Mudlogging as an Exploration Tool: a Case Study of Ugu-16ST 1

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Abstract

This study examines measurement while drilling. Shell petroleum development company (SPDC) well UGU-16ST1 using mud logging concepts and parameters. The equipment – shale shakers, log charts, detectors, etc – as well as the metrics rate of penetration (ROP), weight on bit (WOB), and strokes per minute (SPM) provide an overview of the use of mud logging as an exploration technique. Real-time examination and log interpretation a significant step forward in fluorological evaluation. The stains show, and fluorescence after examination of the mud, it can provide indicators of the lithologies reached and, in most cases, the availability of hydrocarbon in the reached zone. In general, measures are used while approaching nearby lithological evaluation of unfavourable zones. As in gas-bearing sandstone. Mudlogging saves money because only wireline logs and well logs can be used. To "draw the wool over the firm's eyes," so to speak, because the firm will be better technically versed. Finally, this study has provided space for numerous mud logging recommendations, such as the employment of new sophisticated show detectors, correct chemical disposal units, and other efficient equipment commonly used in mud logging activities

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Introduction

Before modern exploration, exploratory wells were drilled with cable-tools rigs consisting of chisel-shaped steel rod bits. The rock chippings in the process of Drilling were removed by a bailer fitted at an end of the cable. The bailer is fitted at an end of the cable Interdrill Manuel (1998) . The bailer is a hollow steel tube fitted with a one-way flap at the bottom. The rock chips are Inspected as they are removed from the bailer. The earliest hydrocarbon Detection techniques were simply to smell the returning mud for gas and to observe any traces of oil Schlumberger (1974).

In the 1930s, instruments of electric logging came into use and cut down the amount of coring being done Shell group (1994). In 1939, the first commercial mud logging service Company was established. Developments mainly in gas analysis techniques evolved over the next decade. In addition to gas analysis, the cuttings were also examined for lithologyMolua *et al*. (2010).

There are now several companies offering mud logging services to operating companies which vary from very basic systems essentially monitoring lithology and hydrocarbon shows to highly sophisticated computer-oriented systems which in addition to the basic services offer drilling engineering, well safety monitoring, and formation fluid pressure evaluation services. Modern and computer link data transmission services are also available. These incorporate data storage facilities onto disk or magnetic tape and incorporate extensive data Display and transmission facilities Molua (2012)

This research seeks to examine or investigate mud logging as an exploration tool. It is also meant to study mud logging principles and the parameters involved. This research will also help to comprehend the practice of hydrocarbon identification, recording, and lithology evaluation. It is also meant to study logs such as the mud Log, or the show evaluation log.

To comprehend all of the information available, the aim of the work helps in Understanding four important areas of mud logging: rate of penetration, gas Detection, formation evaluation, and sample collection and show evaluation.

The scope of the study is attributed to mud logging operations and its parameters As an exploration tool. It also describes how mud logging was carried out in well UGU-16ST1 of SPDC. One major limitation of this study is the neglect of the old drilling operations and their consequent calculations. It also avoids mentioning the use of other Common well logging tools and their applications.

Mud Logging Principles/Operations

Mud logging operations are of no interference to drilling o other rig activities. The Major tools are drilling mud and ditch cuttings, which are circulated out continuously as drilling proceeds. Aigbedion and Oyanna (2003)

In the process of drilling, the cuttings are floated to the surface and discharged onto a screen, which is moved rapidly back and forth called a shale shaker. The cuttings fall off into a pile while the mud goes on to the tanks. This is a reverse order of their geological succession.

As drilling proceeds, a logger periodically takes a sample of the cuttings coming from the shaker at different depth intervals. The essence of mud logging is Therefore a recording of the information received at the shaker against the depth Interval. In the mud-logging unit, instruments and equipment monitor various drilling Operations. From the analysis of the logging unit or logger, we obtain:

1. The amount of methane contained in the drilling mud.
2 The rate of penetration graph.
3 Shale density faults.
4. Operation data such as trips for a new bit, DST, and coring.
5. Lithologic description and log.
6. Characteristics of drilling mud.

Geology of Study Area

UGU-16ST1- is an SPDC 'S exploratory well located in the swampy geographical area of Delta State. It is monitored and drilled by Inter drill Nigeria Limited in 1996.Mavko & Dvorkin (1998).

UGU-16ST1 is found in the Niger Delta basin. Its unique feature is composed mainly of
intercalations of sandstone and shale Kogbe (1989). The sequential lithology of the area is classified into three namely

1. Benin formation 2. Agbada formation and 3. Akata formation.

FORMATION TYPE	DEPTH	CHARACTERISTICS
Benin	0-2000m below sea flow	Consists mainly of clay, Sandstone and Shale intercalation
Agbada	2000-6000m	Consists predominantly of Sandstones with shale intercalation (reservoir rock)
Akata	6500m and above	Below the Agbada formation And associated with impermeable Shale units (source rock)

Materials and Methods

Sample Collection

Probably one of the important jobs of the logger is to collect a Representative sample of drill cuttings from the shale shakers and prepare it for lithological identification and hydrocarbon show evaluation. The shale shaker separates the larger cuttings from the drilling fluid and fines -microscopic or dust-Sized pieces of formation. The fluid is filtered for re-use, and the cuttings are routed to the reserve pit Interdrill manual (1998).

The mudlogger collects some of the cuttings before they are routed to the reserve pit. When the samples are gathered, the logger can analyze them unwashed and wet, washed and wet, or washed and dried. The unwashed samples are untreated, placed in labeled bags, and shipped to the laboratory. Washed samples are washed to flush away the excess drilling mud and are sieved to segregate the cuttings and then put in sample bags. Washed and dried Samples, before they are bagged, are dried in ovens.

They are then bagged and taken for microscopic analysis. Care should be taken to get delegate tests, not just the last part of Arrive at the shaker. The exception is the spot sample, taken to locate precisely. The depth of a particular formation top.

Sample Cutting Interval

The frequency of drill cuttings samples is specified in the labeling proposal and the drilling program. Intervals of 30ft or 50ft are usually required in the upper Section where drilling break is experienced. At proceeding depths Up the Sample, the interval is reduced to ten feet Bachrach *et al*. (2004).

The sample interval may be reduced to five feet as the reservoir is approached. Spot samples are taken at different rates of penetration period. The sample interval may vary depending on the type of Sample being collected. A typical sample program may be as follows.

Sample Preparation

When the samples arrive in the shale shaker they are covered with mud, unsorted by size, and generally unidentifiable. The sample is carefully prepared and washed for microscope examination. In sample

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preparation, sieves of different hole diameters are used to segregate the larger (coarse) cuttings from the fine ones,Ekweozor and Okoye (1980). A water jet is directed to the wet samples placed on the uppermost sieve. This helps to wash and segregate the fine cuttings to the lower sieve.
Retaining the washings from the lower sieve in a pan may collect the very finest material, fine sand, and silt. These samples are cleaned by a gentle panning motion.

Washed and Dried 4 SETS
Required
30ft interval from surface to 13.3/8" shoe
10ft intervals from 13.3/8" shoe to T.D.
(5ft interval through reservoir)
Bulk Washed: 3 SETS
Required
30ft
required from surface to 13.3/8" shoe
10ft intervals from 13.3/8" shoe to T.D
Geochemistry: 3 SETS
Required
50ft intervals from surface to T.D.

Types Of Drill Cutting Samples
There are various types of drill cutting samples considered here in turn:
1. Microscope samples
2. Spot samples
3. Bulk unwashed samples
4. Bulk washed samples
5. Washed and dried samples
6. Geochemical samples

Formation Logging Worksheet
This is used by the Mud logger to record all the information gained during the drilling of the Well. It is used to record all information concerning ROP, gas levels, drilling parameters, Lithology, oil sheaves, bit data; mud repents, lag data, etc. It is used by the mudlogger to produce the basic reference document for the well.
From proper lithological studies, it is revealed that the UGU-16ST1 well is loosely packed in the sand at the Benin formation when drilled through. But the Agbada formation is posed mainly by the intercalation of permeable sandstone and impermeable shale. UGU-16ST1 an SPDC's exploratory well was spudded in on the 15 of July 1996. And drilled with a jack-up rig to a total depth of 8,250ft on the 14h of August 1996.
The water depth to the sea bed is 210ft. The well was prepared to a total depth of 8,800ft. However, it was finally drilled to a total depth of 8,250ft. UGU-16ST 1 was originally planned for 20 days of drilling, however, the drilling phase was extended to 30 days. This was a result of problems uncounted during drilling such as low rate of penetration, tight spots, and High torque.
However, the summary of the well is presented in three intervals as follows:
Interval 01
Interval 02
Interval 03

Interval O1 16inch Hole Section

The objective of this interval is to drill a 16inch hole to 2750ft and set a 13l8 inch casing with water-based mud. The stove pipe was driven to refusal to a depth of 315ft. A 9.18ppg. Dd density was used at an average penetration rate of 45.8ft. The casing was set at a depth 02750ft. A depth of the available solid equipment such as shale shakers, desanders, and distillers are run.

Interval 02 12inch Hole Section

The objective is to drill 12% in the hole to a depth of 5,500n and set a 9/g in the casing. A salt mud of 10.77ppg was employed. The average penetration rate was 44.2t with a deviation of54.50The intervals penetration was started on 23/07/96 and ended on 04/08/96 with a Duration of 12 days. For solid control, the desander and mud cleaner were not used only the. Three shale shakers at 2,850n the hole was circulated and conditioned. Drilling continued
With regular hole cleaning from 2,850N to 5,500n, where a trip was made due to a low rate of Penetration and increased torque. A 12- "casing is run and amounted with the shoe at 5,500ft.

Interval 03 8inch Hole Section

An 82 bit was run in the hole on 23/07/96 on a steerable assembly, drilled out cement from5,455 to 5,500fN. At5,5000, the hole was circulated and drilling continued to 6,719t where
A wiper trip was made to the shoe (maximum over pull 10tons).
As drilling continues a trip was made after a bit of change. The mud type employed here is a petro fare mud with a density of10.35ppg. The interval started on 04/08/96 and ended on 14/08/96. The average penetration. The rate was found to be 28.2ft with a maximum deviation of 45

Interval Discussions

Interval 01 16inch Hole Section

A directional bottom hole assembly was installed High viscosity sweeps were pumped on COnncciions and surveys. In the Theology and hole cleaning, the yield point was maintained At 12 lbs/81 sq ft.

Interval 02 12inch Hole Section

Here malfunctioning pumps resulted from cement plugged rubber entangled in the mechanism is ruined while running the centrifuge to reduce solids low penetration rate and increased torque observed resulted from excessive usage of bit and mechanical stress on the Mud motor.
This problem was overcome by making a trip to change the mud motor and bit. The tight spots were mainly due to directional problems of ledges formed,were corrected by carefully reaming through the sections, while tripping. In the solids
Control, all three shakers were used throughout this interval.

Interval 03 8inch Hole Section

The interval was drilled with no problems..Drilling was completed with one bit of run after drilling and casing.

Sample Collection

Unwashed Samples:

Two (2) sets at 30f intervals

Wasiied and Wet Sample:

One (1) set at 301 intervals.

Washed and Dricd Samples:

Two (2) sets at 30ft intervals

All samples from 2750ft depth to TD
These equipment and cuttings properly analyzed in the mud logging unit gave a good record of the mud effect as drilling continues.Interdril(1998). This information is s a chart on a mud logMahiya (1999). The attached mud log is obtained for the Utu -17ST1 well.

Lithological Analysis of Zones of Interest from the Mudlog.

Depth (ft)	Lithology	Colour	Description
7000-7,030	Sandstone	White	Fine to medium
7,030-7,040	Shale	Dark gray - grey	Moderately hands, bulking
7,040 7,080	Sand	Light grey-white	
7,080-7,100	Shale	Dark grey	Soft moderate hard sticky
7,100 7190	Sand	Light grey-white	Fine medium sieve size 55, R3- R4
7,190-7210	Shale	Light grey	Soft moderate, hand and bulky
7210-7280	Sand	White	Fine medium R3 - R
7280 7290	Shale		
7290 7310	Sand stone	White	Fine medium, 55, R - Ra sporty; yellow fluorescence, light crush cut fluorescence
7310 7365	sand	White	Fine medium, sporty yellow fluorescence light yellow cut fluorescence.
7365-7390	Shale	Grey - dark grey	Moderate hand, Bulky
7390-7440	Sand stone	White	Fine medium S7, Ra Rs Sporty, yellow fluorescence milky cut fluorescence
7440 7480	Shale	Grey	Moderate hard, bulky
7480-7530	Sand stone	White	Fne medium, sporty, yellow fluorescence, Faint yollow cut fluorescence
7530 7570	Shale		
7570 7600	Sand stone	White	Fine medium, sporty yellow fluorescence, Faint yollow cut fluorescence

7600-7630	Shale	Light grey grey	Soft moderate hard, bulky
7630-7660	Sand Stone		
7660-7670	Shale		
7670-7695	Sand Stone	White Light grey	Medium size (S7) sporty yellow plus, light Yellow crush cut fluorescence.
7695-7705	Shale	Dark grey grey	Moderate hard – hard, platy
7705-7780	Silt-Stone	White-light – grey	Very fine, sporty yellow fluorescence, light Yellow fluorescence
7780-7795	Shale		
7795-7850	Sand	White	Fine medium size S_4 (R_3 -R_4) (C_3 gas Detected)
7850-7890	Shale	Grey	Moderate hard, bulky, platy
7890-7930	Sand	White	Fine medium (S_4, R_3 – R_4 size)
7930-7945	Shale		
7945-8010	Sand	White	Fine medium (C_1 gas show)
8010-8030	Shale	Dark grey-grey	Moderate hard – hard, platy
8030-8080	Sand Stone	White	Fine medium (S_4, R_3 – R_4 size)
8080-8095	Shale		
8095-8120	Sand	White	Very fine fine (C_1 gas show)
8120-8140	Shale	Light grey grey	Moderate hard, bulky, platy
8140-8190	Sand Stone	White	Very fine- fine (C_1 show) sporty Fluorescence, milky cut fluorescence
8190-8210	Shale	Dark grey-grey	Moderately hard, bulky, staty
8210-8250	Sand	White	Fine (S_1,R_3- R_4 size)

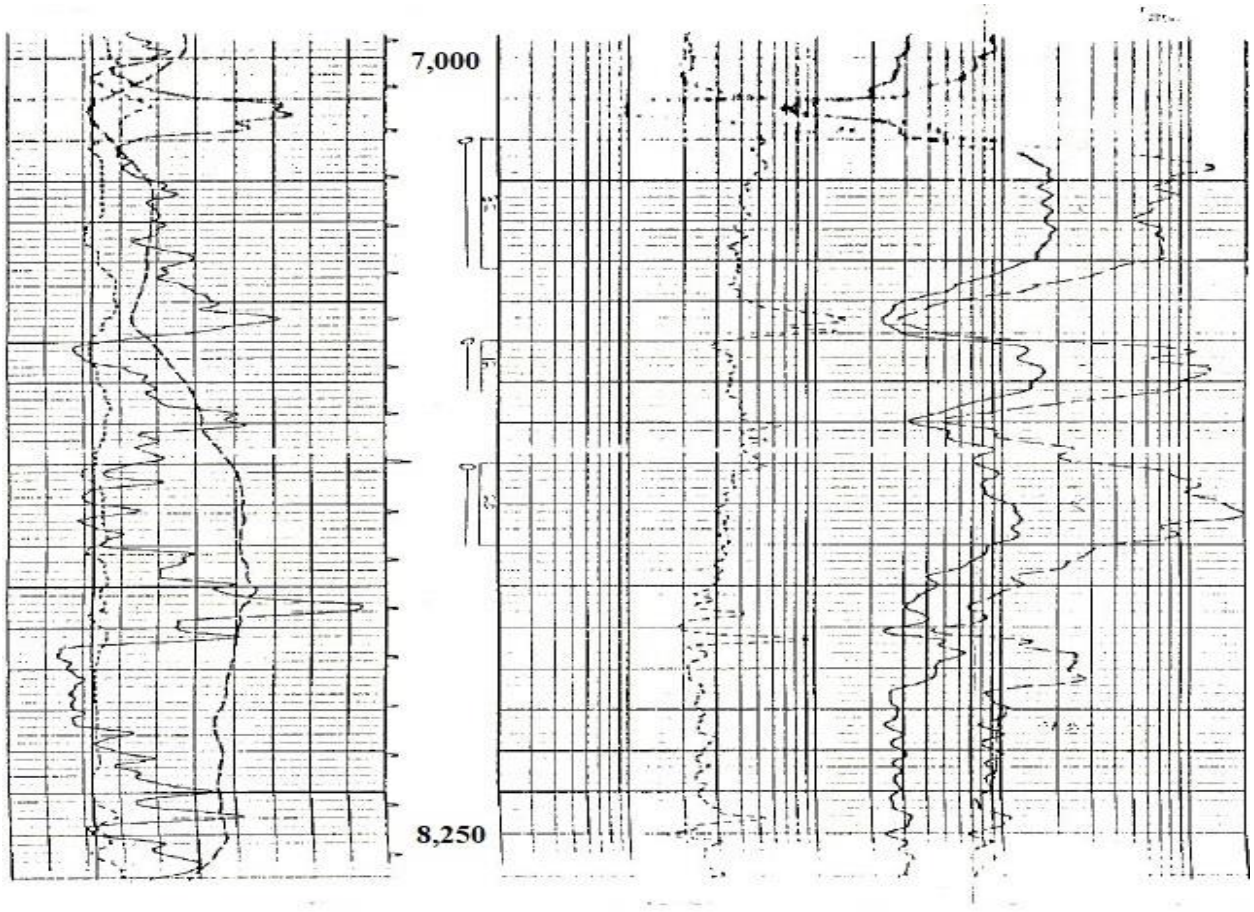

FIG 1: UGU-16ST 1 WELL SECTION {Courtesy Shell Pet. Dev. Co}

Analysis of Result

The analysis of the result obtained from the mud lop interpretation can be related to particular district intervals.

01. Interval 7000-7400

This interval is mainly sandstone dominated with shale intercalation of different structures, text, and color.

Description Sand (Colour And Texture)

The sand has coloration ranging from lightning to white coloring. It has the texture of fine-medium with the size of S4-S7, R3-R4

Shows (Fluorescence): The sand sandstone shows traces of light yellow to yellow fluorescence, milky cut fluorescence.

Chromatographic Analysis: This interval has a background gas of about 6 units. 1t has a chromatographic reading for ethane and propane and conspicuous methane and analysis of C1 = 918 ppm (parts per million), C2 = 258 ppm C3 84ppm

Description Shale (Colour and Texture)

lt possesses cuttings ranging from light grey, grey to dark grey. It is moderately hard and
bulky.

.0.2. Interval 7400-7800

This interval is predominantly sandstone, Shale, and slit Stone and intercalation of different textures and colors.

Description- Sandstone (Colour and Texture)

The sand in this region is white to light grey in coloration. They possess medium Texture.

Show (Fluorescence)

The major show dominating this region is Spoty light yellow to yellow cut fluorescence.

Chromatographic Analysis.

In this interval, the background has a maximum gas unit of 64U. It is chromatographically separated into C1 = 12439ppm, C2 = 2856ppm, C3 =1176ppn. This abundant gas presence is noticed in the siltstone at a depth of 7,700ft.

Description Shale (Colour And Texture)

The shale in this region Forms the caprock and source rock. They are light grey and grey they are moderately hard.

03. Interval 7800 8250

The lithologies of the region include shale sandstone and their intercalation.

Description Sand (Colour And Texture) : The sand in this region has textures S4 – S7, R3 – R4. They are fine in texture and white in coloration.

Show (Fluorescence): The interval possesses rocks with spotty Fluorescence and milky cut fluorescence

Ciiromatograpiic Analysis: The background gases just a total Gas of 9 units.

Description-Shale (Colour And Texture): The shale has a thickness ranging from 10 ft to 40 ft. They are bulky, platy, and moderately hard

Conclusion

Mud logging appears to be the basis behind the success of every explanatory well UTU-ST1 well is no exception from the proceeding results obtained. The process and mechanism involved in mud logging have to do with the collection of cuttings and analysis. Mud log interpretation and various show evaluation under fluoroscopic light to indicate dents or stains of oil and in most cases the odor of gases involved. There is a variance shown in behavior as the mud which is a vital parameter in mudlogging moves down the lithologies encountering different gases and formations. The effect or danger of a blowout resulting from a kick was checked as the density of the mud is mentioned while it moves down the various lithologies. UTU-ST1 being the case study of this work is not remarkably left out as regards mud logging in general. The mud logging carried out in this well aid in the knowledge of the Geological sequence of lithologies of the swampy area.

The lithologies are mainly sand, sandstone, shale, and their various intercalations. The influx of gas is also an encountered effect at the depth of 7,000ft- 7030ft there was a maximum gas influx of 84units showing readings C1= 12438 PPM, C2=2856 PPM, and C3 = 1176 PPM.

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