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# Petrophysical characterizations of Mishrif Formation in Selected Wells of Tuba Oil Field, Southern Iraq

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**Abstract**

The current study includes building (CPI) & Petrophysical analysis of the Mishrif Formation (Cenomanian-Early Turonian) in Tuba oil field to evaluate different logs parameters that control the reservoir quality of Mishrif Formation such as shale volume, effective porosity, and water saturation. Mishrif Formation is subdivided into several units, which are characterized by different reservoir properties. These units are *T.M, MA, CR2, MB1, and MB2*.The results of computer processed interpretation (CPI) show that the major reservoir unit is (MB1 and MB2), characterized by high effective porosity and oil saturation. In addition, these units consist of vuggy rudist-bearing facies. The units TM,MA have lower reservoir quality due to low values of effective porosity and high water saturation .The low effective porosity in these units is related to the dominance of lime-mud rich facies that are recognized in deep marine and lagoon facies associations. The unit CR2 represents a cap unit, which extends in all studied wells.

**Keywords:** Carbonate, Mishrif, Petrophysics, reservoir.

# الخصائص البيتروفيزيائيه لتكوين المشرف في ابار مختاره لحقل الطوبه جنوبي العراق

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**الخلاصة**

تتضمن هذه الدراسه بناء وتحليل وتقيم الخواص البتروفيزيائيه لتكوين المشرف في حقل طوبه للتتابع لعصر السينوماني–التروني المبكر المشرف في حقل الطوبه جنوبي العراق استخدم برنامج (IP V3.5) اجري تفسير للمجسات تضمن حساب حجم السجيل والمسامية الفعالة والتشبع المائي .في هذا الحقل تم تقسيم تكوين المشرف الى خمس وحدات (T.M,MA,CR2,MB1,MB2). وبالاعتماد على نتائج ال (CPI) تبين ان الوحدات المكمنيه الرئيسيه لتكوين المشرف والمنتجه هي (MB1 and Mb2) التي تتميز بمساميه فعاله عاليه وتشبع نفطي بالاضافه الى ذلك تتميز بوجود سحنات الرودست .الوحدات التي تمتلك صفات اقل هي (T.M,MA)التي تتميز بصفات مكمنيه رديئه نتيجه المساميه الفعاله تكون قليله مثل وحده غطاء وتكون ممتده في كل الابار المدروسه للحقل .باستخدام مجس النيترون مقابل الكثافه تبين ان اغلب النقاط تملئ خط الحجر الطيني ونقاط صغيره تملئ خط الدولومايت للابار المدروسه في حقل الطوبه.

## Introduction

The carbonate reservoirs of Mishrif Formation in the oil fields of southern Iraq were discovered before many decades. For example, oil has been produced from the Mishrif Formation reservoirs in Tuba oil field, well Tu-1 since 1960, and production continues after drilling wells. The petrophysical properties are studied based on wireline logs data combined with core.

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**The study area**

The Tuba oil field is found about 35 Km southwest Basrah city between Zubair from the East (5km distance) and South Rumaila from West (2km distance) (Figure-1).The Tuba anticline trends approximately N-S and 29 km long and the width reaches about 9 km (Figure-1).

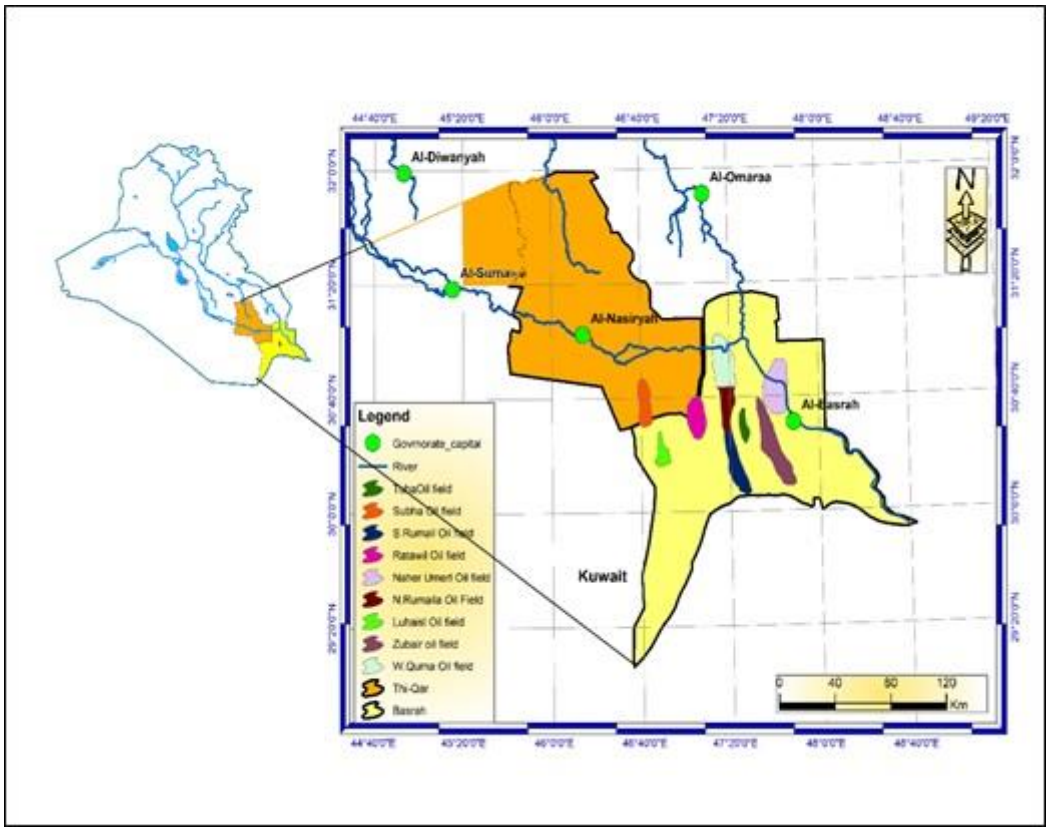


**Figure 1-L**ocation Map of Tuba Field

**Materail and methods**

1- Digitizing well logs by using Didger software.
2- Using (IP, V3.5) software for lithology correction
3- Determination of petrophysical log parameters (porosity, volume of shale, resistivity, water saturation).

**Stratigraphy**

The Mishrif Formation (Cenomanian-Early Turonian) expresses a heterogeneous carbonate succession originally characterized as organic detrital limestones, capped by limonitic freshwater limestone [1], [2]. It is represented an overall progradational marine shelf sequence, with the development of rudist shoal and biostorme [3].The Mishrif Formation consists of two major sedimentary cycles abruptly terminated by the unconformity, which separates the Mishrif from the overlying Khasib Formation [2]. The upper contact is unconformable with Khasib Formation [4].whereas the lower contact of the formation is conformable with the underlying Rumaila Formation,

**Tectonic and structural setting of the study Area**

The study area located in Mesopotamian zone and zubair subzone which is considered as a part of the Mesopotamian Foredeep Basin Mesopotamian Zone occupies southern and middle parts of Iraq, It contains the largest and richest petroleum province in Iraq and is dominated by Cretaceous plays (Aqrawi et al. 2010) Figures-(1-6). This zone was probably uplifted during the Hercynian deformation but it subsided from Late Permian time onwards. The sedimentary column of the Mesopotamian Zone thickness increases to the east. The structural element of Tuba oilfield is an asymmetrical anticline, The western limb gives inclination of 0.9 degree(OEC). The Tuba anticline has a plunging axis type (Figure-2). The thickness of Mishrif Formation in Tuba oil field decreases towards North and South directions (Figure-3).

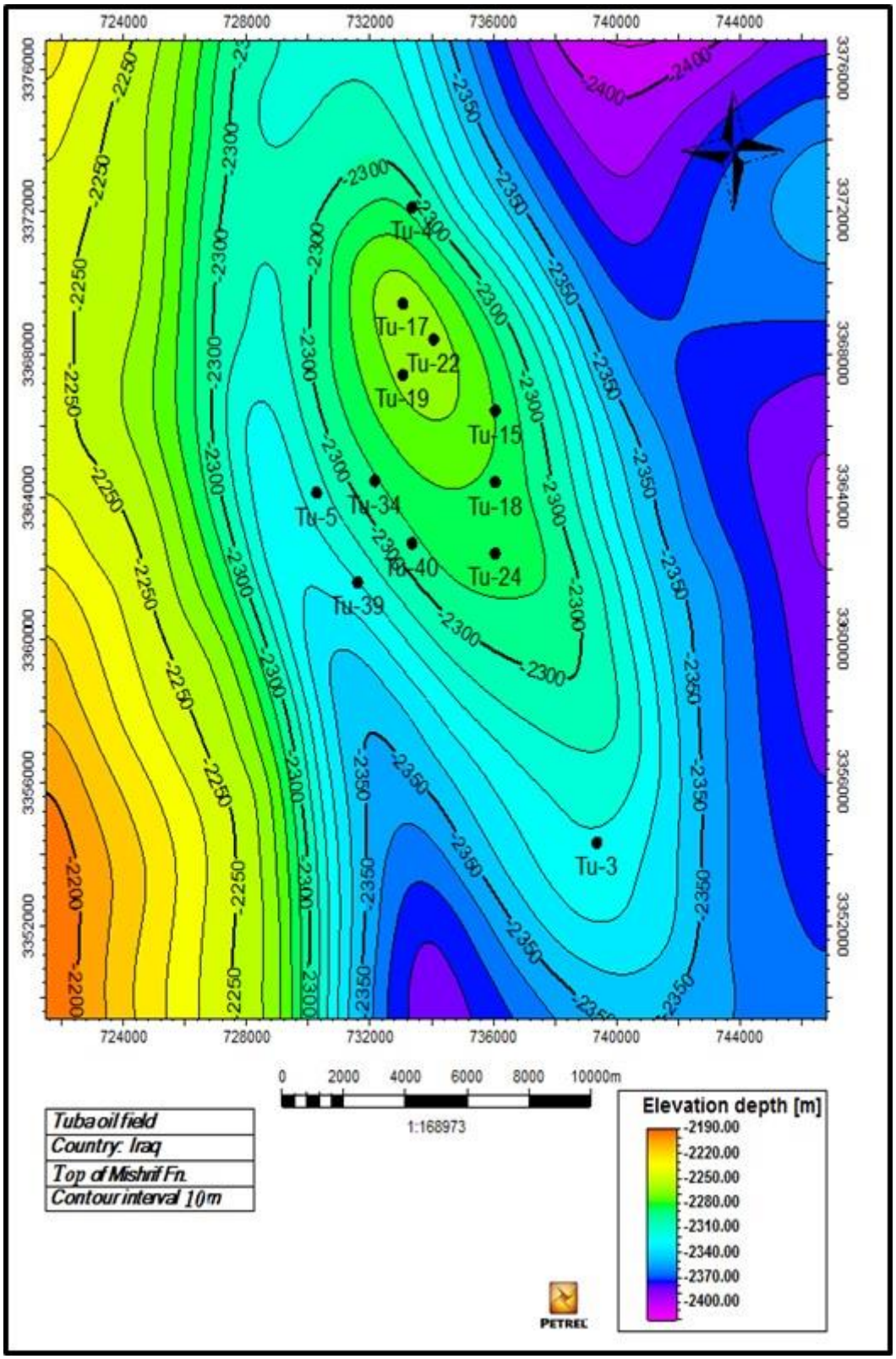


**Figure 2-**Structural counter map at top of Mishrif Formation.

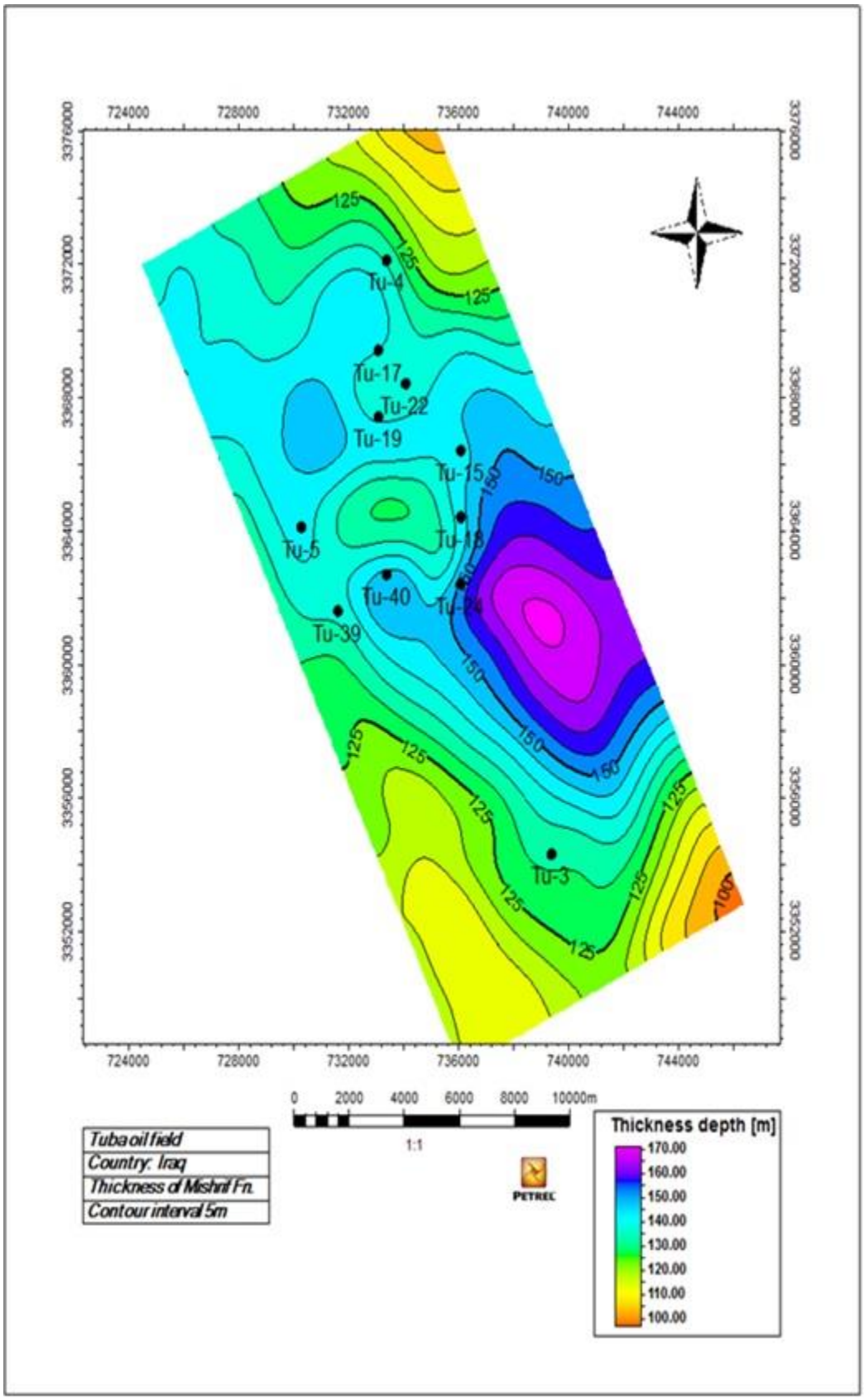


**Figure 3-**Thickness map of Mishrif Formation inTuba oil field

**Computer Processes Interpretation (CPI) & Petrophysical Reservoir Evaluation**

The current study includes building (CPI) & Petrophysical Evaluation of the Mishrif Formation (Cenomanian-Early Turonian) in Tuba oilfield, southern Iraq. By using CPI, the Mishrif Formation was subdivided into five units separated by barrier beds (seal rock) according to the reservoir

characteristics (porosity and saturation). The reservoir units have high porosity, low water saturation with variable quality and separated by tight muddy limestone layers that have high water saturation and poor porosity. The Mishrif Formation consists of three principal oil-bearing units. Main focus of this study is on the oil-bearing units: MA, MB1, and MB2 Figures-(4, 5, 6, 7, 8, 9) the units Top of Mishrif, CR2, non- reservoir or poor reservoir units in the study area. The characterization of reservoir units of Mishrif Formation is explained below:

1-Top of Mishrif unit is a non- reservoir but is characterized by high porosity and water saturation as well as containing low residual oil shows.

2- -MA unit represents the uppermost oil bearing reservoir unit in the Mishrif Formation in wells (Tu-4, Tu-5,Tu-17,Tu-24,Tu-39, Tu-40) that is characterized by moderate oil volume but tend to increase where the porosity increases and water saturation decreases.

3- CR2 unit represents a shale unit that can be found in all wells. This unit is thin and separates the upper part from lower part of Mishrif Formation.

4-The reservoir units MB11and MB2 are characterized by high oil values due to high porosity and low water saturation

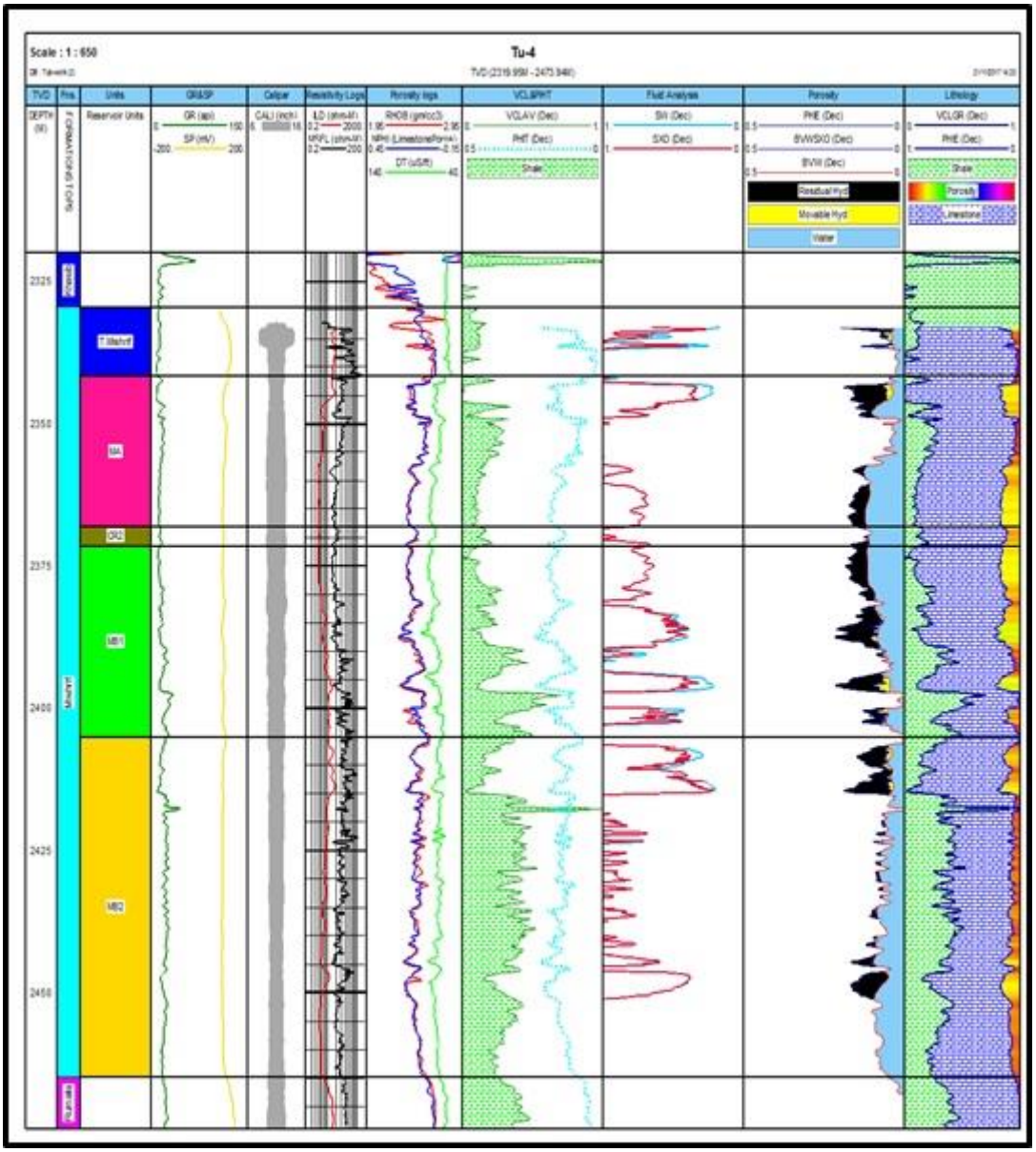


**Figure 4-** Computer Processed Interpretation of Mishrif at well Tu-4

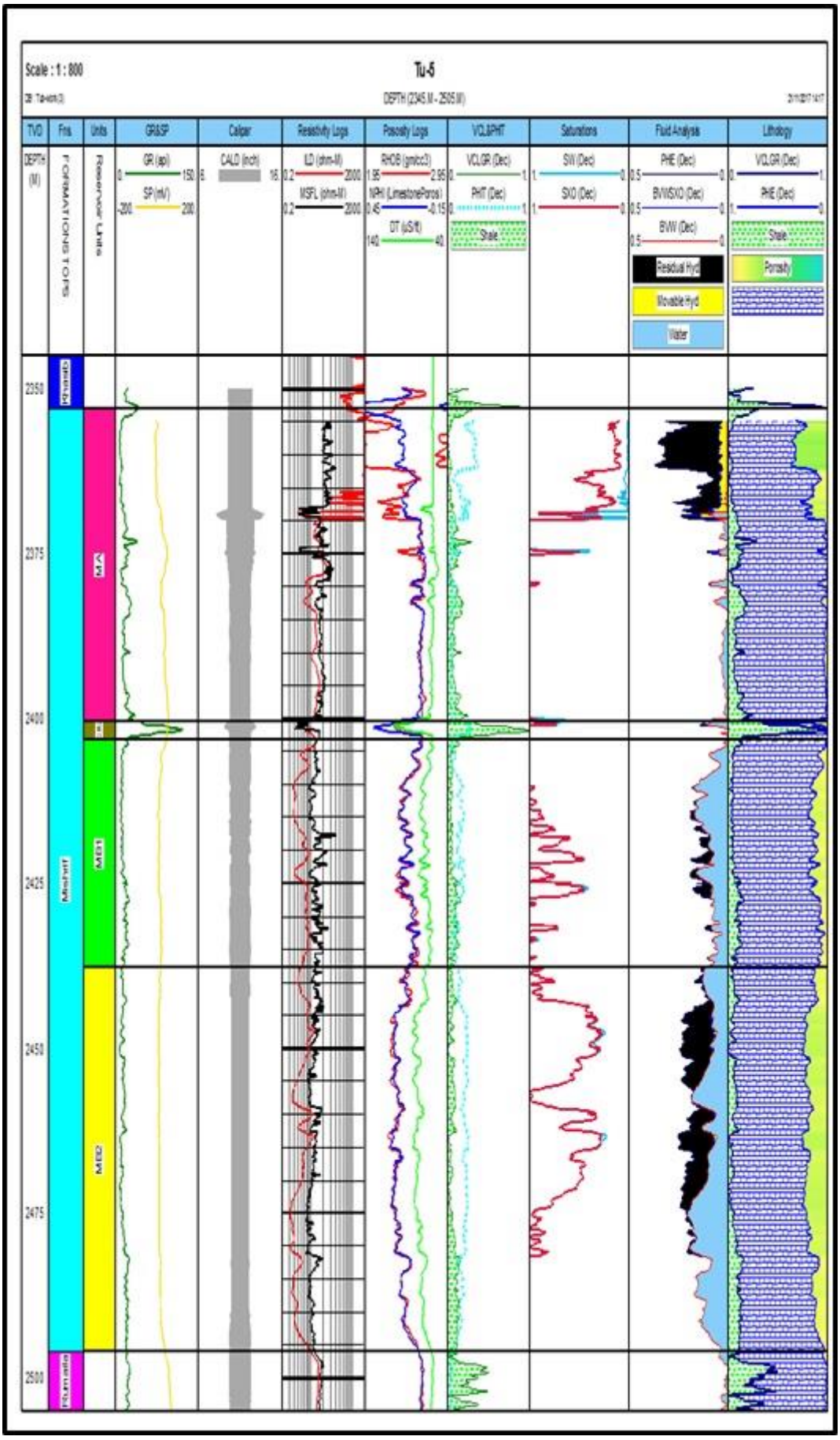


**Figure 5-**Computer Processed Interpretation of Mishrif at well Tu-5

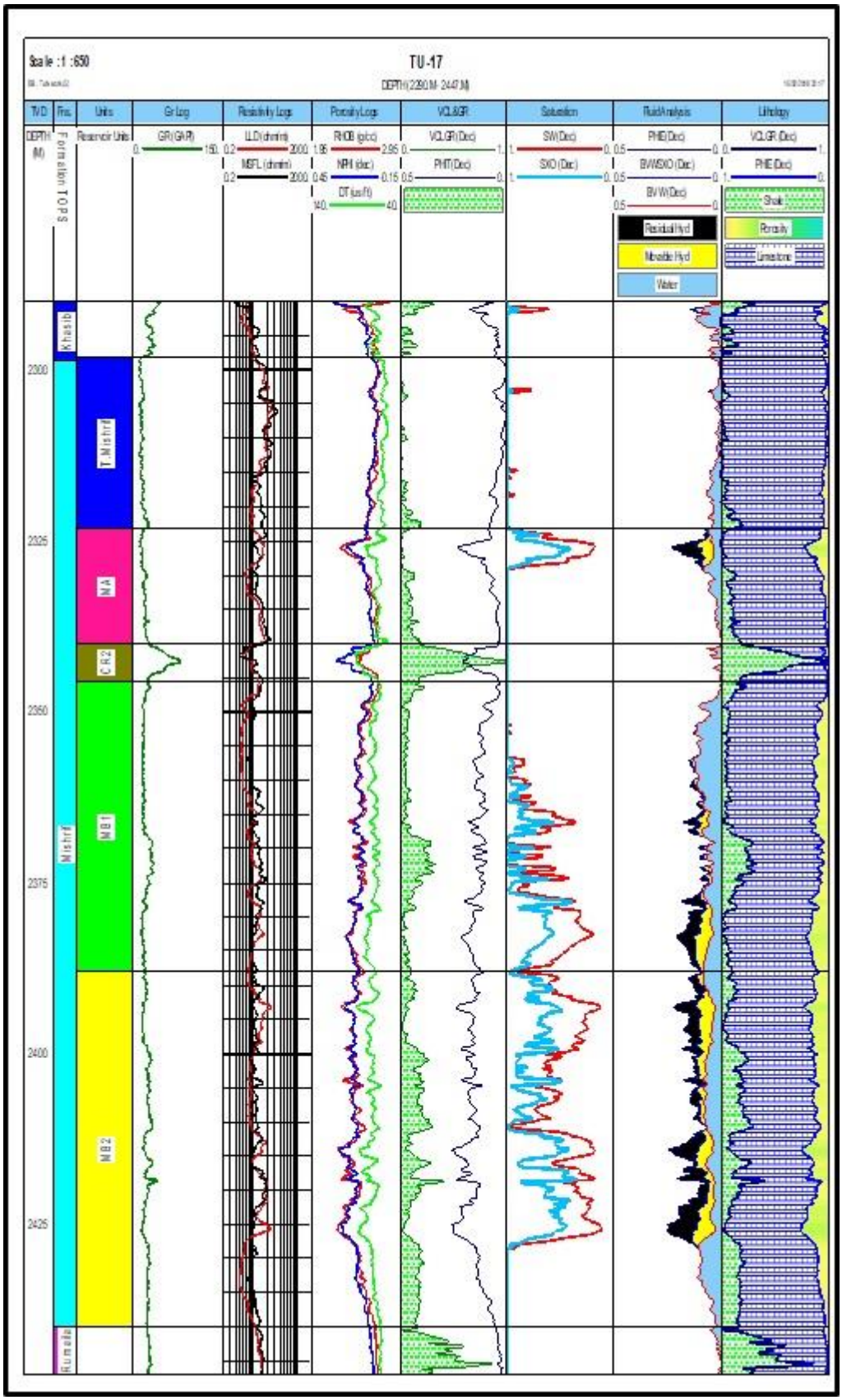


**Figure 6**-Computer Processed Interpretation of Mishrif at well Tu-17

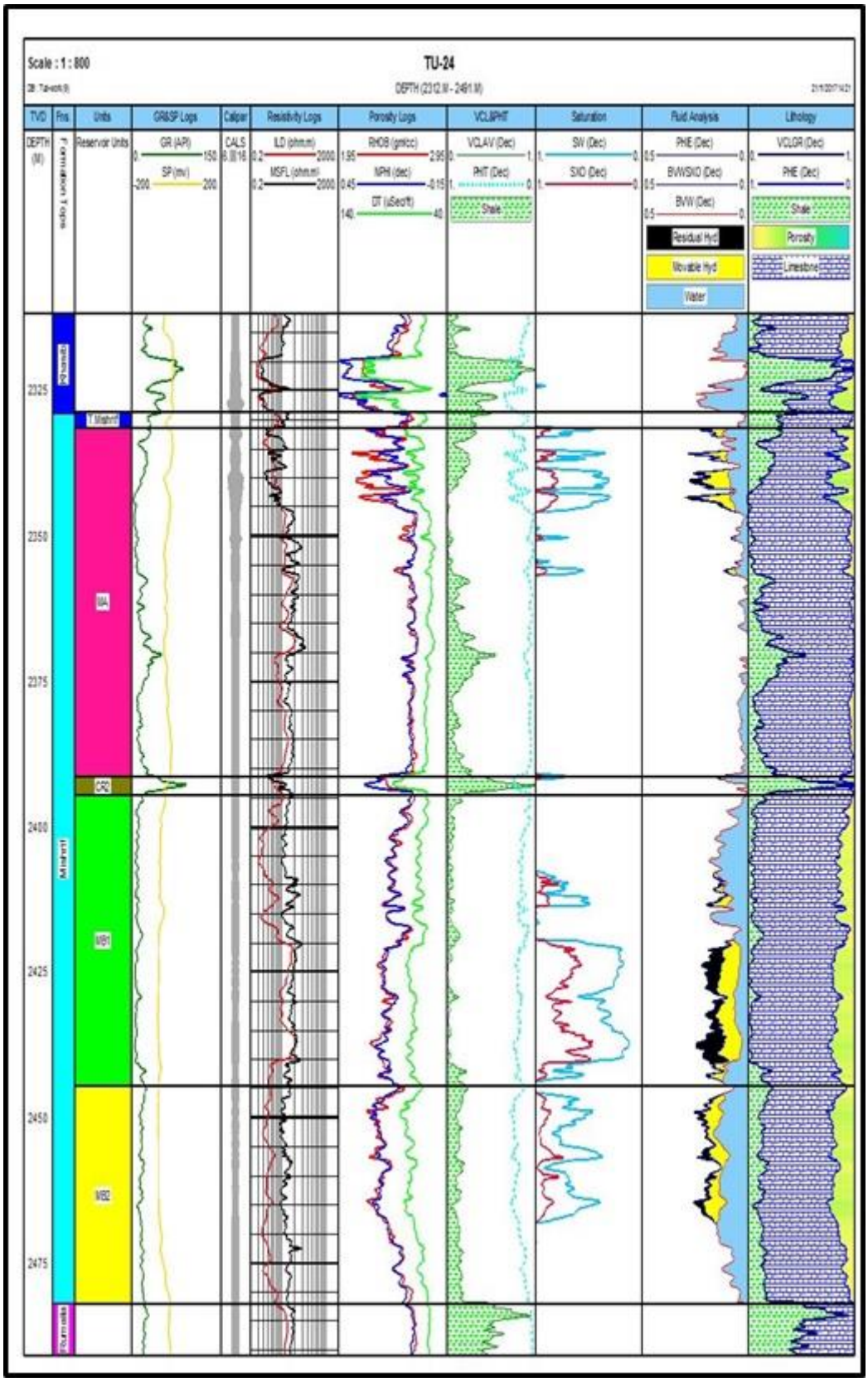


**Figure 7-**Computer Processed Interpretation of Mishrif at well Tu-24

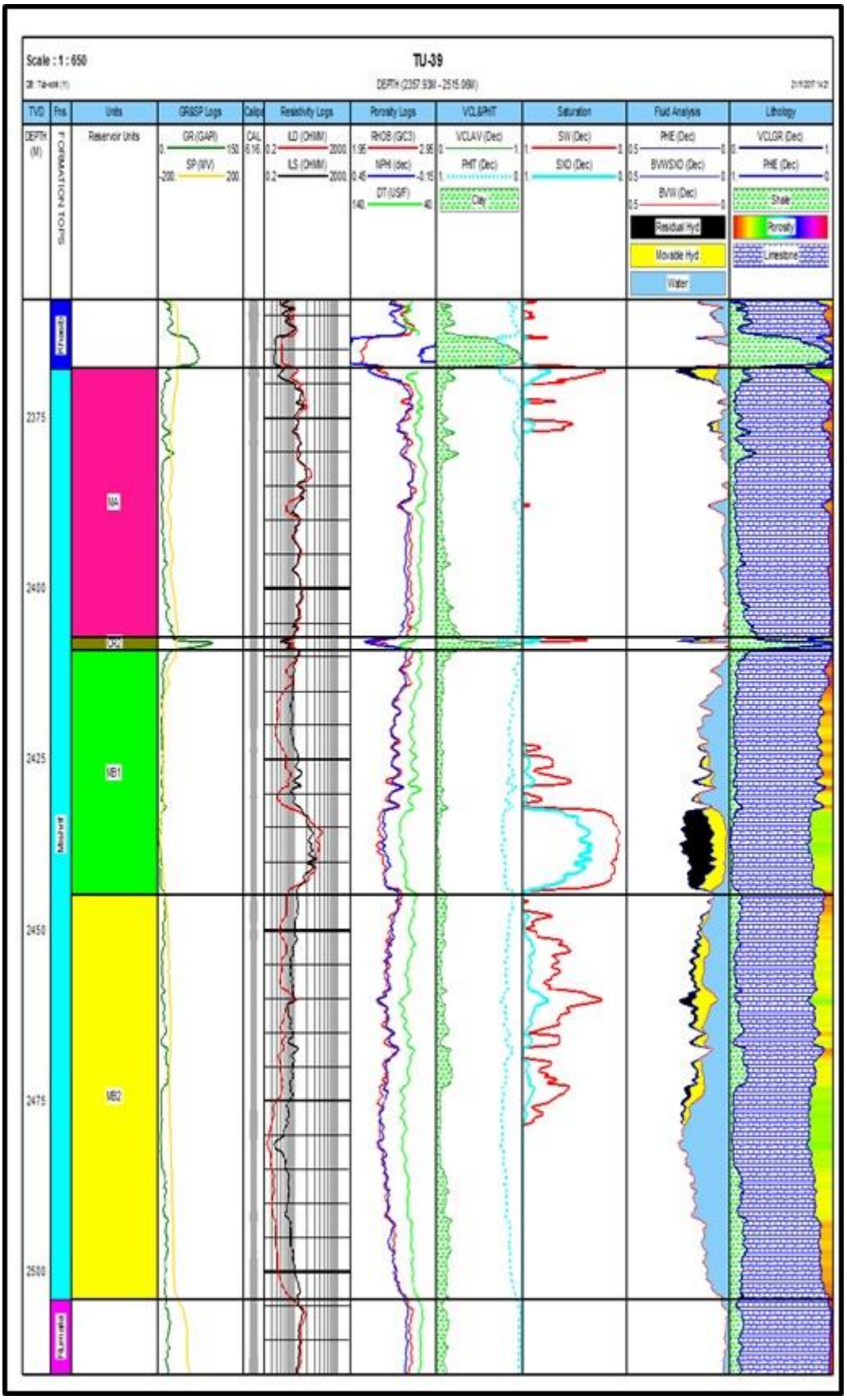


**Figure 8-**Computer Processed Interpretation of Mishrif at well Tu-39

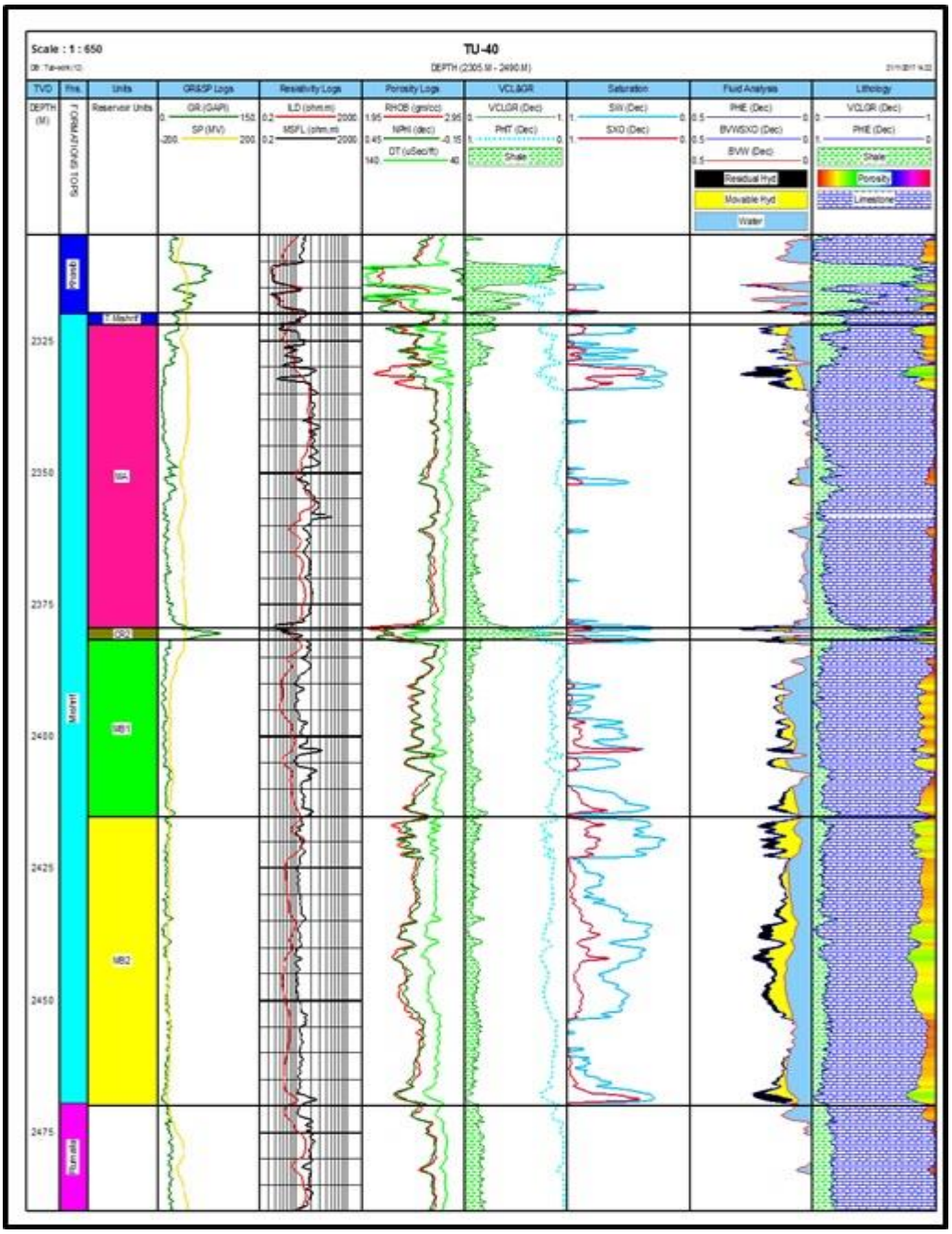


**Figure 9-**Computer Processed Interpretation of Mishrif at well Tu-40

**Determination of Lithology and Mineralogy**

Lithology is a term often used to describe the solid; matrix, portion of the rock generally in the context of a description of the primary mineralogy of the rock [5]. Lithology identification of Mishrif Formation was inferred from log responses using standard petrophysical cross plots. When used in combination rather than individually, the logs give a more accurate indication of porosity and extract much other useful information [6].

**Density vs. Neutron Cross Plot**

The neutron–density cross plot is one of the oldest quantitative interpretation tools it was the principal method for determining the formation lithology. By comparing the neutron log response to the density log response, using the separation of the curves visually or plotting the two values on a special graph {9}. This considers important and very frequently used to provide satisfactory resolution of porosity, good lithological resolution for quartz, calcite, and dolomite. The matrix density differences between the three standard rock types and the neutron lithology effect, the separations

between the quartz, limestone, and dolomite lines indicate good resolution for these lithologies. Also, the most common evaporites (rock salt, anhydrite) are easily identified, [7] From Figuers (9,10,11,12) most points fall on limestone line and only a few points fall on the dolomite line, which indicates the dominance of limestone lithology of Mishrif Formation in the studied wells of Tuba oil field

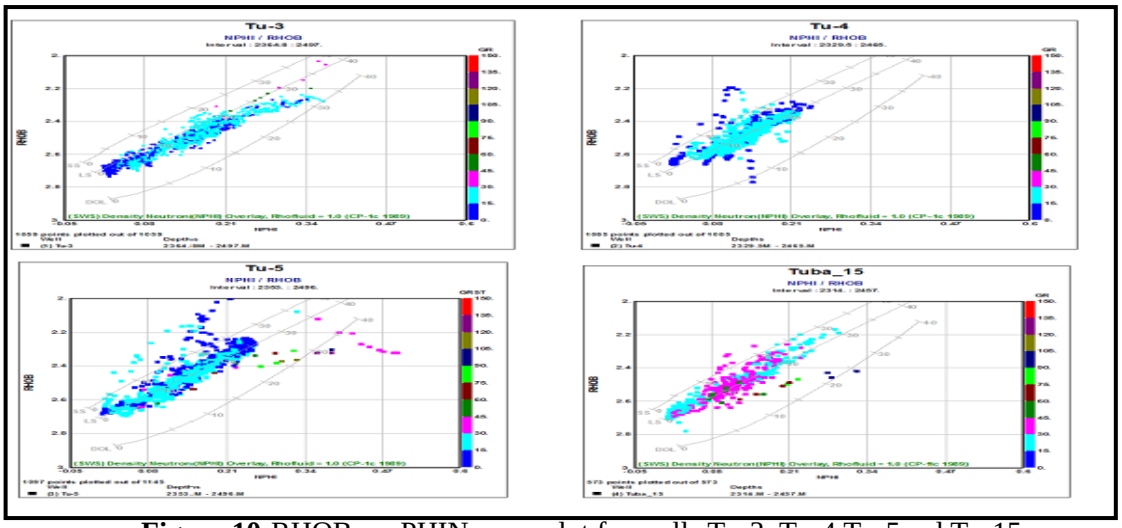


**Figure 10**-RHOB vs. PHIN cross plot for wells Tu-3, Tu-4,Tu-5and Tu-15.

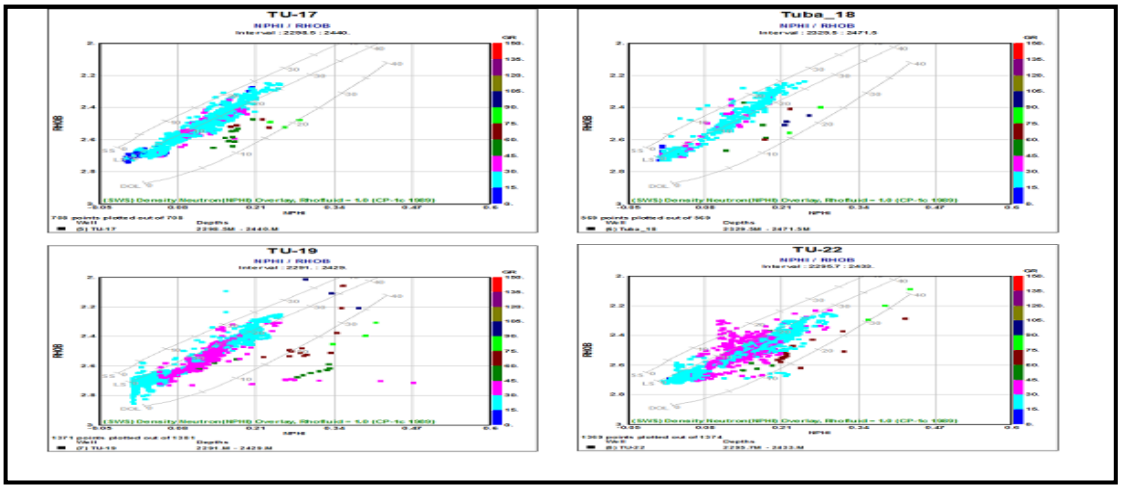


**Figure-11:** RHOB vs. PHIN cross plot for wells Tu-17, Tu-19,Tu-22,Tu-24.

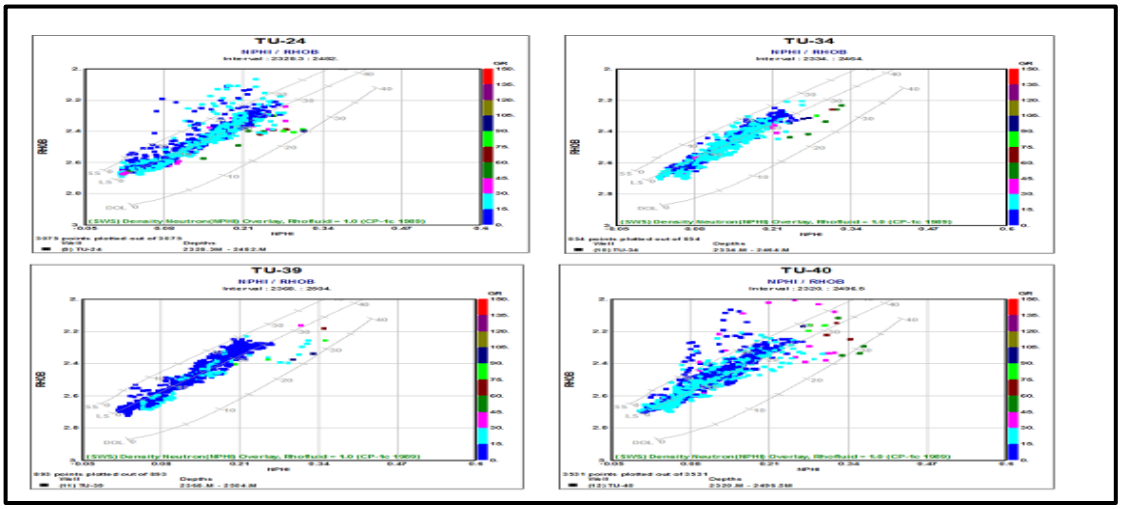


**Figure-12:** RHOB vs. PHIN cross plot for wells Tu-24,Tu-34,Tu-39andTu-40.

**Discussion**

By using Density vs. Neutron Cross Plot showed that most points fall on limestone line and only a few points fall on the dolomite line, which indicates the dominance of limestone lithology of Mishrif Formation in the studied well of Tuba oil field. Interactive Petrophysics Program v3.5 (IP) is used to evaluate different logs parameters that control the reservoir quality of Mishrif Formation such as shale volume effective porosity, and water saturation.Mishrif Formation is subdivided into several units, which are characterized by different reservoir properties. These units are (Top of Mishrif, MA, CR2, MB1, and MB2).The result of computer processed interpretation (CPI) shows that the major reservoir unit is (MB1 and MB2), characterized by high effective porosity and oil saturation. In addition, these units consist of rudist-bearing facies. The units TM,MA have lower reservoir quality due to low values of effective porosity and high water saturation .The low effective porosity in these units is related to the dominance of lime-mud rich facies that are recognized in deep marine and lagoon facies associations. The unit CR2 represents cap units, which extend in all study wells. Structural contour maps of these units show that the Tuba structure represents an anticlinal fold running along a NW-SE direction.

**Conclusions**

The density vs. neutron logs cross plot shows the dominance of limestone lithology of Mishrif Formation in Tuba Field with a secondary occurrence of Dolomite. The computer processes interpretation (CPI) of (12) boreholes of Tuba field have been deduced using IP software. The computer processed interpretation showed that the Mishrif Formation consists mainly of 4 reservoir units separated by non-reservoir (barrier) beds. The most important reservoir units are MB1 and MB1 due to their log response that are characterized by low GR log and high porosity values as derived from sonic, density and neutron logs indicating that mean good reservoir properties .

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