LITHOLOGICAL ANALYSIS OF TEMPERATURE OF DATA OF WELL 6407/2-2 IN THE NORTH SEA

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Abstract

The study looked at lithological analysis of temperature of data of well 6407/2-2 in the North Sea. Two research questions were drawn from the study. Survey research design was used to report secondary data obtained from well in the North Sea. Based on the findings accrued from the study, it is evident that CDL- CNC and SPECTRALOG had the highest deapth logier of 2698, while HRDI had the minimum deapth logier of 335.3. The maximum temperature of BHT^{o}C is 102.8^{0}C at log HRDI and the minimum temperature is 26.7^{0}C on logs DIFC-LSBHC and CDL-CAL-GR. Maximum circulating time is on HRDI at a time lag of 20 and minimum time lag is of 7.0 on log DIFL-CAL-GR. This shows that each logier have their individual temperature change which is significant in the reservation of the crude deposit. On the other hand, Norland, Hordaland, Balder, Lista, Shetland and Cromer Knoll had a temperature of 345^{o}C, 545^{0}C, 73^{0}C, 73-53^{0}C, 53-212^{0}C and 212-65^{0}C respectively. Nordland have the highest thiuknues at 1100, while Lista/Sele had the lowest thiuknues at 53. Finally, it was recommended that in the process of drilling a cat well, temperature of bottom hole depth should be collected to ascertain the presence of hydrocarbon and behaviors of formation fluid.

Keywords: Lithological, Temperature and Well

Introduction

The thermal regime in a sedimentary basin is one of the main factors affecting the formation and accumulation of energy and mineral resources. The generation of hydrocarbon and the types produced are dependent on the temperature reached by the organic-resource rocks during their burial history. Thus, knowledge of the geothermal regime and understanding of the factors controlling it are very important in the analysis of sedimentary basin.

However two categories of geothermal information are presented in this topic, which include; temperature and pressure as regarded to formation Lithology, based on the analysis of well 6407/2-2 unweathered core samples, and the geothermal regime in the sedimentary rock of the North Sea sedimentary basin. There have been several wells drilled in the basin, majority having associated BHT measurement, and an analysis of geothermal regime by stratigraphic and/ or lithological units requires prior knowledge of the stratigraphy, geometry and lithology of the sedimentary basin.

P-wave velocity alone cannot always distinguish between different lithology. In this example from onshore Libya, cross-plotting V_P with V_s aids the discrimination of reservoir from non-reservoir (Hanitch et al, 2006).

P and S waves provide complementary information about the rock matrix properties, pore fluids and pressure from early laboratory rock physics studies to recent service surveys, the combined use of p- and s- wave data help in discriminating lithology. Seismic inversion provides estimate at rock properties used to identify lithologies and fluids. P-wave data alone require the use of long offsets and a technique to derive S-wave impedance and velocities. Joint pp and ps inversion provides s-wave properties directly and hence better fluid and lithology identification than either one alone.

Use to multicomponent data can help discriminate between;

- Sand, shale, carbonates and volcanoes
- Fluids, temperature and pressure changes during production
- Gas and lithology bright spots

Heavy oil reservoirs can be found around the world, including Canada, Venezuela, China and Russia advances in technology are opening access to hydrocarbons once thought uneconomic to provide.

Multicomponent data have several applications in heavy oil developments such as:

- Identification of shale volume through better density estimation
- Tracking temperature changes in 4D surveys
- Identifying local variations in anisotropy

  Shale volume is particularly important parameter for the heavy oil recovery processes because shale units act as barriers or baffles to steam movement.

Literature Review

Mud Logging

Mud logging is the continuous analysis of drilling mud to provide additional information from mud samples, indicating the sequence of formation by the drilling bit and the presence of oil or gas content. Mud logging is widely used in wildcat and exploratory wells; the drill time log and lithological (geological-sample) log are integrated into mud logging practice.

The mud log can record minutes of hydrocarbon that the geologic sample log might miss because it utilizes more mechanical aids than the geologist, data gathering technique is an important factor which serves as a basis for operational decisions in which the drilling mud and cuttings are cautiously tested on their return to the surface, and results of these are correlated with the depth of origin.

A complete mud log analysis of hydrocarbon includes the following records:

- Show of hydrocarbon detected
- Rate of penetration detected
- Lithological log and formation description
- Drilling mud properties
- Data pertinent to wells operation such as conning points trips for new bit, drill stem tests etc.

Temperature

Temperature: This is defined as the measurement in degrees of how hot or cold a thing or high/low temperature, a fall/drop in temperature. The temperature at the earth increases with depth below the surface. A geothermal gradient (expressed in the form of f per 100ft of depth) exists; although a single gradient would be unlikely for deep wells, a low geothermal gradient of 0.3 to 1.0 would be adequate for older formations and a higher gradient of 1.2 to 2.2 would be typical for the newer formations. A well in a geothermal gradient of $1.5F/100^0fy$, will be 225^0F hotter at a depth of 5000ft compared to that at/or near the surface.

Formation Temperature

Formation temperature has been estimated from bottom hole temperature recorded during logging and testing at the upper part of the middle Jurassic sandstone, 2476-2484m by using Horner plot, the bottom hole temperatures recorded during logging have been converted to static formation temperatures. The mean temperature gradient from seabed to TD is approximately $35^{oc/}$km and is in the same order of magnitude as seen in other wells in the area. Two sub-

gradients can be established, one in the Tertiary (22.6^{o}_{c}/km) and one in the Mesozoic succession (43^{o}_{c}/km) both these temperature gradients are of the same magnitude as seen in well 6407/2-1.

Purpose of the Study

The study looked at lithological analysis of temperature of data of well 6407/2-2 in the North Sea. Specifically the study sought to:

- Find out the deapth logier during wire line logging
- Find out the change in temperature along depth.

Research questions

The following research questions guided the study:

- What is the deapth logier during wire line logging?
- What is the change in temperature along depth?

Scope of the Study

The study is limited to an assessment of temperature recordings of bottom hole wire logging of well 6407/2-2 in the North Sea.

Methods

Survey research design was used in the study to obtain secondary data collected from well 6407/2-2 in the North Sea. One drill stem test was carried out in the interval 247m to 2484m in the gas bearing Middle Jurassic Gam formation sandstone. The test produced 1000000 Sm3 gas/day on a 60/64" choke. The gas/oil ratio was ca 5900 Sm3. The liquid petroleum had a density of 0.756 g/cm^3 (55.6 deg API).

Cuttings Available at the NPD

Internal (m): 400.00-3350.00

Cores available at the NPD

Core length (m): 95.89

Core Number Interval

1. 2461.3-3471.1
2. 2473-2476.23
3. 2479-2497
4. 2497-2499.24
5. 2501-2506.35
6. 2501-2513.77
7. 2518-2527
8. 2527-2534.44

Rock Formations:

Nordland Group

Depth interval : 284-1384

Thickness : 110m

Thickness : Early Pleistocene (400-572m)

Age : late Pliocene

(572-1384m)

Lithology

The interval from seabed (284m) to the 30" casing shoe (398m) was drilling without returns. The Nordland Group is composed of light to medium grey unconsolidated clays with minor poorly sorted sand and rock fragments. Traces of shell debris, foraminifera, glauconite and pyrite are found throughout the sequence. Top Tertiary might be picked at the pronounced break in log character at 572m.

Hordaland Group

Depth interval : 1384 d- 1955m

Thickness : 571m

Age : Early Pliocene – Late Miocene

(1384 – 1420m)

Data Analysis

Research question 1

What is the deapth logier during wire line logging?

Table 1: Bottom Hole Temperature Recorded during Wire Line Logging.

LOG	DATE	FIRM MD	DEAPTH LOGIER M RKB	MAX REC. TEMP. BHT^{0}C	TIME SINCE CIRC.(DT)
DIFC-LSBHC	22.5.83	A	865.3	26.7	7. 5
CDL-CAL-GR	22.5.83	1A	866	26.7	10.5
DIFL-CAL-GR	2.6.83	2B	1986.1	38.9	7.0
DIFL-LSBHC	3.6.83	2B	1985	43.9	13.0
CDL-CNC	6.7.83	4C	2698	64.4	9
SPECTRALOG	6.7.83	4C	2698	79.4	24
HRDI	18.7.83	334.3	335.3	102.8	20

Table 1 revealed that CDL- CNC and SPECTRALOG had the highest deapth logier of 2698, while HRDI had the minimum deapth logier of 335.3. The maximum temperature of BHT^{o}C is 102.8^{0}C at log HRDI and the minimum temperature is 26.7^{0}C on logs DIFC-LSBHC and CDL-CAL-GR. Maximum circulating time is on HRDI at a time lag of 20 and minimum time lag is of 7.0 on log DIFL-CAL-GR.

Research question 2

What is the change in temperature along depth?

Table 2: Change in Temperature along Depth

DEPTH M/S	FORMATION	LITHOLOGY	CHANGE IN TEMPERATURE	THIUKNUE
400	Nordland	Unconsolidated Clay and sand	345-974	1100
800	Hordalnd	Rock Fragments Glauconitic & pyrite	974-545	571
1200	Balder	Clay stone & Silt-stone	545-73	80
1600	Lista/sele	Claystone & Silt-Stone	73-53	53
2000	Shetland	Clay stones/siltstone	53-212	240
2400	Cromer Knoll	Clay stones/siltstone	212-65	81.5

Table 2 revealed that Norland, Hordaland, Balder, Lista, Shetland and Cromer Knoll had a temperature of 345^{o}C, 545^{0}C, 73^{0}C, 73-53^{0}C, 53-212^{0}C and 212-65^{0}C respectively.Nordland have the highest thiuknues at 1100, while Lista/Sele had the lowest thiuknues at 53.

Discussion of Findings

Based on the findings accrued from the study, it is evident that CDL- CNC and SPECTRALOG had the highest deapth logier of 2698, while HRDI had the minimum deapth logier of 335.3. The maximum temperature of BHT^{o}C is 102.8^{0}C at log HRDI and the minimum temperature is 26.7^{0}C on logs DIFC-LSBHC and CDL-CAL-GR. Maximum circulating time is on HRDI at a time lag of 20 and minimum time lag is of 7.0 on log DIFL-CAL-GR. This shows that each logier have their individual temperature change which is significant in the reservation of the crude deposit.

On the other hand, Norland, Hordaland, Balder, Lista, Shetland and Cromer Knoll had a temperature of 345^{o}C, 545^{0}C, 73^{0}C, 73-53^{0}C, 53-212^{0}C and 212-65^{0}C respectively. Nordland has the highest thiuknues at 1100, while Lista/Sele had the lowest thiuknues at 53.

Conclusion

The study was able to explain the temperature variation of crude deposit in well 6407/2-2 in the North Sea. The result of the study was able to explain give a minimum and maximum temperature difference that exists along each logging in the oil well which is significant in the drilling process of crude.

Recommendations

Based on the findings of the study, it would be recommended that in the process of drilling a cat well, temperature of bottom hole depth should be collected to ascertain the presence of hydrocarbon and behaviors of formation fluid.

References

Darby, D., R. Funnell, and V. Stagpoole, (2000). Overpressure, seal breaching and stress regimes in East Coast and Taranaki Basins, New Zealand (abs): AAPG international Conference and Exhibition, Bali, Indonesia, IP.

Nwankwo CN, (2007). Heat folw studies and Hydrocarbon maturation modeling in the Chad Basin Nigeria. Unpublished Ph.D. Thesis, University of Port Harcourt, Nigeria pp. 1-45

Shell Todd Oil Service Limited (2002) Technical Evaluation, License PPL. 38705: ministry of Economic Development petroleum Report 2709: http://www.Cronminerals.Govt.nz

Swarbrick, R.E., (2002). Challenges of porosity-based pore-pressure prediction. Recorder, Canadian society of Exploration Geophysicists. www. Cana-dian Society of Exploration Geophysics.