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Comprehending the practice of hydrocarbon identification and Lithological evaluation using Mud Log

Molua O. Collins
Physics Department College of Education, Agbor-Delta State.

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ABSTRACT
A hydrocarbon well log (Onyia well), obtained from the Niger Delta region of Nigeria. Was analyzed. The equipment used –Shale shakers log chart, detectors etc and parameters-rate of penetration (ROP), weight on bits (WOB) and strokes per minute (SPM). All provided evidences of the benefits of mudlogging as an exploration tool. The shows, stains and fluorescence obtained from the lithological analyses of zones of interest, from the Mudlog, ie 7100-8,300ft of well, after through examination indicated that the lithologies reached. and in some cases the availability of hydrocarbon in the reached zones.

Introduction

Mud logging, also known as hydrocarbon well logging, is the creation of a detailed record (well log) of a borehole by examining the bits of rock or sediment brought to the surface by the circulating drilling medium (most commonly mud). Mud logging is usually performed by a third-party mud logging company. This provides well owners and producers with information about the litho logy and fluid content of the borehole while drilling. Historically it is the earliest type of well log. Under some circumstances compressed air is employed as a circulating fluid, rather than mud. Although most commonly used in petroleum exploration, mud logging is also sometimes used when drilling water wells and in other mineral exploration, where drilling fluid is the circulating medium used to lift cuttings out of the hole. In hydrocarbon exploration, hydrocarbon surface gas detectors record the level of natural gas brought up in the mud. A mobile laboratory is situated by the mud logging company near the drilling rig or on deck of an offshore drilling rig, or on a drill ship.

Mud logging includes observation and microscopic examination of drill cuttings (formation rock chips), and evaluation of gas hydrocarbon and its constituents, basic chemical and mechanical parameters of drilling fluid or drilling mud (such as chlorides and temperature), as well as compiling other information about the drilling parameters. Then data is plotted on a graphic log called a mud log.

Other real-time drilling parameters that may be compiled include, but are not limited to; rate of penetration (ROP) of the bit (sometimes called the drill rate), pump rate (quantity of fluid being pumped), pump pressure, weight on bit, drill string weight, rotary speed, rotary torque, RPM (Revolutions Per Minute), SPM (Strokes Per Minute) mud volumes, mud weight and mud viscosity. This information is usually obtained by attaching *monitoring devices* to the drilling rig's equipment with a few exceptions such as the mud weight and mud viscosity which are measured by the derrick hand or the mud engineer.(Loermans and Touati; (2003).

Rate of drilling is affected by the pressure of the column of mud in the borehole and its relative counterbalance to the internal pore pressures of the encountered rock. A rock pressure greater than the mud fluid will tend to cause rock fragments to spall as it is cut and can increase the drilling rate. "D-exponents" are mathematical trend lines which estimate this internal pressure. Thus both visual evidence of spalling and mathematical plotting assist in formulating recommendations for optimum drilling mud densities for both safety (blowout prevention) and economics. (Faster drilling is generally preferred.)

Mud logging is often written as a single word "mudlogging". The finished product can be called a "mud log" or "mudlog". The occupational description is "mud logger" or "mudlogger". In most cases, the two word usage seems to be more common. The mud log provides a reliable *time log* of drilled formations. A Mudlog schematic is shown in fig 3.

Stratigraphy Of The Studied Area

The Niger Delta formation is divided into three stratigraphic units. The Benin formation forms the uppermost unit of the delta complex. It consists of fresh water bearing massive continental sands and gravels deposited in an upper deltaic plain environment. The Benin formation is the thickest unit in the central area of the Niger Delta.

Immediately below the Benin formation is the Agbada formation, which consists of alternation of sands and shales of paralic origin. The sandstones are very coarse to fine grained, well to poorly sorted and generally unconsolidated. The shales are light to dark grey, and become more indurated with depth

According to Ejedawe et. al (1984), the thickness of the Agbada formation ranges form 9000 – 14000ft. The basal unit of the Niger Delta is the Akata formation which is composed mainly of marine shales, deposited as the high energy delta

Tele:
E-mail addresses: moluaogom@hotmail.com

advanced into deep water

Detailed description of the geology of the Niger Delta has been done by several Geologists. Among these are Short and stauble (1967), Daukoru and Weber (1975) and more recently Doust and omatsola in Olear (1992).

Throughout the geologic history of the Delta, its structure and stratigraphy have been controlled by the interplay between rates of sediment supply and subsidence.

Sedimentation rate has been greatly influenced by eustatic sea level changes and climatic variations in the hinterland while subsidence has been controlled largely by initial basement morphology, crustal type (stable or unstable shale, oceanic or continental) and differential sediment loading on unstable shale.

Theoritical Consideration

Mudlogging gas content results compared to production history for CBM wells "back calculated" volumetric gas content based on production has Common form of volumetric gas-in-place (gip) equation for CBM resources.

GCHA3597.1Gb×ρ

G = gas-in-place (mcf)

A= drainage area (acres)

H= coal thickness (feet) ρ

B= coal density (grams/cubic centimeters)

Gc = coal gas content (scf/ton)

"Back calculated "gas content based on production or reserves g. bHA3597.1GCρ

1. Use cumulative gas production for low estimate of gas content
2. Use cumulative gas production plus 48 times current monthly production for high estimate of gas content
3. Use drainage area or spacing unit for "a" (40 acres)
4. Use coal thickness from logs for "h"
5. Use log or measured density for coal density

Overview of factors affecting cbm reserves

Gas content (scf/ton)

• Correlation with coal rank is well known (higher rank, higher gas content)
• Correlation with moisture content less well know (higher moisture, lower gas content)
• Correlation with structural highs supports moisture content concept
• Free gas beneficial, but low porosity of coal and low gas expansion factors at shallow depth limit gas reserve volume
• Fractures and cleats should be drained first. If free gas is present gas should be produced initially. Water is typically produced initially
• Core adsorption gas content typically understates actual gas content
• Re-adsorption isotherm gas content more closely agrees with mudlogging gas content

Height or zone thickness (feet)

• Thickness may be greater than clean gamma ray indicates
• Brown shales, "bituminous shales" or carbonaceous shales often contain gas
• Mudlogging helps define gassy brown, bituminous and carbonaceous shales.
• The dietz 2 which is laminated has highest mudlogging gas reading in the study area

Coal Density (Grams Per Cubic Centimeters)

• Easily measured from logs and samples

Drainage area (acres)

• Spacing unit used as drainage area
• Adjacent wells compete for resource and have interference boundaries
• Water and gas rates don't indicate high permeability
• Use of water treatments don't indicate high permeability
• Why do better wells have higher mudlog gas content, if gas is coming from a large drainage area?
• Faulting and stratigraphic pinch out limit drainage area
• CBM pressure depletes with time, it is not a steady state system. (Bill Donovan,2007)

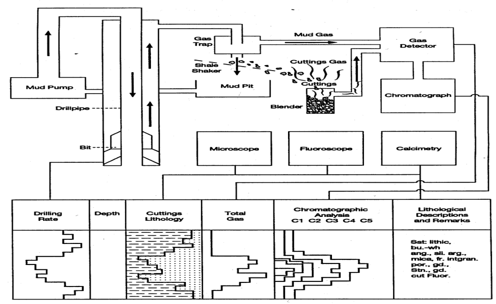

Fig 1: Mud log Schematic (Broid, 1995)

Methodology

Mud logging is a service that qualitatively and quantitatively obtains data from, and makes observations of, drilled rocks, drilling fluids and drilling parameters in order to formulate and display concepts of the optional, in situ characteristics of formations rocks with the primary goal of delineating hydrocarbon "shows" worthy of testing.(AAPG,!985)

The mud logging unit is the information center on the rig site to serve both exploration and drilling. Two sets of unwashed samples were analyzed at 30ft intervals, a set of washed and wet sample were analyzed at 30ft intervals. While two sets of washed and dried samples also were analyzed at 30ft intervals. The well section of Onyia well that was analyzed are showed in figures 2 and 3.

Three main intervals are identifiable these are intervals 7,000-7,400, 7,400-7800 and 7,800-8,250 feet of well.

7,000-7,400ft is mainly sandstone, dominated with shale intercalation of different structure, text and colour. The sand/sandstone shows traces of yellow fluorescence, and milky cut fluorescence. It has a reading for ethane, propane and conspicuously methane.

7,400-7800ft comprises mainly sandstone, shale and silt stone and intercalation of different texture and colours (Dark Grey-Light grey-white and white moderately hard) while the shows dominating this region is the spotty; yellow fluorescence, light crush cut fluorescence.

7,800-8,250ft of well the sand in this region has textures S_4-S_7, R_3-R_4 they are fine in texture and white in colouration.The background gas possesses a total gas of 9 units. The shale is Moderately hard, bulky and Streaky.

Summary and Conclusion

Mudlogging gas content is an effective way to predict production performance.

Mudlogging gas content is especially effective in areas where production performance varies.

Mudlogging gas content measurement is independent of any rationale or theory that predicts the amount of gas present.

This research has shown that mudlog is a Simple and economic method of acquiring reservoir information. And provides a continuous and accurate measurement, it recognize depositional environments or other geologic features, correlate and map formations, aid in interpreting seismic data, detect overpressured zones and estimate fracture gradients, detection and estimation of the potential of hydrocarbon zones. Such as oil-in-place, reservoir management and reassessment.

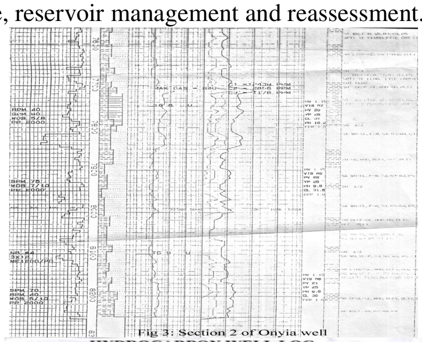

Fig 3: Section 2 of Onyia well

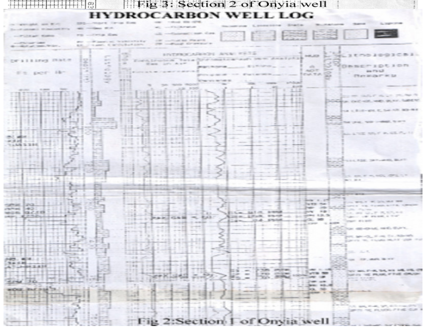

Fig 2:Section 1 of Onyia well

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Results, analysis and conclusion

Table1: lithological analysis of zones of interest from the mudlog.

S/N	Depth(ft)	Lithology	Colour	Description
1	7,080-7,100	Shale	Dark Grey	Soft moderately hard Streaky.
2	7,100-7,190	Sand	Light grey-white	Fine-medium sieve size 55, R_3-R_4.
3	7,190-7,210	Shale	Light grey	Soft moderately hard bulky.
4	7,210-7,280	Sand	white	Fine-medium, R_3-R_4.
5	7,280-7,290	Shale		
6	7,290-7,310	Sand stone	white	Fine-medium 55, R_3-R_4 spotty; yellow fluorescence, light crush cut fluorescence.
7	7,310-7,365	Sand	white	Fine-medium 55, R_3-R_4 spotty; yellow fluorescence, light crush cut fluorescence.
8	7,365-7,390	Shale	Grey-dark grey	Moderately hard bulky.
9	7,390-7,440	Sand stone	white	Fine-medium S_7, R_3-R_5 spotty; yellow fluorescence, milky cut fluorescence.
10	7,440-7,480	Shale	Grey	Moderately hard bulky.
11	7,480-7,530	Sand stone	white	Fine-medium spotty; yellow fluorescence.
12	7,530-7,570	Shale		
13	7,570-7,600	Sand stone	white	Faint yellow crush cut fluorescence
14	7,600-7,630	Shale	Light grey to grey	Soft moderately hard, bulky.
15	7,638-7,660	Sand stone		
16	7,660-7,670	Shale		
17	7,670-7,695	Sand stone	White light grey	Medium size S_7, spotty; yellow plus, light yellow crush cut fluorescence.
18	7,695-7,705	Shale	Dark grey to grey	Moderately hard-hard, platy.
19	7,705-7,780	Silt stone	White light grey	Very fine, spotty yellow fluorescence, light yellow fluorescence
20	7,780-7,795	Shale		
21	7,795-7,850	Sand	white	Fine-medium S_4,(R_3-R_5) (C_3 gas detected)
22	7,850-7,890	Shale	Grey	Moderate, hard bulky, platy
23	7,890-7,930	Sand	white	Fine-medium (S_4,R_3-R_4 size)
24	7,930-7,945	Shale		
25	7,945-8,010	Sand	white	Fine-medium (C_1 gas Show)
26	8,010-8,030	Shale	Dark grey-grey	Moderate hard –hard, platy
27	8,030-8,080	Sand stone	white	Fine-medium (S_4, R_3-R_4 size)
28	8,080-8,095	Shale		
29	8,095-8,120	Sand	white	Very fine-fine (C_1 gas show)
30	8,120-8,140	Shale	Light grey to grey	Moderately hard, bulky and platy
31	8,140-8,190	Sand stone	white	Very fine-fine (C_1 gas show), spotty fluorescence, milky cut fluorescence.
32	8,190-8,210	Shale	Dark grey-grey	Moderately hard, bulky and Streaky.
33	8,210-8,250	Sand	white	Fine (S_4,R_3-R_4 size)