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ARTICLE

AN EVALUATION OF PETROPHYSICAL RESERVOIR ZONE PARAMETERS OF ASMARI FORMATION IN A HYDROCARBONIAL FIELD IN THE WEST SOUTH OF IRAN

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ABSTRACT

Petrophysics is the study of the properties of rocks and their relationship with such fluids as gases, liquid hydrocarbons and the water solution inside. This study intends to investigate the distribution of petrophysical parameters, such as determining the type of porosity, field formation lithology and mineral clay in a hydrocarbonial field of Iran in Asmari formation. The results suggest that there are two main zones of oil reservoir zone and five secondary zones. The first zone (zone 1), in the depth of 3573- 3581, mainly composes of sandstones with an average effective porosity of 25%, low water saturation and high permeability. And the second zone (zone 2), in the depth of 3627. 5 – 3643, mainly composes of sandstone with an average effective porosity of 28%, low water saturation and high permeability. It was also determined that the main clay minerals are mixed clay minerals and Ill it and a composition of clay minerals. The speed rate of primary waves comparing to secondary waves, which are of important parameters in distinguishing layers, is almost 1.8 times of secondary rate, with the most amount of 0. 35 for the Poisson ratio. In the end, elastic impedance has inconstant amounts.

KEY WORDS
Petrophysical Evaluation, Porosity and Permeability, Saturation, Clay Mineral, Lithology

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INTRODUCTION

Petrophysics is the study of rock properties and their interactions with fluids (gases, liquid hydrocarbons and water solutions). The geological elements composing reservoir rock for gathering hydrocarbons must have a three- dimensional net of connected pores to save fluids first and then let them move through the reservoir. Hence, the most fundamental physical properties of reservoir rocks relating to saving and transferring the fluids in reservoirs are porosity and permeability. The thorough knowledge of these two properties for each hydrocarbonic reservoir, and also the knowledge of the properties of fluids, are really influencing for the effective development, planning and predicting the prospective function of oil field [1, 2]. Schematic analysis has been introduced to the oil industry for more than half a century and since then the advanced devices for schematic analysis have been invented and applied. The art of interpreting data also progressed as the science of well- logging moved forward. A schematic analysis program together with core analysis can provide the data needed for making the subsurface structural maps and determine the lithology and the production zone. It can also determine their exact depth and thickness and the distinction between oil and gas. Finally, it makes the reliable quantitative and qualitative interpretation of the properties of reservoir including porosity, permeability and fluid saturation possible. Unfortunately, these petrophysical properties can be measured directly, hence, they must be induced by measuring other parameters of reservoir rocks such as resistance, intensity, sound transit time, radioactive properties and the amount of hydrogen within the rock [3,4]. The aim of this study is to investigate the Petrophysical properties for appropriate diagnosis the economic aspects of this field in Asmari formation. To analyze data, Geolog and Hampson Russell software's were applied.

MATERIALS AND METHODS

Geology of the Area

Asmari formation

The name of the formation has been taken from Asmari Mountain in the east south of Masjedsoleiman, where the sample was taken from. In the past, it was also called Kalhor limestone, Khamir limestone, Jarib limestone and Forat limestone. The place of cutting the sample, in Goltorosh Valley, in the western domain of Asmari mountain, has been formed by 314 meters of resistant beige or brown cement limestone with abundant cracks and gaps in the erosioning surfaces where is between the thin shaly layers. This segment is the age of Miocene formation and the subsections are changed into Pabdeh formation. The under and upper barriers have the same slope as Pabdeh and Gachsaran formation. Asmari limestone is the most important reservoir rock in the sediment basin in Iran and since oil has been discovered there for the first time in Middle East, it is world- known. A well, in an almost good oil field can give an average of about 25000 barrel a day. There is Asmari limestone throughout the Zagros area. The lower sections of Asmari formation has changed into Pabdeh facieses around Bandar Abbas (Abbas port) but it didn't exist in the eastern parts of Ghesh Island in Holoor well, while it exists the island center in Gorzin anticline. Asmari formation is divided into three sections of lower, middle and upper sections based on fossils and its age. The age of the lower Asmari is Oligocene and the age of the middle Asmari and the upper Asmari is the Miocene of the lower. Generally, the age of a formation is Oligocene to fore Miocene. Asmaro formation includes Ahvaz and Kalhor [5, 6, 7].

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The characteristics of the study area

The above mentioned hydrocarnonical field is one of the southwest oil fields of Iran. This field covers an anticline with the length of 67 square kilometers and the width of 6 square kilometers. This field which spreads from west north to east south (parallel to Zagros Mountain) forms two separate anticlines (saddle-shaped) in Asmarian horizon. Asmari formation, in the oil field of Ahvaz, in the south of Dezfool, includes the sandstone section of Ahvaz. Asmari reservoir, part of which is sandstone, forms the main reservoir which covers about three fourth of the reservoir of this field. Another stone reservoir of this field is Sarvak formation. The oil API degree in Asmari and Sarvak are 32.6 and 26 API degrees, respectively. Asmari brimstone weighs 1.5 percent and Sarvak brimstone weighs 3.5 percent. Hydrocarbon has also been found in Khami group, however, nothing has been done for description and revival of this horizon and the amount of its reservation is not determined [7, 8, 9].

Fig.1: The schema of the study oil field.

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In this paper are discussed about the zones reservoir using logs and petrophysical properties and related charts. In continue showed the results.

RESULTS

To determine lithology, the type of clay mineral, total and effective porosity and the hydrocarbonical reservoir zone, Petrophysical logs were applied in this study. Petrophysical logs, specially density logs, neutron and sonic were applied to determine the lithology. Regarding the lithology column and the depicted logs, lithology mainly includes: in upper sections as deep as 3561 to 3565 meters mainly encompass Dolomite with a little Shale and Limestone, in depths of 3535 to 3568 mainly Calcarnite with a little Calcite and Shale, in depths of 3568 to 3571 mainly Calcite with a little Dolomite and clay minerals, in depths of 3571 to 3573.5 mainly Shale and clay minerals, in the depths of 3581 to 3573.5 mainly Sandstone and a little Calcite, the depths of 3581 to 3591 mainly Limestone, Marl Limestone and Dolomite Limestone, depths of 3591 to 3593.5 Shale and clay minerals, the depths of 3593.5 to 3608 mainly Limestone and Marl Limestone, the depths of 3608 to 3620 mainly Sandstone with a little Calcite, the depths of 3620 to 3624 mainly Shale and clay minerals, the depths of 3624 to 3627.5 mainly Limestone and Dolomite lime, the depths of 3627.5 to 3643 mainly Sandstone with little Calcite and the depths of 3643 to 3644 mainly Shale and clay minerals.

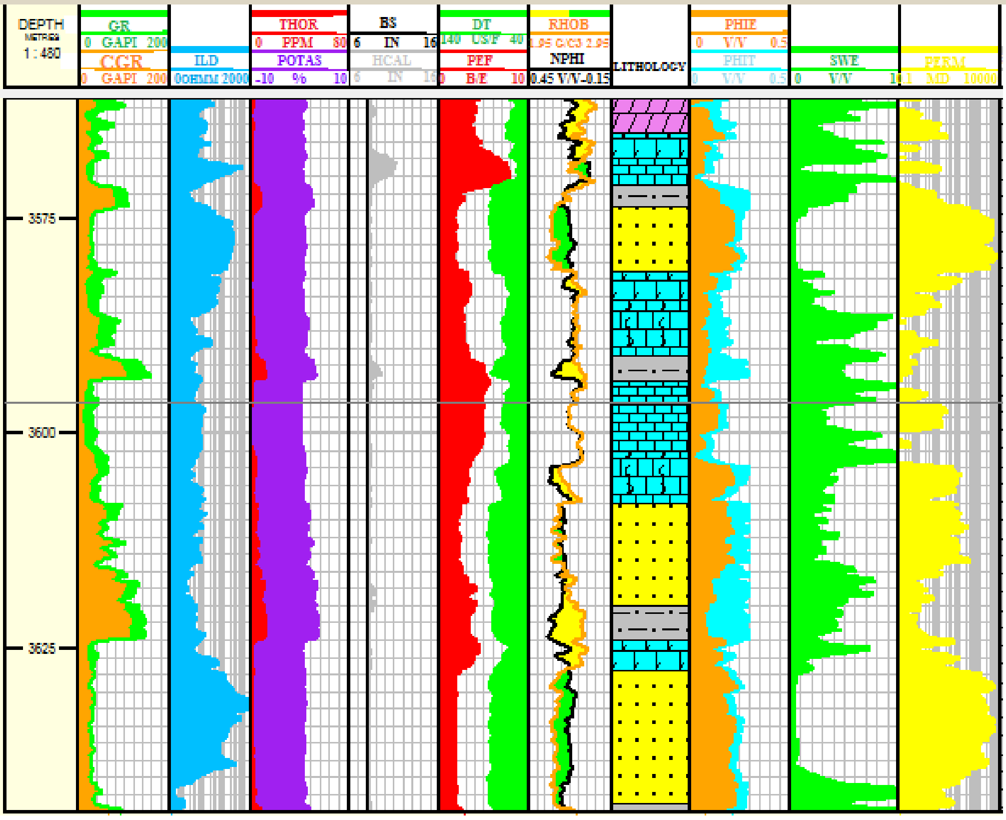

Fig. 2: Diagrams for lithology and permeability diagnosis.

In [Fig. 3] 'A', intensity- sonic crossplot, and in [Fig. 2] 'B' neutron- intensity crossplot has been depicted for lithology diagnosis.

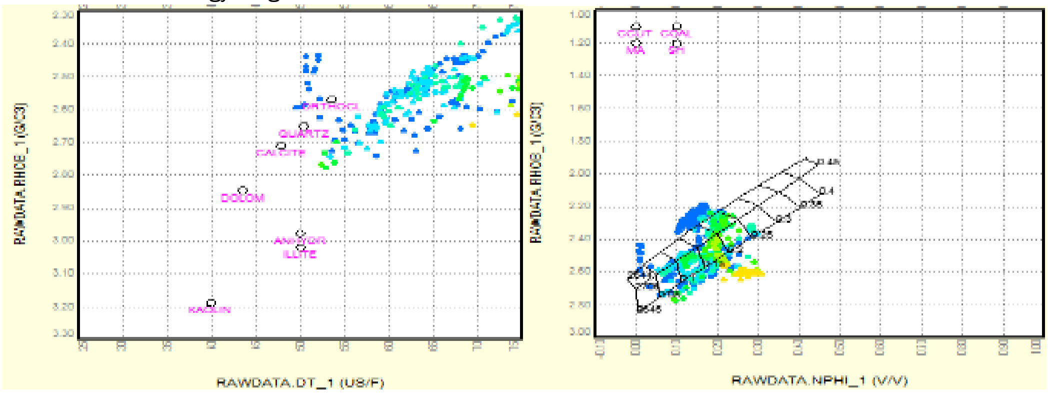

Fig. 3: Well- logging crossplots: A) drawing neutron- intensity crossplot (the right figure), B) sonic- intensity crossplot (the left figure), to determine lithology [10,11,12.13.14].

In continue, total porosity logs and effective porosity are drawn in [Fig. 2]. The most porosity was observed in sandstone layer in the depth of 3571.5 to 3581 with a total porosity of 35% and effective porosity of 30% and in the depth of 3608 to 3616 with a total porosity of 35% and effective porosity of 15% and the depth of 3627.5 to 3643 with a total porosity of 34% and effective porosity of 28%, as the main zones and the depth of 3561 to 3570 with a total porosity of 25% and effective porosity of 15% and the depth of 3581 to 3591 with a total porosity of 30% and effective porosity of 15% and the depth of 3593 to 3608 with a total porosity of 28% and effective porosity of 13% and the depth of 3624 to 3627.5 with a total porosity of 30% and effective porosity of 14%. The frequency chart for effective frequency and frequency porosity based on depth are depicted in [Fig. 3].

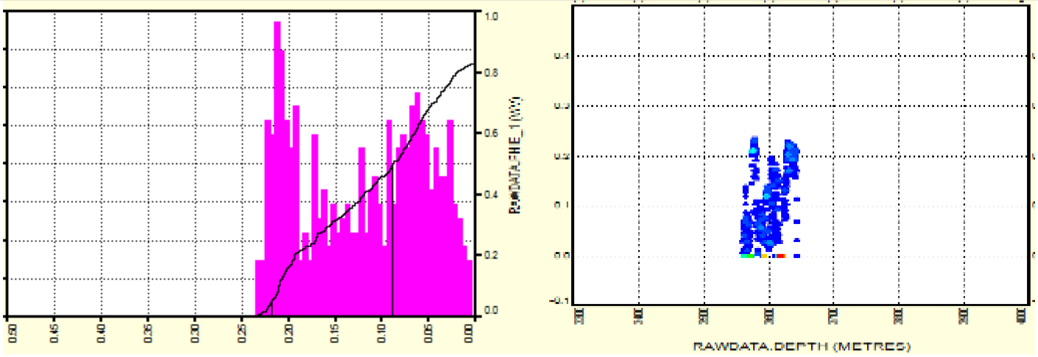

Fig. 4: Changes A) effective porosity based on depth (the left figure) B) effective porosity frequency chart (the right figure).

Realizing the effective porosity and the lithology of different zones, it can be claimed that Sandstone zones are the main hydrocarbonical zones. The two Sandstone zones in the depth of 3571.5 to 3581 and 3527.5 to 3643, the resistivity chart also shows a high amount, and also have a high amount of effective porosity30% and 28%, respectively in the above mentioned zones and low water saturation and high permeability can specially be introduced as the oil zone. Among the secondary and rather important zones are the Limestone zone and the Dolomite Limestone zone in the depth of 3624 to 3627.5 with an effective porosity of 15% and the Limestone and Marl Limestone zone in the depth of 3602 to 3607 with an effective porosity of 14% and Sandstone zone in the depth of 3607 to 3616 with an effective porosity of 13%. Considering the diameter logs and the bit size, the depth of 3567 to 3581 shows the slide of the formation. In continue, using the amount of thorium (brown log) and potassium (green log), the type of clay mineral has been investigated. Looking at the amounts of logs and the clay mineral chart, there is more Illite and a composition of clay layers in reservoir zone. In [Fig. 5], the charts for the changes in the amounts of potassium and thorium based on the depth, and in [Fig. 6] the chart for the diagnosis of clay mineral, based on which, and considering the amount of potassium and thorium on logs, the type of the clay mineral has been determined, are shown [16,17,18].

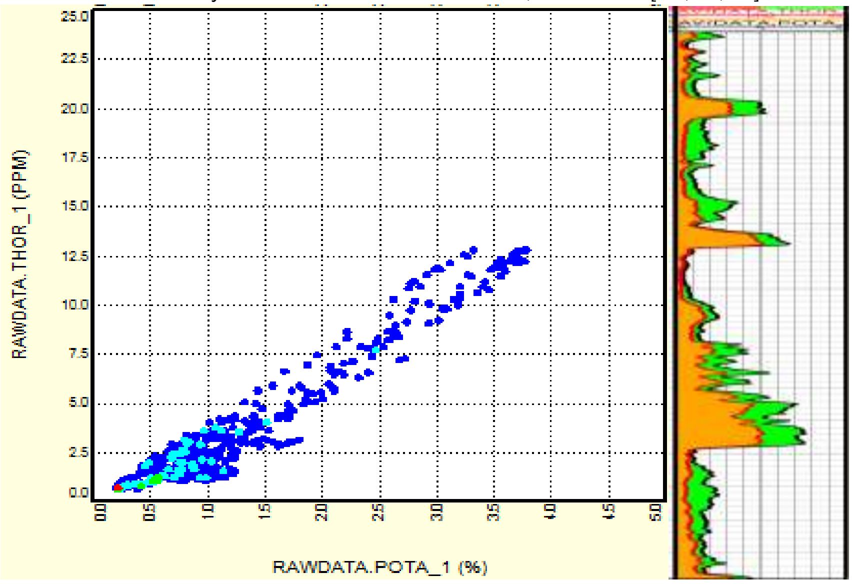

Fig. 5: A) dispersal chart for thorium versus potassium (the left figure), B) thorium and potassium logs (the right figure).

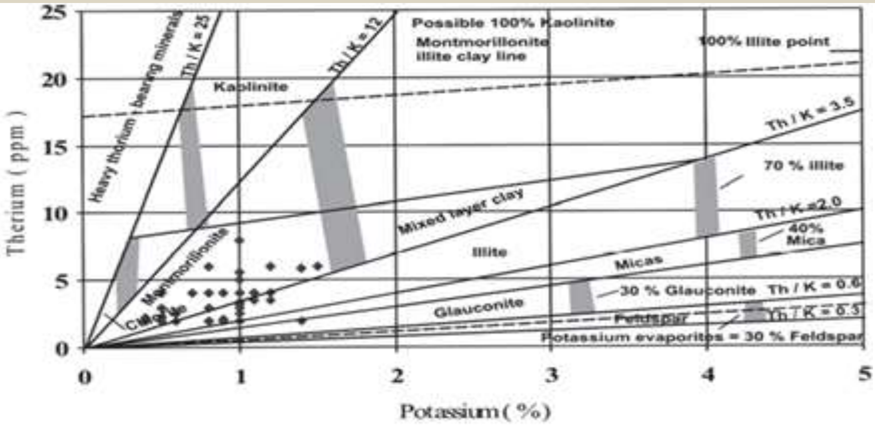

Fig. 6: Clay mineral diagnosis chart [14,19].

[Fig. 7], which is GR chart versus ILD, displays some parts which can be indicative of the intended reservoir. The parts with low GR and high ILD resistance can display the characteristics of a good reservoir [14, 15, 21].

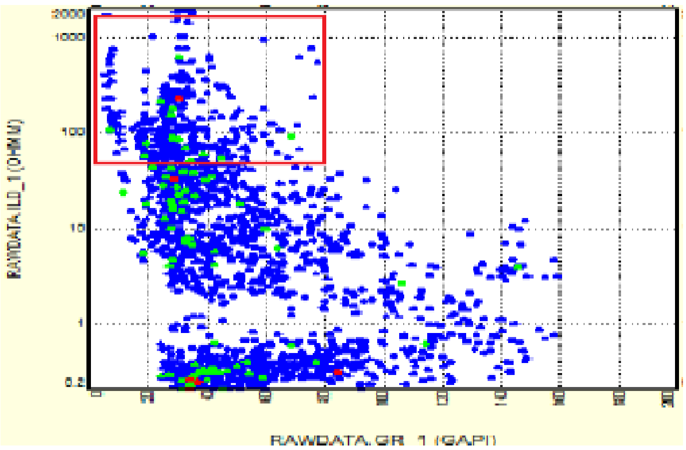

Fig. 7: GR chart versus ILD.

In the continue, the speed logs for the primary waves applying the reverse Grander equation, and the speed of the secondary waves using Castagna equation, the log for the ratio of the speed of primary waves (Vp) to the speed of the speed of the secondary waves (Vs) are calculated using the following relations [9,20]. The resulted logs are displayed in [Fig. 8].

The relation between the speed of primary waves applying the reverse Grander equation: P-wave=C_1*$Density^4$, which C1=0.23.
The relation between the speed of primary waves applying the Castagna equation:
S-wave=C_1* P-wave+C_2 C1=0.86, C2= -3845.14

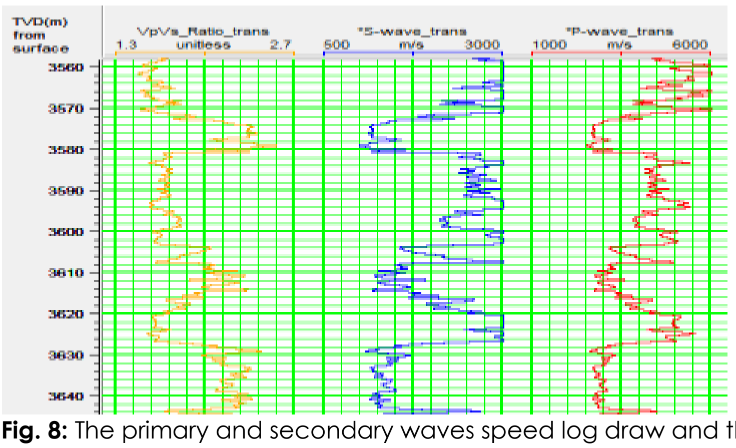

Fig. 8: The primary and secondary waves speed log draw and their ratio.

In the following, applying natural gamma log, Poisson coefficient log is drawn in which the following relation has been used [3,21,22]:

Poisson log= [(gamma ray-sand baseline)/ (shale baseline- sand baseline)]* (Poisson shale value- Poisson sand value) + Poisson sand value

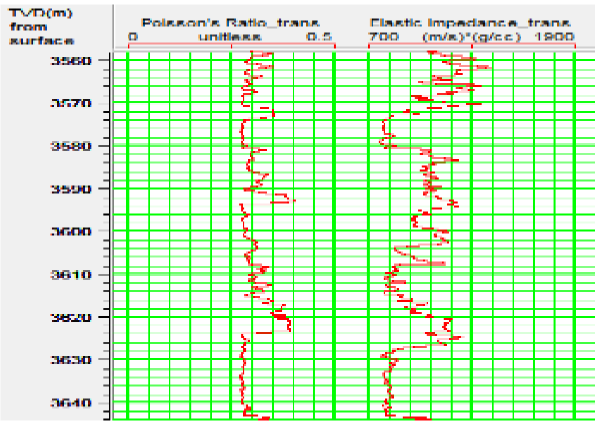

Fig. 9: Poisson Coefficient Log Draw and Elastic Impedance.

CONCLUSION

Applying the sonic, neutron and natural gained gamma logs and its corrected logs, and also considering the sonic- intensity and intensity – neutron well logging crossplots, the hydrocarbonical reservoir of the well was investigated. The studied hydrocarbonical field in Asmari formation was divided into two main reservoir zones and 5 secondary zones. Zone (1) in the depth of 3571.5 to 3581 was mainly Sandstone with an average effective porosity of 30%, the other zone in the depth of 3627.5 to 3643 was mainly Sandstone with an average effective porosity of 28%. Limestone and Dolomite lime zones in the depth of 3624 to 3627.5 with the effective porosity of 15% and Limestone and Marl Limestone with the effective porosity of 3602 to 3607 with the effective porosity of 14%, and the Sandstone zone in the depth of 3607 to 3616 with the effective porosity of 13% can be mentioned as some important secondary zones. In the next stage, applying potassium and thorium logs and investigating the related crossplots the type of the clay minerals, which was mainly a composition of clay minerals and Illite and an amount of a composition of clay minerals was determined. Next, the speed of the primary waves using the reverse Grander equation, and the speed of the secondary waves using Castanga equation and their ratio which were among the important parameters for distinguishing layers were calculated. The primary speed was almost 1.8 times of the secondary speed and Poison ratio gives different amounts for each layer with the most amount of 0.35. Finally, the elastic impedance was drawn to determine the reflex coefficient of the layers which gave different amounts.

CONFLICT OF INTEREST

The author declares having no competing interests.

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FINANCIAL DISCLOSURE

None.

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