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EVALUATION OF ASMARI RESERVOIR PROPERTIES VIA PETROPHYSICAL LOGS IN MANSOUR-ABAD OIL FIELD, SW OF IRAN

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Abstract

Determining petrophysical parameters and reservoir evaluation has special importance in the oil industry. The precise knowledge of these parameters allows the petroleum engineers to have the tools they need in a given field to study precisely the production stages and, with their knowledge, will be more capable of developing oilfields. In this study, two wells in Asmari reservoir in Mansour Abad oil field has been investigated, and reservoir properties such as porosity, shale volume, and water saturation have been calculated, and the volume of water and oil have been determined. All calculations, cross-plots, and logs diagrams are done via software Geolog version 6.7.1. Studies show that the Asmari Formation in this field has a low average shale volume. On the other hand, Asmari reservoir has good porosity, especially in the upper part (Zone 3), and porosity variations of the field are not high. Also, the use of the M-N plot indicates the prevalence of carbonate lithology. In addition, based on Thorium-Potassium cross-plots, the dominant clay minerals were identified as Illite and mixed layer.

Keywords*:* Porosity; shale volume; water saturation; Asmari formation; Mansour Abad oil field.

1. Introduction

Today, the evaluation of reservoir rocks has special importance in the oil industry [1]. Because of the economic accumulation of oil along with factors such as source rock, oil migration, oil traps, and cap rocks, it is also needed for a suitable reservoir rock. Therefore, identification of potential reservoir rocks and the study and evaluation of their reservoir quality in exploratory basins is necessary [2]. Detailed geological and petrophysical information is needed to study the reservoir rocks accurately. Geological information is obtained from well logs, cores and drilling cuttings and general geological information of the region. The purpose of petro physical research is to study the quality of reservoir in different parts of the formation, zoning the reservoir to determine the most suitable zones for optimal use of the reservoir and more intelligent development of oilfields [3]. Determination of the type of lithology, the rate of total porosity, the rate of effective (useful) porosity, water saturation (S_w) of the formation, hydrocarbons and the calculation of shale amount are the most important parameters that should be determined in petro physical evaluation to realize the quality of the reservoir [4]. The correct estimation of these parameters plays an effective role in reservoir modeling, and the success rate of many exploration, drilling, development and exploitation activities of oil and gas reservoirs depends on the estimation accuracy of these parameters [5]. In the oil industry, reservoir parameters are determined by two common and applied methods of core analysis as a direct method and well logging evaluation as indirect method [6-7]. In this study, via data of petrophysical logs, these objectives are considered in the Asmari Formation.

2. Geological setting

Most Zagros oil fields are stretched anticlines generated as a result of Paleocene, Late Miocene, and Paleo-Pleistocene orogenesis, forming uplift zones of Lurestan in the north and

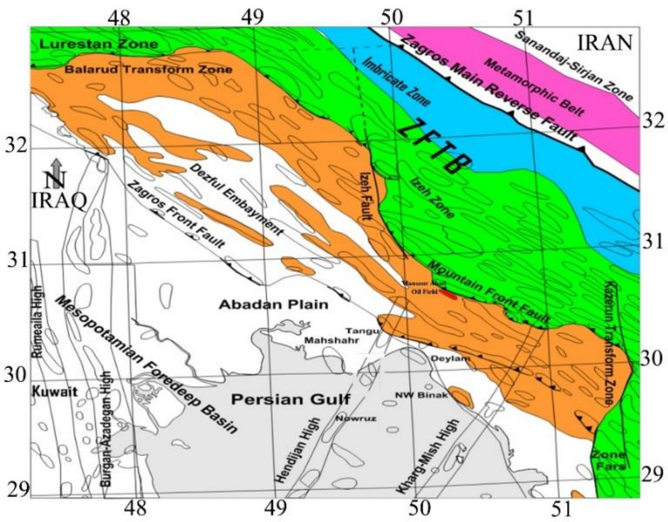

Figure 1. Location of Mansour Abad oil field in Dezful embayment, near the other oil fields, Southwest of Iran

Fars Zone in the South [8]. The Dezful is embayment between these zones, with an area of 60,000 km^2. The Mansour-Abad oil field is located at 10km SE of the Behbahan City and in the Mid of Dezful Embayment basin (Figure 1). The Mansour-Abad oil field is an elongated doubly-plunging anticlinal structure with dimension of 29 km length and 5 km width base in UGC map (Figure 2), and it is considered one of the important productive oil fields in the Oligocene–Lower Miocene carbonate horizons (Asmari Formation) and the Middle Cretaceous carbonate horizons (Sarvak Formation) [9].

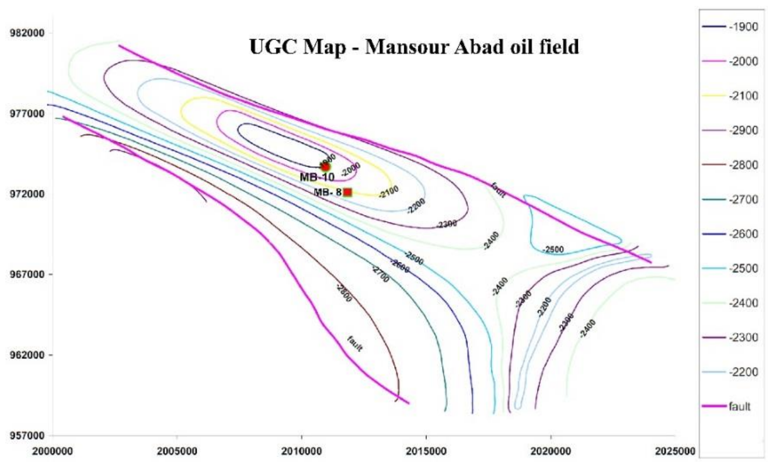

Figure 2. Location of Wells No. 8 and 10 in UGC map of Mansour Abad oil field

3. Methodology

Recognition of lithology, calculation of shale volume (Vsh), total porosity (PHIT), effective porosity (PHIE) and water saturation (S_w), are the most important parameters in the petrophysical evaluation, and these are necessary to determine the quality of the formation [7]. In this study, the raw data from two wells (Wells No.8 and 10) in Mansour Abad oil field Geolog ver. 6.7.1 software has been used to determine reservoir parameters affecting the reservation quality of Asmari formations.

4. Result and discussion

In this study, 2 wells (Wells No. 8 and 10) in Mansour Abad oilfield have been considered for petrophysical studies. These wells have almost complete information and logging data. The most important results of this research are as follows:

4.1. Shale volume calculation

There are various methods for calculating shale volume [10]. In some cases, only a log can be calculated, and in some cases, a combination of two or more logs can be used to calculate shale volume (Table 1). Here, for more accuracy and removal of the effect of uranium, we use the available CGR data to calculate:

$$V_{sh} = \frac{CGR - CGR_{min}}{CGR_{max} - CGR_{min}} \quad (1)$$

Table 1. Shale volume in a different zone of Mansour Abad wells (well No. 8 and 10).

V_{sh} %- Well No.	Zone 1	Zone 2	Zone 3	Zone 4	Average of Shale volume
MA- 8	5.8	5.5	0.1	12.8	6.5
MA- 10	1	1.5	0	28.6	7.77

4.2. Type of clay minerals determination

Shale does not have fixed mineralogy. Among clay minerals, Illite is found more often than other minerals, and chlorite is abundant, while kaolinite is relatively rare [10]. We need a CGR logs to determine the type of clay minerals in different wells, and Thorium-Potassium cross-plots (Th vs. K) is used [11]. As shown in Figures 3 and 4, clay minerals are dominant in both wells:

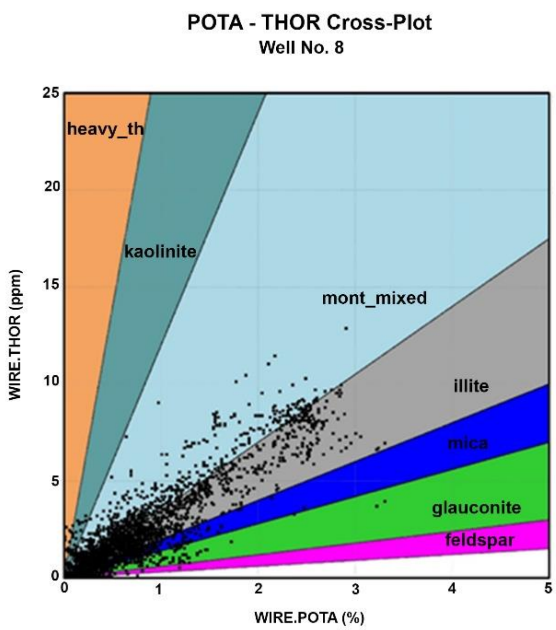

Figure 3. Type of clay minerals determination in well No. 8, Mansour Abad oil field

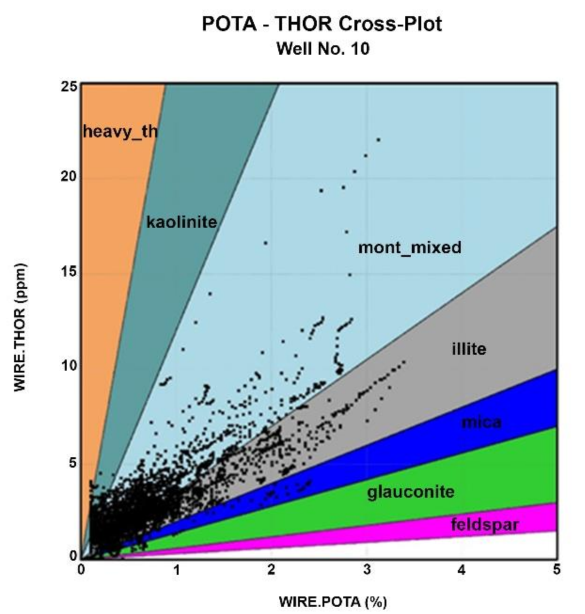

Figure 4. Type of clay minerals determination in well No. 10, Mansour Abad oil field

4.3. Porosity calculation

There are several methods for calculating porosity, depending on the type of logs available in each well. Porosity logs, i.e., neutron-density logs and sonic logs, are used to calculate porosity. Porosity can be obtained from a log or a combination of different logs [12]. In this study, the porosity calculation (Table 2) was performed using the Sonic logs (Equation 2) and the neutron-density logs (Equation 3). Base in Table 2, Zone 3 has a good porosity in this formation.

$$\emptyset_{Sonic} = \frac{DT - DT_{ma}}{DT_{fl} - DT_{ma}} \quad (2)$$

$$\emptyset_{ND} = \sqrt{\frac{{\emptyset_N}^2 + {\emptyset_D}^2}{2}} \quad (3)$$

Table 2. Calculation of porosity in a different zone of Mansour Abad wells (well No. 8 and 10).

Ø % - Well No.	Zone 1	Zone 2	Zone 3	Zone 4	Average of porosity
MA- 8	8.7	10.2	14	10.3	10.80
MA- 10	8.4	10.9	14.5	9.3	10.77

4.4. Lithology detection with M-N Plot

One of the main uses of well logging logs is lithological detection. There are several methods for determining the lithology that their application is dependent on the availability and type of lithological-sensitive logs. There are various cross-plots that combine two or three charts, suggest two or three different mineralogy, one of the most suitable are M-N cross-plots [13].

Considering the complex lithology of Asmari reservoir in the studied field, a combination of different logs can be useful for lithology detection, the best way to use M-N cross-plot. This cross-plot is obtained by combining three neutron, density, and sonic porosity logs. In this graph, the parameter M is the integration of the sonic-density measurement, and the N is the cross-plot slope of the neutron-density. M and N are obtained according to the following equations and are drawn against each other [14].

$$M = \left[\frac{\Delta t_f - \Delta t}{\rho_b - \rho_f}\right] \times 0.01 \quad (4)$$

$$N = \frac{\emptyset_{Nf} - \emptyset_N}{\rho_b - \rho_f} \quad (5)$$

Based on cross-plots drawn from the two wells, and according to the color range of CGR chart, the dominant lithology of carbonate detected (In well 8 and 10, dolomite is more than calcite). Also, well no. 8 shows shales more than well no. 10 (Figure 5 and 6).

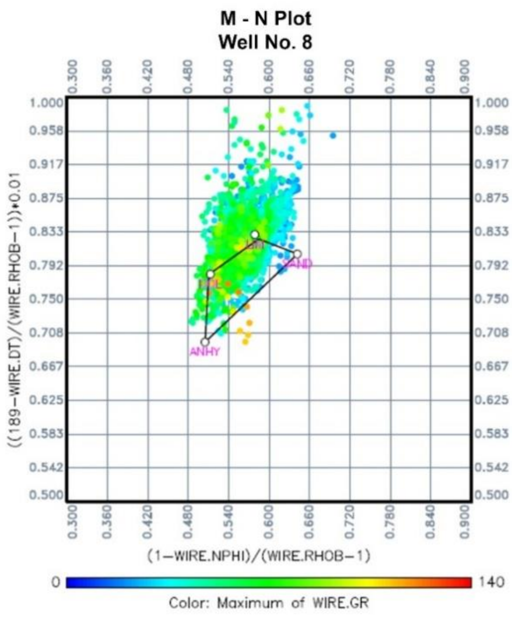

Figure 5. Type of lithology determination in well No. 8, Mansour Abad oil field

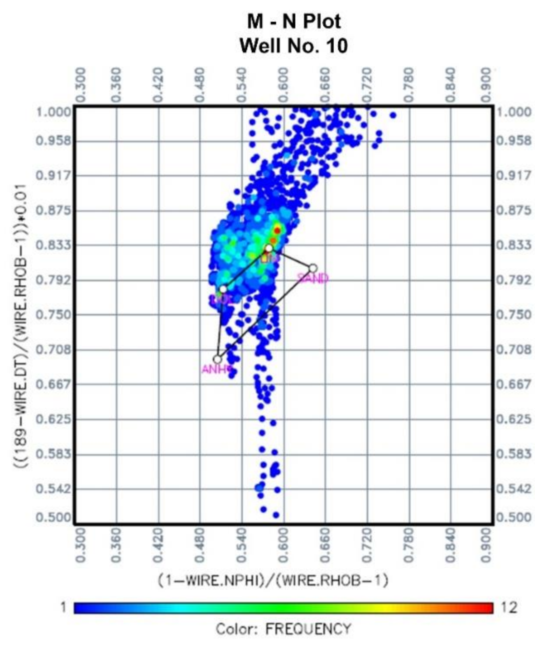

Figure 6. Type of lithology determination in well No. 10, Mansour Abad oil field

4.5. Water saturation calculation

There are different methods to calculate water saturation [15]. Among these methods, the Indonesian equation is more efficient in carbonate rocks. In this study, the Indonesian equation is used as follows [16]:

$$\frac{1}{R_t} = \left[\frac{\emptyset^m}{a \times R_w}^{0.5} + \frac{V_{sh}^{(1-0.5\times V_{sh})}}{R_{sh}^{0.5}}\right]^2 \times S_w^n \quad (6)$$

To enhance the accuracy of formation water saturation calculations, we calculate it by software using Indonesian and Simandoux methods [17]. The volume of water in each well can be obtained in this way as a result of these calculations as shown in Table 3.

Table 3. Average of Water saturation in Mansour Abad wells base on Simandoux and Indonesia method

Sw % - Well No.	SWSIM	SWINDO
MA- 8	0.453	0.450
MA- 10	0.425	0.442

4.6. Asmari reservoir zoning

Based on lithological and petrophysical characteristics, Asmari reservoir is zoned in studied wells (Figure 7):

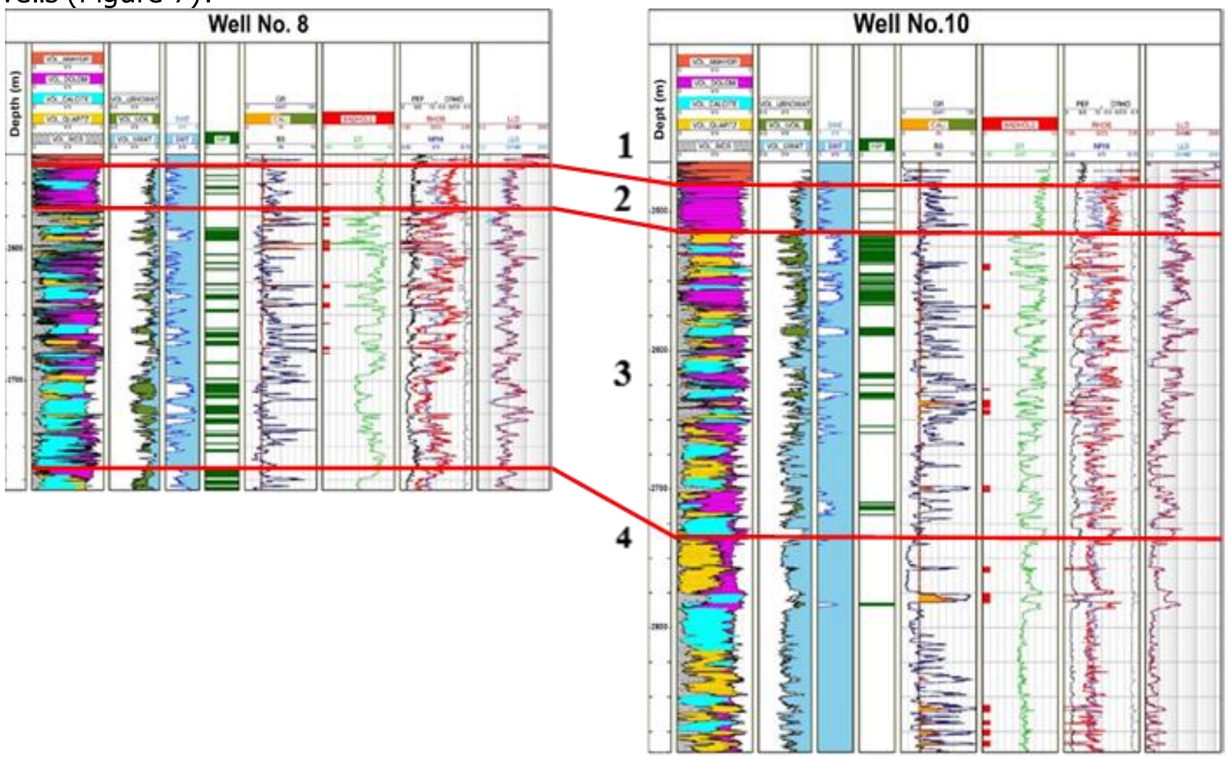

Figure 7. Determination of 4 zone in wells No. 8 and 10, Mansour Abad oil field

4.6.1. Well No.8

In well No.8, the drilled section of Asmari Formation includes 255m layers of carbonate rock. The Asmari formation in this well zoned into 4 zone. Zone 1 (from 2528m-2537m), zone 2 (from 2537m- 2571m), zone 3 (from 2571m-2760m) and zone 4 (from 2760m-2783m). In each of zones, the porosity and water saturation are respectively, 14% and 0.33 (for zone 1), 10.2 and 0.47 (for zone 2), 8.7% and 0.57 (for zone 3) and 10.3 and 0.43 (for zone 4). According to petrophysical calculations, the useful thickness and the effective thickness ratio to total thickness for each zone are 3 and 0.19 (Zone 1), 8 and 0.23 (Zone 2), 37 and 0.33 (Zone 3), 6 and 0.26 (Zone 4).The best zone for reservoir condition in this well is, zone 3.

4.6.2. Well No.10

In well No.10, Asmari Formation is included from 426m layers of carbonate rock. The Asmari formation in this well zoned into 4 zones. Zone 1 (from 2465m-2477m), zone 2 (from 2477m- 2517m), zone 3 (from 2517m-2733m) and zone 4 (from 2733m-2891m). In each of zones, the porosity and water saturation are respectively, 14.5% and 0.35 (for zone 1), 10.9% and 0.44 (for zone 2), 8.4% and 0.51 (for zone 3) and 9.3 and 0.47 (for zone 4). According to petrophysical calculations, the useful thickness and the effective thickness ratio to total thickness for each zone are 3.5 and 0.18 (Zone 1), 8 and 0.2 (Zone 2), 41 and 0.29 (Zone 3), 27 and 0.17 (Zone 4).The best zone for reservoir condition in this well is, zone 3.

5. Conclusion

Based on the analysis of well logs and calculation of petrophysical reservoir parameters, the results are as follows:

- Asmari Formation in this field has a low average shale volume and the upper part of this formation is important in production, the reservoir is made of clean lithology and the amount of shale in the lower parts of the formation is slightly higher. The low amount of shale is probably due to the sedimentation of the formation in an energetic environment.
- Well logs analysis shows that this reservoir has good porosity, especially in the upper part of the formation. Porosity variations are not high at the surface of the field, but due to the low amount of shale, we conclude that most of these porosity are effective. Proper porosity in this field can be affected by sedimentation.
- The lithology of Asmari Formation has been estimated using various methods such as M-N cross-plots. This methods indicate the predominance of carbonate lithology (calcite, dolomite).
- In this study, Indonesian and Simandoux equations have been used to calculate water saturation. Due to the low amount of shale, the values obtained from these equations are very close.
- Based on the thresholds defined for the separation of gross and net sections, the thickness of these segments has been calculated. Due to the amount of low shale and good porosity, almost all of the formation is good reservoir, but due to the amount of water saturation, the thickness of the produced zone varies in wells.
- According to the lithological and petrophysical characteristics of Asmari reservoir in the studied wells, this field is classified into 4 zones, and base in petrophysical parameter, Zone 3, is suitable for reservoir condition.
- Based on thorium-potassium cross-plot, in both wells the dominant clay minerals have been identified as Illite.

References

[1] Darling T. Well Logging and formation evaluation. Gulf Professional Publishing 2005, Elsevier, 326 pages.
[2] Pickett GR. Formation evaluation, unpublished lecture notes. Colorado School of Mines 1974, Golden, Co.
[3] Rider MH. The Geological interpretation of well logs. Blackie, Technology & Engineering 1986, 175 pages.
[4] Shazly TF, Ramadan MAM. 2011, Well logs application in determining the impact of mineral types and proportions on the reservoir performance of Bahariya formation of Bassel-1x well, western desert Egypt. Journal of American Science, 2011; 7(1): 498-505.
[5] Tiab D, Donaldson CE. Petrophysics, theory and practice of measuring reservoir rock and fluid transport properties. Gulf Professional Publishing, Elsevier 2004, Second edition, 926 pages.
[6] Serra O. Fundamentals of well-log interpretation. University of Paris 2009, 487 pages.
[7] Poupon A, Leveaux J. Evaluation of water saturation in shaly formations. trans. SPWLA 12th Annual logging symposium 1971, O1-2.
[8] Aghanabati SA. Geology of Iran. Geological survey and mineral exploration of Iran 2003, p 586.
[9] Motiei H. Geology of Iran. The stratigraphy of Zagros. 5st ed. Tehran1993, Iran: Geological Survey of Iran.
[10] Patchett G. An Investigation of Shale Conductivity, the Log Analyst, 1975; 16(6): 25.
[11] Waxman MH. Smith LJ. Electrical conductivities in oil bearing shaly sands. SPE Journal of Petroleum Technology, 1968; Tans.95-120pp.
[12] Hearst JR, Nelson PH, and Paillet FL. Well Logging for Physical Properties, John Willey and Sons 2000, Ltd., Chilchester.
[13] Rezaee MR. Application of Well Log Analysis, A short Course for N.I.O.C, 1997.
[14] Burke JA, Schmidt AW, and Campbell RL. The Litho/Porosity Cross Plot. Log Analyst, 1969; 10(6): 25.

[15] Archie GE. The electrical resistivity log as an aid in determining some reservoir characteristics, Petroleum Transactions of AIME, 1942; 146: 54–62.
[16] Timu, A. An Investigation of Permeability, Porosity, and Residual Water Saturation Rela-tionships. SPWLA 9th Ann. Log. Symp.1968, Paper J.
[17] Simandoux P. Mesure électriques en milieu poreux, application a mesure des saturations en eau, Etude du Comportment des massifs Argileux. Supplementary Issue, Revue de I'Institut Francais du Petrol. 1963

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