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Petrophysical Evaluation and Reservoir Summation of Bentiu Formation –Diffra west Area, Muglad Basin, Sudan

Hamid.O.E [*], Hafeiez.M.A

[*] Geophysics department, faculty of science, University of kordofan

omereisa6346@gmail.com

Petroleum department Faculty of Petroleum and Minerals

Abstract - This study represents the petrophysical evaluation of Bentiu Formation-Muglad basin, Diffra west oil field block (4) using well logs, A successful petrophysical interpretation for any hydrocarbon system still motivates the researchers, to conduct more studies to discover a new productive zones as well as to sustain their continuity productivity.

In this study petrophysical evaluation had been done for five wells using Interactive Petrophysics software to detect the petroleum parameters and reservoir characteristics in the study area, Focusing on Bentiu formation Evaluation which is the main reservoir at this part of Muglad basin manually compared with interpretation for all logs have been done to confirm the software results.

Many reservoirs in addition of many determination, water cut had had been determined, which were considered to be negatively affection on the future production rates. The solution of this reduction impact was already proposed.

Comprehensive results were achieved after calculating the amount and distribution of shale throw all the layers of Bentiu Formation using single curve method determination, the average porosity of Bentiu Formation about 15%, and average water saturation had also been determined by 62% these values were considered to be very compatible with the characteristics of the reservoirs but some different cases had been noted, such as high water cut in Diffra1 about (93%) and in Diffra5 about (94%).

Index Terms - petrophysical cut-off values determination, (Sw Cut-Off),multi-target prospect in Bentiu, Diffra west oil field.

I. Introduction

Muglad Basin represents parts of Central Africa Rift System, which extends from North of Cameron and South Nigeria at the Atlantic Coast to western and Central Sudan. Extending southeast wards from south Darfur to the Sudanese Kenyan border (Fig2), The basin is oriented

NW-SE and it occupies an area of about 160000km² There is a huge amount of locally deposited Cretaceous- Neogene sediments of about 13km in thickness (Idris, 2001). In the Late Jurassic time, a triple junction began to develop along the Kenya coastline, separating the Malagasy island. The arm of this triple junction extended from the Lamu Embayment through the Anza Trough in Kenya and into the southern Sudan at the same time (Late Jurassic) and to the west, the African and South American cartons began to separate (Figure1).

Figure1 Separation of Africa and South America Continents

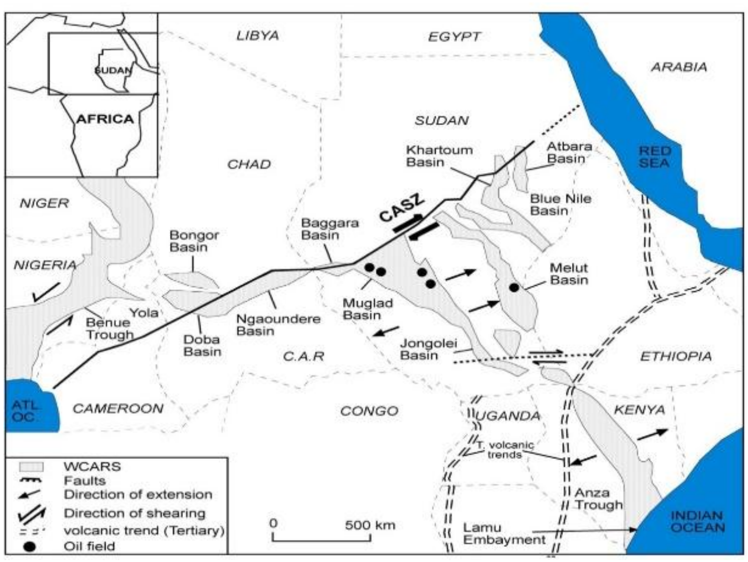


Figure2 Tectonic Model of the West and Central African Rift System

Due to these major events, a shear reactivation along the CASZ developed, which led to the development of parallel and subparallel half grabens of NW-SE orientation in the central and southern Sudan cratonic areas (Figure2).

2-Study area

The study area is named Diffra west, it is located in the southwestern part of Muglad basin. It's approximately. It's approximately bounded by latitudes 10º 4´to 10º 5´N and longitudes 28º 26´ to 28º 27´ E. The study area width is about 1.84km and length is about 1.85km, with the total area of about 3.5km ² (Figure3).

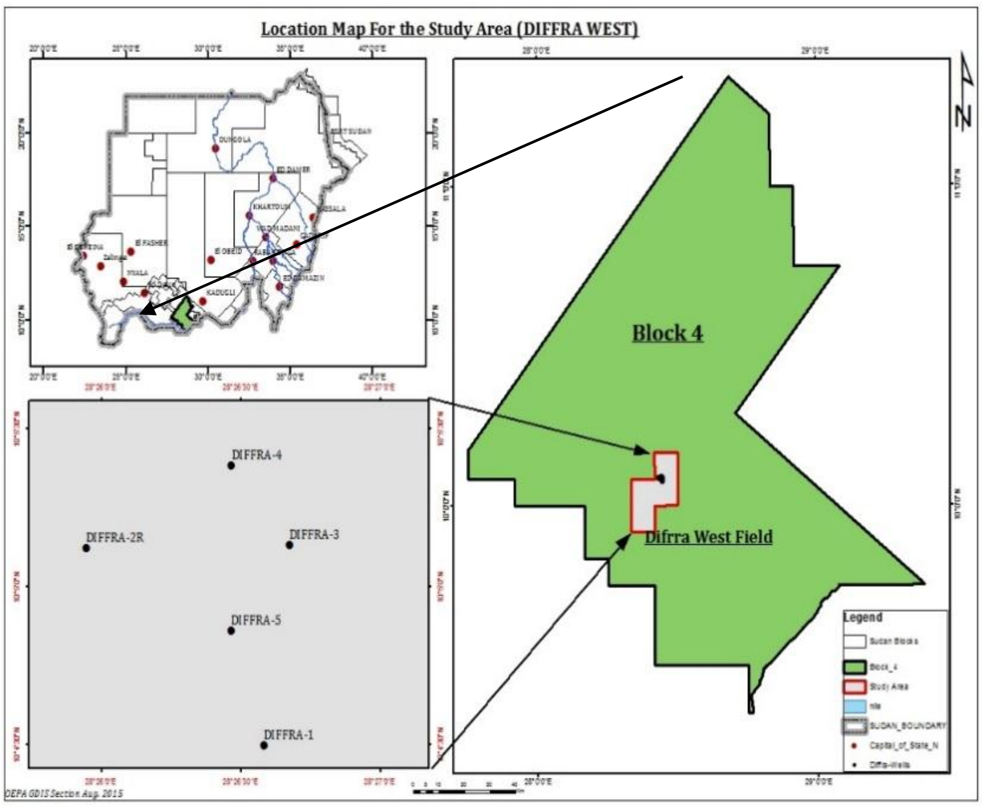


Figure3 location map of the study area

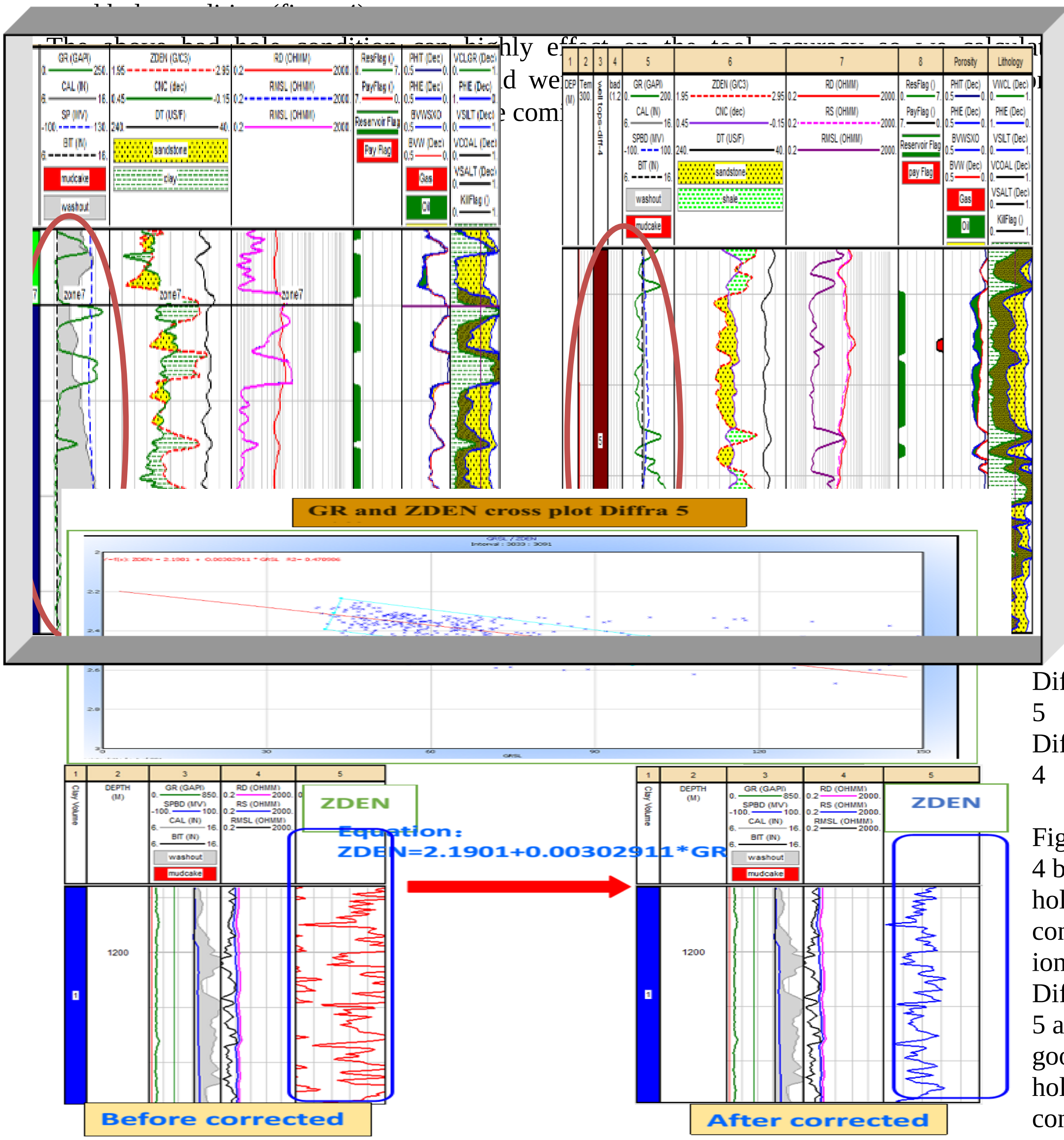
3-research methodology

The method that was used in this study is the analysis of well logs for five wells manually and through software and the outcome of both of them was assist.

2.1 Log Quality Control (LQC)

The term log quality control (LQC) is very important part of every logging job because log data can be affected by the borehole conditions such as wash out (caving) and or tool problems. as it appear that in the position that marked by circle in Diffra 5 (Well) caliber log showed high caving while in diffra4 (well) the circled position showed less caving which considered to be

The above bad hole condition can highly effect ... the ... was ...



Diffra 5

Diffra 4

Figure 4 bad hole condition Diffra 5 and good hole condition

Diffra 4

Figure 5 density tool (bad hole reduction)

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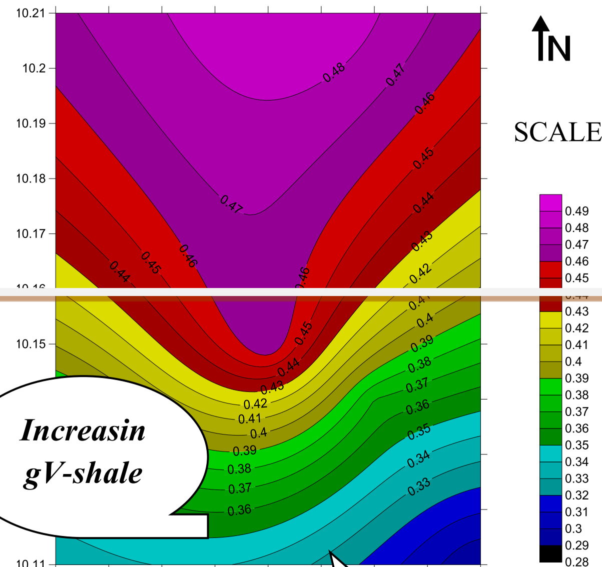
4-results and conclusion

4-1 v-shale and porosity model

After we calculated the volume of shale we had calculated the amount of porosity using density log and the following equation had been used to achieve the all area

$$\text{porosity}.\phi = \rho ma - \rho b / \rho ma - \rho f$$

And from the calculated porosity the high values was found in the opposite side of increasing volume of shale in the area as it appear from (Figure 6)



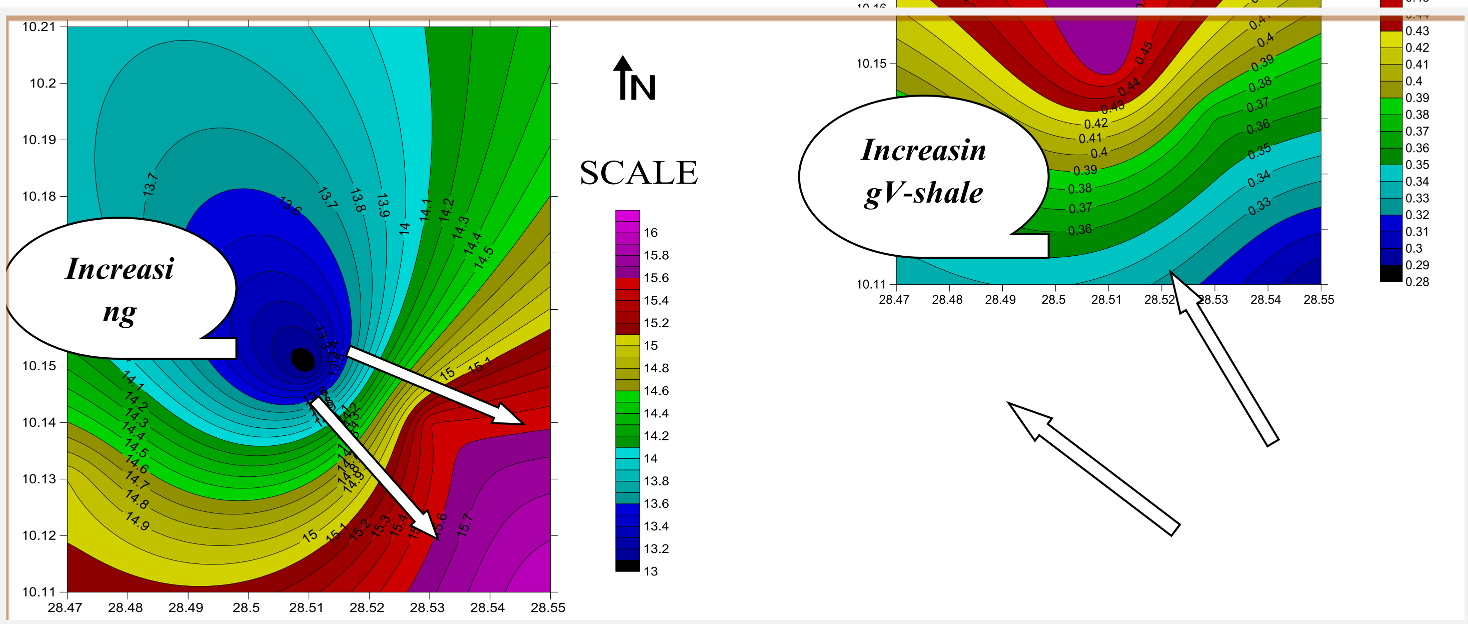


Figure 6 porosity map of the study area and v-shale map

4-2 Fluid type identification from water saturation calculation

Water saturation is calculated by the Archie (1942) equation in interactive Petrophysics software. Deep resistivity values are used from. On the basis of water saturation, pay zone is separated from reservoir intervals. The R values are estimated by using the histogram. Following, Archie, (1942) equation is used.

$$Sw = \sqrt{R0} / Rt$$

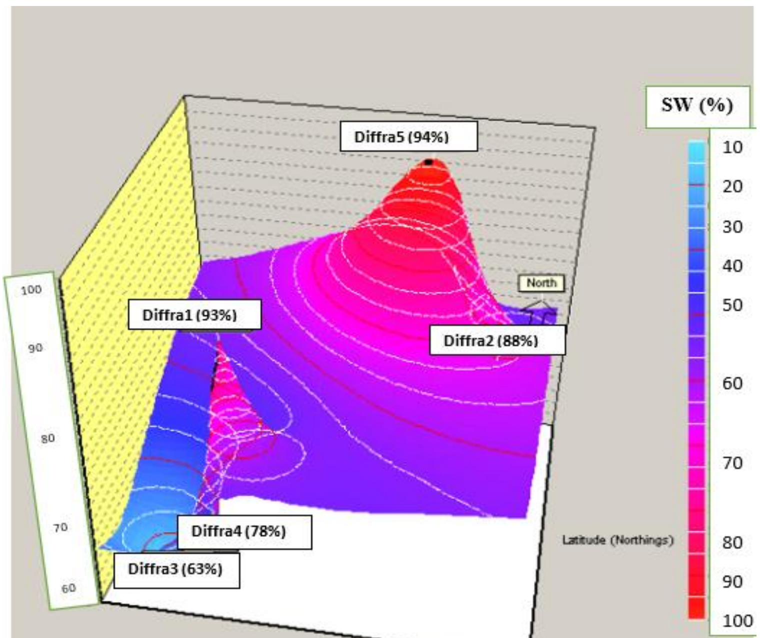
Where:

Sw = water saturation

R0 = resistivity of water formation

RT = true resistivity of the formation.

From the previous calculations the amount of water in all wells were obtained and water model for Bentiu formation had been predicted.



From the direct quick look of interpretation from the log we can easily distinguish between the oil and water by the characteristics shape of some parameters like Gamma-ray, resistivity and porosity reading against the zone.

From figure(7) below its clear that the wells Diffra1 and Diffra5 are mainly shows high values of water saturation which mean

that the porous non filled with water should be filled with oil, and these wells were mention showed high water cut and were considered to be nonproductive wells.

Figure 7 -3D-model of water saturation in the area.

4-3 -Hydrocarbon saturation (net-pay)

Hydrocarbon saturation can be computed easily after calculation of SW an Sxo. Hydrocarbon saturation may be movable or residual hydrocarbons. The movable hydrocarbon saturation (Shm) is very important because it can be studied in commercial view, while the residual hydrocarbon saturation (Shr) is not important due to its difficult to extraction. In simple forms, both movable and residual hydrocarbon can be calculated as the following:

(Sh = 1– SW , Shr = 1– Sxo , Shm = 1– Shr)

Where:

Sh = hydrocarbon saturation, Shr = residual hydrocarbon saturation

Sxo = hydrocarbon saturation, Shm= movable hydrocarbon

From the above application on (IP software program) 3D model for the movable hydrocarbon had been generated and perforation zones also were marked too, its appear that the maximum net pay thickness is found in the well (Diffra3) followed by (Diffra2) and (Diffra4) as shown on (Fig 8).

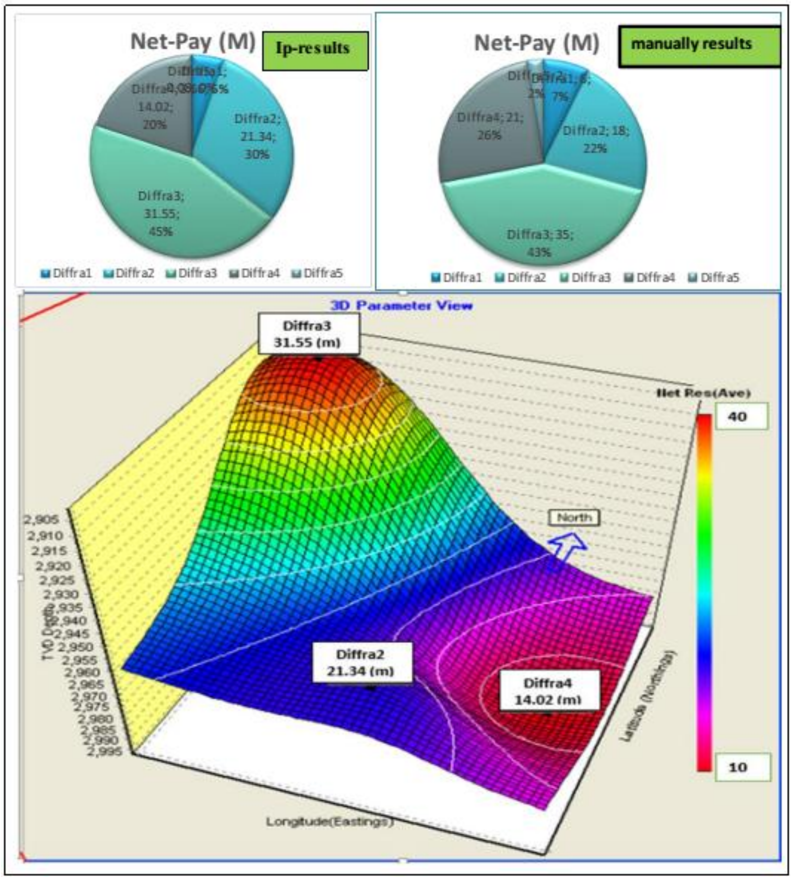


Figure 8 - the 3D model presents movable hydrocarbon (Net-pay) distribution in Bentiu formation for the most three productive wells.

4-4 Conclusions

The present study is reflect the petrophysical evaluation of Bentiu Formation, in Diffra west oil field in Muglad basin, Sudan and that has been carried out.

It's highly ambitioned this theses will help by one way or another in future purposes and hoped to be guidance for coming studies on petrophysical evaluations. Due to the high water cut problems in the Diffra west oil field the petrophysical approach was chosen to assess the reservoirs within the Albian age Formation.

Petrophysical evaluation and brief summary of the chapters and recommendations from this study can be summarized as following.

The data that have been used to conduct this study include wire line logs for five wells.

Due to bad hole effect on density tool reading, single method shale indicator which depends on Gamma-ray reading had been used to calculate shale volume in all Bentiu formation. Because its important step in petrophysical evaluation to know the distribution of shale in order to pick out non-reservoir rocks. This obtained statistically using the cross plot and compared with histograms for all wells, had been found that all Bentiu reservoirs contain Vshale <50% and countoring map was built for better representation**.**

The most important factor that must be calculated for better determination of potential reservoirs is porosity which can be obtained using various different methods(sonic,density,neutron) and density).and here density-neutron had been used to calculate porosity, the porosity obtained excluding shale effect is called the effective porosity which reflect the reservoir quality. Optimum porosity in this study had been achieved,>16%. 3D model had been generated to show the variations between wells.

Water saturation was also determined using Archie Equation in this study, depend on water cut of <50%, and 3D model had been designed to reflects the water saturation variations along all wells in the study area.

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