PETROPHYSICAL STUDY OF LOWER TRIASSIC SHALY SANDSTONES (TAGI) RESERVOIR IN BERKIN BASIN, STRUCTURE OF SIF-FATIMA (ALGERIA)

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Abstract.- *A petroleum reservoir Study includes both characterization and evaluation of potential interval, in order to identify all parameters related to the reservoir (geology, petrophysics, logging, formation tests). For this study, 3 wells were selected (SF-2, SF-3, SF-4) in Berkin Basin, Southeast Algeria. The aim of the present paper is to discover the petrophysical quality of lower Triassic shaly sandstones reservoirs in Berkin Basin, perimeter Sif-Fatima. The results of laboratory petrophysical analysis suggests that the lower Triassic shaly sandstones is a good reservoir with high-quality of petrophysical parameters with an average core porosity and permeability of: 18.15% and 540.10 md respectively.*

Key-words: *TAGI, reservoirs, Berkin basin, petrophysical analysis, porosity, permeability, core analysis.*

ETUDE PETROPHYSIQUE DU RESERVOIR TRIAS ARGILEUX GRESEUX INFERIEUR (TAGI) DANS LE BASSIN DE BERKINE, DE LA STRUCTURE DE SIF-FATIMA (ALGERIE)

Résumé.- *L'étude des réservoirs pétroliers comprend à la fois la caractérisation et l'évaluation des intervalles potentiels, afin de toucher à tous les paramètres liés au réservoir (géologie, pétrophysique, diagraphie, essais de puits). Pour cette étude, trois sondages ont été sélectionnés (SF-2, SF- 3, SF-4) forés dans le bassin de Berkin, Sud-Est de l'Algérie. Le but du présent article est d'étudier les caractéristiques pétrophysique du réservoir Trias Argileux Gréseux Inférieur (TAGI) dans le bassin de Berkin, périmètre Sif-Fatima en utilisant les donnes d'analyse pétrophysique au laboratoire. D'après cette étude petro physique, on constate que le TAGI a les caractéristiques d'un bon réservoir avec des porosités de l'ordre de 18,15 % et de permutabilité de l'ordre de 540.10md*

Mots clés: *TAGI, réservoirs, bassin de Berkin, analyse pétrophysique, porosité, perméabilité, analyse sur carottes.*

Introduction

The SIF-FATIMA permit located in the Berkine Basin (block 402b) in the eastern Grand Erg. It was the subject of some work before 1970, including gravimetry and magnetometry studies, recognized by the first well (SF1) drilled in 1983 by the SONATRACH / TOTAL association. The main objective of this well is the sandstone of the lower Triassic shaly sandstones but the results of the various tests revealed only a small oil production from a sandstone intercalation of 3m in the Carbonated Triassic [1].

Later (SF2) revealed the presence of hydrocarbons at the lower Triassic shaly sandstones (LTS) on two distinct horizons. Therefore, SONATRACH was encouraged to explore more the area with (SF3) and (SF4) which proved to be very promising [1] (fig.1).

The Berkine basin located in the South-East Algerian Sahara and extends over 120 000 Km^2 across the Algerian territory. The region of SIF-FATIMA positioned about 230 km South-East of Hassi Messaoud, limited by the parallels: 31°- 32° N and the meridians: 8° - 9° E.

Our study region is bounded from the:
• North: by the dome of Dahra and Hassi Messaoud area,
• South: by the Illizi basin,
• West: by the Amguid horst and the el-biod dorsal,
• Est: by the mole of Tihemboka and the Tuniso-Libyan border [2].

The aim of the present paper is to show the high quality of LTS Reservoirs in Sif-Fatima perimeter through a laboratory analysis to perform a petropphysical reservoir characterization using core samples recovered from wells studied.

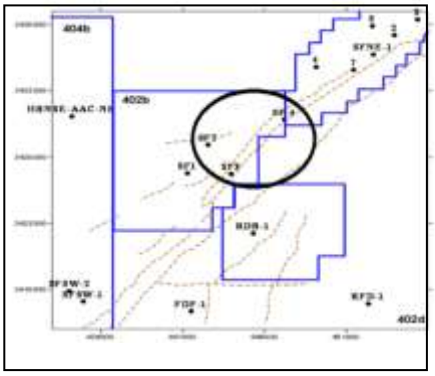

Figure 1.- Positioning Map of well's study

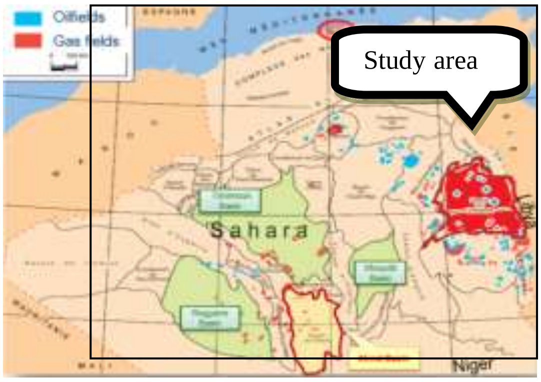

Figure 2.-Geographical and geological setting of the Berkine Basin

1.- Experiments

For better exploitation of a given hydrocarbon reservoir, the reservoir quality of productive levels must be determined. It is based on petrophysical parameters (porosity, permeability) measured from the samples (plugs) taken from cores each 25 cm.

1.1.- Sample Preparation (plugs)

Before starting any analysis, we must use:
1. Toluene and chloroform to extract hydrocarbons and contaminations.
2. Methanol to extract salts.
3. After that, the sample is dried at 110°C [1].

1.2.- Measurement of porosity in the laboratory

The porosity (Φ) of a rock is its property to have voids, pores and fissure. It is expressed quantitatively by the percentage of the voids' volume related to the total volume of the rock.

Moreover, the useful porosity (Φμ), is the porosity corresponding to the interconnected voids or voids' volume which may be occupied by fluids.

After washing and drying plugs, the measurement methods are different, depending on the nature of the sample and its dimensions. Among these methods we cited the one used by SONATRACH [1] consists of;

1.2.1.- Calculate the total volume (Vt)

The total volume (Vt) measured using a mercury volumetric pump composed of :
a sample cell with a porthole system to identify the Constant level of mercury; Vacuum pressure gauge and Gate valve.

To process the analysis, firstly we calibrate the device to zero (o), after that, we proceed to the immersion of the plug in mercury. The total volume (Vt) is obtained by measuring the Archimedes thrust. The reading of the total volume (Vt) will be indicated on the manometer [1].

1.2.2.- Calculate the Void volume (Vv)

To obtain the volume of the voids (Vv) we must pursue the following steps:
• We ponder the plug to know its total weight (Wt).
• make the sample in the oven to extract all fluids existing in the pores.
• We weigh the sample a second time to determine the solid weight (Ws).
• using a simple mathematical operation we can get the weight of fluids (Wf).

$$Total\ weight\ of\ sample - solide\ weight = fluids\ weight \ (1)$$

Depending on the nature of fluid we can calculate the void volume by the formula for density;

$$Density = \frac{\text{fluid weight (kg)}}{\text{fluid volume}} \ (2)$$

And as the fluids inside the void of the rock represents consequently the volume of the void. So, we can write that:

$$Void\ volume = \frac{Fluids\ Weight}{Fliids\ Density} \ (3)$$

And finally: $Porosity(\Phi) = \frac{\text{Totla volume of rock}}{\text{Void Volume}}$ (4)

1.3.- Measurement of permeability in the laboratory

A porous area allows the movement of fluids between his connected pores: it is the permeable area. The permeability is measured using a conventional permeameter required to apply Darcy's law (laminar flow. It uses nitrogen (inert gas) for the measurement of permeability composed essentially by:
- Two graduated manometers, one for the reading of the mercury and the other for the height of water.
- A sample holder cell made inside by rubber tubing to keep sample under a pressure of 200 psi.

We put the sample (plug) in the cell, then we passed through by a gas. It is necessary that the reading on the mercury manometer will be at 60 psi, and on the water gauge will be less than 30 psi to ensure the condition of atmospheric pressure and laminar flow.

The permeability can be calculated using the following equation

$$Permeability = \frac{L*C*HW*Q}{S*200} \quad (5)$$

With :
C: mercury constant
Q: Flow in CC/sec
L: length of the sample in Cm
HW: Water level in the pressure gauge
S: section of the cell in cm^2

2.- Results and discussion

2.1.- Results

The results of the petrophysical analysis in the laboratory allowed us to perform a quantitative study of porosity and permeability through reservoir interval in our study wells.

2.1.1.- SF-2 well

The histogram of the porosity classes shows a growing distribution : the higher porosity values (20%) is the most dominant class, represents around (52.74%) of the porosity values in the reservoir, the porosity classes which oscillate between [10-15].- and [15-20].- represent (37.36%) of the porosity values in the reservoir and those between [0-10] represent (9.90%).

The histogram of the permeability classes shows an unimodal distribution with the predominance of a single class where the values are between [100-1000] md represents (72.52%) of the permeability values, the class oscillating between [10 -100] is about (13.8%) and classes that range from [0.1-10] are (5.5%).

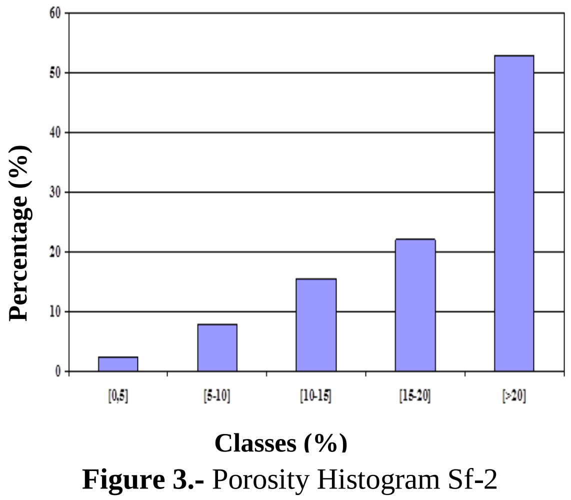

Figure 3.- Porosity Histogram Sf-2

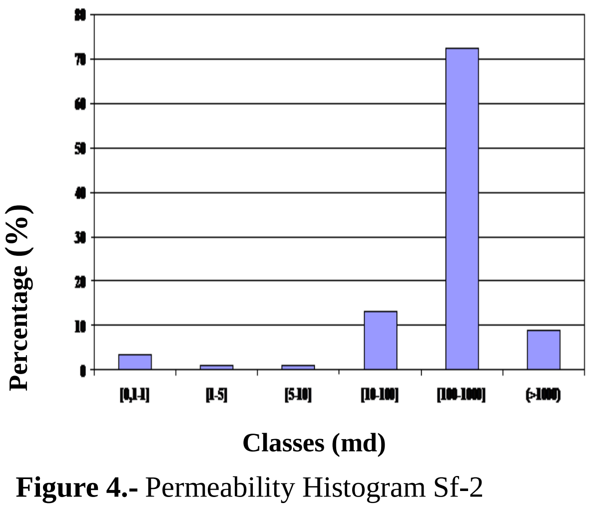

Figure 4.- Permeability Histogram Sf-2

2.1.2.- SF-3 well

The histogram of the porosity classes shows a distribution in progress : the classes of the values oscillating between [15-20].- and [> 20].- are the most dominant. It represents respectively (52.72%) and (36.36%) of the porosity values.

The classes oscillate between [10-15].- represents (9.1%) and those between [5-10].- representing (10.92%.- [0-5].- is absent.

The histogram of the permeability classes shows a unimodal distribution. The permeability class varies between [100-1000].- md. It is the most dominant and represents (78%) of the permeability values of the reservoir. The classes varying between [10-100].- and [> 1000].- occupy respectively (12.73%) and (8.18%). Classes oscillate between [0.1-10].- represent (8.19%).

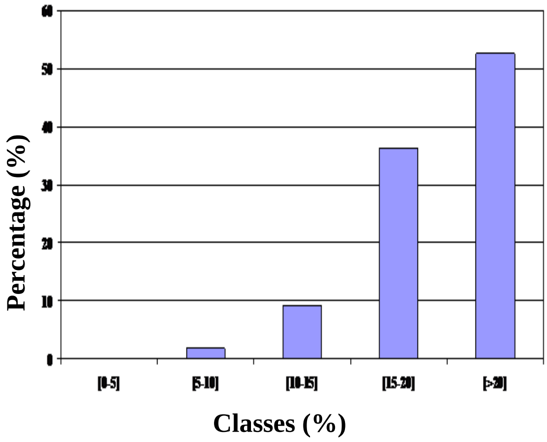

Figure 5.- Porosity Histogram Sf-3

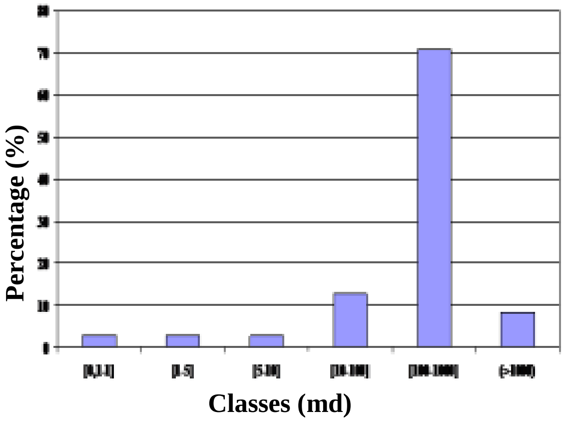

Figure 6.- Permeability Histogram Sf-3

2.1.3.- SF-4 well

The histogram of the porosity classes shows an increasing distribution: classes oscillate between [15-20] and the class higher than 20% is the most dominant (29.6% 43.2% respectively).

The classes varying between [0-5] and [5-10] represents (13.6%) of the reservoir porosity values.

The histogram of permeability shows a unimodal distribution with class dominance oscillate between [100-100].- md. It represents (46.4%) of the permeability values of the reservoir. Classes vary between [10-100] and [> 1000] represents respectively (18.4%) and (21.6%) of the permeability values of the reservoir and the classes oscillate between [0.1-10] represents (13.6%).

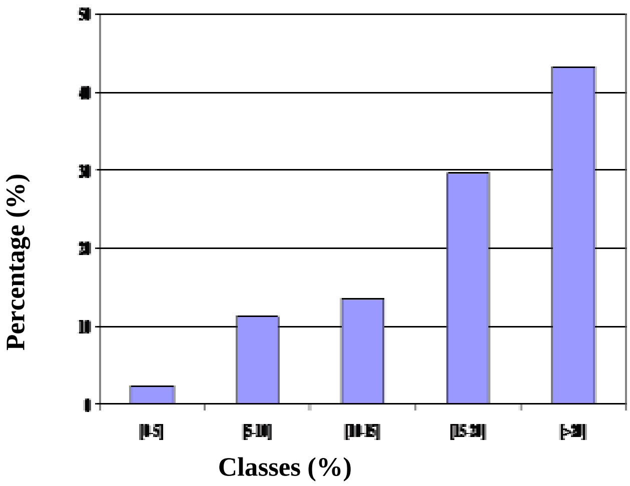

Figure 7.- Porosity Histogram Sf-4

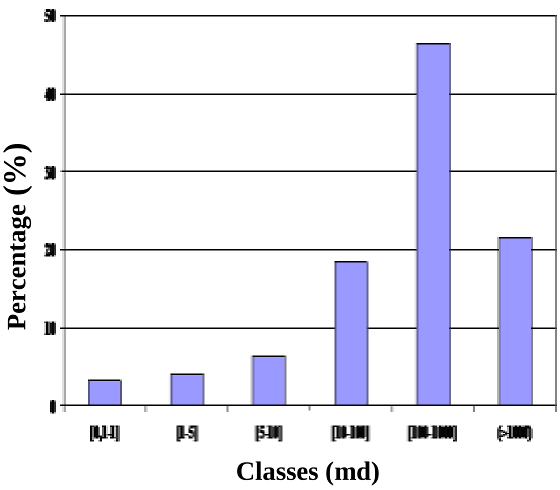

Figure 8.- Permeability Histogram Sf-4

3.2.- Discussion

The interpretation of the histograms that represent the petrophysical characteristics of the Lower Triassic shaly sandstone reservoir shows:

3.2.1.- SF-2 well

It has a very good porosity expressed by the higher values of porosity (more than 20%) representing (52.74%) of all porosity values. Classes which represent the low values of porosity oscillate between [0-10].- represent only (9.9%).

The other classes have an average to good porosity oscillate between [10-20].- correspond to (37.36%) of the reservoir porosity values.

The very good permeability is relevant to the most dominant permeability class that varies between [100-1000].- md and match to (72.52%) of all permeability values recorded.

3.2.2.- SF-3 well

The good Porosity to very good marked by values of porosity classes oscillate of [15-20].- and [> 20].- occupying 89.05% of the total porosity values of in the reservoir. The low porosity values vary of [5-10].- corresponding only to (1.82%).

The very good permeability is due to the highest class with values between [100-1000].- md representing (70.90%) of the reservoir permeability values.

3.2.3.- SF-4 well

The very good porosity as the classes of porosity [> 20%].- and that which oscillate of [15-20].- are the most dominant (72,8%).-. Low values of porosity oscillate of [0-5].- and [5-10].- occupy (13.6%) of the porosity values.

The very good to excellent permeability is for the reason that the values vary of [100-1000].- md and [> 1000].- occupying respectively (46.4%) and (21.6%) of the permeability values of the reservoir.

Classes oscillate of [0.1-1].- and [1-5].- represents the low permeability values occupying only (7.2%) of reservoir permeability values.

Conclusion

Results obtained of reservoir rock characterization based on the petrophysical core measurement of the TAGI in Berkin Basin show that the reservoirs have a good to excellent characteristics with porosity around 18,15% and permeability of 540,10 md.

The variation of the permeability as a function of the porosity in the TAGI reservoir shows a good correlation coefficient through all study well which indicates a strong relationship between the porosity and the permeability.

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