



Evaluation of Tertiary Reservoir in Hamrin Oil Field, North Iraq

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Abstract

Hamrin oil field is one of the important oil field in northern Iraq. The field represent an asymmetrical anticline that extend North West-South East for more than 101 km, with width (4-7) km. Hamrin oil field was located at the south western boundary of foothill zone of the unstable shelf area according to the tectonic division of Iraq. The Tertiary reservoir represented by Jeribe and Euphrates formations as main reservoirs and Dhiban formation as secondary reservoir that represent an attractive petroleum completion target in Hamrin oil field. The aim of this study is to determine the petrophysical properties of these formations, using log data, because these properties affect the estimate of reserves (porosity and saturation) and well deliverability (permeability). This study shows that the petro physical properties of these formations were controlled by depositional environment, diagenesis and tectonic activity. The evaluation of the petro physical for tertiary reservoir in Hamrin oil field was necessary to choose the best interval for well completion.

Keywords: Formation evaluation, Hamrin oil field, Tertiary reservoir, Petro physical properties

Abbreviations: NW-SE-North West-South East

Introduction

Hamrin oil field is one of the important oil fields in northern Iraq. The field represent an asymmetrical anticline that extend NW-SE for more than 101 km, with width (4-7) km (Figure 1) [1]. Hamrin oil field located at the south western boundary of the foot hill zone of the unstable shelf area according to the tectonic division of Iraq [2]. The foot hill zone is gently folded during the Pliocene age and is characterized by wider shallow syncline [3]. The foothill zone has the deepest precambrian basement in Iraq (≈ 13 km) and very thick Miocene-Pliocene molasses sediments (3 km thick) [2]. The zone comprises two longitudinal units, the Makhul-Hamrin subzone in SW and Butmah-Chemchemal subzone in the NE [4]. The tertiary reservoir in Hamrin represented by two main formations, Jeribe and Euphrates formation and one secondary is Dhiban formation. These formations belong to latest Eocene-Recent Megasequence, AP11 of the tectonic history of Iraq, this mega sequence is associated with the closure of Neo-Tethyan basin along N and E sides of the Arabian plate, and opening of the Gulf of Aden and Red sea on the S and W of the plate [2]. The two main elements of the petroleum system of this area, the reservoir units represented by Jeribe, Euphrates formations and the cap rock that sealing the reservoirs units represented by Fatha formation were deposited during this mega sequence.

The determination of rock petro physical properties is needed during the reservoir characterization process because it affects the estimation of reserves (porosity and saturation) and well deliverability (permeability) as well as to determine the ability of borehole to produce hydrocarbon [5,6]. As the petro physical properties are controlled by depositional environment, diagenesis, tectonic process and the depositional environment of the reservoir units of the hydrocarbon bearing formations in Hamrin oil field will show vertical

and lateral variation of its petro physical properties across the field. The best knowledge of these variation of the petro physical properties, laterally and vertically will be necessary to choose the best location for the drilled wells in the future and the best interval for perforation during the development of the oil fields.

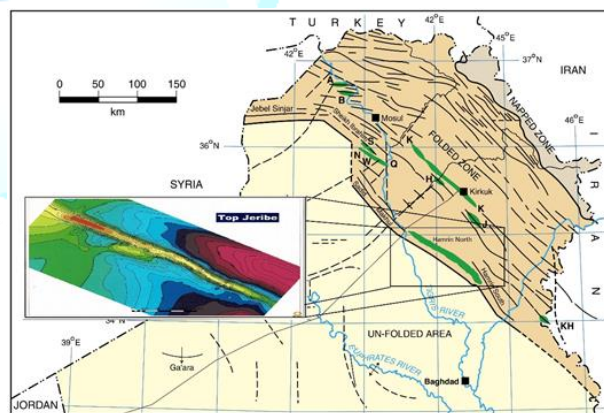


Figure 1: Location map of the study area.

Material and Method

Computer Processed Interpretation (CPI) was performed using Interactive Petrophysics (IP) software version 3.5 for log interpretation to estimate the petro physical properties of Jeribe, Euphrates and



Dhiban formations. Depending on well log data, Gamma Ray log (GR), tool that detects the natural radioactivity of the rocks, The Density Log (RHOB), tool that determine the density of rocks, Neutron Log (NPHI), to calculate the porosity, Sonic Log (Δt) to measure the transient time for sonic waves that travel through the formation, and resistivity log to determine the resistivity of the formation that reflect the type of fluids (water, hydrocarbon) trapped in these formations. Seven wells (Hr-54, Hr-58, Hr-63, Hr-59, Hr-69, Hr-56, and Hr-66) in Hamrin oil field were selected to conduct the study.

Formation Evaluation

Formation evaluation is the application of scientific principles, engineering concepts and technological innovation in exploration and prospecting hydrocarbon resources in the geological formation. It plays critical role in resources assessment and is important in selection the best locations for wells as well as the best interval for perforation during the development phase of the oil fields [7]. It involves detailed and systematic data acquisition, gathering, analysis and interpretation, both quantitatively and qualitatively while applying engineering and scientific principles.

Tertiary Reservoir in Hamrin Oil Field

The main tertiary reservoirs in Hamrin oil field are Jeribe and Euphrates formations, and the secondary reservoir is Dhiban formation (Figure 2).

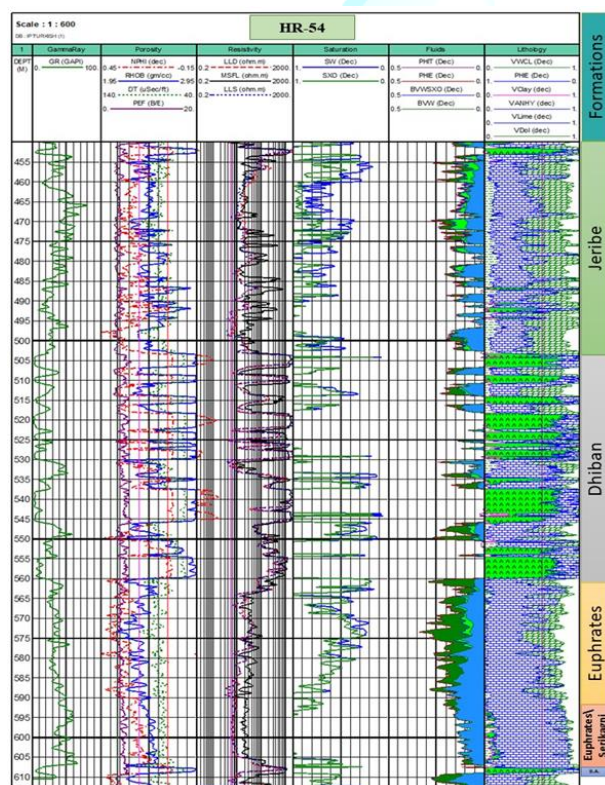


Figure 2: Computer processed interpretation for Jeribe, Dhiban and Euphrates formations in Hamrin oil field.

The studied formations belong to a group of carbonate reservoirs which houses much of Iraq's proven reserves. Jeribe formation is an attractive petroleum completion target in most of the northern oil field of Iraq. The formation was first mentioned by Damesin in 1936, but was first defined by Bellen in 1957. The formation represents the basinal, transgressive limestone dominated part of the Middle Miocene sub-cycle [3]. The thickness of Jeribe formation in Hamrin area is about 50 m. The formation was deposited in lagoon (back reef) and reef

environment, with sign of more off shore facies. There are in fact three main facies, which interfinger extensively with each other. These are a lagoon facies, reef facies and detrital facies that were probably deposited in front of a reef in shallow quiet sea, a gulf or an extended sea arm. The Euphrates formation (lower Miocene) was first described by De Becockh and Viennot in 1929 [8]. Where the type section was near valley Fuhaimi near Anah city west Iraq, the formation is consist of three unites from bottom to top:

Unit A, cavernous and conglomeratic limestone, unit B, shelly limestone and unit C, marly and chalky limestone, most of studies reported that Euphrates formation was deposited in shallow marine environments and lagoonal environments isolated by an organic barrier [8]. Dhiban Formation was defined by Henson in 1940, and amended by Bellen in 1957 [8]. From the type area near Dhiban village in the Sinjar area of the foothill zone of NW Iraq.

The formation comprises of gypsum and thin beds of marl and brecciated crystalized limestone that represent the reservoir part of the formation in Hamrin oil field. The thickness of formation in Hamrin area is around the meters. The age of the Dhiban formation has been defined on the basis of stratigraphic relationship with other formations. In Hamrin oil field Dhiban formation overlies Euphrates formation that overlaid by Jeribe formation, therefore the age has been established as early Miocene. The formation was deposited in basin-centered sabkhas and Salinas that extend North West-South East with two depocentres that separated by the Abujir area that was a high margin at that time, [2].

Result and Discussions

Seven wells were selected to evaluate tertiary reservoir in Alas dome of Hamrin Oil field, using I.P software version 3.5 for log interpretation. Four of these wells were completed as producers from Jeribe formation, while two wells were completed as producers from Euphrates formation and one well completed as producer from Dhiban formation. The completion target (interval) in Hamrin oil field was changed from Jeribe formations to Euphrates or Dhiban formations across the field as the pay zone moved up or down through the whole tertiary interval due to the structural location of the well relative to the structure (limbs or crest) or due to the effect of faulting that cause changes in the elevations of the fluid contacts. The log interpretations of the wells that completed within Jeribe formation (Hr-58, Hr-63, Hr-59, and Hr-69) showed that the formation mainly divided to two parts according to the petro physical properties, (Figure 3, Figure 4, Figure 5 and Figure 6). The upper part of the formation shows high porosity and permeability but unfortunately high water saturation, with high flushed zone water Saturation (S_{ox}) that emphasizes the high permeability of this part of the formation.

The production test for the wells (Hr-58, Hr-63, Hr-69) showed high production rate that was proportional to it is good petro physical properties (high porosity and permeability), while the well Hr-59 showed no natural flowing due to high water saturation and bad petro physical properties (Figure 5). The perforation interval in the wells Hr-63 and Hr-69 were selected in the upper part of the formation that have good petro physical properties, while the perforation of the well Hr-59 were conducted in the lower part of the formation that have bad petro physic properties as well as very close to oil water contact that will cause production problems in the future such as water conning.

The log interpretations of the wells that completed within Euphrates Formation (Hr-56, Hr-54), showed that the formation divided to three thick units and one thin unit in the well Hr-56 while the well Hr-54 shows nearly continuous homogenous properties through the whole interval of the formation. The compartmentalizing of the well Hr-56 may be due to high clay volume that was nearly disappeared in the well Hr-54 (Figure 7 and Figure 8).

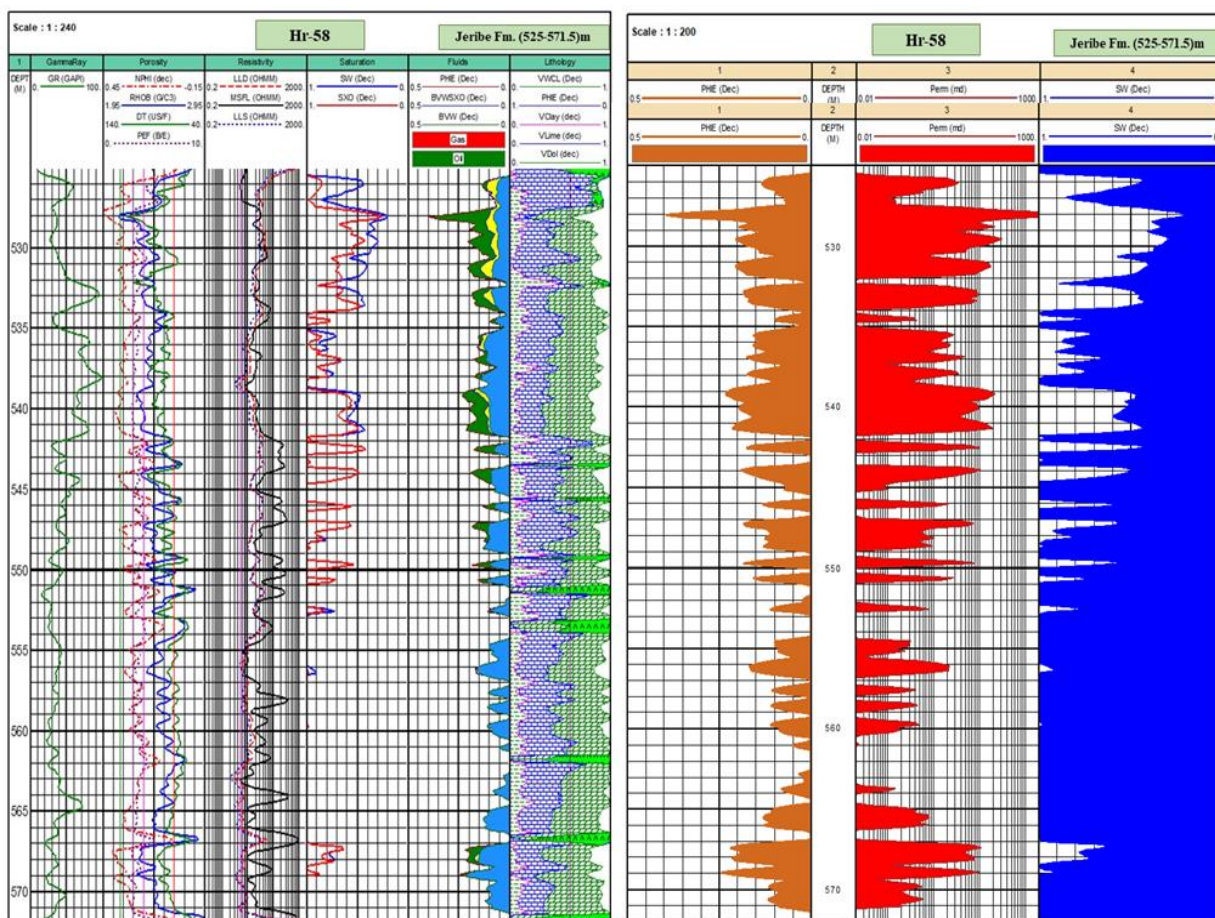


Figure 3: Computer processed interpretation for Jeribe formation in Hr-58.

The production rate of Hr-54 was 160 bpd (barrels per day), with chock size (16/64)" and very low differential pressure ($\Delta p=2$ psi), while the production rate of Hr-56 was 400 bpd (chock size 32/64)" with high differential pressure ($\Delta p=160$ psi) that refer to a very good petrophysical of the well Hr-54 though It had lower production rate than the well Hr-56.

The log interpretation of the well Hr-66 that completed within Dhiban formation divided to four main units that were matching with limestone interval that represent the reservoir units within the formation that composed mainly of anhydrite (Figure 9). The tertiary reservoir stratigraphy of Hamrin oil field represented by Euphrates, Dhiban and Jeribe formations can be subdivided to three main depositional phases according to its petro physical properties.

Phase one starts with deposition of basal anhydrite bed (few meters) near the close of the Oligocene basin, renewed flooding of the basin in return to deposition of deep water marls of Serekagni formation, whereas the transition to the Euphrates records the progradation of Miocene aged carbonate platform over the site of the Hamrin structure, a maximum flood (the NG10 of Sharland et al) [9] probably lies in the basal part of Serekagni. Phase two started with the major sea level fall that resulted in isolation of the basin and development of basal brines, from which Dhiban evaporates were deposited. These evaporate passes transitionally into the lower part of Jeribe formation.

Phase three represent the re-establishment of an open marine basin across the region, and deposition of upper part of Jeribe formation that represent a good reservoir unit in this study.

Conclusion

The Tertiary reservoir of Hamrin oil field represented by Jeribe, Dhiban and Euphrates formations were evaluated using well log interpretation. The log interpretation of these formations showed that the Jeribe formation divided to two units, the upper unit had better petro physic properties than the lower unit. Dhiban formation divided to four units that was matching with the limestone beds that alternate with anhydrite that represent the main lithology of this formation. Euphrates formation divided to three thick units and one thin unit.

These petro physical units reflect generally the deposition environment of these formations. The basal Anhydrite that remarks the close of the Oligocene basin, overlain by interval (Serekagni-Euphrates) that records the progradation of Miocene aged carbonate platform across the location of the Hamrin structure after the flooding of basin in the beginning of Miocene that refer to the depositional phase one. Phase two starts with major sea level fall and development of brine basin resulted in deposition of Dhiban formation and lower part of Jeribe formation. The development of a stable shallow water platform system and deposition of the upper part of Jeribe Formation represent the phase three.

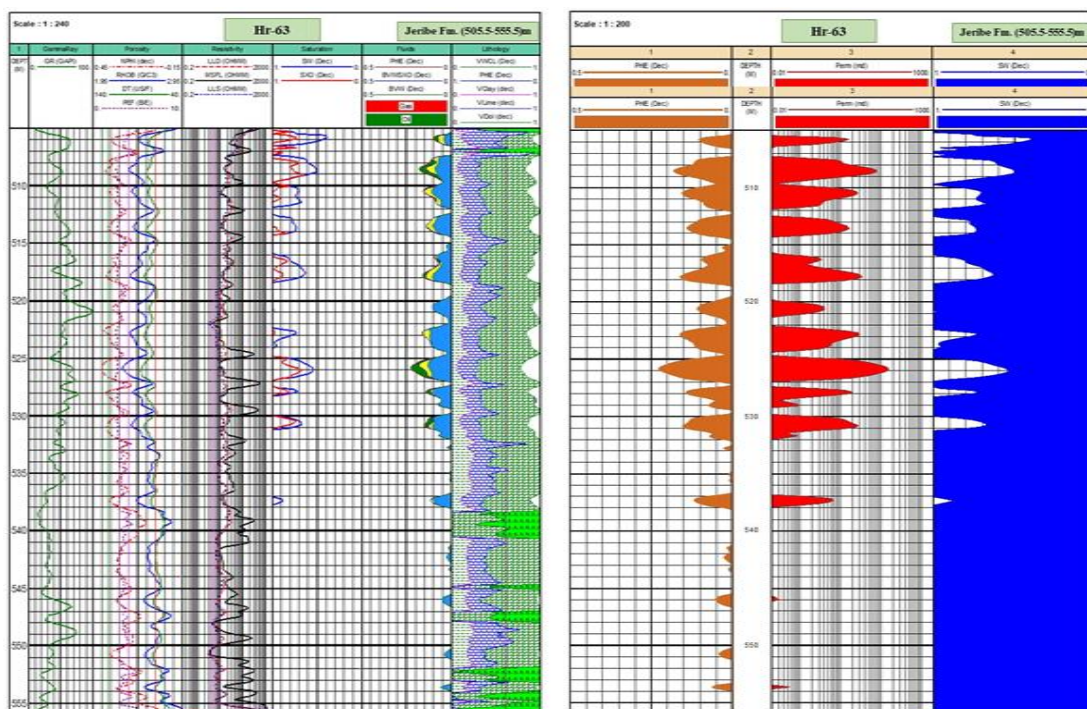


Figure 4: Computer processed interpretation for Jeribe formation in Hr-63.

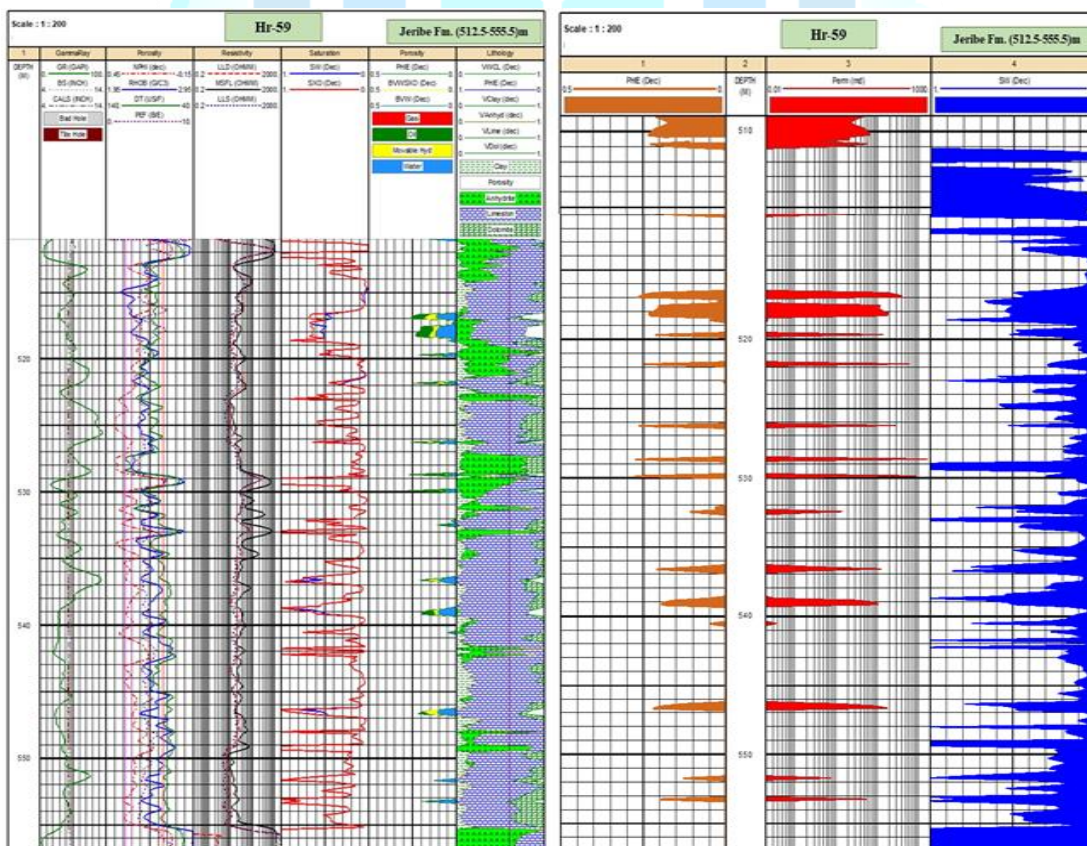


Figure 5: Computer processed interpretation for Jeribe formation in Hr-59.

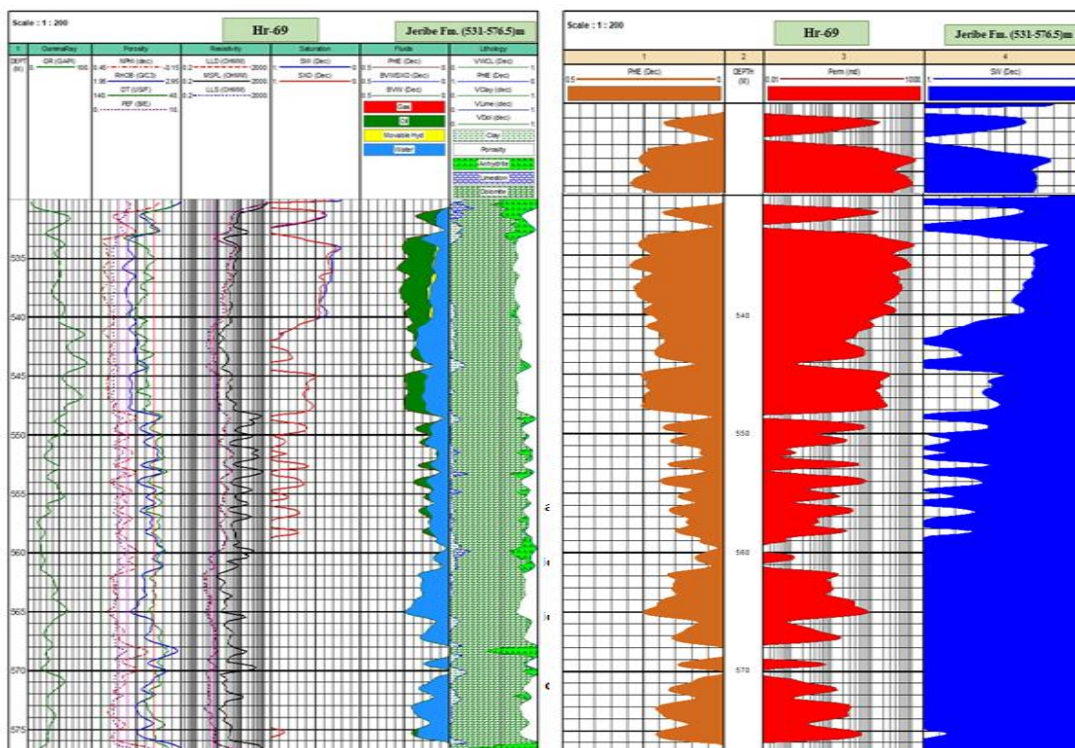


Figure 6: Computer Processed Interpretation for Jeribe Formation in Hr-69.

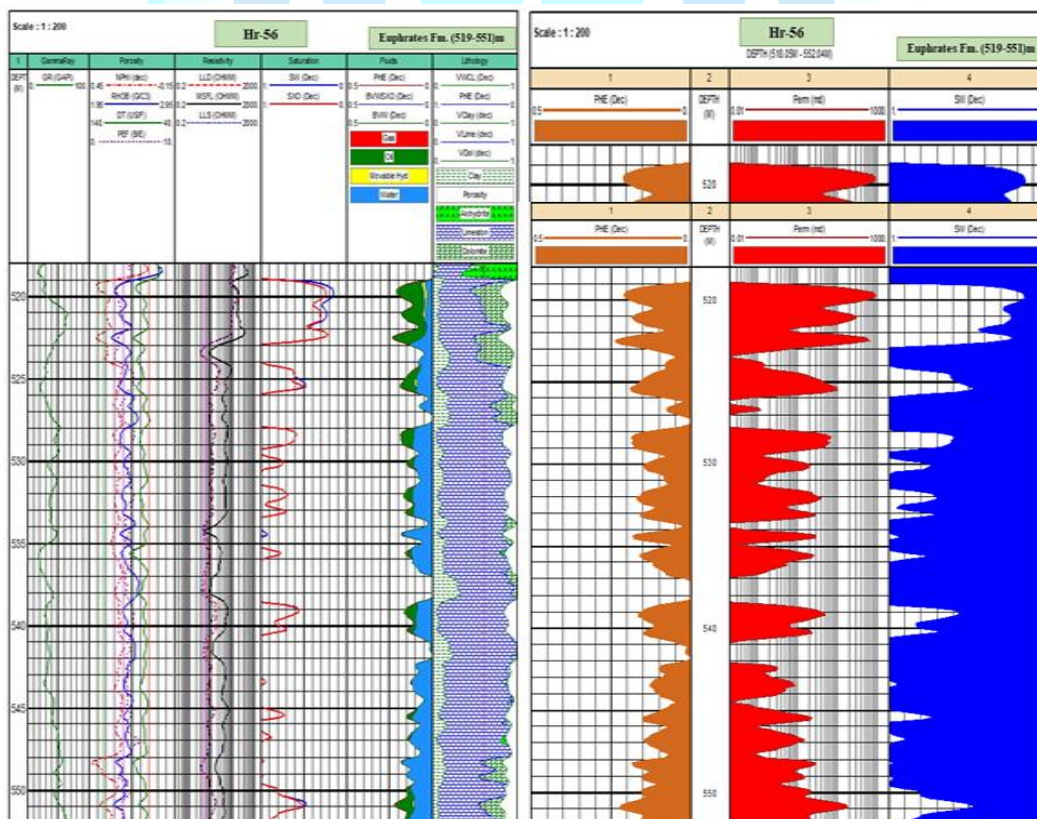


Figure 7: Computer Processed Interpretation for Euphrates Formation in Hr-56.

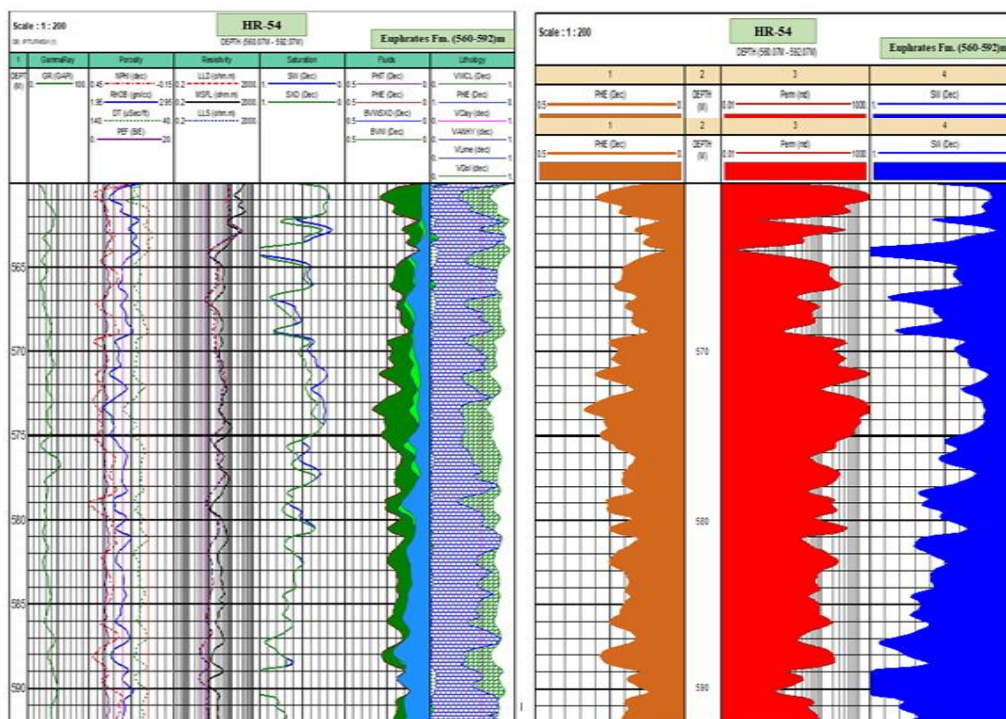


Figure 8: Computer Processed Interpretation for Euphrates Formation in Hr-54.

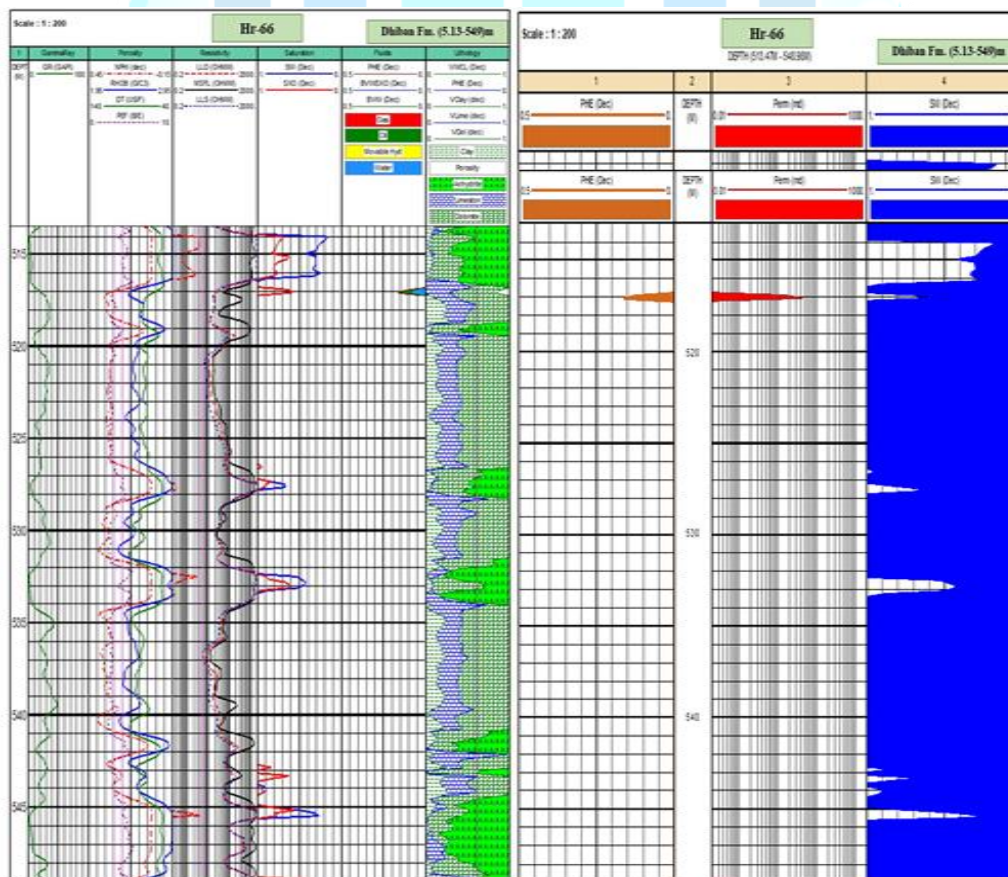


Figure 9: Computer Processed Interpretation for Dhiban formation in Hr-66.



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