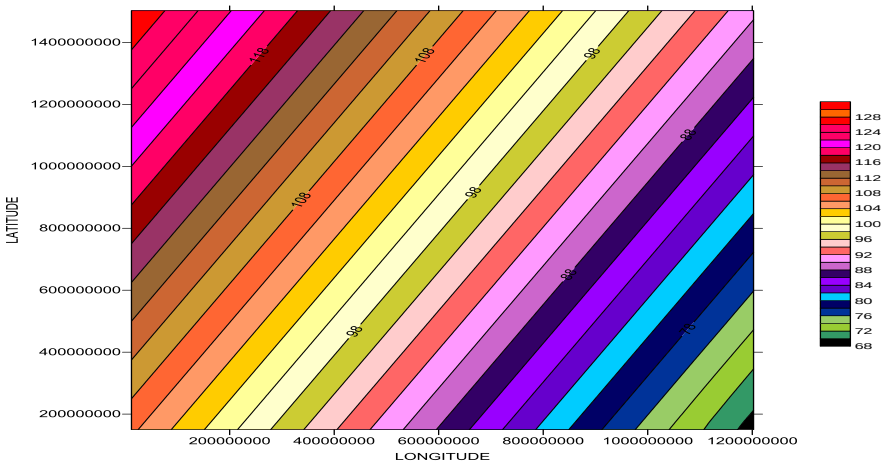

Fig. 7.0: Formation temperature map within the study area

4. CONCLUSION

The formation Temperature distribution within Fika Shale source rock of the Bornu basin was investigated. The linear increase of temperature with depth was evident throughout the study area within each well especially within Krumta and Kinasar wells while Masu, Tuma and Wadi shows high formation temperature variation with depth. The spatial variation of Formation Temperature clearly shows that some area (the south western region to the north eastern region) depicts steepy variations in temperature (68^0C to 128^0C) this is attributed possibly to substantial magmatic intrusive bodies which the basin is noted for within this region this may be responsible for non availability of hydrocarbon within the basin since the formation temperature within this region is very high for liquid hydrocarbon to accumulate.

5. REFERENCES

- Ajayi, C. I & Ajakaiye, D.E. (1983). The Origin and Pecularities of the Nigerian Benue Trough: Another look from recent gravity data obtained from middle Benue. Tectonphysics, Vol. 10(80), pp. 285-303.
- Avbovbo, A. A, Eyoola, E. O. & Osahon G. A. (1986). Depositional and structural styles in Chad basin of Northeastern Nigeria. American Association of Petroleum Geologists Bulletin. 80, pp. 1787-1798.
- Ayoola E.O. Amaechi, M. & Chukwu, R. (1982). Nigeria's Newer petroleum Exploration provinces Benue, Chad and Sokoto Basins. Journal of Mining and Geology. Vol. 19(1), pp. 72- 87.
- Cratchley, C. R. Louis, P. & Ajakaiye, D. E. (1984). Geophysical and geological evidence for the Benue – Chad Basin Cretaceous rift valley system and its technique implications. Journal of African Earth Sciences. Vol. 6(2), pp. 141- 150.

- Ilozobhie, A.J. Okwueze, E .E & Egeh, E.U (2009). Sand – shaliness evaluation of part of Bornu basin using well log data. Nigerian Journal of Physics Vol. 21(1), pp. 11- 19.
- Ilozobhie, A.J, Obi, D.A Okwueze, E.E and Okereke C.S (2014) Geophysical studies of part of Bornu Basin from Seismic, Well log and Aeromagnetic data. World Journal of Applied Science and Technology Vol. 6 (2) pp105-113
- Ilozobhie, A.J. Obi, D.A & Okwueze, E.E (2015). Geostatistical analysis of porosity distribution from well log data, in part of Bornu Basin, North- eastern part, Nigeria using Kriging and Co- Kriging methods. Advances in Applied Science Research Vol. 6(2) pp.83-95.
- Kutasov I.M. & Eppelbaum L.V. (2003). A new method for determining the formation temperature from bottom-hole temperature logs. Journal of Petroleum and Gas Engineering Vol. 1(1), pp. 1-8.
- Neglia, S (1979). Migration of fluids in sedimentary basins. America Association of Petroleum Geologists Bulletin. 63, pp. 573 – 597.
- Nwankwo C.N. & Ekine,A.S. (2009). Geothermal gradients in the Chad Basin, Nigeria, from bottom hole temperature logs. International Journal of Physical Sciences Vol. 4 (12), pp. 777-783.
- Okosun, A. E. (1995). Review of the geology of Bornu Basin. Journal of Mining and Geology. Vol. 31 (2), pp. 112 - 113
- Onuoha, K. N & Ekine, A.S (1999). Subsurface temperature variations and heat flow in the Anambra basin, Nigeria Journal Africa Earth ScienceVol. 28(3), pp. 641 – 652.

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