# Contribution of Nuclear Logging to the Identification of the Lithology of Reservoir Rocks Crossed by an Oil Well: Case of the Mibale-18 Well, Mioc-Offshore in Dr. Congo

Alidor KAZADI MUTAMBAYI (1),TONDOZI KETO (1), (2), Rais SEKI LENZO (1), (3), Kevin LUMPUNGU LUTUMBA(1), GeorgesMABIALA MA DIAMBU (1), Eric MAKANGILA NTIMANSIEMI(1), Kati KATAYI KABAMBA (1).
(1): Center of Research in Geophysics, Departments of Internal, External and Environmental Geophysics, Kinshasa, DR Congo;
(2): University of Kinshasa, Faculty of Sciences, Department of Physics, Kinshasa, DR Congo;
(3) University of Kinshasa, Faculty of Oil, Gas and New Energies, University of Kinshasa, Department of Exploration and Production, Kinshasa, DR Congo

**Abstract:- In this paper we study the ability of logs to make an appreciable contribution in the search for complementary geological information by interpreting the data recorded during the prospecting of wells by nuclear probe. We focused on nuclear logs such as gamma-gamma (or density logs), neutron-neutron and natural radioactivity logs (gamma ray) used in the Mibale-18 well surveys located in the city of Muanda in Kongo Central a western province of Democratic Republic of Congo. It is much more a pedagogical and methodological approach of the subject intending to show that the logs are based on the measurements of some physical parameters which allow a horizontal and vertical follow-up of the lithological units with a correlation between the variations of the stratigraphic units between the drill holes of different logs.The different recordings in the Mibale-18 wellhave led to a qualitative differentiation of the various lithological units thereby confirming the restructuring of a stratigraphic log from the logs. The results obtained were coherent in the synthesis characterizing the oil reservoirs of the Mibale field in Muanda coastal basin in the Upper Pinda. In the drilling of the Mibale-18 well; it was possible to identify oil indices well marked by the stratigraphic recordings and correlations of the different measurements made by different probes. This allowed us to identify and** limit the potential of our well.

***Keywords:-*** *Logs, lithology, Mibale-18, Upper Pinda.*

## I. INTRODUCTION

Offshore exploitation of oil resources currently accounts for around one-third of world oil production. With approximately 22% of the world's reserves, the seabed conceals more than 70 million km$^2$ of sedimentary basins, including at least 30 million km$^2$ under more than 50 m of water. In view of the evolution of technical and technological means and a better knowledge of geophysics, the production of marine oil should increase. This energy resource, despite its scarcity, remains a strategic issue for nations and multinationals, especially since many areas are still being explored.However, exploration operations become very costly, thus limiting the improvement of the quality of petroleum studies. As such, surveys using the geophysical tool allow less destructive investigations at a lower cost compared to core surveys. In addition, the latter generally do not provide good results for drilling several kilometers deep. Thus, logs using the principles of nuclear physics make it possible to effectively understand certain physical and chemical parameters of the rocks on which they are applied.

Four types of nuclear logs have been explained in the context of our work:

- "Gamma ray" logs of natural radioactivity, for measuring the low percentage of potassium isotope: 40 K, thorium: 232 Th and uranium: 238 U;
- Gamma-gamma logs for measuring the density of rocks from the phenomenon of Compton's diffusion of gamma rays on rocks;
- Neutron-neutron logs, based on the interpretation of the phenomenon of the slowing down of fast neutrons by the nuclei of the atoms constituting the rocks in order to obtain information on the water content;
- Logs by neutron capture based on the interactions of neutrons with the nuclei of the atoms constituting soils or rocks.

As the nuclear logs make it possible to identify the presence of hydrogen and therefore to provide summary information on the presence of water and hydrocarbons, the combination with the other logs helps in the delimitation of the hydrocarbon reservoirs. In this case, the nuclear logs proved to be a particularly efficient detail on the technical level for the limitation and identification of the Pinda reservoirs which are the interest of the study. Our work is to show the importance of the application of physical phenomena such as natural and induced radioactivity in the oil industry.

ISSN No:-2456-2165

## II. MATERIAL AND METHOD

### *A. MATERIALS*

To carry out this work, we used a nuclear probe emitting neutrons based on the AmBe alloy connected to a computer.

### *B. METHODS*

Logs make intensive use of the measurement of radioactivity in boreholes. Nuclear logs have, in fact, a great advantage: they can be recorded in open or cased holes, empty or filled with any type of fluid. There are two types of nuclear logs: logs of natural radioactivity and logs of induced radioactivity.

a) NATURAL RADIOACTIVITY LOGGING

- THE GAMMA RAY LOG

The simplest nuclear log, the gamma ray, is a measure of the natural radioactivity existing in certain rocks. This log provides lithological information by clearly highlighting the coals, the evaporites and especially the clay levels which often constitute the limits of the reservoirs in the subsurface. On the other hand, the gamma ray log makes it possible to estimate the percentage of clay in the sandy formations. Unlike log PS which has the same function, it can be used in cased boreholes, in the presence of resistant muds and in air-filled boreholes.

The dominant radioactive elements are three in number and play a notable role in the natural radioactivity of minerals and rocks. These are Uranium, Thorium and Potassium 40. The others are extremely unstable or extremely rare. All rocks can be a priori radioactive due to the very general dissemination of these elements, however their preferential fixation on fine sediments means that these are generally more radioactive than coarse sediments.

Clays are most often highly radioactive, this particularity can have very diverse causes. It is:

- Potassium clays;
- Non-potassic clays but containing many accessory minerals to Potassium, Uranium and Thorium;
- Non-radioactive clays originally, but having subsequently absorbed cations comprising Uranium andThorium.

Different rocks can be classified according to their degree of radioactivity. We have:

- Rocks with high radioactivity: potassic granites and rocks derived from them, certain sands and sandstones rich in minerals accessory to uranium and thorium, phosphatic rocks, potassium evaporites, most clays and black shales;
- Rocks with medium radioactivity: sandstones, sands and gneisses;
- Rocks with weak radioactivity: limestones and dolomites, coals in general, evaporites without potassium, halite, anhydrite, basic and ultrabasic rocks.
- **Recorded parameter:** There are several gamma ray tools. One can, in fact, measure the whole range of gamma emissions produced by the formation or, by a suitable choice of energy window, make a distinction between the radiation due to potassium, that due to thorium and that due to uranium. In this case, we speak of gamma spectrometry.
- **Operating principle:** Modern tools use a scintillation counter which works as follows: a scintillating crystal (usually sodium iodide activated with thallium) emits a light photon when hit by a gamma ray. This photo emission is transformed by a photomultiplier into an amplified electric pulse to become measurable. The intensity of each light emission is proportional to the energy of the gamma photons which produced it and is proportional to the energy of the incident gamma radiation. The sensitivity of these counters is a function of the size and shape of the crystal. The larger the crystal used, the greater the number of pulses measured. The crystal generally measures a few cubic centimeters, which allows an excellent vertical definition, however the temperature has a great influence and these counters are most often in thermos vases.
- **Scale and units:** Gamma ray logs are recorded with a wide variety of units. In oil logging, the unit currently used is the API (American Petroleum Institute). This unit is standardized, 16.5 API units correspond to a concentration of radioactive elements equivalent to 1µgram of radium per ton. Clays have an activity varying between 100 and 200 API, sands 30 to 80, carbons 10 to 50. In simple devices used for water research, the units are only relative and rarely calibrated, it is most often strokes per second (cps), or strokes per minute (cpm).

b) LOGGING OF CAUSED RADIOACTIVITY

Logs of this nature are all based on the principles of the interaction between incident radioactivity and the components of the formation subjected to the radioactive bombardment. In our work we looked at the gamma-gamma log (or density), the neutron-neutron log and the neutron capture log.

a. THE GAMMA-GAMMA LOG (OR DENSITY LOG)

- **Operating principle**: The formation is bombarded by a constant energy gamma ray beam (0.1 to 1 MeV). These gamma photons collide with the electrons of matter (figure 1). At each collision, the energy of the incident beam is attenuated, this attenuation can be done in three ways: the photoelectric effect, the Compton effect and the pair production effect. The following figure 1 illustrates these different corpuscular interactions.

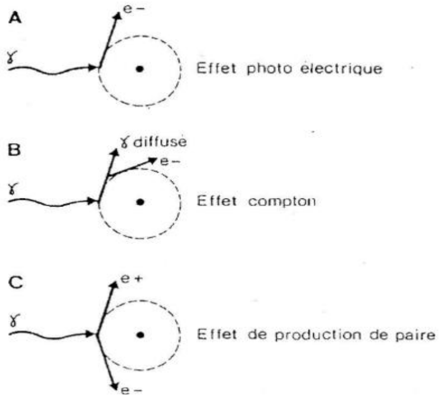


Fig. 1: Corpuscular interactions: a) Photoelectric effect, b) Compton effect, c) Pair production effect.

In the energy domain that interests us, the Compton effect is clearly preponderant over the other two attenuation modes. In this reaction, the incident photon loses part of its energy to eject an electron and continues its trajectory in another direction in the form of a scattered photon. This is caused by the number of Z electrons of the elements encountered by the incident photon. At a certain distance from the source, a detector makes it possible to count the gamma rays, the number of scattered photons returning to the detector will depend on the number of orbital electrons present and the energy of the source. The tool's response is therefore essentially determined by the electron density (number of electrons per $cm^3$) of the formation. The electron density is practically proportional to the atomic mass. Ultimately, it is therefore justified to consider only the density of the formation, which depends on the density of the matrix, the porosity and the density of the fluids filling the pores.

- **Photoelectric effect:** The photoelectric effect concerns "hard" ultraviolet photons, X photons and γ photons. The energy of the incident photon is completely absorbed by the atom. This energy is essentially imparted to one of the electrons. The energy of the photon is totally absorbed and the electron is ejected from its electron shell. There is therefore ionization of the atom. The kinetic energy of the electron is given by the principle of conservation of energy. The photoelectric effect can only exist if the energy of the incident photon is greater than the binding energy of the electron. This phenomenon leaves the atom in an ionized state. Ionization is followed by a reorganization of the atom's electronic procession in which fluorescence photons or Auger electrons are emitted. The probability of interaction by photoelectric effect is very important in the middle of high Z.
- **Compton effect:** The Compton effect concerns X photons and γ photons. The energy of the incident photon is partially absorbed by the atom. Part of this energy is transferred to one of the peripheral electrons of the atom, the remaining energy is carried away by a scattered photon, the electron is ejected from its electron layer. During this interaction the photon will lose energy and its direction of propagation is modified. In this case we speak of inelastic scattering of the incident photon. Figure 2 below illustrates this interaction.

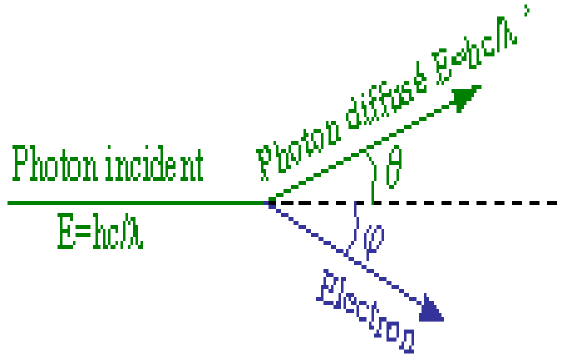


Fig. 2: Compton effect

- **Effect of production of Cooper pair or electron pair:** The materialization or creation of electron-positron pair concerns X photons and γ photons. The photon can materialize in the form of two electrons, one with a positive charge (called a positron) and one with a negative charge. Photon energy is converted into mass energy. The mass energy of the electrons is converted into the energy of two photons. The annihilation of the two electrons takes place at rest, the two photons are emitted in opposite directions and their energy is equal to the mass energy of one electron (0.511 MeV).

- **Measurement:** The number of cps (strokes per second) given by the tool depends on both the source, the receiver and the spacing and diameter of the hole, modern logs are directly recorded in $g/cm^3$, at this density scale can be matched with a porosity scale. For zero porosity, the tool will read the density of the matrix, the more the porosity increases the more the density decreases.
- **Tool response**: Factors that can cause gamma-gamma anomalies are: Water level, change in fluid density; the Mud Cake, the casing with fittings and hole diameter.
- **Effect of clays:** Clays have a high porosity and a matrix density which varies between 2.8 and 2.9 $g/cm^3$. The overall density can be very low for very lightly compacted clays with a lot of water, but the clay mineral being relatively heavy, its density is not significant, it depends a lot on the compaction. Figure 3 below illustrates this phenomenon.

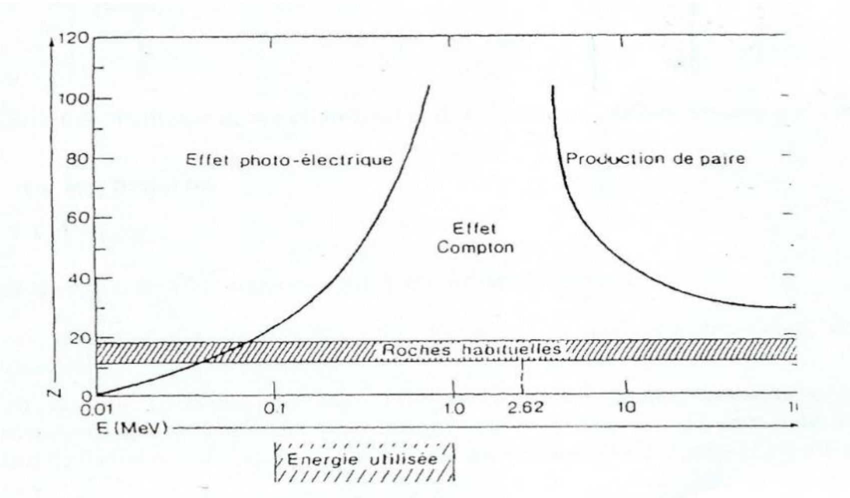


Fig. 3: Predominant effect in space (Z, E)

b. THE NEUTRON LOG

- **Operating principle:** Log neutron or neutron-neutron logging uses the phenomenon of the slowing down of fast neutrons by the nuclei of the constituent atoms of the medium in which they are emitted (Ménard and Cariou, 1978). It is the hydrogen nuclei that play a major role in the domain of slowing down and diffusion.

This time, the formation is bombarded by fast neutrons which are subjected to two complementary consecutive effects during their migration:

- ➢ First a slowing down due to collisions with the atoms constituting the medium, a slowing down which will be all the more marked as the atom encountered will have a mass closer to that of the neutron. In this case the hydrogen atoms are more effective;
- ➢ By these successive collisions the neutrons will lose their energy, they are said to be thermalized, when their energy is lower than 0.025 eV they can then be captured.

Figure 4 below illustrates these different interactions.

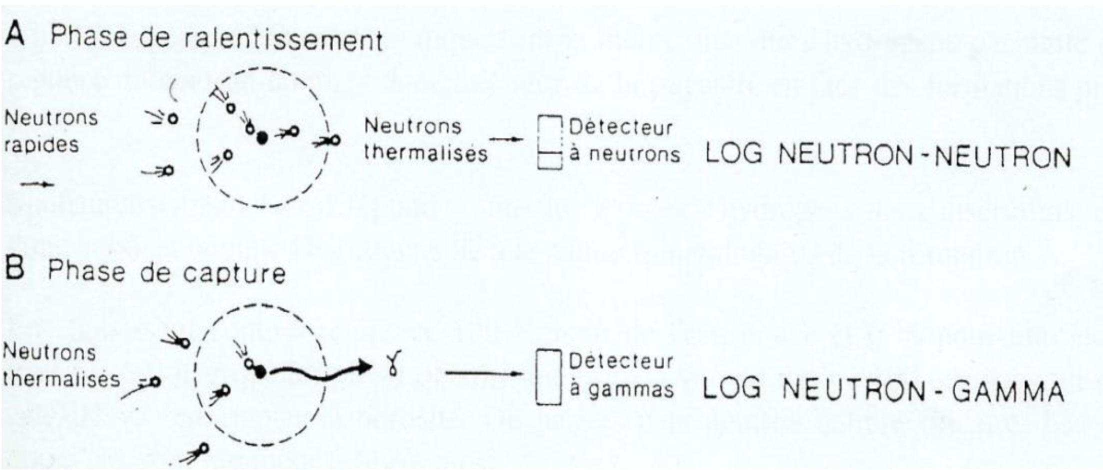


Fig. 4: Corpuscular interactions: a) Deceleration phase, b) Capture phase

This capture is accompanied by an emission of gamma rays which is characteristic of the sensor element. From this point of view, chlorine is the most active element.

- **Measurement:** There are several types of neutron logs depending on whether we count the number of neutrons present at different energy levels, or gamma photons emitted by capture, we speak of neutron-neutron or gamma neutron. Most often we use a neutron-neutron, that is to say a tool that measures neutrons at their different energy levels. This tool will give us a first approximation of the concentration of hydrogen atoms. The number of neutrons arriving at the detector increases when the hydrogen concentration decreases and vice versa. Finally, a hydrogen index is recorded. Oil and water contain almost the same amount of hydrogen per unit volume, so the neutron response will give an idea of the porosity in front of clean and saturated formations. Unfortunately, the tool responds to all hydrogen atoms without discrimination, so it will also take into account the hydrogen linked to the mineralogical nature of the formation. Figure 5 below illustrates the operating principle of the neutron probe.

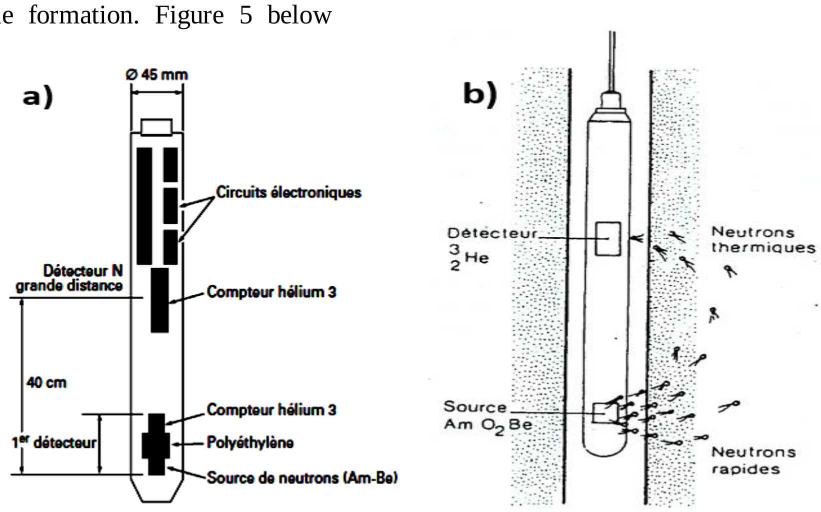


Fig. 5: Principle of the neutron probe

- **The response of the tool:** The neutron reads each of the elements in proportion to their quantity, if we want to obtain real values of porosity, we must be able to separate the different factors: lithology, clays, quantity and types of hydrocarbons in presence.
- **Effect of clays:** Clays generally contain a lot of water, which will result in a high neutron reading, which will be an indication of a porosity much higher than the effective porosity. Gas and air have a very low hydrogen index, the neutron will read very low values in front of a porous gas or air zone.

c. THE LOG BY NEUTRONIC CAPTURE

- **Operating principle:**The interactions of neutrons with the nuclei of the atoms that make up soils or rocks produce three types of gamma radiation:
  - Gamma radiation which is emitted at the moment of each inelastic collision of a neutron with a nucleus;
  - Gamma radiation which is emitted for each capture of a neutron by a nucleus;
  - Gamma radiation which can be emitted by the artificial isotope resulting from a neutron-nucleus reaction.

Some elements give off only one kind of gamma radiation. Others may give both or all three categories. The inelastic collisions of neutrons with the nuclei of atoms only take place for neutron energies above 7 or 10 MeV. Capture gamma radiation comes from the neutron capture reaction by the nucleus of an atom and this reaction therefore only occurs for fairly low neutron energies (close to the thermal level). Finally, the nuclear reactions giving rise to an artificial isotope can be of different types and the artificial isotope produced can then emit so-called "activation" gamma radiation. These nuclear reactions, depending on their type, take place for variable neutron energies.

The neutron emission is ensured by an isotopic source of Californium 252 whose activity corresponds to a neutron emission of $4.10^6$ neutrons per second. The gamma radiation detector, allowing the observation of neutron capture reactions produced in the field, is located at a distance of 30 cm from the source of Californium 252 boron-loaded polyethylene shielding and associated with a mixed screen of lead + boron is between the source and the detector; which makes it possible to protect the latter from neutron emission. The chosen detector is a 2-inch x 3-inch bismuth germanite crystal, which gives very high detection efficiency for the high energy gamma radiation emitted during neutron capture reactions. Each chemical element, when it captures a neutron, emits gamma radiation of characteristic energy. Judicious use of the spectrum of these capture gamma rays makes it possible to qualitatively determine the presence of a particular chemical element present in the material. Under certain calibration conditions (on reference slabs and on samples taken on site), it is possible to obtain a quantitative log of a particular chemical element. This type of logging makes it possible to obtain interesting information on the lithology of soils and rocks by providing information on the presence of constituents. The following figure 6 shows us a composite log gathering all the aforementioned nuclear logs.

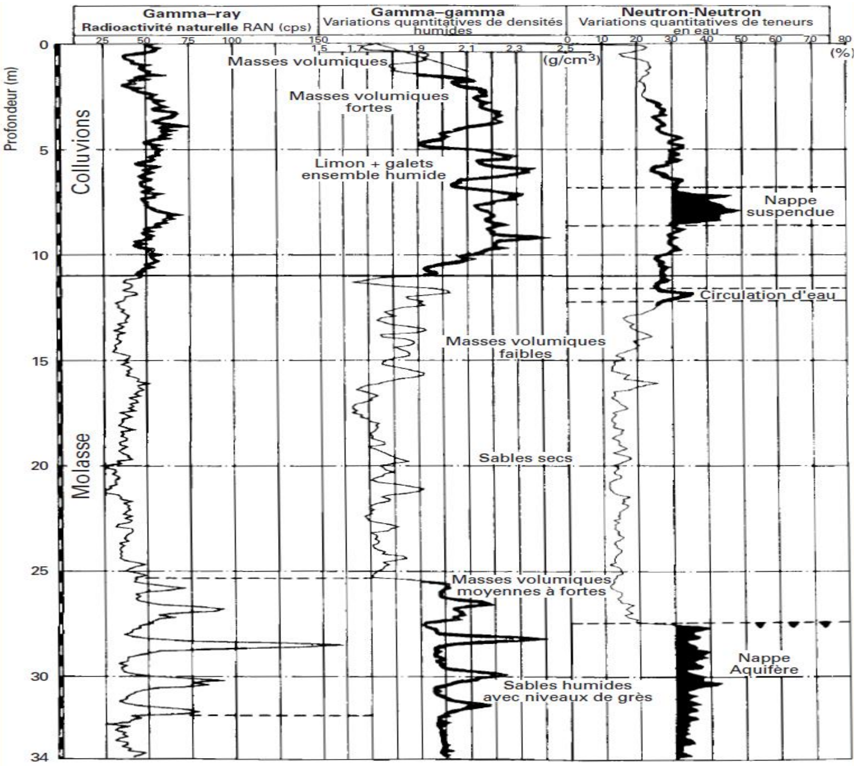


Fig. 6: Composite log of nuclear logs and their simplified interpretation

## III. PRESENTATION OF THE MIBALE-18 WELL

The Mibale field was discovered in 1973 by drilling the Mibale-1X exploration well, started on March 20, 1973 and completed on April 25, 1973. This well tested oil at 29.5° API from the reservoir of the Pinda formation. Two appraisal wells (Mibale-2 and Mibale-3) were drilled. The Mibale field was put into production in 1976 and is by far the largest field discovered in the Democratic Republic of Congo.

It is located south of the Kambala field in Angola, precisely in the province of Cabinda. It is bordered to the east by the two East-Mibale and Tshiende fields at land level (onshore), to the west and south-west by the Motoba field and to the south-east by the Mwambe field. The average depth of sea water varies between 10 and 30 feet. The following figures 7 and 8 show us respectively the map of the structure of the Mibale field and the seismic section through the Mibale field.

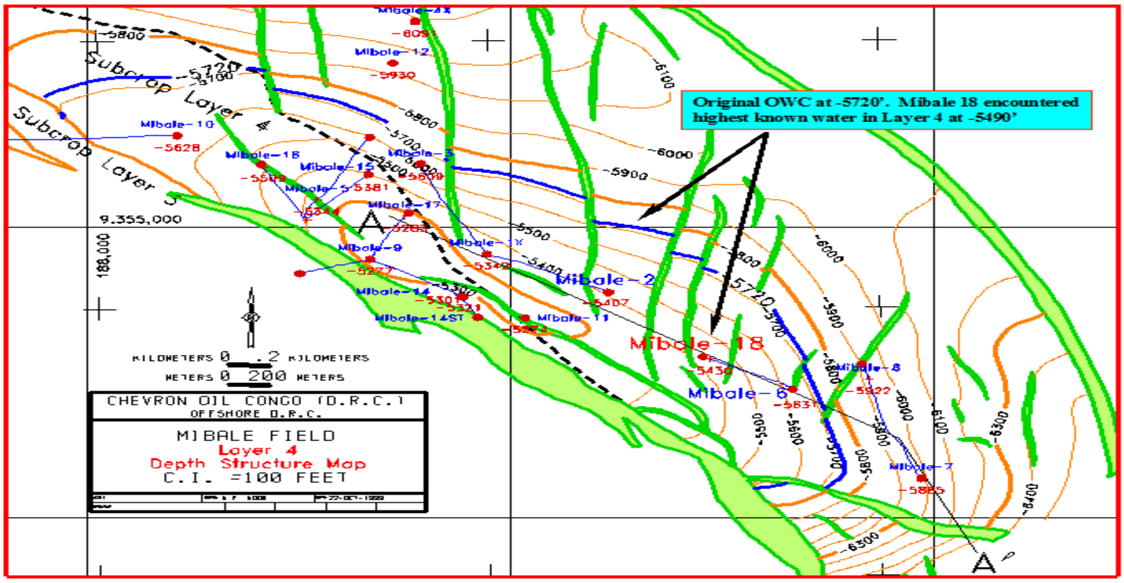


Fig. 7: Map of the MIBALE field structure showing the location of the Mibale-18 well

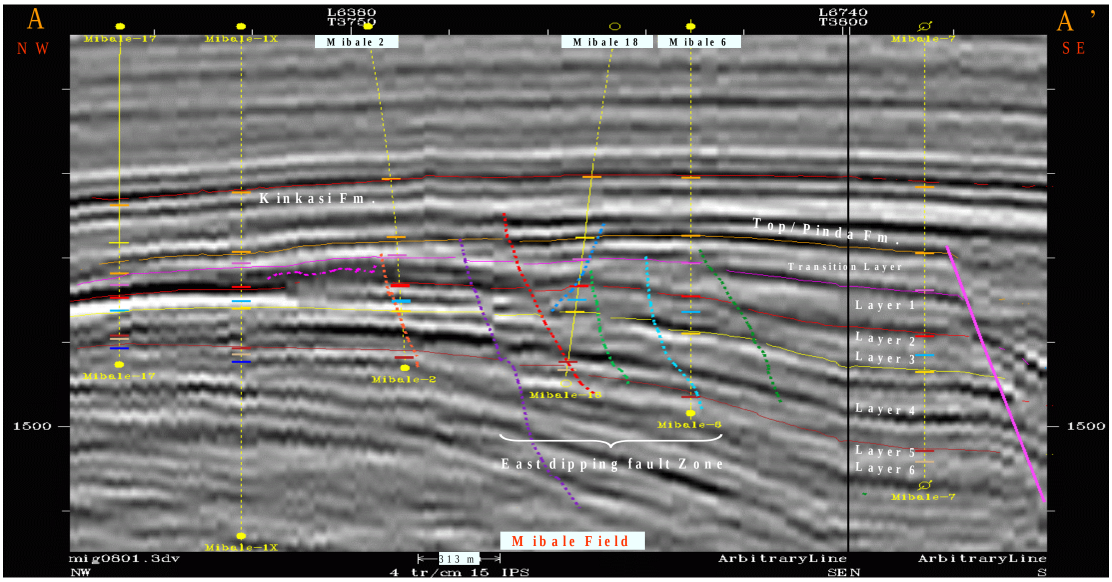

Fig. 8: Seismic section through the Mibale field (MIOC, Offshore-DR Congo).

## IV. MIBALE FIELD PRODUCTION

The Mibale field began production in 1976, shortly after the GCO field, initially from the L4 and L5 horizons (see seismic section above) where a rapid decline was observed in the first two years of production. Current production comes mainly from horizons L1, L2 and L3. Initial production was around 20,000 barrels of oil per day, however the reservoir pressure dropped quite quickly. It was then that water injection was applied in 1978 with the aim of increasing production. After additional development drilling, peak average production of 23,230 barrels of oil per day was reached in 1984, using 3 water injection wells and 7 oil producing wells. Higher levels were expected, but a premature breakthrough of water in 1985 reduced the annual average to 16,990 barrels per day.

## V. RESULT OF THE INTERPRETATION OF THE MIBALE-18 WELL LOG

Figure 9 below shows the composite log of the Mibale-18 well.

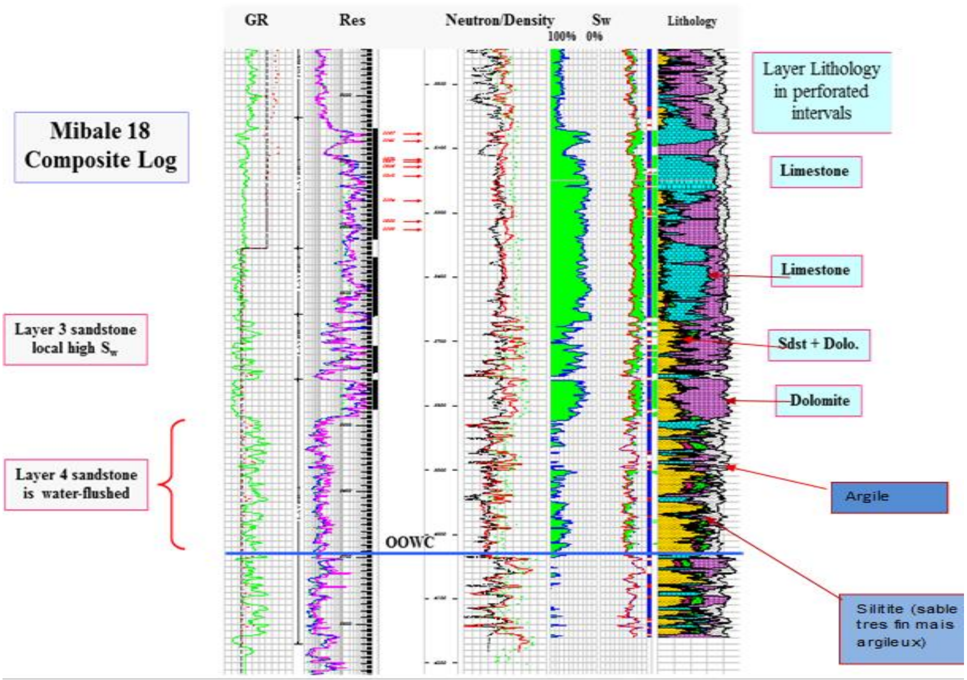

Fig. 9: Composite log of Mibale-18 well logs

It should be remembered that in our interpretation we rely more on the results of our nuclear probe which is the subject of our study and for this we have divided our log into four horizons:

- Horizon 1: at a depth MD between 5352' to 5555' (5033' to 5231' TVDSS);
- Horizon 2: at a depth MD between 5555' to 5658' MD (5231' to 5331' TVDSS);
- Horizon 3: at a depth MD between 5658' to 5759' MD (5331' to 5429' TVDSS); and
- Horizon 4: at a depth MD between 5759' to 6153' MD (5429' to 5813' TVDSS).

With MD: Measured Depth and TVDSS: True Vertical Depth from Sea Surface.

*A. HORIZON 1*

We consider Horizon 1 as the beginning of our study area because we are already observing the progressive and constant appearance of neutron peaks on our detector reflecting the presence of hydrogen atoms, a layer of limestone rocks and sandstone and clay (fig.10).

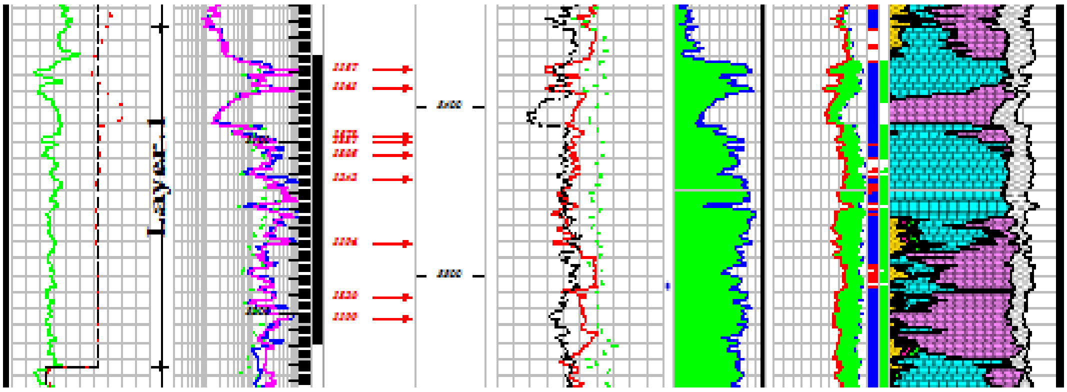


Fig. 10: Horizon 1 nuclear logs.

- **Lithology:** It consists of pelite limestones (mudstone) with crypto-crystalline wackestone of light gray color in place, silty, of poor porosity, covered with abundant oil stains having a fluorescent dull yellow in color.

Table 1 below gives the log density (RHOB) and porosity (NPHI) values of Horizon 1 for every 10 feet of depth.

| Measured Depth “MD” (ft) | Density “RHOB” (g/cc) | Neutron Porosity “NPHI” (V/V) |
|---|---|---|
| 5352 | 2,50 | 0,21 |
| 5360 | 2,50 | 0,18 |
| 5370 | 2,50 | 0,18 |
| 5380 | 2,35 | 0,21 |
| 5390 | 2,35 | 0,21 |
| 5400 | 2,40 | 0,30 |
| 5410 | 2,36 | 0,33 |
| 5420 | 2,40 | 0,21 |
| 5430 | 2,40 | 0,21 |
| 5440 | 2,40 | 0,21 |
| 5450 | 2,30 | 0,21 |
| 5460 | 2,35 | 0,21 |
| 5470 | 2,35 | 0,21 |
| 5480 | 2,35 | 0,21 |
| 5490 | 2,45 | 0,21 |
| 5500 | 2,55 | 0,18 |
| 5510 | 2,35 | 0,21 |
| 5520 | 2,45 | 0,24 |
| 5530 | 2,45 | 0,21 |
| 5540 | 2,50 | 0,21 |
| 5550 | 2,35 | 0,21 |
| 5555 | 2,36 | 0,18 |

Table 1: Log density (RHOB) and porosity (NPHI) values for Horizon 1.

*B. HORIZON 2*

In this horizon, we notice a constant growth of the peaks of hydrogen atoms, a significant amount of sandstone, limestone, dolomites and little clay (fig.11).

ISSN No:-2456-2165

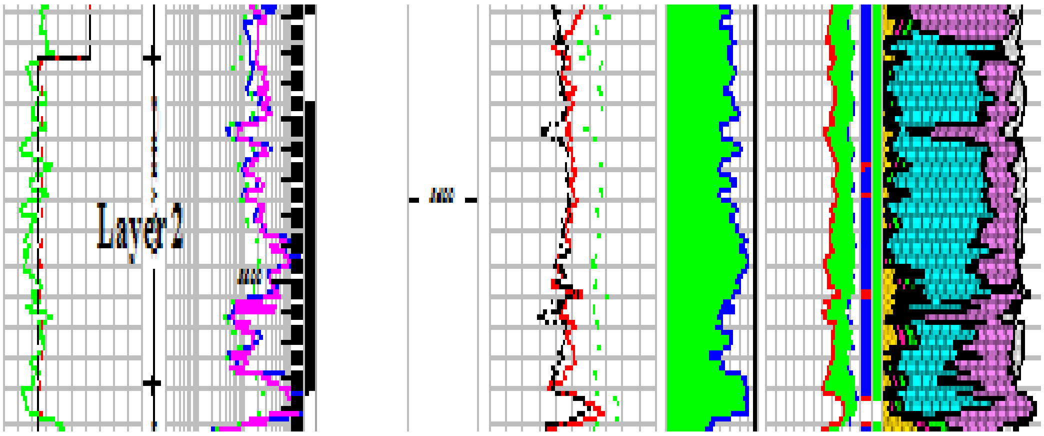

Fig. 11:Horizon 2 nuclear logs.

- **Lithology:** It consists of a dolomitic limestone and a fine-grained sandstone. This horizon is not a dolomite as is the case in the other wells of the Mibale field. The limestone is dolomitic, crypto-crystalline to fine crystalline packstone to wackestone. The oil stains are brown and scattered with a dull yellow fluorescence. The sandstone is fine to very fine grained, well sorted, calcareously cemented, with poor to fairly good porosity.

| Measured Depth “MD” (ft) | Density “RHOB” (g/cc) | Neutron Porosity “NPHI” (V/V) |
|---|---|---|
| 5555 | 2,36 | 0,18 |
| 5560 | 2,45 | 0,18 |
| 5570 | 2,44 | 0,19 |
| 5580 | 2,45 | 0,21 |
| 5590 | 2,45 | 0,19 |
| 5600 | 2,45 | 0,15 |
| 5610 | 2,40 | 0,18 |
| 5620 | 2,35 | 0,21 |
| 5630 | 2,45 | 0,15 |
| 5640 | 2,45 | 0,27 |
| 5650 | 2,45 | 0,18 |
| 5658 | 2,30 | 0,10 |

Table 1: Log density (RHOB) and porosity (NPHI) values for Horizon 2.

### *C. HORIZON 3*

In this horizon, our nuclear probe shows a peak plateau with level fluctuations (fig.12).

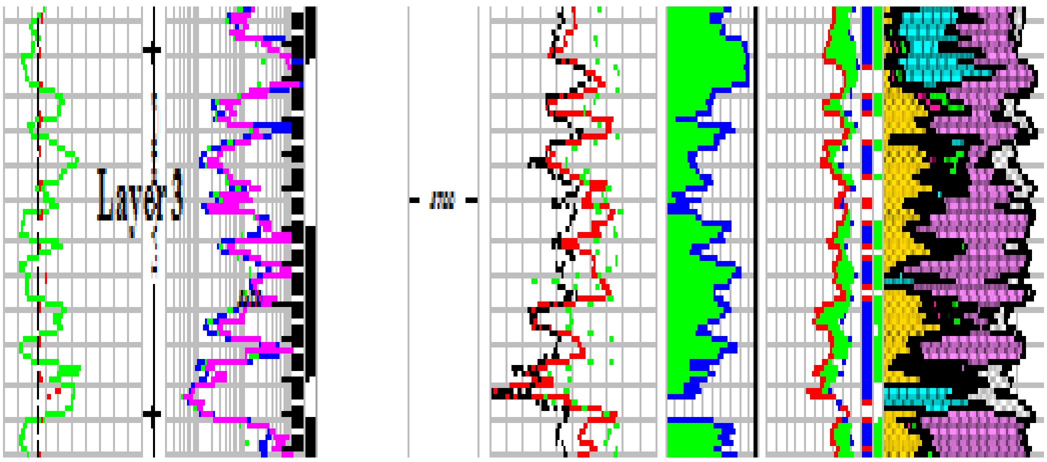

Fig. 12: Horizon 3 nuclear logs.

- **Lithology:** It consists of sandstone and dolomite intercalations. The latter has poor to fair porosity, and sandstone has fair to good porosity. Brown oil stains are scattered and show a dull yellow fluorescence.

Table 3 below gives the log density (RHOB) and porosity (NPHI) values of Horizon 3 for every 10 feet of depth.

| **Measured Depth "MD" (ft)** | **Density "RHOB" (g/cc)** | **Neutron Porosity "NPHI" (V/V)** |
|---|---|---|
| 5658 | 2,30 | 0,10 |
| 5660 | 2,45 | 0,24 |
| 5670 | 2,55 | 0,15 |
| 5680 | 2,35 | 0,20 |
| 5690 | 2,40 | 0,27 |
| 5700 | 2,55 | 0,21 |
| 5710 | 2,45 | 0,21 |
| 5720 | 2,60 | 0,18 |
| 5730 | 2,25 | 0,27 |
| 5740 | 2,50 | 0,21 |
| 5750 | 2,15 | 0,39 |
| 5759 | 2,55 | 0,17 |

Table 3: Log density (RHOB) and porosity (NPHI) values for Horizon 3

### *D. HORIZON 4*

In this depth we noticed a significant drop in the neutron peaks captured by our probe to a negligible level near the area called "OOWC" (Original Oil Water Contact). So, clay, limestone, clay-sand (fig.13).

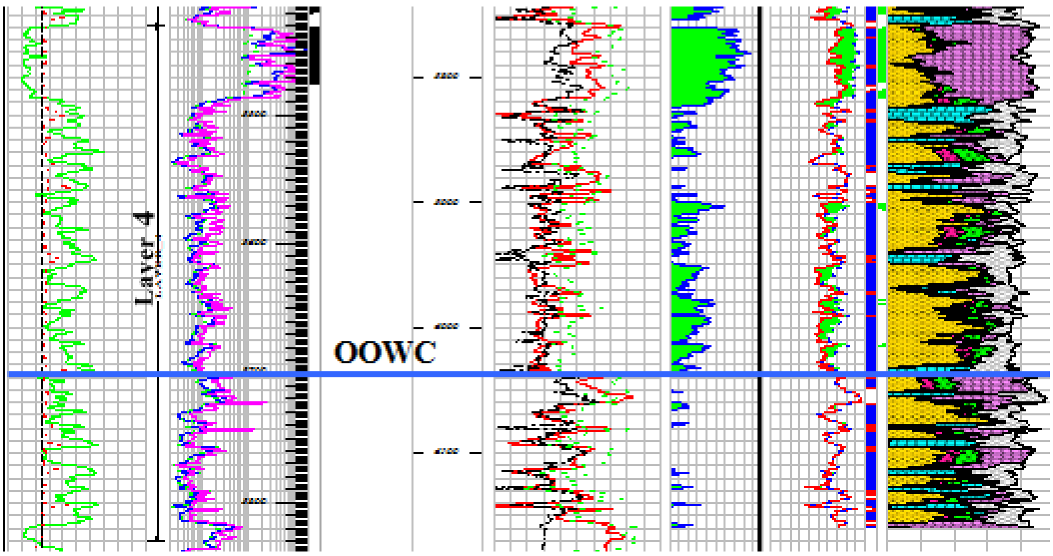

Figure 13: Horizon 4 nuclear logs

- **Lithology:** It consists predominantly of very fine to fine grained sandstone with intercalations of dolomite. The sandstones are very porous, mainly washed out by water following the effective sweeping by the injection of water. The 50' thick dolomite bed sits at the top of this horizon and contains oil.

Table 4 below gives the log density (RHOB) and porosity (NPHI) values of Horizon 4 for every 10 feet of depth.

| **Measured Depth "MD" (ft)** | **Density "RHOB" (g/cc)** | **Neutron Porosity "NPHI" (V/V)** |
|---|---|---|
| 5759 | 2,55 | 0,18 |
| 5770 | 2,46 | 0,15 |
| 5780 | 2,45 | 0,22 |
| 5790 | 2,45 | 0,21 |
| 5800 | 2,55 | 0,225 |
| 5810 | 2,54 | 0,15 |

Table 4: Log density (RHOB) and porosity (NPHI) values for Horizon 4

ISSN No:-2456-2165

By studying the results of the Mibale-18 well through the different logs, we notice that, in accordance with the other logs, the Sw log (water saturation) clearly shows a variation in peaks linked to the presence of hydrogen atoms in the strata located in depths ranging from 5300 to 5810 feet. Beyond these depths, we no longer see any flow on our log which means that beyond this depth the hydrogen atoms are negligible as indicated by the blue line Original Oil Water Contact "OOWC". The principle of nuclear logging that we used consists in bombarding matter with neutrons and analyzing the intensity of the signal recorded by the sensors of our probe.

## VI. CONCLUSION

This work aimed to show the importance of nuclear logs in the identification of the different lithologies of the rocks crossed by the Mibale-18 well. These logs constitute a very rich source of data because the variation of each curve reveals the presence of a contrast of petrophysical parameters, the latter being very useful in the identification of reservoir rocks. Indeed, several lithologies such as identified limestones, dolomites and sandstones can be considered as potential reservoirs. In this work we used a probe whose neutron sources are based on Ambe atoms. The disadvantage of a probe made of this alloy is that it is sensitive to all hydrogen atoms without discrimination. It will therefore also take into account the hydrogen linked to the mineralogical nature of the formation. Which, for a good interpretation, requires the differentiation of the origin of the hydrogen atoms captured by the probe. It is therefore this differentiation of hydrogen atoms of mineralogical origin and those linked to the various imbibition fluids that will be the subject of our research topic in the future.

## REFERENCES


[1.] Perenco DRC, MIBALE-18 Final Well Report, August 18, 2000.
[2.] Muanda International Oil Company LTD, Monthly Production, October 2002.
[3.] Perenco RDC, MIBALE 18 Well Summary TCM 2000.
[4.] Halliburton Logging Services enregistra les diagraphies
[5.] Wood Mackenzie, West Africa Ustream Service – July 2011.
[6.] Cours Diagraphies et géophysique de forage par Richard LAGABRIELLE Ingénieur Civil des MinesDocteur ès Sciences Directeur technique Laboratoire Central des Ponts et Chaussées.
[7.] Cours de diagraphies nucléaires appliquées au génie civil, par Valéry Ferbert
[8.] Cours de diagraphies aquifères et pétrolières par le professeur D.chapellier,
[9.] Cours sur les relations vitesse sismique - propriétés pétro physiques des terrains sédimentaires, par KOUAME L.N., SOMBO B.C., KOUASSI G. , SOMBO A.P : Laboratoire de Géophysique Appliquée, UFR Sciences de la Terre et des Ressources Minières, Université de Cocody, 22 BP 582 Abidjan 22, Côte d'Ivoire.Par ESSOH A.S. : Département de Géophysique, PETROCI, BP V 194, Abidjan, Côte d'Ivoire.
[10.] Notes Inédites du Cours d'Evaluation de Formation, Forage et Production, par Pierre NTUMBA KALALA, 2013-2014.
[11.] Site officiel d'offshore technology: http://www.offshore-echnology.com/projects/girassol/
[12.] Site de dnv : http://www.dnv.co.uk/technologyservices
[13.] Site officiel du Ministère de l'industrie : http://www.industrie.gouv.fr
[14.] Site officiel d'euro-pétrole : http://www.euro-petrole.com.