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DETERMINATION OF DIFFERENT LITHOLOGY COMMUNITIES IN ASMARI RESERVOIR VIA PETROPHYSICAL DATA AND STATISTICAL ANALYSIS, MANSURI OIL FIELD, SW OF IRAN

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Abstract

Determining reservoir parameters has special importance in the formation evaluation. The main aim of this study focuses on the lithological zoning of Asmari formation in Dezful embayment Mansuri oil field via statistical analysis of petrophysical data. For this purpose, histograms of different parameters, including velocity ratio of compressional to shear waves (V_P and V_S), transit time of compressional wave, density, and neutron porosity have been plotted for 4 wells in this aria. Then, according to different range of petrophysical parameters, in each histogram, different lithological were separated. Results of comparing different histograms provided valuable information about Lithological zoning based on these parameters. The ratio of pressure wave to cutting (Vp/Vs) can be used as a key factor in diagnosing some important characteristics of reservoir such as lithology. Considering the histogram chart, Shale, sandstone, anhydrite, carbonated and evaporation was identification. Base on this study, in this histogram the calcite community has overlapped with anhydrate and the dolomite community with quartz.

***Keywords**: Lithology; Asmari Reservoir; Velocity ratio of sonic waves; Mansuri oil field.*

1. Introduction

In a petrophysics study, usually a set of well logging such as density, neutron, GR, velocity and so on is provided [1]. In fact, these well loggings are the main origin of information about the other buried characteristics in the heart of the well that are analyzed by different instruments to obtain the aims [2]. In the studies of hydrocarbon reservoirs, determining different geological, geophysical and geomechanical parameters are of great importance. The registered physical parameters by well logging give valuable information to oil engineers and geologists in this field [3]. One of the most important challenges of developing hydrocarbon oil fields is determining the combination of rocks [4]. The importance of lithology recognition according to its effects on petrophysical parameters, the probability of hydrocarbon existence, drilling and well stability can be understood [5]. In general, lithology recognition is done in two ways; direct (coring) and indirect (logging) [4]. On the one hand, gaining information by coring is very difficult and expensive, and on the other hand there are problems such as mechanical zone un-instability of reservoir and the lack of possibility of simulation of reservoir situations in lab-coring that makes logging inevitable [6]. There are several porosity systems that allow heterogeneous Petrophysical properties in the carbonate reservoir rocks [7]. Hence, the relative percentage and type of pores and their distributions are strongly effective in producing indexes and carbonate reservoirs simulation [7]. In this study, the lithology recognition is done by logging interpretations and the information available there. For this purpose, different methods have represented that cover a range of conventional methods to modern methods.

The aim of this essay is classification and separation of different parts of lithology according to the physical changes of characteristics based on classical methods of statistics science and combining statistical information with geological classifications. In this study, little differences

existing among geological formations, which is only possible by coring experimentation according to the logging changes properties, and determining statistical community on the basis of geological parts is clearly visible.

2. Mansuri oil field

Mansuri oil field is located North of the Dezful Embayment and in the middle part of this structural zone along the AB-Teymur anticline (Fig. 1). This large oil field was discovered by a two-dimensional seismic method in 1963 and is made up of two oil reservoirs (Asmari, Bangestan) and that our study was done on Asmari reservoir. The Asmari reservoir of Mansuri oil field is one of the Iranian carbonated tertiary [8] reservoirs (Fig. 2) that has been located 50Km from southeast of Ahwaz [9]. The geographic location of this field is limited to Ahvaz oil field from the northwest, AB-Teymur field from the west, Shadegan oil fields from the northeast. This reservoir has been divided in to eight zones that each zone possesses its own special lithology and petrophysical characteristics [10]. Considering that in Asmari reservoir of Mansuri oil field there are every three main lithologies of reservoirs (sandstone, limestone, and dolomite). The study of lithology and its effect on petrophysical parameters of reservoirs is of great importance [11].

The structure of Mansuri oil field is an anticline with low width and longitudinal with northwest- southeast direction in western and central parts and northeast-southwest direction in eastern end, with very distinct torsion in the middle of structure that has given to quadrilateral mode to the north direction [9].

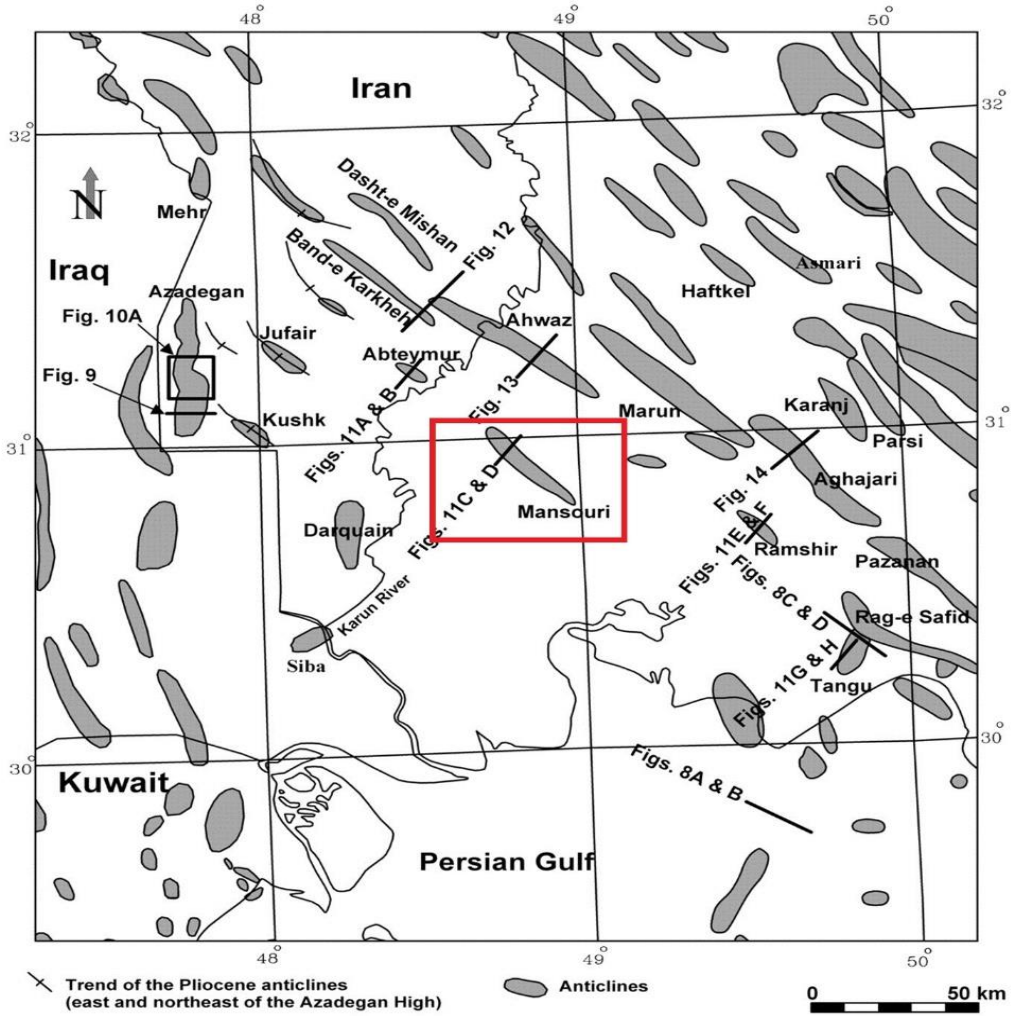

Figure 1. Location of oil fields in southwest of Iran and Mansuri oil field ([12])

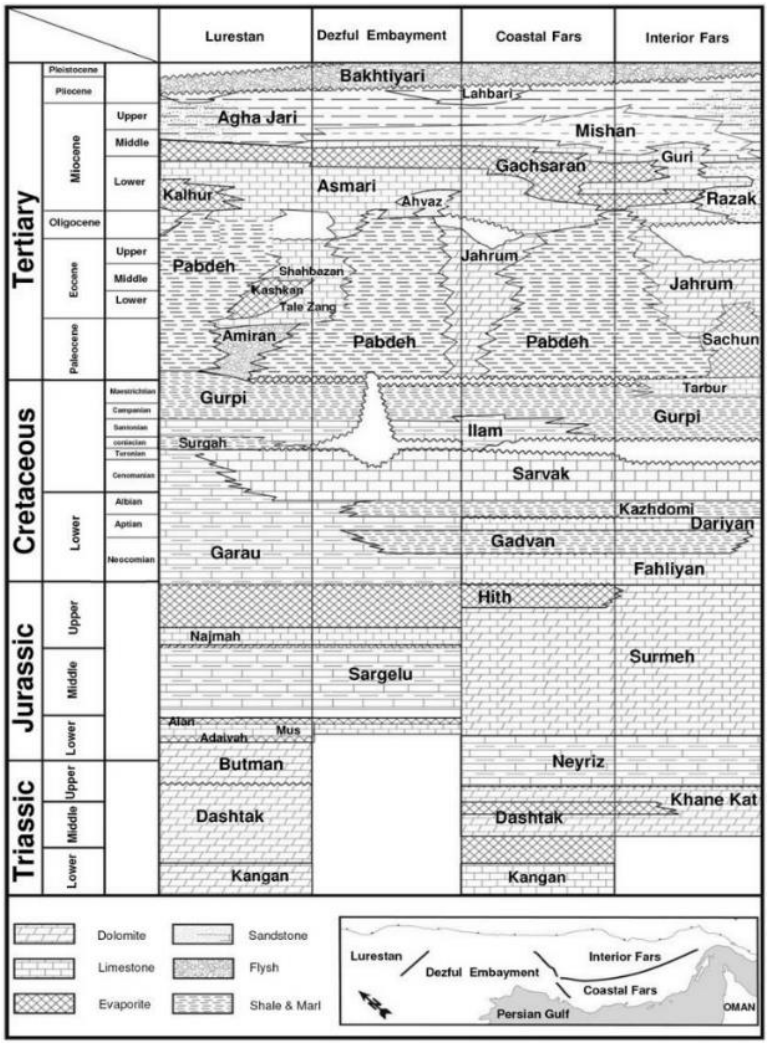

Figure 2. Stratigraphic nomenclature of rock units and age relationships in the Zagros basin ([13])

In this study, the petrophysical data from 2 wells of the Asmari reservoir are available. These wells have almost complete information and logging data.

In these wells, density, neutron porosity, and the velocity waves and also lithology from well logging have been registered. The data of these wells belong to the zones (1, 2, and 3) of Asmari formation and mainly include reservoir zone and therefore containing oil. Thus separating lithology and specially sandstone zones from carbonated ones will be of high importance [12]. In this study, the raw data of Asmari formation was evaluated via Geolog software ver.6.7.1, and petrophysical parameter such as lithology was investigated.

3. Results and discussion

In well logging with consideration to the well situation, some appropriate physical parameters are chosen for surveying the geological layers. Among them, the ratio of pressure wave to cutting (Vp/Vs) can be used as a key factor in diagnosing some important characteristics of reservoir such as lithology [14]. In order to distinguish lithology, this ratio is calculated in wells (Fig. 3). Based on cross-plots (DT/RHOB-NPHI/RHOB) chart, and according to the color range of GR, the dominant lithology of sandstone detected (sandstone>calcite>dolomite>anhydrite) (Fig. 4).

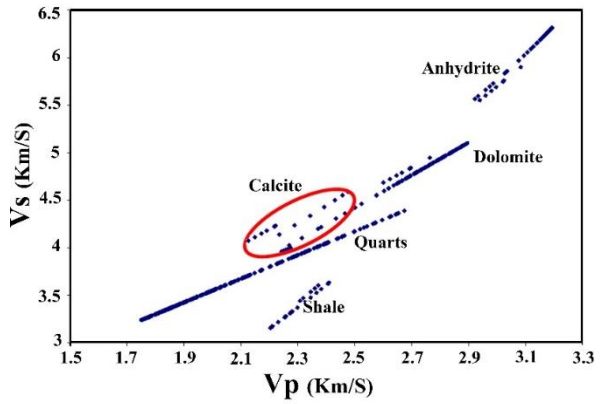

Figure 3. Dispersion diagram of the ratio of Vp/Vs in well logging data of Mansuri oil field

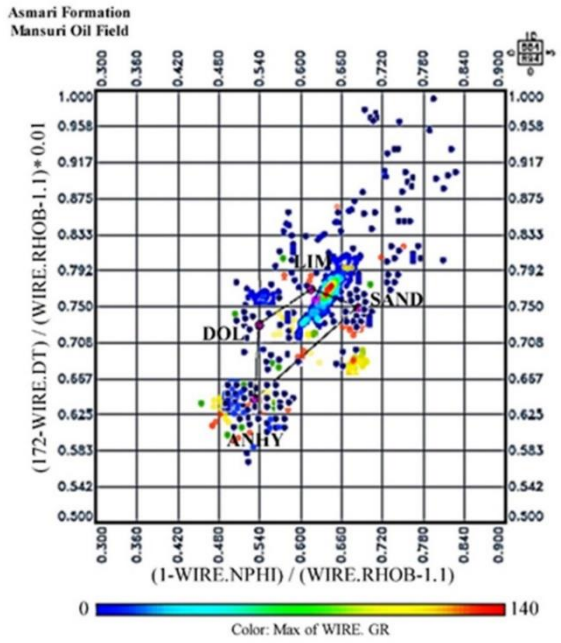

Figure 4. Lithological detection base in M-N Plot in Mansuri oil field

In general, for recognizing each community, we need some data. Data is the most important instrument for calculating the frequency distribution. Drawing histogram is the first process of surveying the form of the frequency distribution of a community from data. The classical statistic is a branch of statistics that studies the quantity distribution in one or some communities without considering their space situations to each other. In the first step, for separating different communities of Lithology, the dispersion diagram of pressure wave speed to cutting was used (Fig. 3).

Evaporate, carbonated, and sandstone communities, according to the diagram slope are visible respectively. With more surveys of other wells, the fourth community was observed (red ellipse in picture one), which was neither separable from other communities nor could be relinquished. In continuation of obtaining the goal by using ArcGIS-9.3 software, the histogram of sonic waves was drawn. In the next process, by exerting the related intervals of different lithologies, their related communities were separated in this histogram. Relating communities of sandstone and Anhydrite were easily separable (Fig. 5), while the carbonated rock community itself contains two dolomite and calcite communities. In Figure 6, carbonated rock is separated into two dolomite and calcite communities. Therefore, according to pictures 5 and 6, we can easily see five statistical Shale, sandstone, dolomite, calcite, and anhydrate communities.

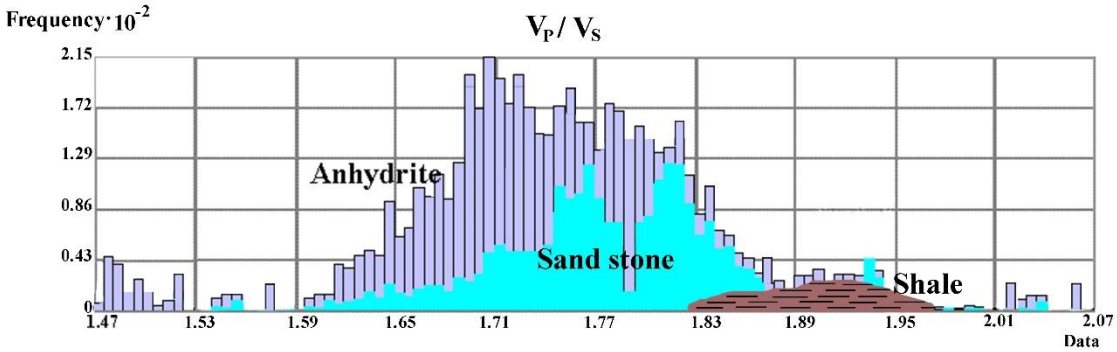

Figure 5. Histogram of V_P/V_S for separation of Sand stone-Anhydrite- Shale lithologies in the Mansuri oil field

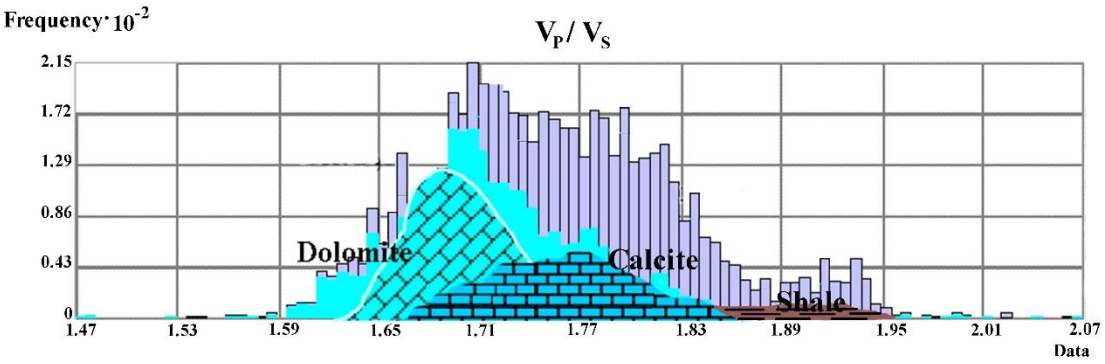

Figure 6. Histogram of VP/VS for separation of Calcite-Dolomite lithologies in the Mansuri oil field

For inquiring the accuracy of the gained conclusions, similar activities were done for other petrophysical data. For this purpose, the histogram of density data, porosity, and time- passing pressure waves were drawn, and different lithology communities were shown on the histogram (Fig.6). The histogram in Figure (7) shows the separation of Asmari reservoir lithologies, and the border of these communities' separation is represented in Table 1.

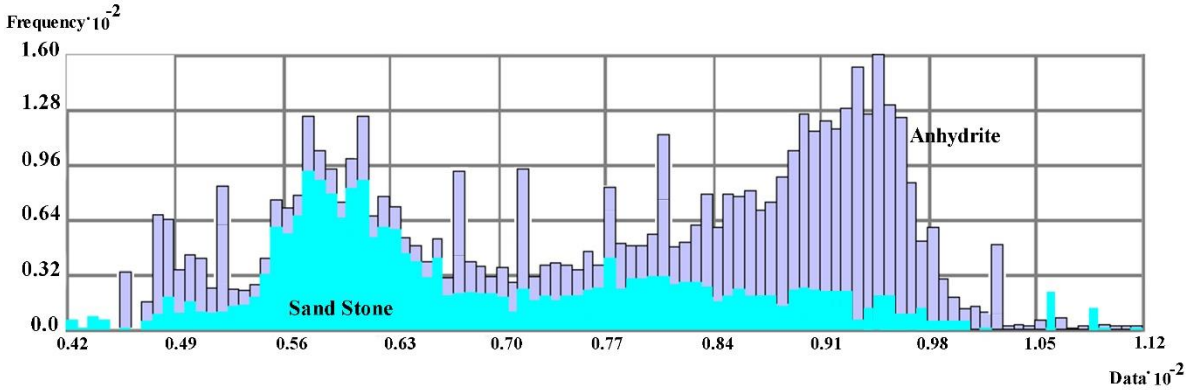

Figure 7. Histogram of time of the compression wave for separation of different lithologies in Mansuri oil field

The diagram (Fig. 8) shows the histogram of the frequency density of Logging data. Considering this histogram at the first look, the zones of fore Shale, sandstone, carbonated, and evaporation communities are seen. According to the above conclusions, the separation border of these zones have been changed in the histogram and was shown in table 1.

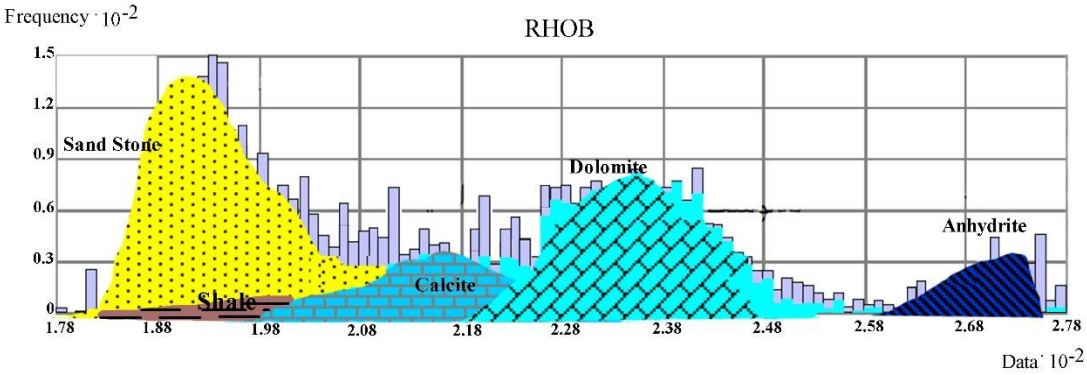

Figure 8. Density histogram for separation of different lithologies in the Mansuri oil field

In Figure 9, for drawing the porosity histogram and normalize data, for the reason of dispersion and rupture, COX- BOX conversion of 0.25 parameter has been used and the conclusion has been represented in Figure 8 and Table.1, it is necessary to mention that in this

histogram the calcite community has overlapping with Anhydrate and the dolomite community with quartz.

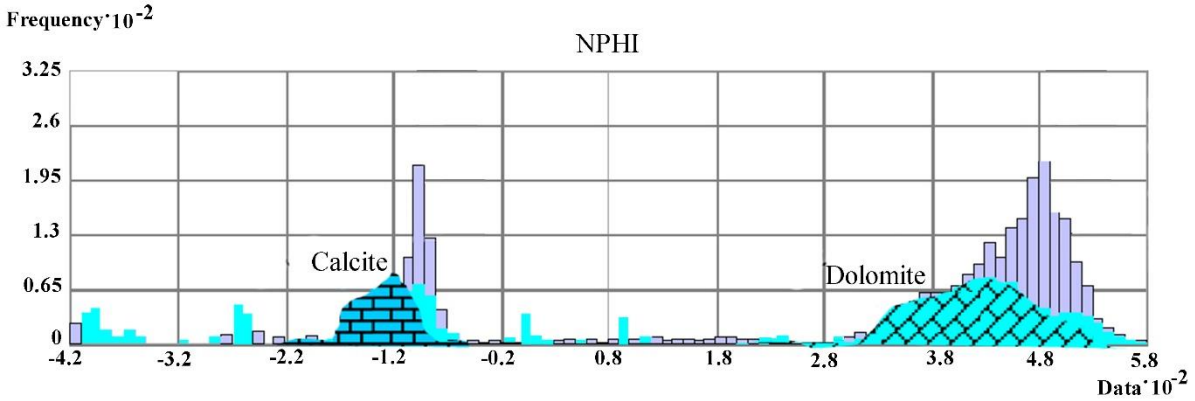

Figure 9. Neutron histogram for separation of different lithologies in the Mansuri oil field

Table 1. Separation intervals of different lithology communities based on petrophysical parameters

	RHOB	NPHI	Dtc.	Vp/Vs
Quarts	1.99-2.33	10-37	83-120	1.7-1.9
Dolomite	2.39-2.73	8-40	53-75	1.65-1.8
Calcite	2.19-2.5	0.13-0.33	72-100	1.7-1.9
Anhydrite	2.78-2.96	0.17-0.29	45-60	1.9-2
Shale	1.9-2.65	18-40	85-110	1.6-1.85

In well No.93, the drilled section of Asmari Formation includes about 275m layers of detrital, carbonate, and evaporate rocks (Fig. 10). To determine of lithology, petrophysical logs such as DT (acoustic log), NPHI (neutron porosity), PEF (photoelectric factor), RHOB (density porosity), Caliper, RT (Resistivity) were used. The dominant lithology detected by the PEF graph. Main type of lithology determined by petrophysical logs showed that Sandstone is dominant constituent.

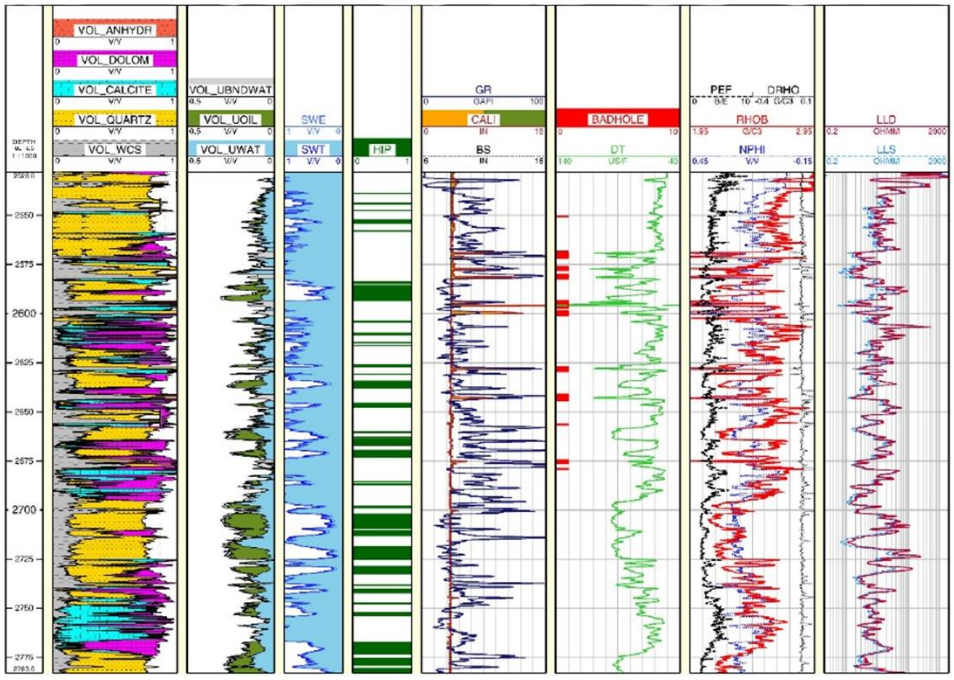

Figure 10. Lithological column and well logs parameter with petrophysical details of Asmari formation in well No.93, Mansuri oil field

4. Conclusion

With the help of statistical techniques and the combination of histogram data and using ArcGIS software, we can separate the statistical communities in a better way. As it is observed, for physical parameters, the ratio of pressure wave speed to cutting (Vp/Vs), the time-passing pressure wave (Dtc), density (RHOB), and porosity (NPHI), we can determine specific border figures for separation of different lithologies. By determining appropriate intervals, we can better separate the different combined statistical communities (different lithologies). These border figures have been got with trial and error and also with precision in each parameter histogram and necessarily not final. By using the ratio of the speed of sonic waves, the gained conclusions of these activities can be affirmed. In the end, by using the loggings of existing lithology, the credit of obtained conclusions for these wells has been compared, and the accuracy of this method was sealed.

References

[1] Anselmetti FS, and Eberli GP. Sonic velocity in carbonate sediments and rocks. In book Carbonate seismology, Soc. Explor. Geophys, 1997; 53 – 74. ISBN 978-1-56080-038-5.

[2] Durrast H, and Siegesmund S. Correlation between rock fabrics and physical properties of carbonate reservoir rocks. Int. J. Earth Sci., 1999; 88: 392-408.

[3] Flavio SA, Gregor PE. The velocity-deviation log A tool to predict pore type and permeability tend in carbonate drill holes from sonic and porosity or density logs. Am. Assoc. pet. Geol. Bull., 1999; 83(3): 450-466.

[4] Lucia FJ. Petrophysical parameters estimated from visual descriptions of carbonate rocks: a field classification of carbonate pore space, Journal of Petroleum technology, 1983; 35(3): 626-637.

[5] Tiab D, and Donaldson EC. Petrophysics theory and practice of measuring reservoir rock and fluid transport properties. Gulf Publishing Company Houston 2004, Texas, p.889.

[6] Rezaee R, Saeedi A, Clennell B. Tight gas sands permeability estimation from mercury injection capillary pressure and nuclear magnetic resonance data. 2012; 88-89: 92-99.

[7] Gholami Zadeh P, Adabi MH. Porosity Evolution in Carbonate Reservoir Rock of Sarvak Formation, Zagros Basin. Iran, 1 st International Applied Geological Congress, Department of Geology, Islamic Azad University-Mashad Branch 2010, Iran, 1915-1920.

[8] Tabatabaei H, Motamed A, Solimani B, Kamali MR. Geochemistry of Gurpi-Pabdeh-Asmari formations and its implication on chemical variation during deposition of Pabdeh Formation, Zagros Basin. Himalayan Geology, 2012; 33(2): 126-138.

[9] Noorian Y, Moussavi- Harami R, Mahboubi A, Abdollahi-Moussavi AA. Evaluation of Reservoir Characterization in the Framework of electrofacies: a case study from the Bangestan reservoir in the Mansuri oilfield, SW of Iran. Geosciences Journal, 2017; 21(5): 713-727.

[10] Kaviyani Nezhad H, and Tabatabaei H. Simulation of petrophysical parameters of Asmari reservoir using SGS method in Mansuri oil field, Southwest of Iran. Open Journal of Geology, 2017; 7(8): 1188-1199.

[11] Folk RL, Andrews PB, Lewis DW. Detrital sedimentary rock classification and nomenclature for use in New Zealand. New Zealand Journal of Geology & Geophysics, 1970; 13: 937- 968.

[12] Tabatabaei H. Evaluation of water saturation models in shaly limestone zone of Asmari formation, Kupal oil field, SW of Iran, Petroleum and Coal, 2018; 60(6): 1250-1256.

[13] Sepehr M, Cosgrove JW. 2004, Structural framework of the Zagros Fold– Thrust Belt, Iran. Marine and Petroleum Geology, 2004; 21: 829–843.

[14] Rezaee MR, Kadkhodaie A, Barabadi A. Prediction of shear wave velocity from petrophysical data utilizing intelligent systems: An example from a sandstone reservoir of Carnarvon Basin, Australia. Journal of Petroleum Science and Engineering, 2007; 55: 201–212.

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