

# The regime of tectonic stresses and fault type based on petrophysical charts

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## Abstract

Given that reservoir rock of most of the hydrocarbon fields in the south of Iran are carbonate and such reservoirs have tectonic complexity and reservoir characteristics, so for protective production of reservoirs and development of hydrocarbon fields, understanding how to build tectonics and tectonic behavior in the area and the porous elastic relationships are of particular importance, so this paper investigates the tectonic stresses regime and fault type based on petrophysical charts. The studied gas field is located in the northwestern part of the Persian Gulf approximately 120 km of southwest of Bushehr Port, 130 km south of Kharg Island and adjacent to Iran's water border with Saudi Arabia. In order to interpret the petrophysical charts, information on conventional and advanced petrophysical charts including Full Set and DLIS format FMI chart as well as LAS format core data was loaded into the software. There are several software for petrophysical evaluation. In this study, we used the Geolog software and Multimin modeling method which is possible to calculate reservoir parameters such as porosity, permeability, lithology and water saturation in eight reservoir zones (K1, K2, U1, U2, U3, U4, U5, U6). Petrophysical interpretation was performed using a probabilistic multi-mineral method that the results of petrophysical interpretations were in good agreement with the core data after correction. The basis of the petrophysical interpretation was to match the lithology and porosity with the mud window results. The direction of maximum and minimum horizontal stresses has been the same for all zones. By combining the results of this study, tectonic stresses regime and fault type were obtained in each of the reservoir sub-formations in the study well.

**Keywords:** Tectonic Stresses, Fault Type, Petrophysical Charts, Core Information

## INTRODUCTION

Geomechanics actually involves the prediction and management of rock deformation. Undiscovered unplanned deformations impose billions of dollars on the oil industry annually <sup>[1]</sup> and identify the dangers of land stress situations is important for safe drilling operations and for completing geomechanical models. Excavation and management of some fields both technically and economically due to the complexities such as high pore pressure, well wall instability, reservoir compaction, wall pipe damage, sand formation, surface subsidence, fault performance, etc are one major challenge. Land stresses also affect other aspects of field development and completion <sup>[2,3]</sup>. Well instability is the most important crisis during drilling operations (well completion, petrophysical evaluation and cementing).

Iran has approximately 200 hydrocarbon structures in the Zagros and the Persian Gulf that the formation of these reservoirs is associated with the tectonic evolution - deposition of the Zagros basin. In other words, the early activity of faults during sedimentation resulted in the formation of basins surrounded by faults and sedimentary facies with different tectonics that differed in sex, lithology (thickness, age, and other features of the overlying rocks in the after sedimentation activities and in the compressive phase of these faults have led to different rheological

cognitive behavior profile (mechanical anisotropy and consequently differences in size, geometry, folding characteristics and metamorphic style of these rocks in Zagros). This has also had a direct relation to the distribution of hydrocarbon reservoirs. Given that reservoir rock of most of the hydrocarbon fields in the south of Iran are carbonate and such reservoirs have complex tectonic and reservoir characteristics, therefore, to protective production of reservoirs and development of hydrocarbon fields, Understanding the type of tectonic and the tectonic behavior that governs the region and porous elastic relationships is of

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particular importance. so this paper aims to investigate the tectonic stresses regime and fault type based on petrophysical charts.

### Geographical location of the study area

The studied gas field has been located in the northwestern part of the Persian Gulf approximately 120 km southwest of Bushehr Port, 130 km south of Kharg Island and in the vicinity of Iran's water border with Saudi Arabia. The continuation of this field on the Saudi side is known as Hasbh. It is shared with Saudi Arabia. The main reservoir units of this field consist of shallow marine carbonate sequences, the Kangan and Dalan formations and the Middle Sen Permian to Lower Trias formation that the upper Kangan and the upper Dalan are separated by an impermeable anhydrite layer called Nar anhydrite and the lower part that has been composed of the Faragon formation. They are the main carbonate reservoirs and are considered as a reservoir due to the lack of hydraulic separation between the two formations. Based on exploratory and geological studies these two formations have been deposited in shallow carbonate environments that containing different reservoir facies, the reservoir part of these formations has been composed of dolomitic and calcareous facies. The presence of these massive carbonate sequences that have been deposited on the lower Paleozoic rocks ever since sea advance in Permian along with the favorable status of the area's structure and the presence of a wide range of Silurian age-rich source rocks as well as deposition of Dashtak formation as caprock are the background of main formations of huge hydrocarbon reservoir structures in the region. The hydraulic connection of the reservoir units of the two Kangan and Dalan Formations has also been consistently considered as a gas reservoir and is based solely on the K and K3 4, K2, K. reservoir characteristics and stigography sequence into four reservoir units of done studies indicate that the thickness and lithology variations of these reservoir units are negligible in the horizontal direction and the reservoir parameters are strongly controlled by pre-burial diagenesis, especially leaching and dolomitization. On the other hand, pore cementation and fractures with anhydrite also play an important role in reducing the reservoir quality of these units. In general, among the tectonic factors influencing the shape and position of the Middle East region, the primary and basic structure of the basement rock appears to have the most influence on the occurrence of the studied field, and other factors such as salt movements and movements of the Middle Miocene orogeny (Zagros orogeny) have acted weaker.

### Petrophysical evaluation of well studied in deheram group:

Interpretation of Petrophysical Charts: In line with the interpretation of petrophysical charts, information on conventional and advanced petrophysical charts including Full Set and FMI chart with DLIS format as well as LAS core information was downloaded into the software.

There are several software for petrophysical evaluation. In this study we used Geolog software and Multimin modeling

method that can be calculated reservoir parameters such as porosity, permeability, lithology and water saturation in eight reservoir zones (K1, K2, U1, U2, U3, U4, U5, U6).

The operations to interpret petrophysical charts in this study are as follows.

1. Comparison of digital information with reference images and quality control of digital information
2. Smoothing and uniformizing sampling intervals
3. Depth matching
4. Precalc calculations
5. Environmental corrections
6. Determination of petrophysical parameters (Parameter picking)
7. Determine the Uncertainties Log Uncertainties parameters
8. Construction of petrophysical model for four designated zones (K1, K2, K3, K4) in Kangan Formations, upper Dalan
9. Petrophysical Evaluation of Well
10. Correction and processing of core information

### Preparation of raw data of well-logging

In this study, after gathering the required data and selecting the appropriate software of Geolog 7.4 for petrophysical evaluation and determination of reservoir zones, the raw data obtained from well logging have been prepared by performing the following steps:

1. Upload data: Includes a complete set of well logs in a LAS file, numerical value of the headers and drilling mud information.
2. Quality control and data editing: If any petrophysical information is available, all available data were reviewed for quality review and images correction. logging operation has been performed at different times with different tools depending on the wells. Therefore, the quality of these operations was carefully examined in this well. These images are of good quality in the Kagan and Dalan formations. The presence of Barit has an effect on the reading of the PEF log (at some interval), so it has not been used at all intervals throughout the well.

Quality control and editing of logs involve various steps such as removing noises on Sonic log, depth matching, correction and smoothing of logs, eliminating smooth lines on logs, First Reading phenomenon, combining a log obtained in different logging of the same log and the log reconstructioning if needed.

During cable logging operations, sometimes because these operations are performed in several runs to measure different logs, so different sets of logs may have some depth of movement together when calibrating the tool, that this happens for a variety of reasons such as (tool stoppage, slow tool movement, engineer error, and so on). Hence the

phenomenon of the same deepening has also been done at the observed intervals.

1. Calculate the required parameters before the main calculation: In this study, according to the type of drilling mud (the water base) outputs of this section used in petrophysical evaluation are: numerical value of drilling mud salinity and mud filtered into the formation, temperature profile, pressure profile, drilling mud resistance, crust mud resistance, Filtered mud resistance, crust mud thickness, U parameter (photoelectric macroscopic cross-section, conductivity of breach zone (CXO) and original zone conductivity (CT).
2. Environmental correction: To compensate for the effect of mud weight, internal well conditions, water salinity, formation pressure, mud cake thickness, plastic gasket size, invasion zone, mud percolation, mud salinity and drill size, environmental corrections are applied on well logging. The results of this section are stored in the software with the `_COR` suffix next to the log name. some logs are corrected by well logging companies and no longer need environmental correction. In this study, environmental corrections have been performed on gamma, neutron and density logs. In this study, the CGR log has been used in the petrophysical evaluation and therefore, the relevant section on gamma log correction has been performed on the existing CGR log.

For the neutron log correction, TNPH log has been used. Therefore, the possibility of software related to correction of this log in software has been used. Finally, LDT-related software feature has been used for density log correction and by this software feature two RHOZ and PEFZ logs have been corrected. It is important to note that this software feature also converts the PEFZ log to U, which results are in high agreement with the Precalc result, and one of them can be customized for use in petrophysical evaluation.

### How to build a model and perform a petrophysical evaluation:

After preparing the data, considering the advantages of probabilistic petrophysical method over definitive petrophysical method, this method has been used as the main method of evaluation. In order to perform a petrophysical evaluation in the probabilistic way one must build a model known as the Multimin model in the software. In each Multimin model, there are different sections: equations section, minerals section, constraints section, formulas section, methods section and fluid properties section.

In the equations section, one of the available information in the multipath model is determined. This information includes petrophysical logs from the project that are trusted and used for evaluation.

The minerals constitute the available unknowns in the probabilistic model. In this section, minerals in the studied

formations that have been determined by lithology-related cross-plots as well as geologic well head reports are entered the model. In addition to minerals, fluids in the leached and pristine zones around the well wall are also determined in this section to determine their volume by model-based petrophysical evaluation.

The formulation section consists of several different parts. The first part is the response of logs to each mineral in the well being studied (Volume Log Responses). The second part contains the matrix properties of each mineral, which are constant numbers for each mineral (Volume Properties). The third section deals with constraints associated with any mineral that cannot be controlled by the interpreter (Volume Constraints). The fourth and final part is the upper and lower boundaries for each mineral or fluid in the model, which is determined by the interpreter to what extent each of them will be calculated at the output of the petrophysical evaluation of the model (Volume Bounds).

In the Methods section, the type of method or formula used for each log in solving the model equations is determined. For example, there are various methods and relationships to determine water saturation such as Archie, Indonesia, Simandox, etc. In this model, the Indonesian relation has been used because of the shale in the studied formations. Also, the values of the Archie coefficients are entered in this section. There is an option in the methods section against each log called Uncertainty, which is one of the control options to improve the results of the model's petrophysical evaluation. In other words, using uncertainty logs for using a fixed number for each log in the whole interval improves the results of the evaluation and make the model used in the mathematical and physical dimensions provide more realistic results. There is a software option to calculate the uncertainty of each log in Geolog.

In the Fluid Properties section of the model, the properties of the fluids available in the washed and pristine zone are also determined. Types of these properties include the determination of the type of drilling mud, the amount of potassium chloride (KCl), the temperature and pressure of the tank, the oil and gas gravity, and the properties of the drilling mud filtered into the well.

Finally the models built in this project are executed by possible software possibility. In this possible software possibility in addition to petrophysical models built, other information includes oil or gas gravity in the formations studied, temperature and formation water resistance, temperature and pressure profiles in Precalc part, drilling mud type and potassium chloride (KCl) concentration is required.

### Correction and processing of core information:

Core information and logging information are typically deeply divergent. This discrepancy is due to the change in the

method of measuring tool of the depth of this information as well as the fragmentation of the cores. Therefore, after loading the core information, depth matching of this information was corrected with well logging logs. For depth matching, gamma-core information was used. Accordingly, a reference depth column was provided to correct the depth of core information. In some cases, gamma core data were not available and depth matching was performed using porosity logs. After depth matching, the effect of pressure was corrected.

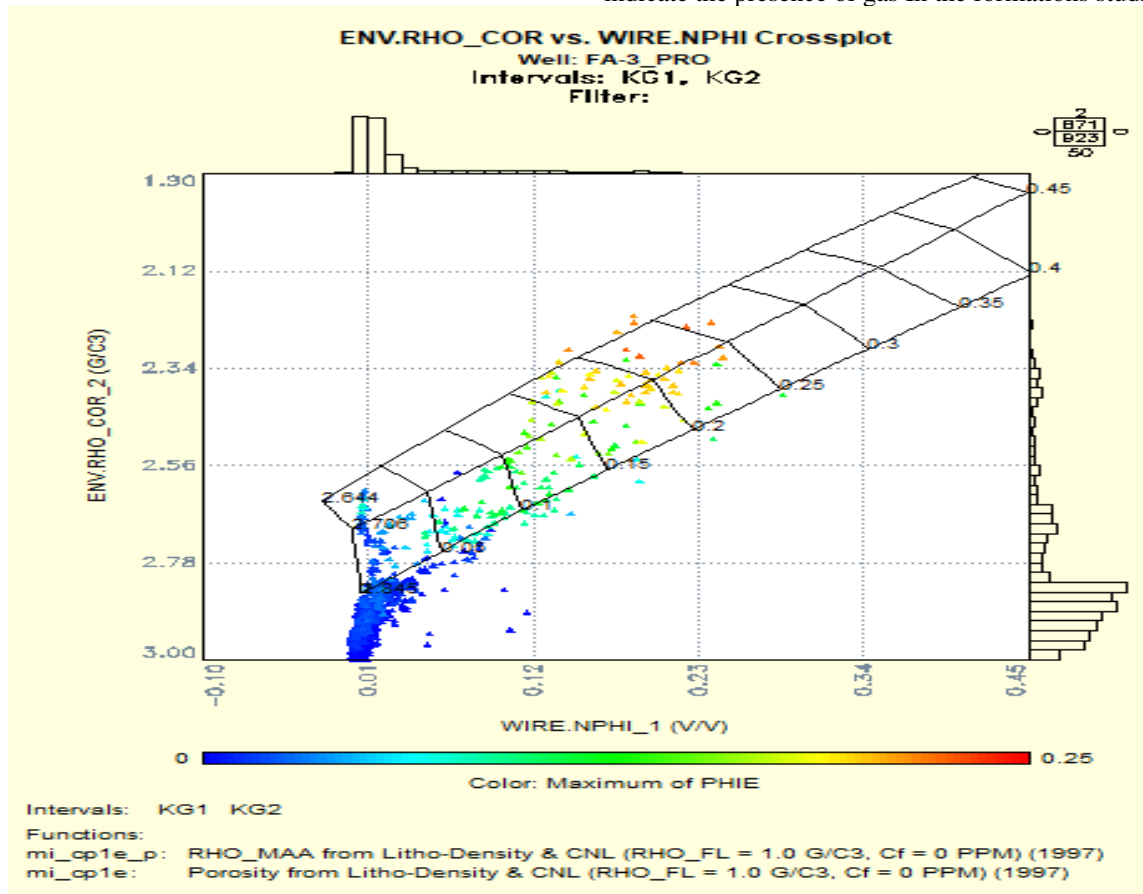
**Determination of Lithology: Determination of lithology is done by the following methods.**

1. Drilling Core
2. Well log graphics
3. Crossover diagrams including: neutron-density crossover diagram, M-N Plot, MID Plot RHOMA-UMA RHOMA-UMA

In this study, neutron-density crossover diagrams were used to determine lithology.

**1-Determination of lithology using neutron-density transverse chart:** This transverse chart has the best separation limit of different minerals of the formation between binary charts and is more pronounced in terms of lithology [4] in this cross-plot has been drawn three curves for quartz, calcite and dolomite lithologies called matrix lines. The point distance from the matrix lines indicates the percentage of mineral [5]. This cross-plot also provides an accurate and proper idea of the porosity in the study reservoir.

Figure 1-A- shows the mentioned cross-plot for the Kangan formation and Figure 1-B- the Dalan formation in the study well. Based on neutron-density cross-plot, the upper part of Kangan (KG-1) is composed mainly of dolomite and anhydrite (Figure 1-A), while the lower Kangan (KG-2) and Dalan have been composed of limestone and dolomite which contain low content of clay and anhydrite (Fig. 1b), although the Kagan and Dalan formations in the study area are predominantly calcareous and dolomitic, but some of the points is placed in the northwestern part of the cross-plot that indicate the presence of gas In the formations studied.



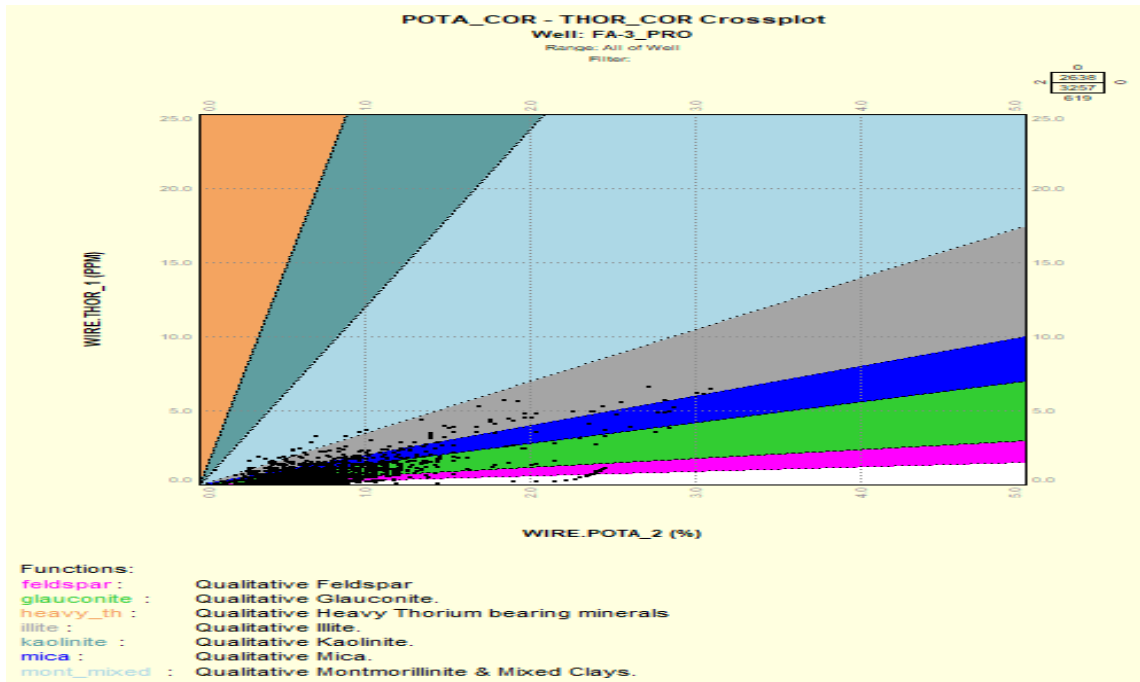
**Figure 1:** A- Neutron-density transverse chart of the Kangan formation in the well studied  
In order to use other transverse charts of lithology determination, it is necessary to know the parameters such as M and N obtained by software possibility of apparent matrix properties.

**2- Determination of clay mineral type:** The influence value of clays on reservoir depending on the volume and type

of clay minerals present in the reservoir formation and their distribution properties and In addition to determining shale volume, clay minerals type also need to be identified due to

different distribution and thus different impact on reservoir quality in petrophysical assessments. XRD analysis results of rock samples are used to precisely determine the type of clay minerals, but due to the lack of XRD analysis results in this study, standard Schlumberger cross-plates such as thorium-potassium cross plate have been used. According to the results of the drawing cross plat in this study, there is no

dominant clay mineral in the Kagan and Dalan formations, and in all of the sections illite, mica and glauconite are placed (Fig. 2). Therefore, wet clay mineral (WCS) is considered as clay mineral in a petrophysical evaluation model that contains the mean response of clay minerals and has been detected through Pickett plots.



**Figure 2:** Cross-plot thorium-potassium in the Kagan and Dalan formations in the studied well

### Determination of water saturation calculation parameters:

The parameters of water saturation calculation have an important role in the results of the petrophysical evaluation. In petrophysical evaluation, the Archie model is used to calculate water saturation. The Archie model has been shown in relation 1.

$$S_w = \left( \frac{R_o}{RT} \right)^{\frac{1}{n}} \quad (1)$$

Sw: Water saturation in (v/v)

Ro: Electronic resistance of reservoir rock in condition Sw=100% ( in ohmm ):

RT: true electrical resistance of the formation (in ohmm)

n: Saturation power

In relation, 1 - RT is obtained from electrical resistance diagram reading. Saturation power is also extracted using core information or standard charts. Whereas Ro is a parameter that depends on porosity, lithology and rock texture. Therefore, the precise determination of this parameter at all reservoir intervals is very difficult, and its use

increases uncertainty in water saturation calculations. The Ro parameter is defined by the relation 2.

$$F = \frac{R_o}{R_w} \Rightarrow R_o = F \times R_w \quad (2)$$

In which

Rw: Formation water resistance in reservoir conditions

F: Formation resistance coefficient

There is also an empirical relationship between the formation resistance coefficient (F) and the porosity ( $\phi$ ). This relation is expressed by Equation 3.

$$F = \frac{a}{\phi^m} \quad (3)$$

In wich

Rock porosity

a: winding constant

m: cementation factor

The parameters of winding constant (a) and the cementation factor (m) are related to the rock texture. Using relations (3) and (4) one can rewrite Archie's relation in a way that is more capable of petrophysical evaluation. This form of Archie model has been presented in relation 4.

$$(2),(3) \Rightarrow S_w = \left( \frac{aR_w}{\phi^m RT} \right)^{\frac{1}{n}} \quad (4)$$

The parameters n, m and a must be defined before performing the evaluation specified in the petrophysical model. As can be seen in this relation, the saturation of water and consequently the hydrocarbon in calculated place in the static reservoir model is a function of these parameters. Therefore, these parameters must be correctly and appropriately determined. There are two different methods to determine these parameters (a, m, n) as follows.

Core specific analysis results (SCAL)  
Using (Pickett Plot)

**Formation water resistance (Rw):** Formation water resistance is also one of the most important parameters in calculating water saturation. Formation water resistance was determined using the results of hardness of formation water. This analysis has been performed by the reservoir part. According to this analysis, the specific resistance rate of water formation is 0.014 ohm at 216 Fahrenheit degree.

**Water saturation calculation model:**

The formations of Kangan and Dalan are carbonate and according to geological data and core studies, these formations have low shale volume. Shale minerals have electrical conductivity. As a result, the presence of these minerals in the formation causes an error in the water saturation calculated by the Archie model. Different models have been proposed to account for shale conductivity in water saturation calculations. These models are also based on the Archie model. Some of the most commonly used models are as follows.

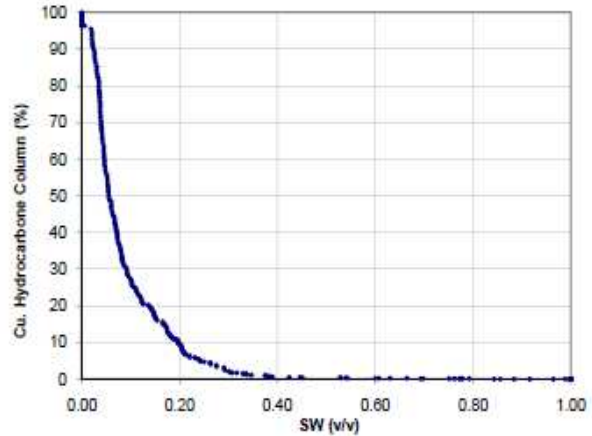
- Simandoux
- Waxman-Smith
- Juhasz
- Indonesian
- Dual Water

**Indonesian model:** The Indonesian model is based on the rules of electricity flow propagation in parallel orbits. This model is suitable for calculating water saturation in layered shale formations. According to the diagrams, the shale in the Kangan and Dalan formations are of a layered type and as a result the Indonesian model was used in the petrophysical evaluation of these formations. This model has been presented in relation 5.

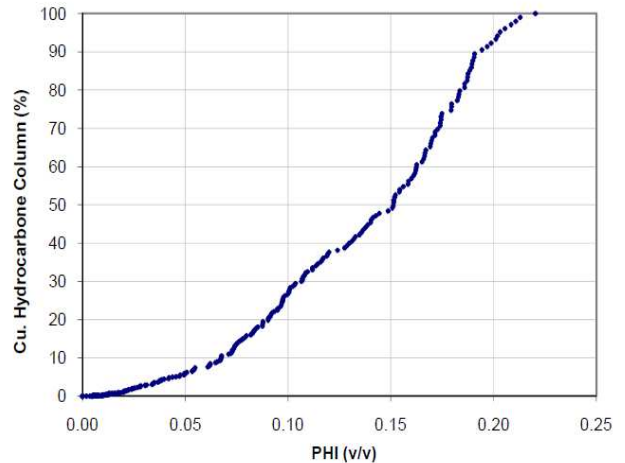
$$\frac{1}{R_r} = \left[ \left( \frac{\phi^m}{a \times R_w} \right)^{0.5} + \frac{(V_{sh})^{(1-0.5V_{sh})}}{(R_{sh})^{0.5}} \right]^2 \times S_w^n \quad (5)$$

**Cutoff limit**

The cutoff limits for water saturation and porosity were 85% and 2%, respectively, based on the criteria presented in Figures 3 and 4.



**Figure 3:** Diagram of the cutoff limit of water saturation



**Figure 4:** Porosity cutoff limit diagram

**Petrophysical Evaluation Results**

**1- Petrophysical analysis and interpretation of Kangan formation in K1 reservoir zone**

The K1 reservoir zone in the study well has 102 meters thick and its dominant lithology is anhydrite with the limited amount of shale. In this zone, the mean of porosity is 0.63, the mean of water saturation is 0.8%, which indicates that the reservoir quality of this zone is poor.

The maximum horizontal stress direction is northeast-southwest and the minimum horizontal stress direction is perpendicular to the northwest-southeast direction and based on the results of one-dimensional mechanical calculations of the earth based on the calculation of in situ stresses of Hσ, vσ, hσ indicates the normal along strike fault that the overall mentioned vertical distance has poor reservoir quality and that the stresses and faults in this area did not affect the K1 reservoir quality.

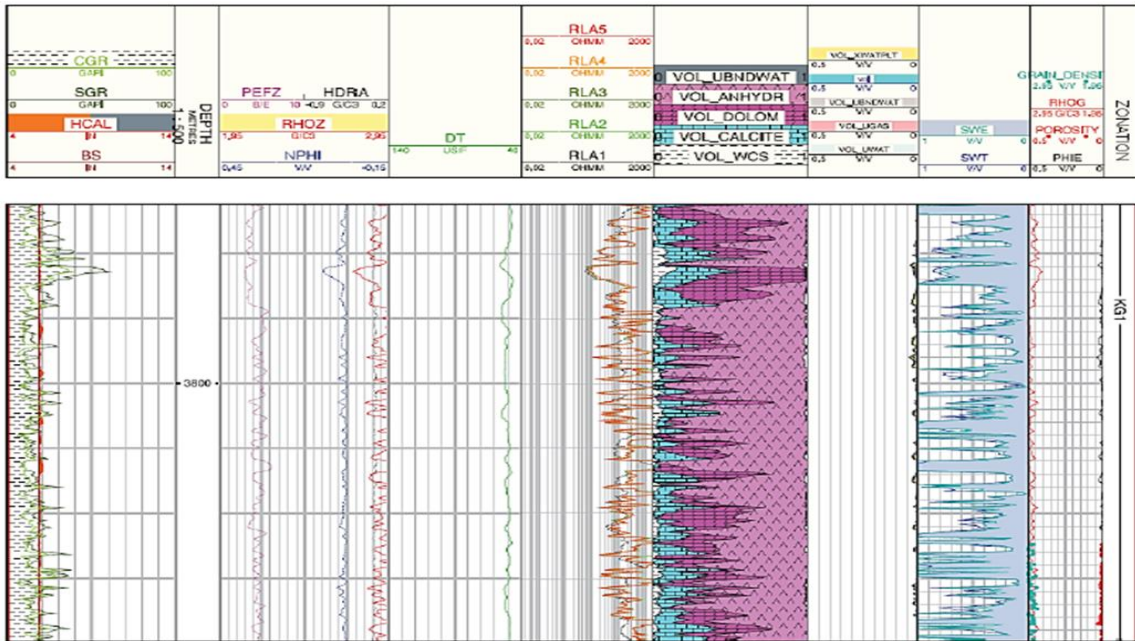


Figure 5: Petrophysical evaluation in K1 zone Kangan formation

## 2- Petrophysical analysis and interpretation of Kangan formation in K2 Reservoir Zone

The K2 reservoir zone in the study well has 38 meters thick and its dominant lithology consists of dolomite and lime. In this zone the mean of porosity is 9.31, the mean of water saturation is 8.48. This zone has good reservoir quality with respect to petrophysical parameters and it has good gas volume.

The maximum horizontal stress direction is northeast-southwest and the minimum horizontal stress direction is perpendicular to the northwest-southeast direction and based on the results of one-dimensional mechanical model calculations of the earth based on the calculation of in situ stresses of  $H\sigma$ ,  $v\sigma$ ,  $h\sigma$  indicates the normal along fault.

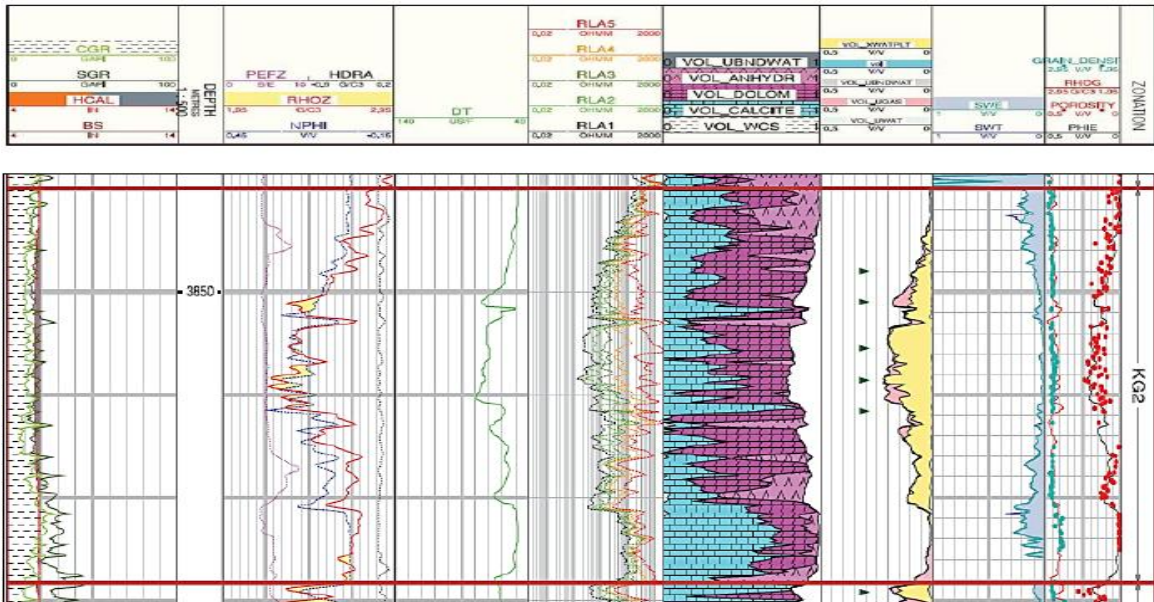


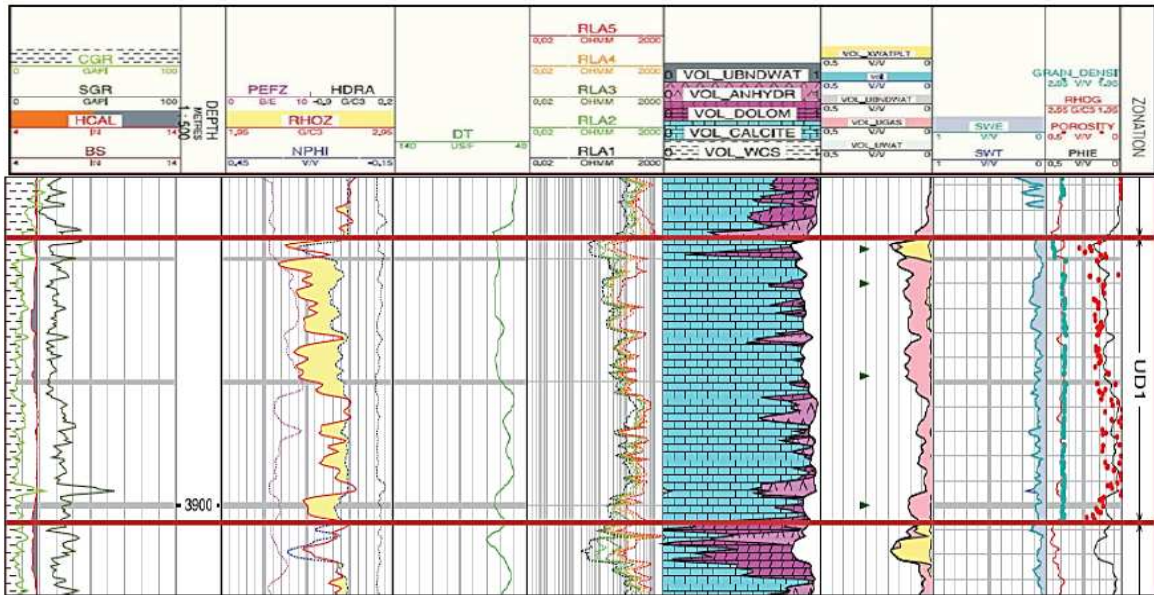
Figure 6: Petrophysical evaluation in K2 zone Kangan formation

## 3- Petrophysical analysis and interpretation of the Kangan formation in the U1 Reservoir Zone

The U1 reservoir zone in the study well has 32 meters thick and its dominant lithology is composed of lime which has an effective porosity and very proper gas volume. In this zone,

the mean of effective porosity is 9.06, the mean of water saturation is 6.77. This zone is one of the best zones of Kangan and Dalan formations in terms of reservoir quality. The maximum horizontal stress is northeast-southwest and the minimum horizontal stress is perpendicular to the

northwest-southeast direction and based on the results of one-dimensional mechanical model calculations of the earth based on the calculation of in situ stresses of  $H\sigma$ ,  $v\sigma$ ,  $h\sigma$  indicates the normal along fault.

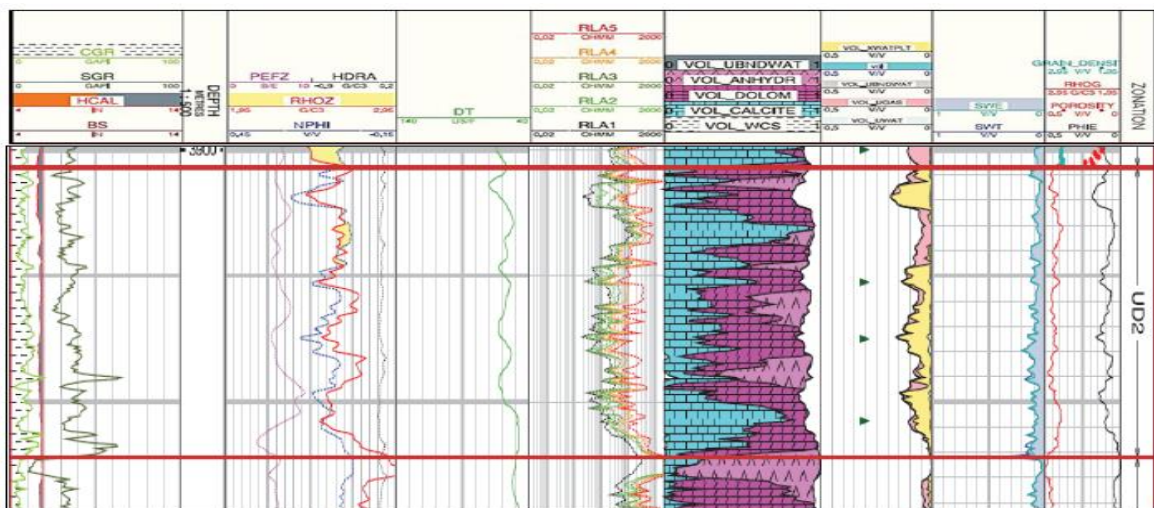


**Figure 7:** Petrophysical evaluation in U1 zone Kangan formation

#### 4- Petrophysical analysis and interpretation of the Kangan formation in the U2 Reservoir Zone

The U2 reservoir zone in the study well has 13 meters thick and its dominant lithology consists of dolomite and lime. In this zone, the mean of porosity is 8.51, the mean of effective water saturation is 8.21. This zone has good reservoir quality in terms of petrophysical parameters and its gas volume is medium and similar to K2 zone.

The maximum horizontal stress is northeast-southwest and the minimum horizontal stress direction is perpendicular to the northwest-southeast direction and based on the results of one-dimensional mechanical model calculations of the earth based on the calculation of in situ stresses of  $H\sigma$ ,  $v\sigma$ ,  $h\sigma$  indicates the normal along fault.



**Figure 8:** Petrophysical evaluation in the U2 zone Kangan formation

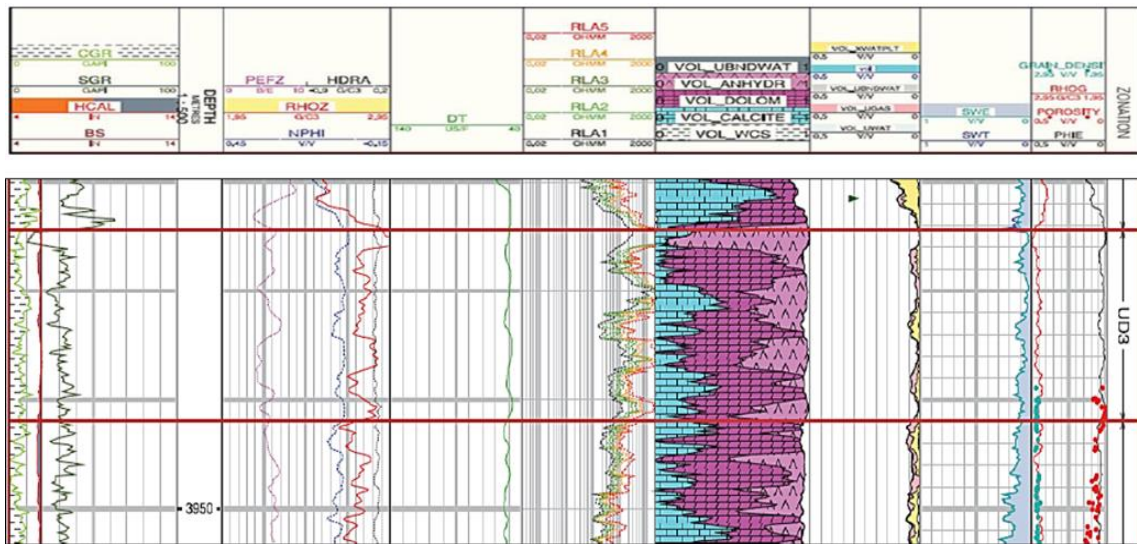
#### 5-Petrophysical analysis and interpretation of the Kangan formation in the U3 reservoir zone

The U3 reservoir zone in the study well has a thickness of 17 meters and the dominant lithology is dolomite. There is also

lime and anhydrite in this zone. In this zone the mean of porosity is 2.77, the mean of water saturation is 7.26. Due to the low porosity and volume of gas in this zone, its reservoir quality is average.

The maximum horizontal stress direction is northeast-southwest and the minimum horizontal stress is perpendicular to the northwest-southeast direction and based on the results

of one-dimensional mechanical model calculations of the earth based on the calculation of in situ stresses of  $H\sigma$ ,  $v\sigma$ ,  $h\sigma$  indicates the normal along fault.

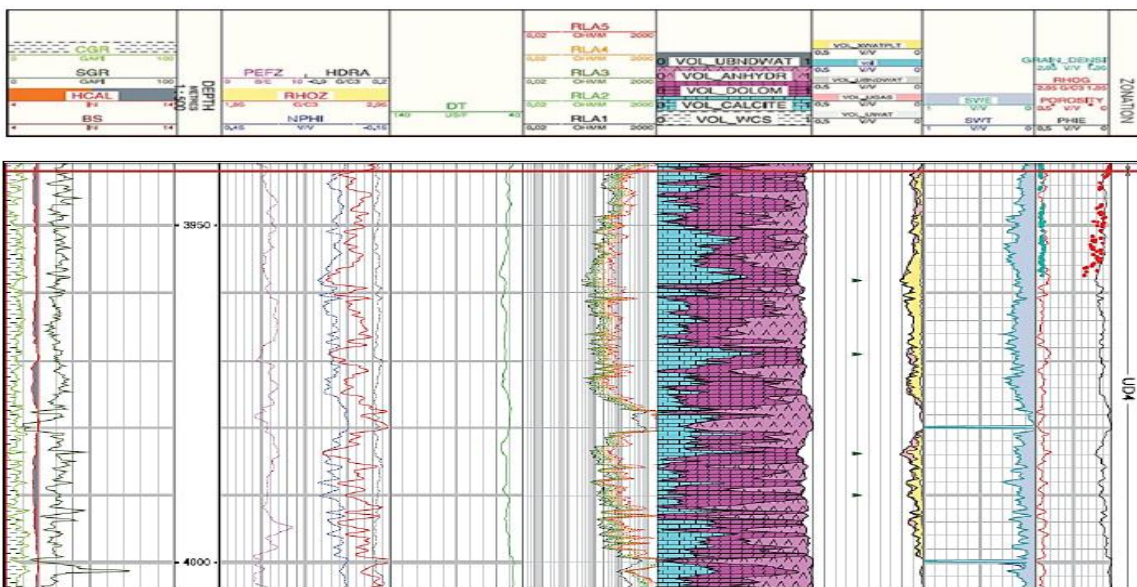


**Figure 9:** Petrophysical evaluation in U3 zone

### 6- Petrophysical analysis and interpretation of the Kangan formation in the U4 reservoir zone

The u4 reservoir zone in the study well has 64 meters thick and its dominant lithology is composed of lime, dolomite and anhydrite. In this zone, the mean of porosity is 5, the mean of water saturation is 14.26 which indicates that this zone has moderate reservoir quality between the zones in these two formations.

The maximum horizontal stress direction is northeast-southwest and the minimum horizontal stress is perpendicular to the northwest-southeast direction. Based on the results of one-dimensional mechanical model calculations of the earth based on the calculation of in situ stresses of  $H\sigma$ ,  $v\sigma$ ,  $h\sigma$  indicates the normal along fault.

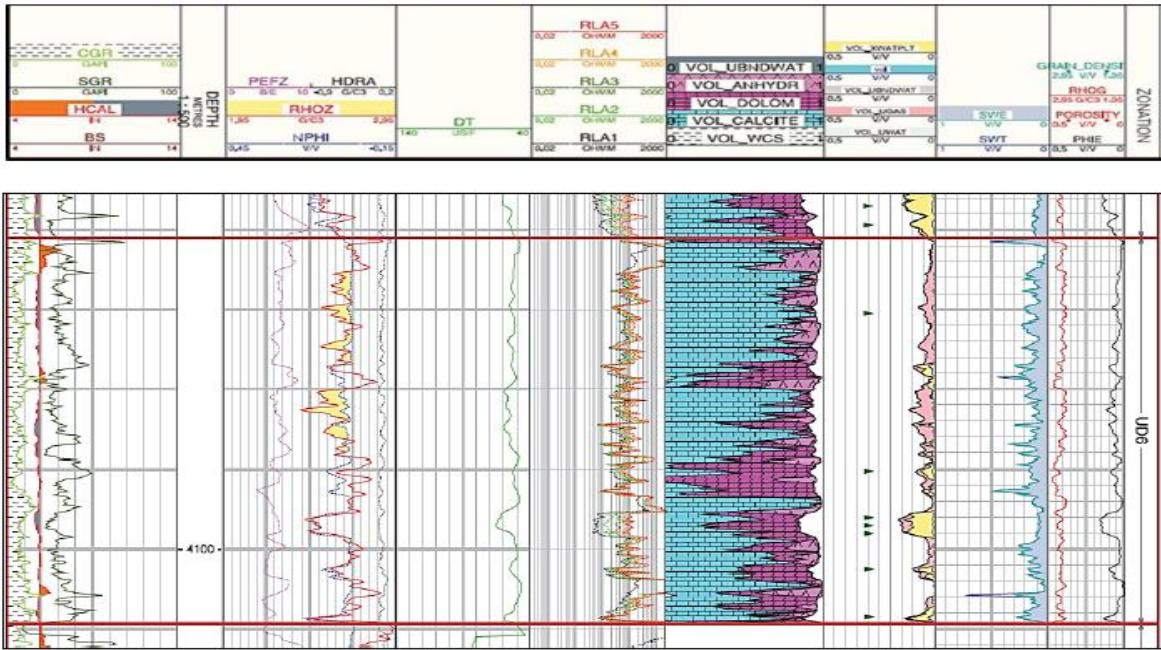


**Figure 10:** Petrophysical evaluation in U4 zone

### 7- Petrophysical analysis and interpretation of the Kangan formation in the U5 reservoir zone

The U5 reservoir zone in the study well has 55 meters thick and the dominant lithology is dolomitic lime with a little anhydrite. In this zone the mean of effective porosity is 9.96,





**Figure 12:** Petrophysical evaluation done in the U6 zone

**Petrophysical Evaluation Results Based on Cutting Limit Apply in deheram Group reservoir**

Table 1 shows the general results of petrophysical evaluation and interpretation in the well of field studied.

**Table 1:** Petrophysical evaluation results

Zone	Top	Base	Gross(m)	NET (m)	N/G (m/m)	PHIE_AV (fr)	SW_AV (fr)	PHI_Gross (fr)
K1	3737.52	3839.96	93.88	1.07	0.01	0.03	0.25	0.03
K2	3839.96	3878.26	38.25	29.57	0.77	0.12	0.08	3.43
U1	3878.26	3901.4	23.17	22.56	0.97	0.09	0.09	2.01
U2	3901.4	3924.4	23.01	21.79	0.95	0.1	0.1	2.07
U3	3924.4	3941.94	17.53	8.38	0.48	0.04	0.15	0.34
U4	3941.94	4006.5	64.62	55.32	0.86	0.06	0.21	3.15
U5	4006.5	4061	54.41	54.41	1	0.1	0.11	5.4
U6	4061	4100	48.31	38.71	0.8	0.06	0.17	2.37

The fourth and fifth columns of this table on the left show the thickness of the impure and pure stone columns in the zones in meters. From the sixth zones onwards, the pure thickness rate of the zones is equal to zero and gradually their impure column height rate is added, indicating that these zones are non-reservoir. The fourth and fifth columns on the left show the ratio of pure to impure height and the height of the hydrocarbon column in meters for each zone. In the seventh and eighth columns, we see the mean of porosity and the mean water saturation that has been estimated for each zone, and based on this information, it is observed that Zone 2 with the highest porosity and the lowest water saturation will be the best reservoir zone. The last column on the left also shows the porosity in the total thickness of the desired layer.

**CONCLUSION**

Petrophysical interpretation was performed using a probabilistic multi-mineral method that the results of petrophysical interpretations were in good agreement with the core data after matching. The basis of the petrophysical interpretation was to match the lithology and porosity with the drilling mud window results.

The maximum and minimum horizontal stresses direction has been the same for all zones.

By combining the results obtained in this study, the regime of tectonic stresses and fault type were obtained for each of the reservoir sub-formations in the well studied. According

to done studies of fault type, only in zone K1 which is lithologically different, anhydrite is different and its type is along strike but zones K2, U1, U2, U3, U4, U5, U6 are of normal fault type and their dominant lithology is calcareous and dolomitic

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