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Determination of Petrophysical characteristics using Techlog Software of Jeribe Reservoir in Hamrin - Allas Oilfield, Northern Iraq

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Abstract

This study aims to assess the formation evaluation of the Jeribe Formation in Hamrin oilfield. The present study involved four selected wells of (Early- Mid Miocene) Jeribe Formation in Hamrin structure-Allas field; HR-2, HR-8, HR-9, and HR-16 located North of Iraq. The work deals with the available data that includes the most required information to improve such studies. Techlog Software V.2015 was used to carry out a reliable calculation of petrophysical properties utilizing conventional logs to determine the reservoir characteristics (lithology, porosity, and saturation). The computed CPI (software resulted) based on log information divided the Jeribe reservoir into two reservoir units (Jr-1 and Jr-2) within the studied wells. The calculated effective porosity and water saturation revealed that the unit Jr-1 in Hamrin- Allas oil field contains hydrocarbons at wells HR-2 and HR-16. In contrast, unit Jr-2 was 100% water-saturated along the selected well depths at wells HR-2, HR-8, HR-9, and HR-16.

Keywords: Jeribe Formation, Hamrin Oil field, Allas-dome, Well logs, Reservoir, petrophysical properties. Formation Evaluation

حساب الخصائص البتروفيزيائية باستخدام برنامج التكلوك لتكوين الجريبي في حقل حمرين – علاس النفطي شمال العراق

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الخلاصة

الهدف من هذه الدراسة هو تقييم مكمني لتكوين الجريبي في حقل حمرين . تضمنت الدراسة اربعة ابار مختارة ضمن تكوين الجريبي في حقل حمرين–قبة علاس شمالي العراق, الابار هي (حمرين–2, حمرين–8, حمرين–9, وحمرين–16) بالتتابع. في هذه الدراسة تم التعامل مع ماتوفر من معلومات تتضمن المتطلبات المهمة لاكمال وتحسين هذه الدراسة قدر الامكان. تم استعمال برنامج التكلوك (اصدار 2015) لحساب الخصائص البتروفيزيائية بالاعتماد على تفسيرات المجسات التقليدية ليتم تحديد الخصائص المكمنية للتكوين (الصخارية, المسامية, التشبع). تم تقسيم تكوين الجريبي من خلال مخرجات برنامج التكلوك الى وحدتين صخاريتين اساسية (جريبي–1, جريبي–2) ضمن الابار المدروسة. القيم المحسوبة للمسامية الفعالة والتشبع المائي اظهرت ان الوحدة المكمنية الاولى (جريبي–1) في قبة علاس هي الوحدة الرئيسية للتكوين والمتضمنة الهيدركربونات في البئرين (حمرين–2 و حمرين–16). بينما الوحدة المكنية الثانية (جريبي–2) كانت ذات تشبع مائي 100% ضمن اعماق ابار الدراسة.

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Introduction

Log interpretation procedures and their results are the essential topics of this research. To obtain basic petrophysical properties (lithology, porosity, and water saturation), well log analyses were completed. Logs interpretation process results were used as the basis for geology and reservoir modeling [1]. The measurements of well logs result from the physical properties (log data) along the borehole. Hamrin is a northwest-southeast trending anticline and approximately 70 km long and 4 km wide. Allas dome is the southeast dome of Hamrin structure and the deepest one with 37 km length and 4 km width. Jeribe (Early-middle Miocene) is an important carbonate formation in the Iraq petroleum system [2]. Initially, the formation is of heterogeneous characteristics and identified to be organic limestone detritus. In this research, An attempt to evaluate the Jeribe Formation characteristics in Hamrin oil field-Allas dome was done, Northern Iraq, at selected wells which are: HR-2, HR-8, HR-9, and HR-16 depending on wireline log data interpretation by using the Techlog Software (2015) which is a wellbore-centric petrophysical application platform can handle the basic and advanced formation evaluation uncertainty analyses on all wellbore data types attainable.

Study area

The Hamrin Oil Field is situated within the Low Folded Zone, which is part of the Zagros Fold Belt of the Unstable Shelf. It is nearly 10km from north of Salahaddin Governorate and about 80km southwest of Kirkuk City, north of Iraq [3]. The Jeribe Limestone was defined by Bellen in 1957 from the type locality near Jaddala village in the Sinjar anticline and assumed to be of the Early Miocene age [4]. However, the formation was later included within the Middle Miocene sequence [5]. A Middle Miocene age is indicated by the presence of the Orbulina datum near the base of the Jeribe Formation [6][7]. Jeribe formation is considered as the main reservoir unit with a total thickness of 47.7 m, overlain by transitional beds that contain limited hydrocarbons shows [8]. The total number of drilled wells within the Hamrin oil field reaches 83 well penetrated the studied wells as in the table below:

Table (1-1-Tops, bottom, and thickness of Jeribe Formation and geographic coordinates of the studied wells, (Final geological reports, N.O.C., 1962)

Well name	Top (m)	Bottom (m)	Thickness (m)	Northern (m)	Eastern (m)
HR-2	487.7	540.5	52.8	1 417 000.73	1 422 763.76
HR-8	522.5	566	43.5	1430 582.791	1405 718.611
HR-9	511.5	558	46.5	1 429 422.505	1 408 894.696
HR-16	511	559	48	3850 654.39	416 631.52

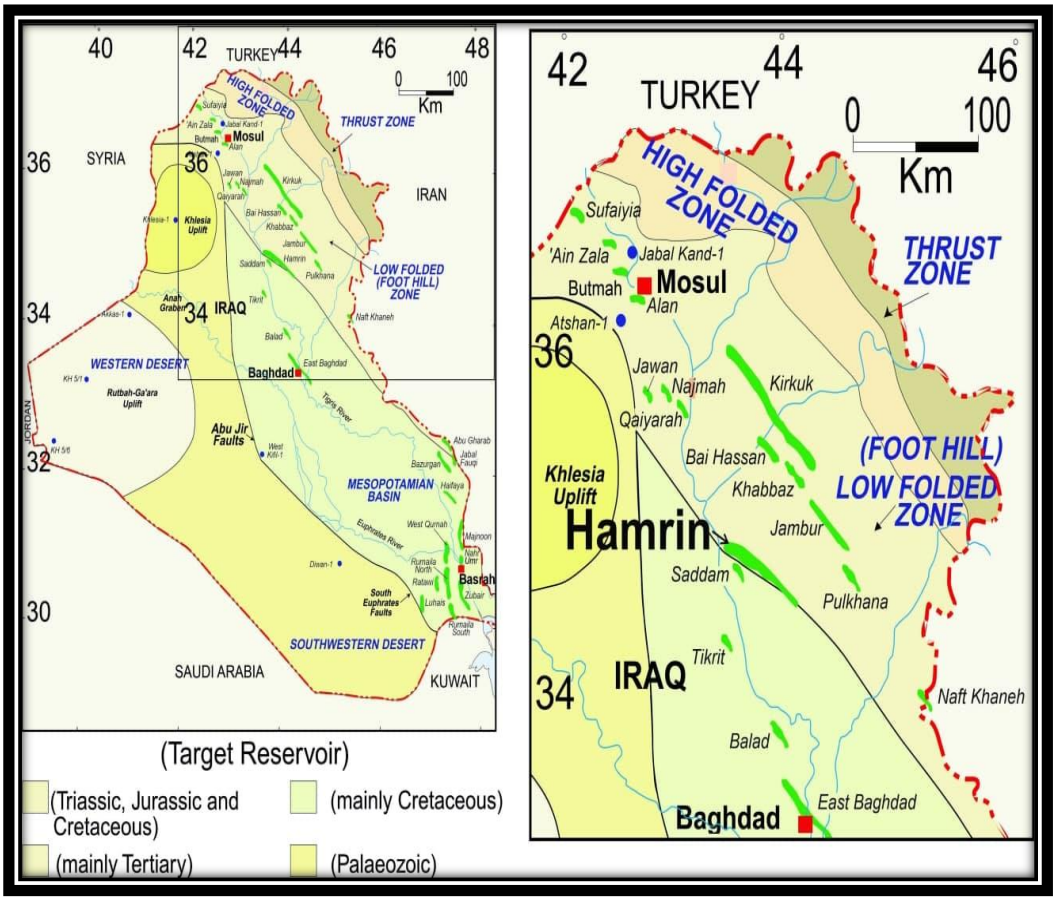

Figure 1-A Simplified tectonic map of Northern Iraq with an indication for the studied Hamrin Oil Field (after Al-Ameri and Zumberg,2012), B: Location of the studied wells in Allas Dome

Tectonic and structural settings for the studied area

The average topographical elevation of the Hamrin structure ranges between 220-240 m above sea level [6]. Hamrin is a Northwest-southeast trending anticline and approximately 70 km long and 4 km wide. The Hamrin Oil Field is situated in Iraq's Low Folded Zone, which is made up of Neogene sedimentary rocks uplifted and bent, with Eocene limestone of Upper Cretaceous sedimentary rocks exposed in the cores of anticlines [3][4]. The surface topography of Hamrin indicates a series of three domes, from northwest to southeast,

- The Albu fadhul dome
- Nukhaila dome
- Shiekh Allas dome

Allas dome is the southeast dome of Hamrin structure and the deepest one with (37 km length and 4 km width [6]

The studied Jeribe Formation belongs to the Arabian Plate Megasequence 11 (AP11) [4]

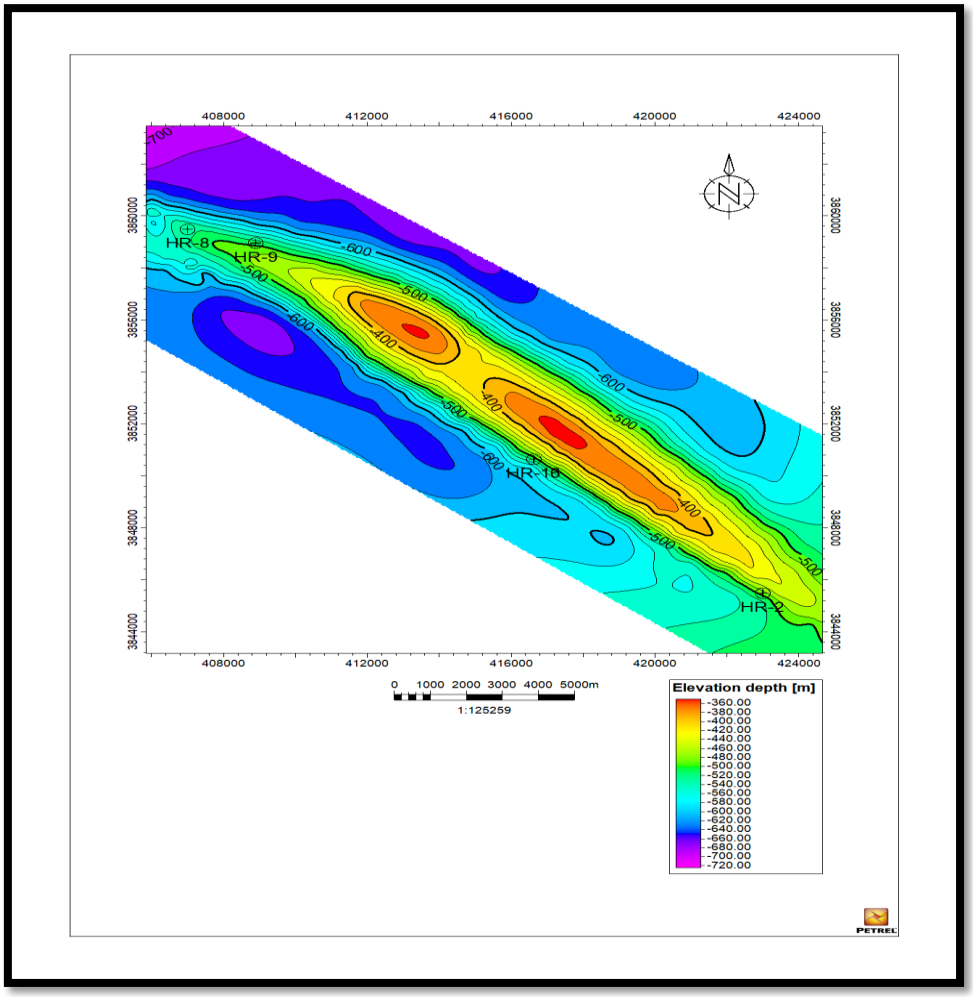

Figure 2-Structural map of top Jeribe Formation in Hamrin Oilfield

Methodology

The workflow procedure deals with the available log data (Gamma Ray, Resistivity, Neutron, Density, Sonic, and Spontaneous potential). Well logs analysis and interpretation were used to evaluate Petrophysical parameters (shale, porosity, lithology, and water saturation) of the Jeribe Formation for each reservoir unit using the Techlog Software (2015).

Lithology

Jeribe Formation consists of dolomitic limestone of calcareous origin that was deposited in shallow marine waters as it is in the inner ramp environment. Marly limestone and anhydrite sections were reported as well [9]10]. In early Middle Miocene time widespread shallow water lagoonal and reefal carbonates (Jeribe Formation) were deposited on a broad carbonate platform [11]. The Jeribe Formation comprises 70m of massive recrystallized and dolomitized limestones [3]. The highest thickness of 63 meters was measured at well Injana-5. Argillaceous limestone in well sections (Ain Zalah, Mushorah, Najmah, Samarra, Khlesia, Awasil) and anhydrides (Khlesia, Ain Zalah, Mushorah, Samarra) have been recorded [10].

Bellen et al. (1959) mentioned that this formation's thickness ranges from 55 to 70 m, the upper contact is unconformably overlain by the Fatha Formation while the lower contact is conformable with the Dhiban Formation [8]. The thick gravel bed at the base of the Fatha and overlying the Jeribe may indicate important unconformity at the contact [3].

Thick recrystallized shelly limestones are possibly present in the Hit area (60 km NNW of Ramadi) equivalent to the Jeribe Formation. The Jeribe Formation consists of 70 meters of massive recrystallized and dolomitized limestone [2].

Results and Discussions

Well-log interpretation results are important for reservoir evaluation by using the available interpreted log data to detect the best reservoir units in terms of excellent properties and high potentiality to gain hydrocarbons. By depending on three rock properties, which are: shaly, porosity, and permeability, the Jeribe Formation in the studied wells was divided into two main reservoir units to distinguish between the horizons of different reservoir capacities. The created CPI for the wells HR-2, HR-8, HR-9, and HR-16 presenting Jeribe Formation at Hamrin oil field as a reservoir that is composed of dolomite with some limestone and anhydrite layers and consisting of two reservoir units extend along the field. Figures 3, 4, 5, 6 show Computer Processed Interpretation of wells HR-2, HR-8, HR-9, and HR-16, respectively.

A. Reservoir Unit 1 (Jr-1):

The upper and main reservoir unit of the Jeribe Formation in the Hamrin Oilfield-Allas dome has an average thickness of (4.25 m). lithology mainly consists of dolomite with a small presence of anhydrite layers. The unit shows good petrophysical properties which in general means better reservoir qualities. Jr-1 is considered as un hydrocarbon-bearing unit in wells HR-2 and HR-16 with porosity varying between (4.2-18%, and average 9.65%) and water saturation ranging between (27.25-99.4% and average 72.1%), while in wells HR-8 and HR-9 porosity values ranging (5.7-8.5%), and SW values are ranging between (96.5-100%), where the wells are almost of water saturated.

B. Reservoir Unit 2 (Jr-2):

The lower reservoir unit of the Jeribe Formation has an average thickness of (40.87 m). The unit is characterized with more presence for the anhydrite layers with thickness vary within the depth of the well and have different existence all along with the unit. Lithology may show minor changes due to the diagenesis processes. The selected wells HR-2, HR-8, HR-9, and HR-16 within the unit are almost 100% water-saturated reservoir (SW values are ranging between 77.4- 100%), with porosity ranging between (0-13.6% and average 4.92%).

Table 1-2-Petrophysical properties of reservoir units in the studied well

Well No.	Reservoir Unit	Unit Thickness (m)	Average Effective Porosity PHIE%	Fluid type
HR-2	Jr-1	8.5	0.101	Hydrocarbons
HR-8	Jr-1	3.75	0.09	Water
HR-9	Jr-1	0.75	0.057	Water
HR-16	Jr-1	4	0.092	Hydrocarbons
HR-2	Jr-2	42.5	0.083	Water
HR-8	Jr-2	37.25	0.036	Water
HR-9	Jr-2	41.7	0.0168	Water
HR-16	Jr-2	42	0.061	Water

Conclusions:

1. The petrophysical most important parameter, the porosity (total and effective), was calculated using Techlog software from the Neutron-density method.
2. The computer processes interpretation (CPI) of (4) boreholes of the Jeribe Formation in Hamrin Oilfield-Allas dome have been deduced using Techlog software. Depending on the variation and contrast of the petrophysical properties, the Jeribe Formation was divided into

two reservoir units where reservoir units are (Jr-1 and Jr-2), varying in thickness and reservoir quality.

3. Jr-1 represents the main unit of the Formation in the Hamrin field with an average thickness of (4.25 m). lithology mainly consists of dolomite with a small presence of anhydrite layers. The unit is an oil-bearing unit with good reservoir quality (hydrocarbons potentiality) at the wells HR-2 and HR-16 with porosity varying between (4.2-18%, and average 9.65%), and water saturation ranging between (27.25-99.4% and average 72.1%), while Jr-1 in wells HR-8 and HR-9 porosity values ranging (5.7-8.5%), and SW values are ranging between (96.5-100%), where the wells are almost of water saturated.

4. The lower reservoir unit of the Jeribe Formation (Jr-2) has an average thickness of 40.87 m. The unit is characterized with more presence for the anhydrite layers, and even though the unit has good petrophysical properties but no hydrocarbons saturation occurred, to be almost totally water saturated. The selected wells (HR-2, HR-8, HR-9, and HR-16) within the unit are from nearly 100% water-saturated reservoir with SW values ranging between (77.4-100%), porosity ranging between (0-13.6% and average 4.92%).

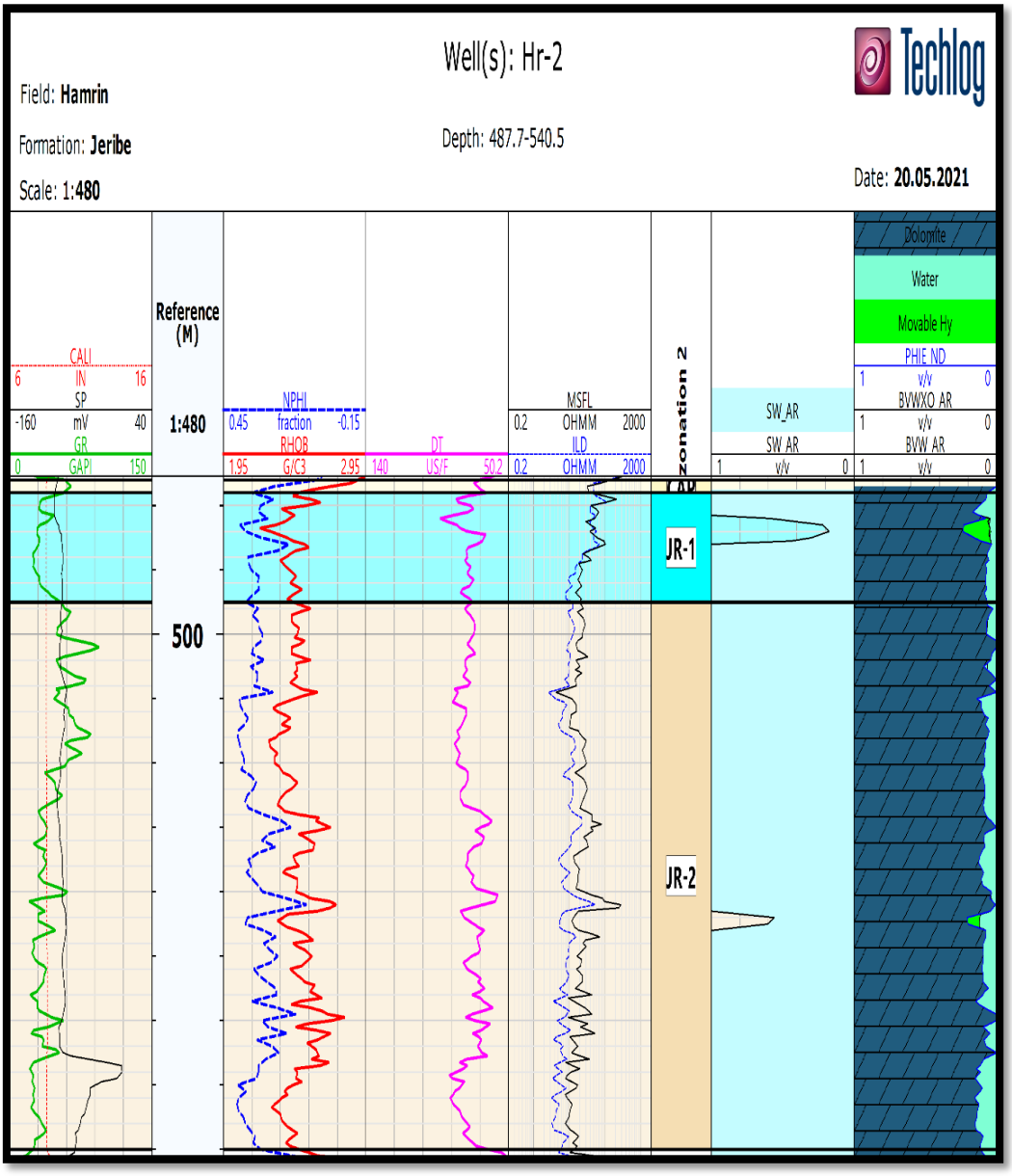

Figure 3-Lithological section, logs and reservoir characteristics of the Jeribe formation in well HR-2 (using Techlog software)

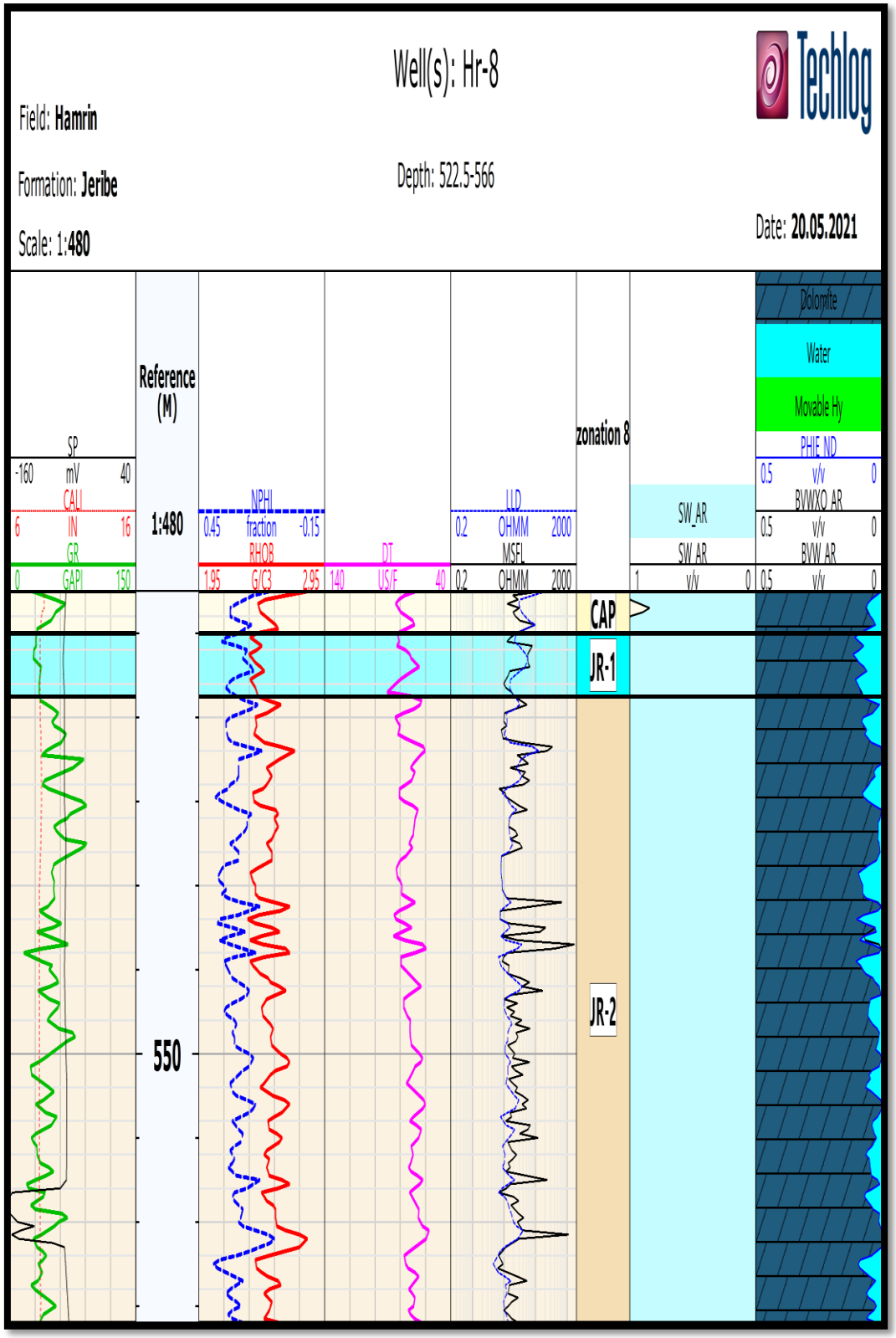

Figure 4-Lithological section, logs and reservoir characteristics of the Jeribe formation in well HR-8 (using Techlog software)

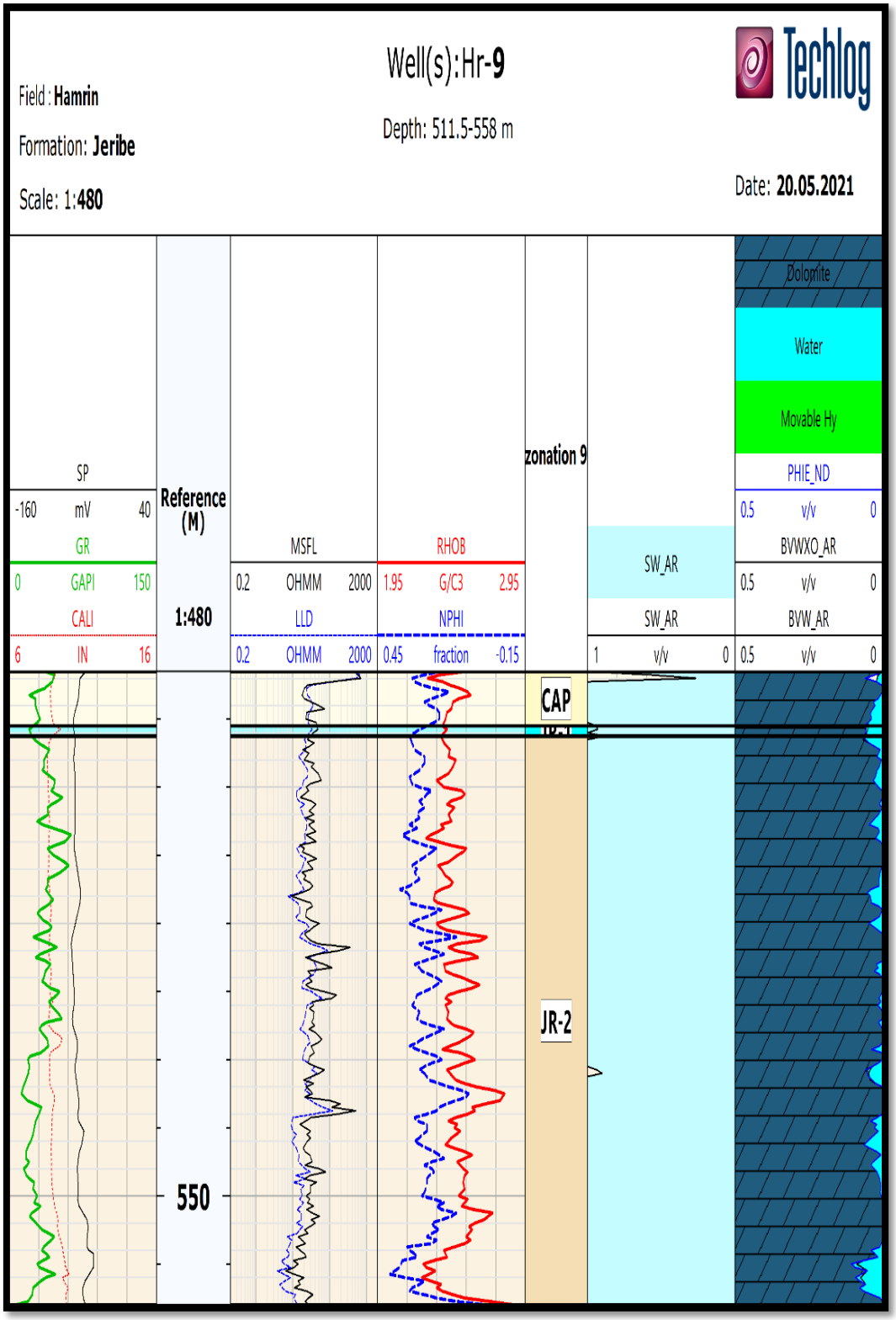

Figure 5-Lithological section, logs and reservoir characteristics of the Jeribe formation in well HR-9 (using Techlog software)

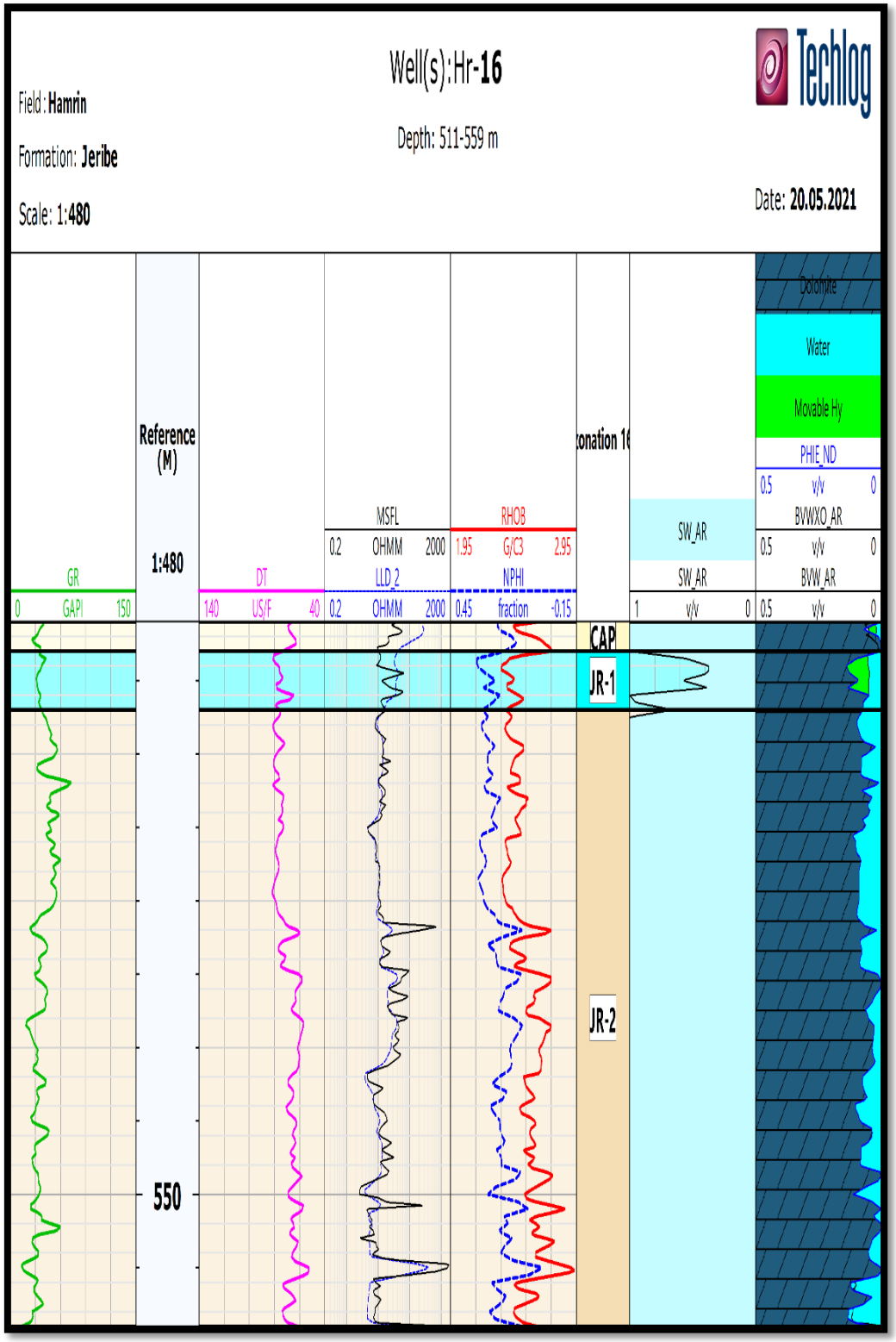

Figure 6-Lithological section, logs and reservoir characteristics of the Jeribe formation in well HR-16 (using Techlog software)

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