sjst.scst.edu.ly
Surman **J**ournal for **S**cience and **T**echnology
ISSN: Online (2790-5721) - Print (2790-5713)
مجلة صرمان للعلوم والتقنية
Vol**4**, No.**2**, Dec. 2022
Pages: 060 ~ 075

Reservoir Quality of Gargaf Formation in Belhedan Field By Used The Petrophysics properties &Repeat Formation Test & its Effect On Production, Sirt Basin, Libya

Naser Altoumi

University of Zawia – Faculty of Oil and Gas Engineering
n.altoumi@zu.edu.ly

ABSTRACT

This study is focused on the Gargaf Formation which represents the main reservoir production in the Belhedan Field with gross thickness that ranges from 130 to 187 feet. The aim of this study to determine the fluid contact with identifies the hydrocarbon zone. The gathered data that were utilized in performing this study are the petrophysical analysis of three wells (01-59, 02-59 & 03-59), using well log data such as (Gamma Ray Log, Resistivity Log, Neutron Log , Sonic Log and Density Log). The applications that were used are Techlog software for analyzing the log data, whereas the surfer software for mapping.

From analyzing the petrophysics data of the subjected reservoir, the results identify the reservoir contain column of hydrocarbon and water. Besides by integrating the results of petrphysics with RFT data for defining the reservoir fluid type and contacts. Moreover, the pressure profiles of Gargaf reservoir in subjected wells were constructed. Through the pressure profile and petrophysics data, most dominated hydrocarbon in the reservoir are mainly two phases Gas and Oil Zones.

Key words:Cementation factor, Tortuosity factor, Saturation, Archie equation

Introduction

The Belhedan Field is located in the Sirt Basin, an extensional basin of Mesozoic and Tertiary age. Numerous major north-northwest trending troughs (grabens) and platforms (horsts) define the basin. The Belhedan structure, located on the south-eastern edge of the Beda Platform, is a small horst block which trends north-northeast. The field is bounded by a local graben to the west that separates the field from the Samah and Balat fields, and bounded to the east by the deep Marada (Hagfa) Trough. Rifting of the Sirt Basin started in the Cretaceous period, resulting in some 15,000 feet of sediments being deposited. The wells of interest are (01-59, 02-59 and 03-59). The following figure represents the main location study well in the concession 59. The selected wells include 01-59, 02-59 & 03-59. Both 01-59 and 03 -59 wells are located on the eastern south Beda Platform while the wells 02-59 is bounded to the eastern Marada Trough. A more detail of the location of these wells are shown in the (Figure 1 & 2).

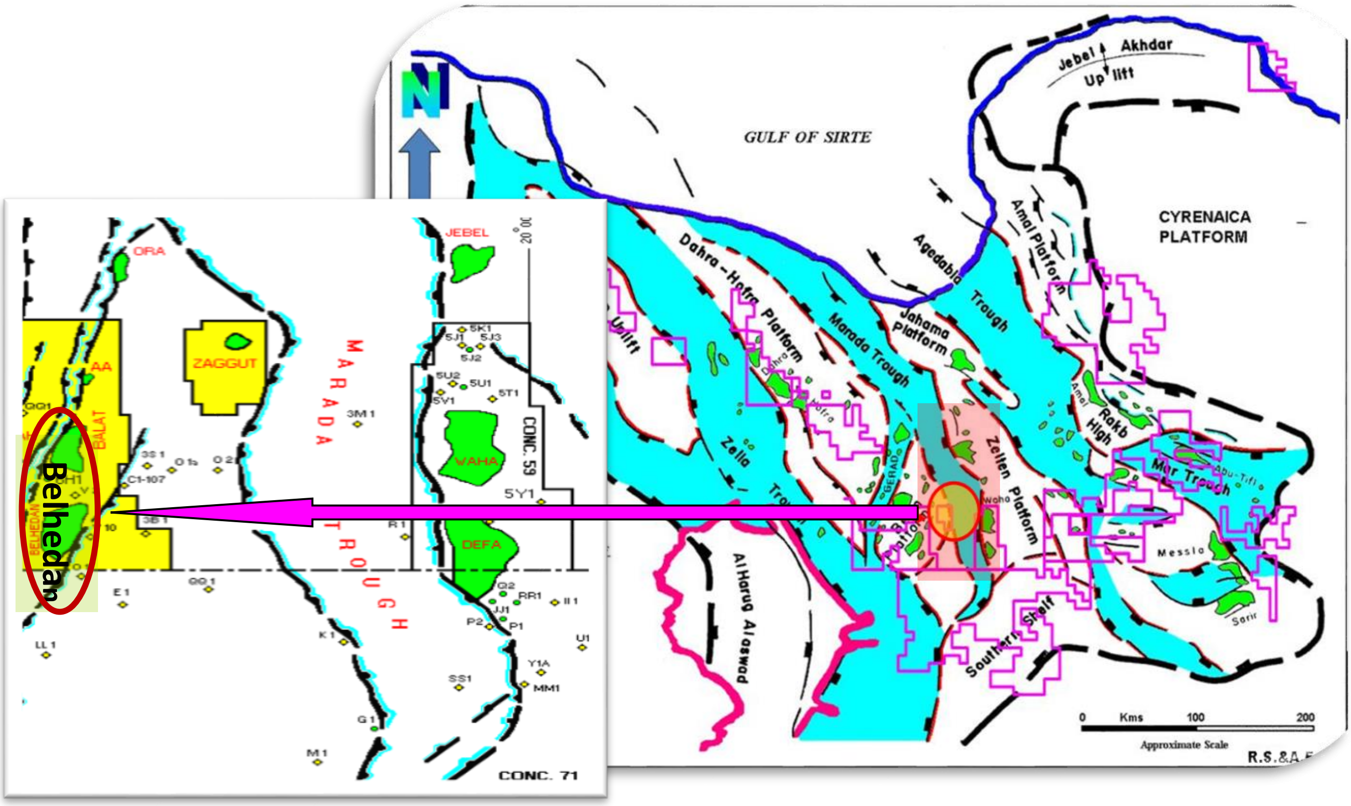


Figure 1: Location Map of The Study Area, Central Sirt Basin, Libya, Indicating Studied Wells 01-59, 02-59 & 034-59(After Waha Oil Company, 2022).

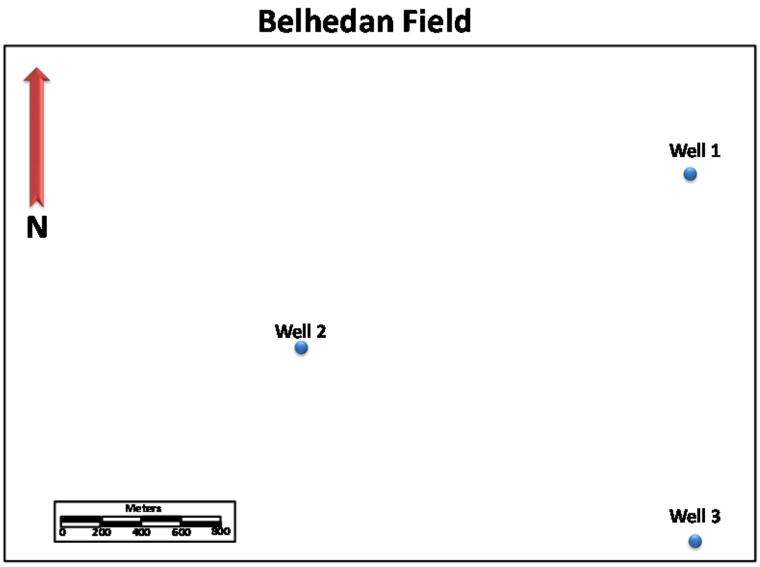


Figure 2: Location Base Map Of The Study Area, (After Waha Oil Company, 2022).

Method of Study

The main method used in this study were applied petrophysical analysis for three selected wells content electrical logs, include GR, Acoustic, Bulk density, Neutron Porosity and induction Logs and Formation tops, by using new software as Petrel and Techlog software for petrophysics analysis and Formation tops, by using in order to determine the quantity of petrophysical properties for the reservoir such as porosity, permeability, water saturation and net pay, and combined them with the geological information and Repeat Formation Tester(RFT) data for three wells were used in this study, and surfer 8 for drawing mapping as structure map.

Objective

The aim of the presented study is to:

1. Defining the reservoir fluid contacts (Gas Water Contact/Oil Water Contact/Gas Oil Contact) and fluid type are one of the major target of this study by integrate well log results with Repeat Formation Test (RFT) in study area.
2. To petrophysics evaluation of main reservoir.
3. Integrate the results of petrophysics with RFT with logging data result for defining the reservoir fluid type and contacts.

General Geological History Of The Sirt Basin

Libya is located on the Mediterranean foreland of the African Shield, extends over a platform of cratonic basins that can be divided into two geologic regions, each of which includes a number of sedimentary basins (Figure 3). The northern part of the country is situated on a tectonically active subsiding margin, and includes from west to east the Sabratah Basin, Benghazi Basin, Sirt Basin and Cyrenaica Platform. The southern part of Libya, which lies within a stable cratonic area, includes the Ghadames and Murzuq Basins to the west, separated by the Tibisti crystalline basement massif from the Al Kufra Basin in the southeast. As a result of their position at the edge of the African Plate, these basins were affected by successive phases of continental collision and plate divergence. The tectonic features of the Sirt Basin were formed by large-scale subsidence and block faulting in response to latest Jurassic/early cretaceous rifting, which controlled the pattern of deposition during the late cretaceous and early tertiary.

ISSN: Online (2790-5721) - Print (2790-5713)
Vol**4**, No.**2**, Dec. 2022
Pages: 060 ~ 075

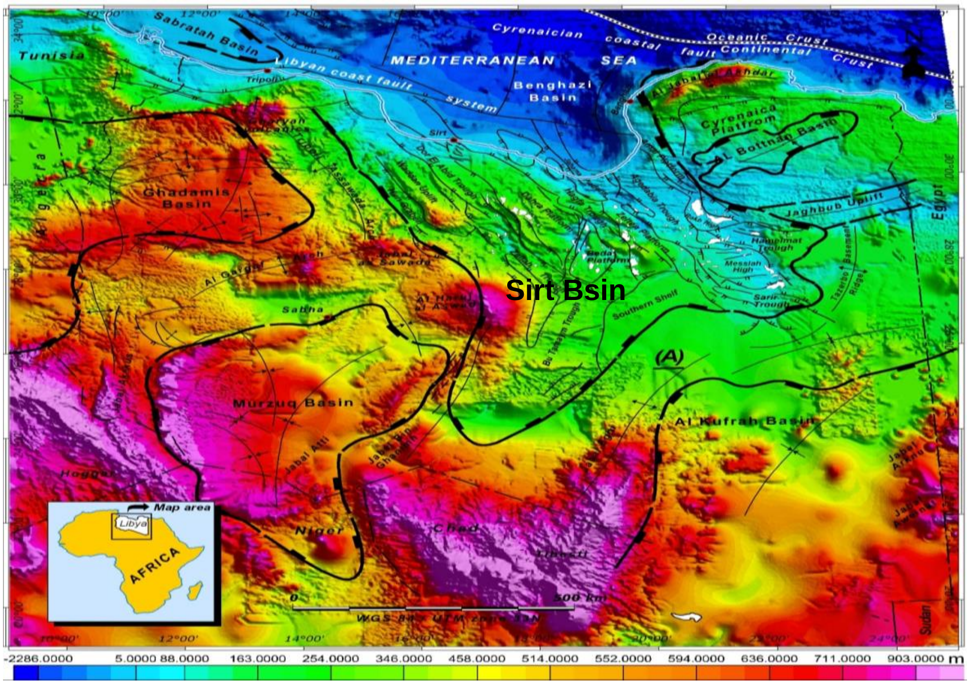


Figure 3: Shows The Major Tectonic Elements Of The Sirt Basin.

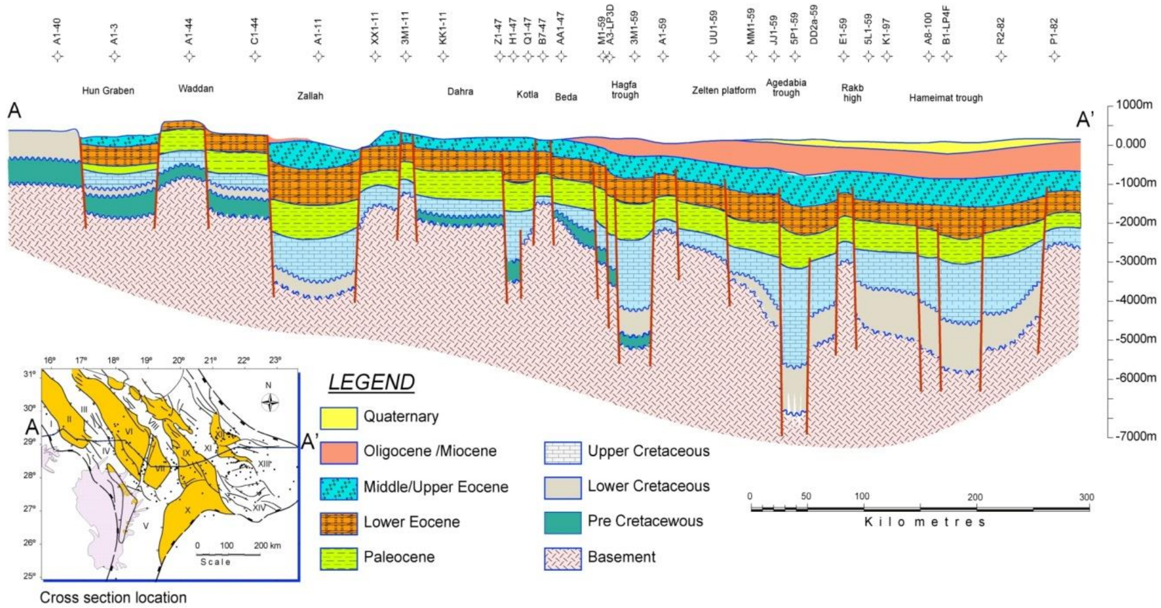
Major Structural Elements

The tectonic history of the Sirt Basin is complex. It started in the Late Precambrian time, when several heterogeneous basement blocks were welded together as a result of the Pan African Orogeny. This event was followed by a rifting period during the Latest-Precambrian to Early Paleozoic time. As a result, a series of NW-SE horsts and grabens were formed throughout the African Platform. This pattern of grabens (or Embayment), which were separated by horsts (or arches), has received clastic deposits throughout the Early Paleozoic time. These deposits, which include the Cambrian Ordovician, and Silurian rocks, were thought have been deposited throughout the North African Platform, particularly in present Sirt Basin area.

In the Middle Miocene time, the rat of subsidence has dimensioned gradually and the sea regression has occurred (Figure 4).

Figure 4: East-West Onshore Structural Cross Section Across Sirt Basin. (Modified from Roohi, 1996).

sjst.scst.edu.ly
Surman **J**ournal for **S**cience and **T**echnology
ISSN: Online (2790-5721) - Print (2790-5713)
مجلة صرمان للعلوم والتقنية
Vol**4**, No.**2**, Dec. 2022
Pages: 060 ~ 075



Stratigraphic Evolution

The pattern of sediments accumulated within the Sirt Basin is typical of a rift complex. In total, five sedimentary sequences (cycles) are superimposed:

The Pre-Rift Sediments.
The first onset of the formation of the Sirt Basin occurred prior to the rifting and block faulting. It developed on a substratum of basement rocks and sedimentary strata of (Paleozoic, Triassic and probably Jurassic age.)

The Lower Cretaceous syn-rift basin fill.
It is continental-marine siliciclastic rocks deposited during active faulting, forms the first depositional cycle during the earliest stage of the Sirt Basin development between the Late Kimmerian and Austrian orogenic events. The Upper Cretaceous syn-rift basin fill. Marine siliclastics and carbonate rocks, also deposited during rifting and active faulting, developed between the Austrian and Laramide orogenic events.

The Syn-Rift Basin Fill Of The Paleogene (Paleocene To Early Eocene)
Shale, carbonate and evaporite strata deposited during renewed rifting and faulting and developed between the Laramide and Pyrenean orogenic events.

The Post-Rift Basin Fill (Neogene Strata)
Mixed carbonate and siliciclastic deposits, followed by terminal continental siliclastic strata deposited after faulting had effectively ceased.
These broadly defined sedimentary successions are characterized by: cycles of transgressions and minor regressions, resulting in an admixture of marine, transitional and continental deposits. vary from deep marine shales to shallow marine carbonates, and they change in thickness and time interval depending on the tectono-stratigraphic setting in different parts of the basin.

SJST sjst.scst.edu.ly
Surman Journal for Science and Technology
ISSN: Online (2790-5721) - Print (2790-5713)
مجلة صرمان للعلوم والتقنية
Vol4, No.2, Dec. 2022
Pages: 060 ~ 075

The five sedimentary cycles were conducive to the preservation of:

- rocks of reservoir
- and seal quality,
- and hydrocarbon source rock potential.
- The thick marine shaly sequence in the grabens contains the principal source rocks,
- while the reservoirs are shallow marine clastics and carbonate deposits on horst blocks.
- About one third of Libya's production is from rocks of Cretaceous age

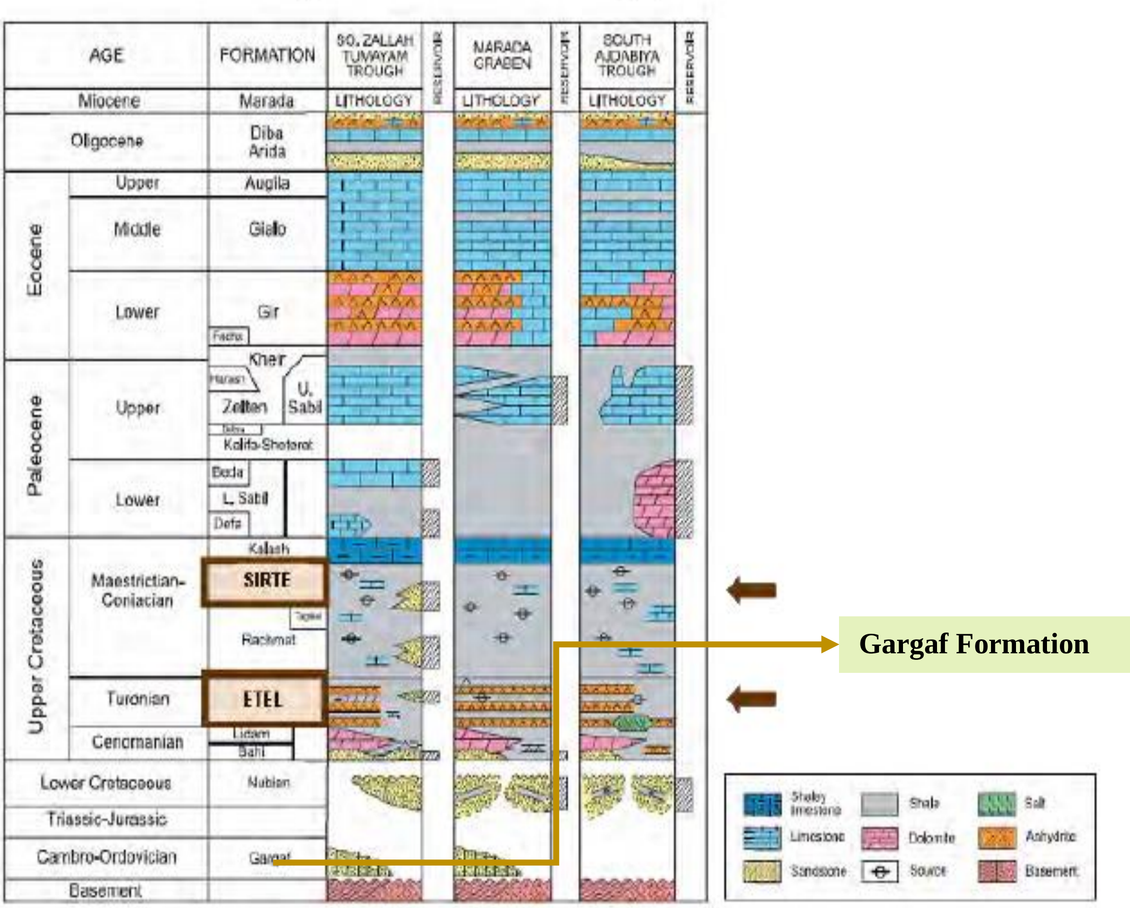


Figure 5: Generalized Stratigraphic Columen Across Section In Central Sirt Basin (Sirt and Tibesti arms), (modified from Barr and Weeger, 1972; The primary hydrocarbon source and seal rock intervals are shown. In addition reservoirs are indicated by dots).

Petrophysical Result

The average porosity, volume of shale, water saturation & oil saturation of each wells (01-59, 02-59 and 03-59) is summarized in (tables 1, 2, 3 &4).

Table 1: Summarized Average Affective Porosity

Average Effective Porosity %

Well 01-59	Well 02-59	Well 03-59
25.3	18.14	19.5

Table 2: The Average Volume of Shale (Vsh)Values of Each Wells Are Summarized

Average Effective Porosity %		
Well 01-59	Well 02-59	Well 03-59
20.3	10.3	16.07

Table 3: The Average Water Saturation (Sw) Values of Each Wells Are Summarized

Average Effective Porosity %		
Well 01-59	Well 02-59	Well 03-59
17	1.8	2.79

Table 4: The Average Oil Saturation (So)Values of Each Wells Are Summarized

Average Effective Porosity %		
Well 01-59	Well 02-59	Well 03-59
83.16	98.2	97.2

Oil Water Contacts

To define the oil water contact can be use wireline logs in any produce well which using resistivity log with neutron density cross plot. Contact between water and hydrocarbon a clear contact can be observed where the resistivity become low, we need known the hydrocarbon type and contact between oil and gas show figure below. To indefinite the type of hydrocarbon in well we using the RFT data to recognize the type of hydrocarbon also the contact between fluid in reservoir.

Net Pay Thickness

The net pay thickness of the reservoir represents intervals having porosity greater than or equal to the porosity cut-off (10%) , water saturation is less than cut-off of (50%) , and volume of shale of less than of (30%) . The net pay thickness of each well is summarized in table (5).

Table 5: The Net Pay Thickness of Gargaf reservoir

Average Effective Porosity %		
Well 01-59	Well 02-59	Well 03-59
82.5	90	90.5

Intergrate RFT With Petrophysics Result

In this study the Repet Formation Tester (RFT) data and well logs used for interpreting the reservoir fluid type and contacts between fluids such as the gas oil contact and oil water contact for Gargaf reservoir by using some wells in Belhedan Field in Sirt Basin – Nort Libya. Defining fluid contacts (Gas Water Contact/ Oil Water Contact/ Gas Oil Contact) is one of the major variables for estimating the initial hydrocarbons in place as well as in planning redevelopment strategies.

Data Quality Control : Data Description

Pressure measurement problems, supercharging, or depth errors may cause bad data. In most cases, bad data cannot be corrected. Thus, the best strategy is the identification of bad or suspect data and its elimination from the data set. The data normally supplied to the geologist is a table of summary pretest formation pressures, their depths, hydrostatic pressure, and drawdown mobilitys (formation permeability / fluid viscosity). Quality must be assessed from the transient pressure data and other data available on the pressure-test logs.

Logging Data

Logging data through well 01-59 used in this study Caliper, Laterlog shallow (LLS), Laterlog deep (LLD), Gamma Ray (GR) log, Neutron Log, Formation Density log. Qualitative analysis of well log includes determination of porous zones, sand and shale base line, water bearing formation, hydrocarbon zone, and oil water contact (OCW). Quantitative analysis obtains: porosity, water and hydrocarbon saturation, shale volume, and calculation of formation temperature, effective porosity value obtained from density-neutron logs and corrected from shale volume and hydrocarbon fluid contain. Hydrocarbon saturation is estimated from water saturations which are calculated from true resistivity (Rt). The result of petrophysices analysis for 01-59 show the contact between hydrocarbon and water at depth 8170 feet, this contact between them but what type of hydrocarbon is main target in this study, so bwe used RFT for distinct between hydrocarbon type. The raw data in table below: Pressure data sheet from RFT test was obtain in main reservoir Gargaf in well 01-59 after petrophysics analysis as show in figure below to recognize the type and contact hydrocarbon.

⊕ 2 [SSTVD]					
SSTVD	GR	SP	DT	ILD	RHOB
1:2955	-11.17 gAPI 154.15	-90.75 mV 110.25	30.19 US/F 221.80	0.1000 ohm.m 10,000.0000	1.1946 G/C3 3.1599

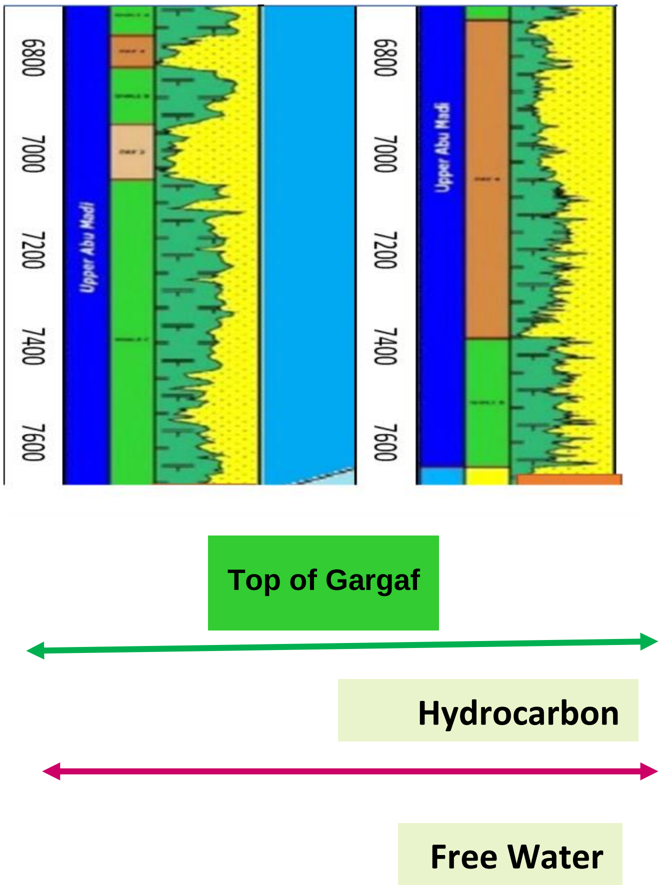


Figure 6: Contact Hydrocarbon & Free Water Zones in Gargaf Resrvoir (Techlog 2015)

Text-Table 6: illustrates RFT pressure data points for well (01-59).

Points	Depth TVD	FP	HYD1	HYD2	Temperature	Remarks
1	-49	2327.73	4000.20	4000.121	130.2909	Good Test
2	1184	2328.43	4000.98	4000.64	131.1245	Good Test
3	2685	2327.47	4000.06	4001.58	131.2588	Good Test
4	3046	2328.46	4002.96	4002.64	130.5496	Good Test
5	3308	2329.08	4003.64	4003.39	131.3545	Good Test
6	3587	2329.90	4004.21	4003.89	134.0963	Good Test
7	4099	2332.50	4005.65	4005.39	138.2767	Good Test
8	4407	2332.39	4005.30	4005.97	139.7572	Good Test
9	4635	2334.41				
10	4939	2334.00	4013.79	4013.58	139.2588	Good Test
11	5229	2337.22	4033.96	4033.69	141.288	Good Test
12	5300	2338.03	4034.44	4034.23	142.340	Good Test
13	5754	2338.95	4035.26	4035.14	144.2933	Good Test

Pressure gradient estimation

According to the difference in fluid densities, a difference in the pressure gradient occurs during the measurement. Obtained by inversely slope from plot formation pressure versus depth. The ranges which have been used are:

The different measured formation pressure opposite the reservoir is plotted against the depth and from this plot the nature of the flowing fluids (oil, gas or water) can be identified from their gradients. If this analyzed gradient give the value of density of water then, the continuous phase is water, while if the measured densities are that of oil or gas, the continuous phase will be oil or gas. Also, the depth of free water level can be estimated by studying the abrupt change in pressure on the pressure gradient.

The relationship between fluid density and the pressure gradient can be expressed as follow:

1. Gas gradient range from (0.08-0.18) psi/ft.
2. Oil gradient range from (0.28-0.39) psi/ft.
3. Water gradient range from (0.433-0.465) psi/ft.
    a. Fresh water gradient = 0433 psi/ft.
    b. Saline water gradient = 0.465 psi/ft.

Pressure gradient can be calculated by used this equation:

Gradient = (P2-P1)/(MD1-MD2) ………………………………Equation (4.10)

Where:

P1=pressure bed number 1 P2=pressure bed below number 2

MD1=depth bed number 1 MD2=depth bed number 2

The intersection of the water gradient with the oil or gas gradient represents the free water level, as shown in the following figures below. Figures (7) below represents the formation pressure against the depth, for Gargaf reservoir in Belhedan field 01-59, 02-59 & 03-59) wells. The pressure profile clearly indicates tow fluid.

Figure (7) the pressure profile for well 01-59 show clearly indicates tow distinct trends, The first gradient represents the gas gradient with a density of 0.14g/cc and the second is the oil water gradient with density of 0.41 g/cc, the contact between gas-oil at depth subsea (-6376 or 8678 kb ft) and thickness of gas zone in this well about 48 ft, the contact between oil-water at depth sub sea (-6414 or 8716 kb ft) from petrophysices analysis, thickness of oil zone about 38 ft see (Fig 7 & 8).

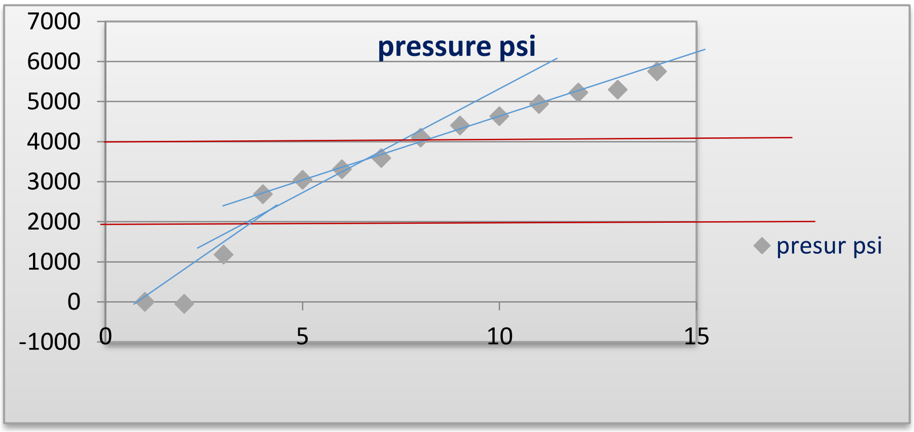


Figure 7: RFT result of well 01-59 Belhedan Field

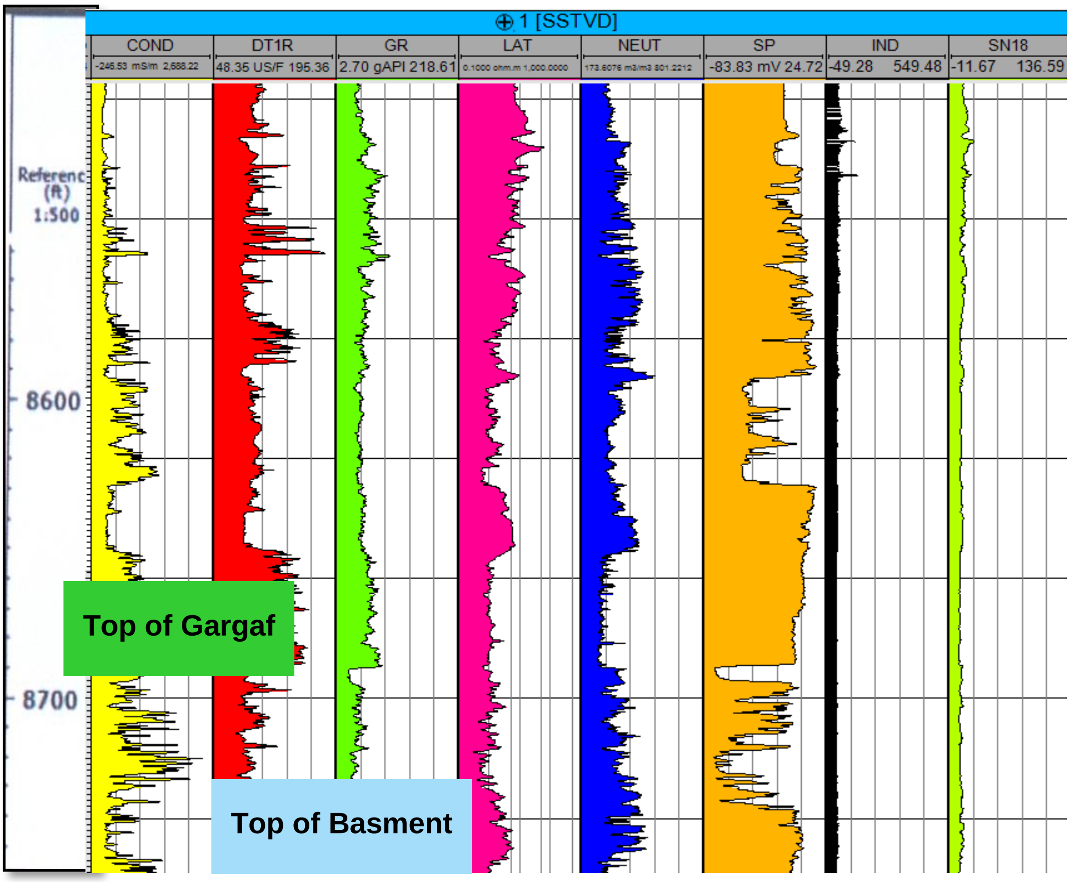


Figure 8: Integrate RFT and Petrophysics result of well 01-59, (Belhedan Field, Sirt Basin, Libya).

Figure (9) represent the petrophysics result of well 02-59, thickness of Gargaf about 134 feet and hydrocarbon zone thickness about 109 feet, the formation pressure against the depth, Gargaf in Belhedan Field in this well was run.

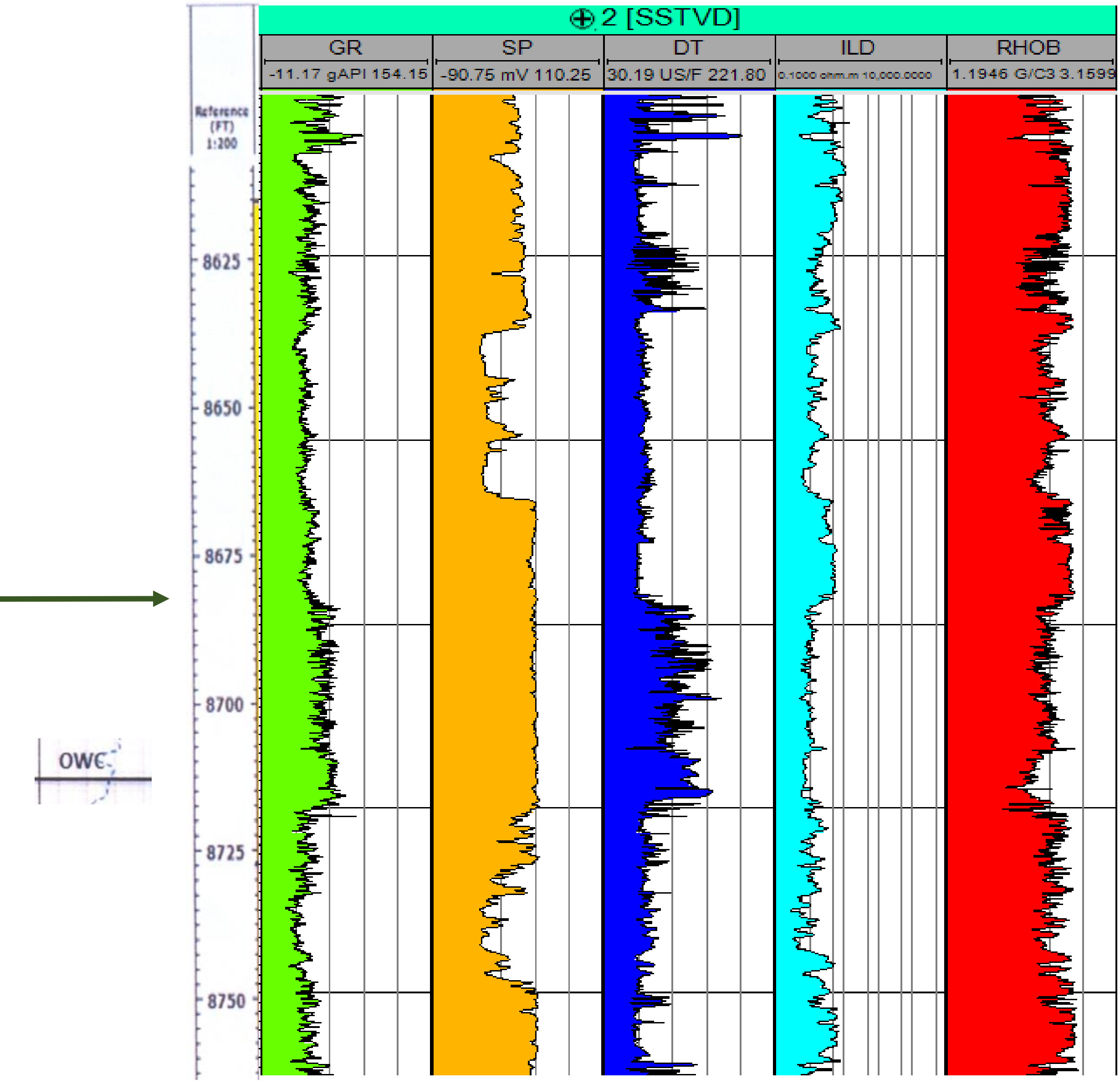


Figure 9: Show Petrophysics Result of Well 02-59 (Belhedan Field, Sirt Basin, Libya).

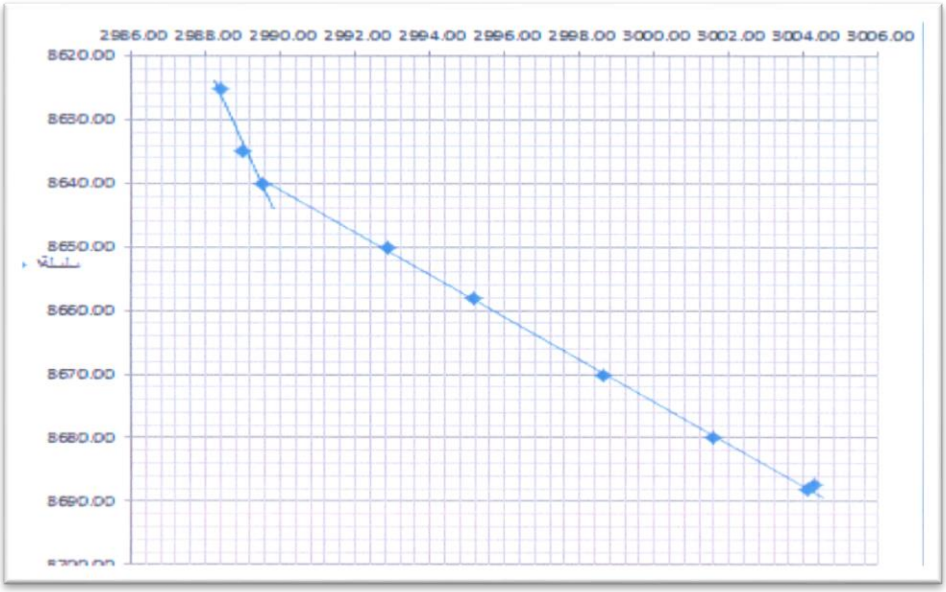


Figure 10: RFT result of Well 02-59 Belhedan Field, Sirt Basin, Libya.

The pressure profile clearly indicates two distinct trends. The first gradient represents the gas gradient with a density of 0.06 g/cc with thickness of gas zone about 24 feet, the oil gas contact at depth 8640 feet and the second is the oil gradient with density of 0.3 g/cc, and the oil water contact at depth 8727 feet with thickness of oil zone about 87 feet (fig 10 & 11).

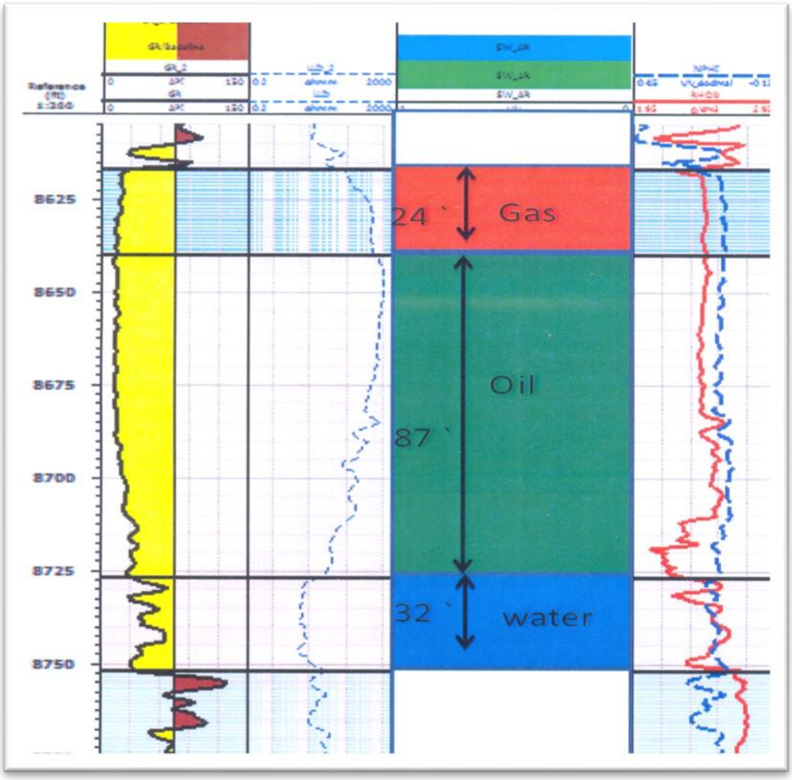


Figure 11 Integrate RFT and petrophysics results of Well 02-59

Figure (12) shows, the petrophysics result by using Techlog Software for well 03-59, which indicates two zones of fluid, one is hydrocarbon and water, the contact between hydrocarbon and water at depth 8691 feet, but what type of hydrocarbon is not clear indicates, we apply RFT . The result show the pressure profile of well 02-59 which indicates two distinct gradient. The first gradient represents the gas gradient with a density of 0.07 g/cc and second is the gradient with density of 0.36 g/cc. The gas/oil contact lies The gas/oil contact lies depth 8650 ft, the well result summary, net pay thickness 70 feet of hydrocarbon; 35 of gas and 35 feet of oil in figures (13, 14). The Integrate RFT and Petrophysics results of wells in the study area in figure (15) and table (7).

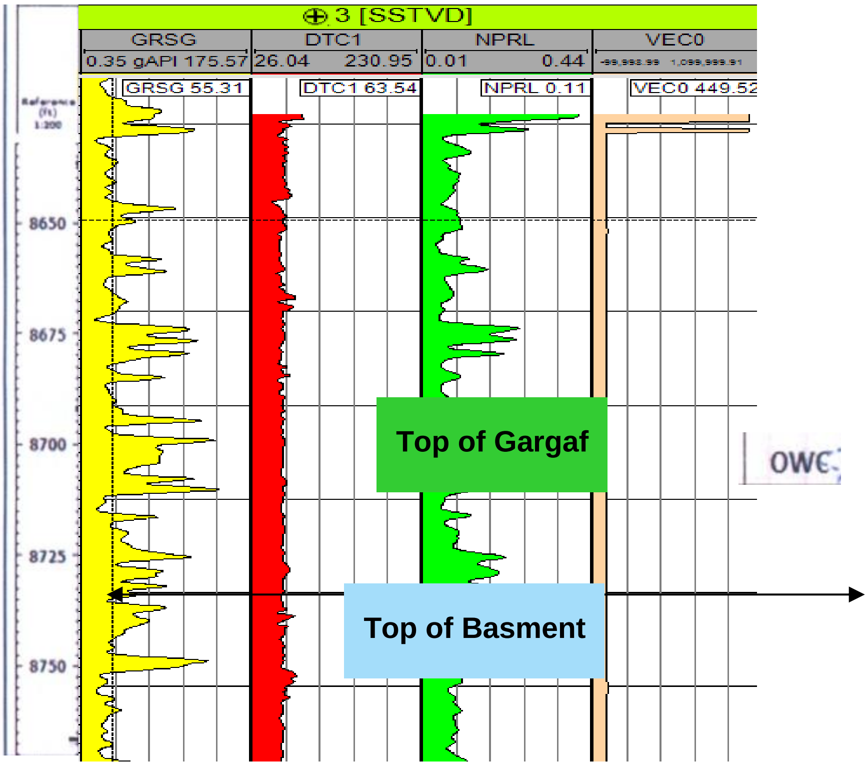


Figure12: Show petrophysics result of Well 03-59 Belhedan Field

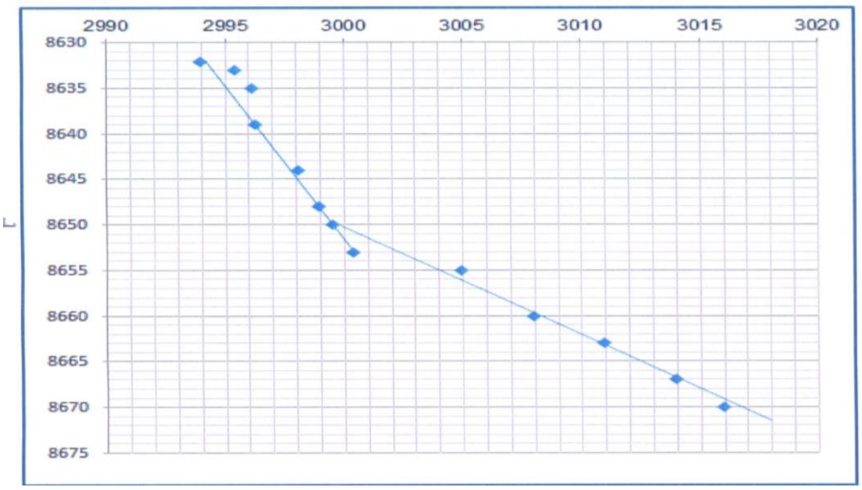


Figure 13 Show RFT result of Well 03-59 Belhedan Field

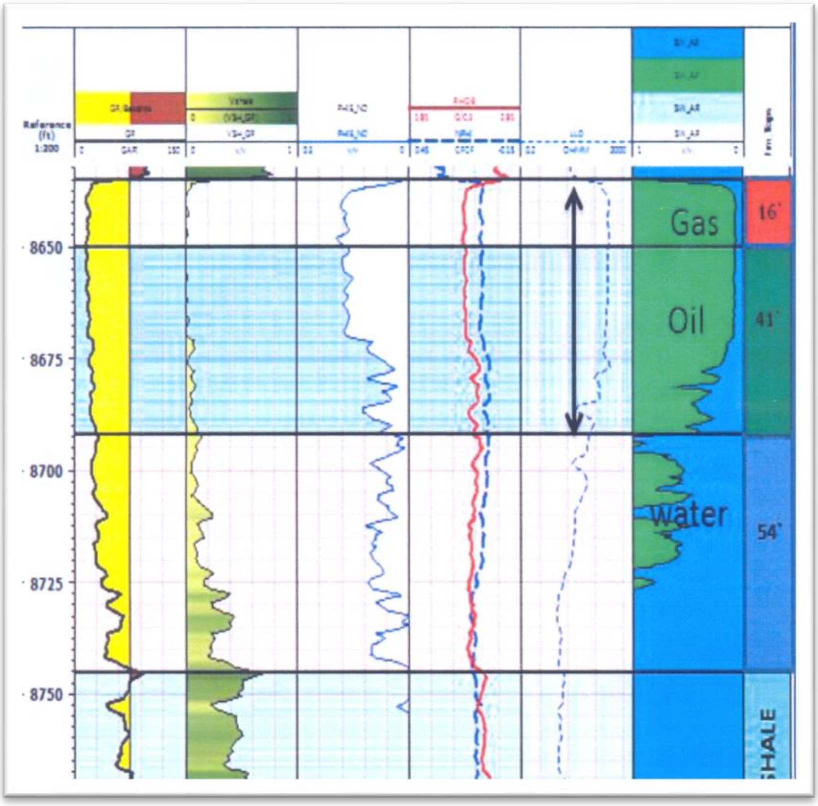


Figure 14: Integrate RFT & petrophysics results of Well 03-59, (Belhedan Field, Sirt Basin, Libya).

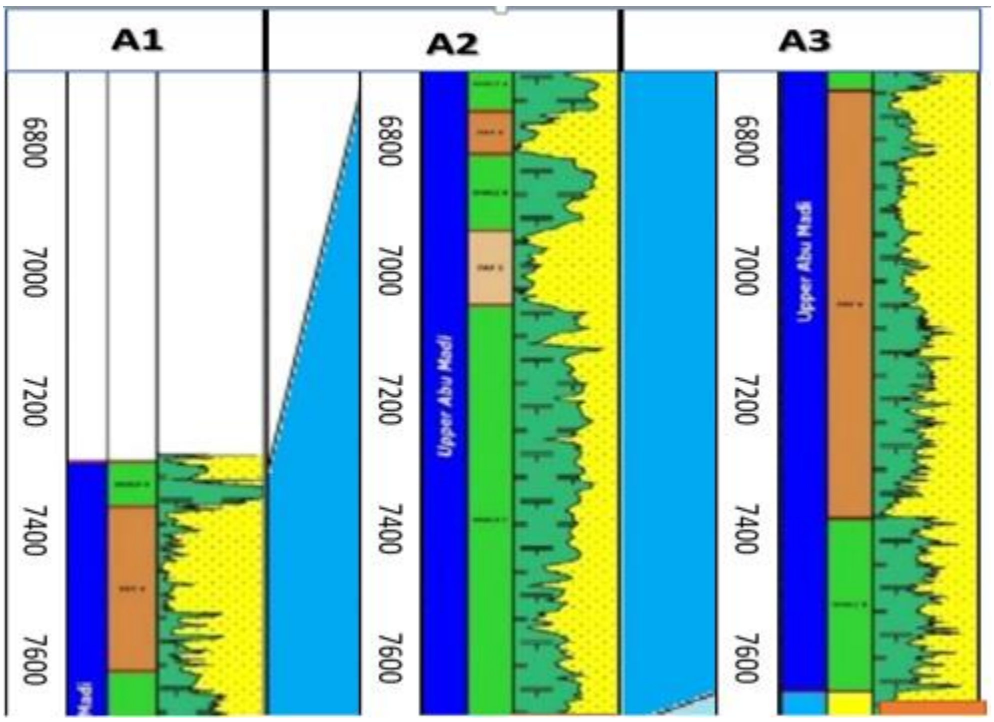


Figure 15: Integrate RFT and Petrophysics results of wells in the study area

Table7 Summary result

Well Name	01-59	02-59	03-59
Top Gargaf (feet)	**8617**	**8585**	**8555**
THK (feet)	**143**	**118**	**118**
Hydrocarbon Zone (feet)	**8727**	**8585**	**8535**
GOC @	**8640**	**8620**	**8653**
THK (feet)	**87**	**45**	**18**
OWC @	**8727**	**8655**	**8691**
THK (feet)	**46.5**	**14**	**35**
Watrer Zone THK (feet)	**41**	**15**	**44**

Conclusion

1. The Repeat Formation Tester is an important tool for production and reservoir engineering.
2. RFT data can be interpreted to obtain formation actual formation pressure that can be applied for a better understanding of petroleum reservoirs. The application is applied on Gargaf in three wells distributed in Belhedan Field in Sirt Basin North of Libya. The application discussed is based on the analysis of petrphysics integrate with RFT pressure profiles. Plotting formation pressures versus true vertical depth produces a pressure profile.
3. Evaluating the gradient of this profile provide information about the type of fluids and the contact between them by monitoring the abrupt changes in the pressure gradients.
4. The pressure profiles of Gargaf reservoir in 01-59, 02-59 and 03-59 were constructed.
5. Through the pressure profile, most of the dominated fluids are the gas, oil and water the contacted gas with oil was distinguished the oil can be extracted from the studied wells.

REFERENCES

1. **Ahmed Altayeb Ahmed Jobara & ect,** Improve Estimation for Fluid Contacts Using Excess Pressure, 2016
2. **A.Z. NOAH (2014),** Use Repeat Formation Tester for Determination of Some Reservoir Characteristics for Kareem Formation in Some Wells at Amal Field, Gulf of Suez Area, Egypt, American Journal of Research Communication, vol 12 (4) :157-167)
3. **D.Hallet, (2002),** Tectonic Elements of Sirt Basin Geology of Libya
4. **Dr.Paul Glover** Fluid Testing and Pressure Logs Fluid Testing and Pressure Logs
5. **K.Boral, S. Sharmal (2012),** Understanding Complex Fluid Contact Distribution in a Brown Carbonate Field – Mumbai High, AAPG
6. **Schlumberger, (1986)** Repeat Formation Tester, Princeton Junction, NJ
7. **Schlumberger, (2006),** Reservoir Optimization Conference - Libya