



ISSN: 0067-2904

## Hartha Formation divisions Based on Well Logs Analysis in Majnoon Oil Field, Southern Iraq

Gheed Chaseb\*, Thamer A. Mahdi

Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq

Received: 24/7/2019

Accepted: 22/10/2019

### Abstract

This study aims to evaluate reservoir characteristics of Hartha Formation in Majnoon oil field based on well logs data for three wells (Mj-1, Mj-3 and Mj-11). Log interpretation was carried out by using a full set of logs to calculate main petrophysical properties such as effective porosity and water saturation, as well as to find the volume of shale. The evaluation of the formation included computer processes interpretation (CPI) using Interactive Petrophysics (IP) software. Based on the results of CPI, Hartha Formation is divided into five reservoir units (A1, A2, A3, B1, B2), deposited in a ramp setting. Facies associations is added to well logs interpretation of Hartha Formation, and was inferred by a microfacies analysis of thin sections from core and cutting samples. The CPI shows that the A2 is the main oil-bearing unit, which is characterized by good reservoir properties, as indicated by high effective porosity, low water saturation, and low shale volume. Less important units include A1 and A3, because they have low petrophysical properties compared to the unit A2.

**Keywords:** Hartha Formation, Majnoon oilfield, Reservoir units, Well logs.

### تقسيمات تكوين الهارثة بالاعتماد تحليل سجلات الابار في حقل مجنون النفطي, جنوب العراق

غيد جاسب\*, ثامر عبدالله مهدي

قسم علم الأرض، كلية العلوم، جامعة بغداد، بغداد، العراق

### الخلاصة

تهدف هذه الدراسة الى تقييم الخصائص المكنية لتكوين الهارثة في حقل مجنون النفطي بالاعتماد على المسجلات البئرية لثلاثة ابار (Mj-1, Mj-3, Mj-11). تفسير المسجلات اجريت باستخدام المجموعة الكاملة من المسجلات لحساب الخواص البتروفيزيائية الرئيسية وهي المسامية الفعالة والتشبع المائي وكذلك حساب حجم السجل. تضمن تقييم التكوين عمليات تفسير computer processes interpretation (CPI) باستخدام برنامج Interactive petrophysics (IP). بالاعتماد على نتائج CPI تم تقسيم تكوين الهارثة الى خمسة وحدات مكنية وهي (A1, A2, A3, B1, B2), ترسبت ضمن بيئة المنزلق. دراسة المجاميع السحنية اضيفت الى تفسير سجلات الابار وقد تم استنتاجها من خلال الدراسة المجهرية للسحنات الدقيقة لشرائح عينات اللباب والفتات الصخري. تظهر نتائج CPI ان الوحدة المكنية A2 هي الوحدة الرئيسية الحاملة للهايدروكربون والتي تتميز بخصائص مكنية جيدة. حيث تتصف بمسامية فعالة جيدة وتشبع قليل بالماء ومحتوى الطين قليل وتليها وحدات اقل اهمية وهي A1, A3 بسبب انخفاض الخواص البتروفيزيائية مقارنة مع الوحدة A.

\*Email: Gheed.alghanemy@yahoo.com

## Introduction

Hartha Formation (Late Campanian-Maastrichtian) is one of the important formations deposited during the upper Cretaceous. The formation includes important carbonate reservoirs that are producible in central and southern Iraq. It acquired its importance because of the presence of quantities of hydrocarbon, due to the petrophysical characteristics [1]. The present study is conducted through well logs interpretation to determine the reservoir units and evaluate their petrophysical properties for the formation in Majnoon oilfield.

## Location of the study area

The study area is located in Majnoon oilfield, which lies in southern Iraq. It is located about 60 km from Basra governorate, near the Iraqi-Iranian borderlines (Fig.1). Three wells are selected for this study, which are distributed along the structure of Majnoon oilfield. The geographic coordinate of these wells are shown in Table-1.

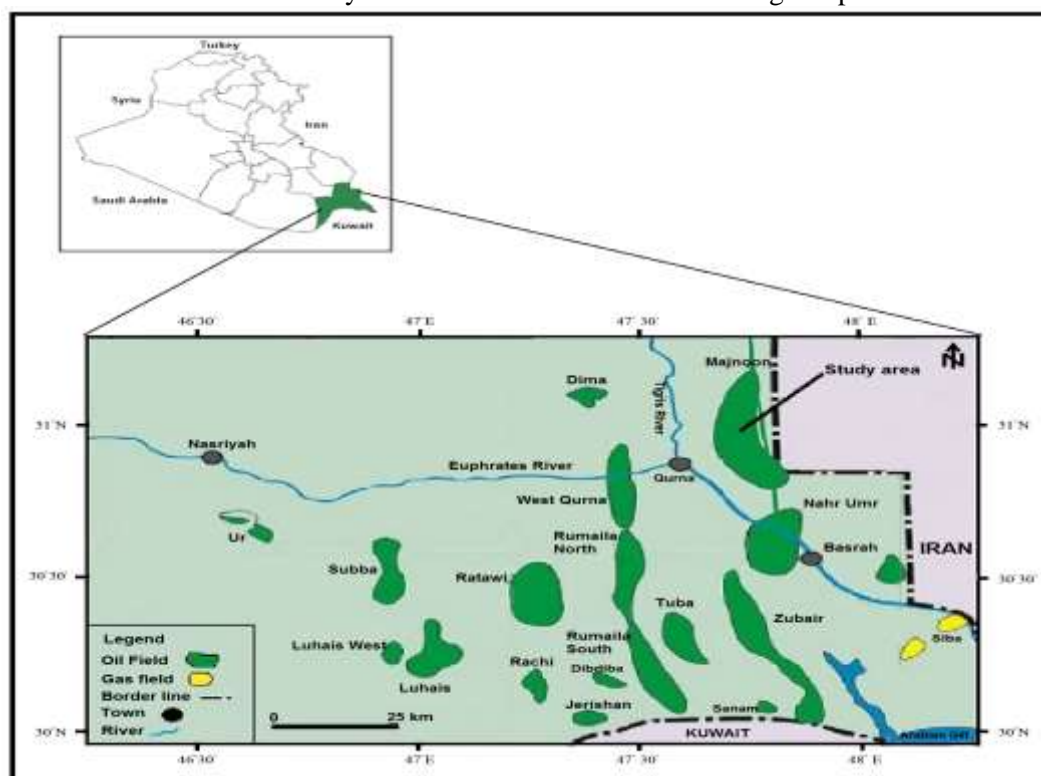
**Table 1-**Geographic coordinates of the studied wells in Majnoon oilfield (final geological report).

Wells	Easting	Northing
MJ-1	747325.8	3446428
MJ-3	746106	3440478
MJ-11	747904.7	3451345

## Methodology

The methodology of the present study included the following analyses:

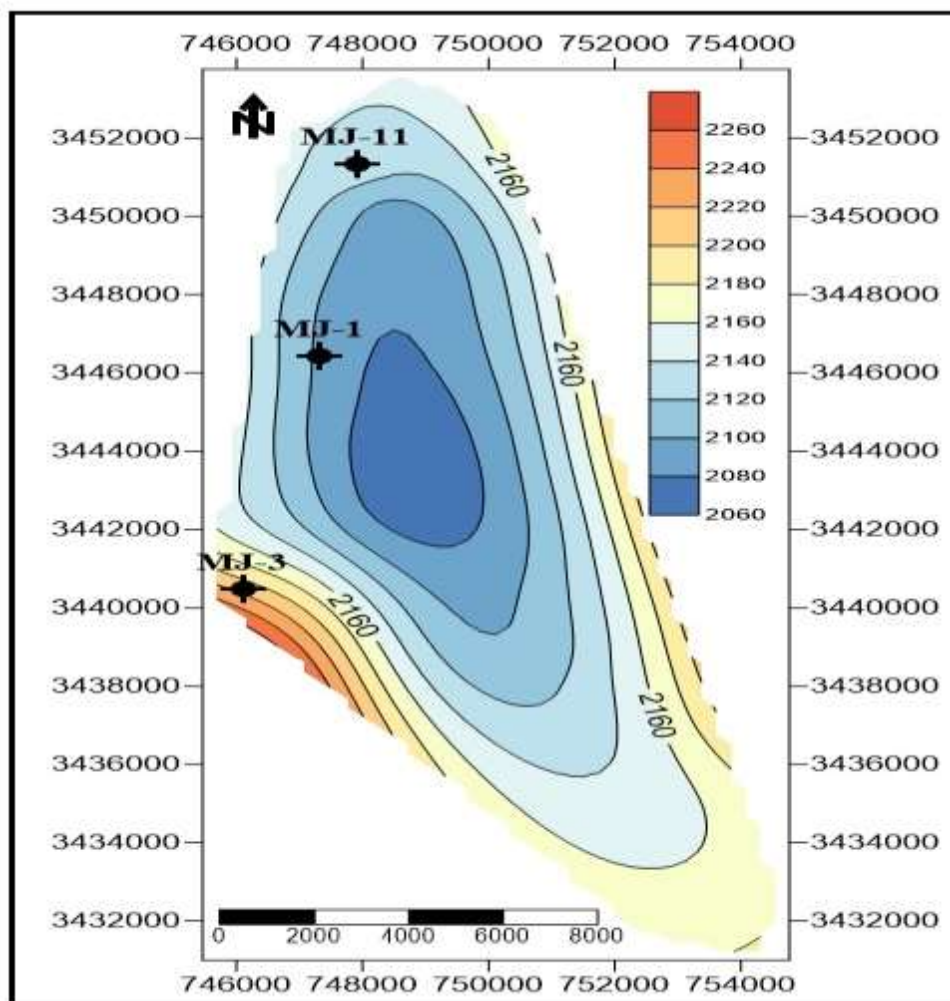
- 1- Digitizing well logs by using Digger software.
- 2- Well logs analysis and interpretation of gamma ray, density, neutron, sonic, and resistivity logs by using Interactive Petrophysics software (IP).
- 3- Petrographic study and microfacies analysis were used to determine the facies associations of Hartha Formation based on the study of thin sections for core and cutting samples.



**Figure1-**Location map of the study area [2].

### Stratigraphy and Geological Setting

Majnoon oilfield is located within the stable shelf in the Mesopotamian Zone within Zubair Subzone, according to the tectonic subdivision of Iraq [3]. The trend of the structures in this tectonic unit were influenced by the geometry of the underlying basement blocks and faults [4]. The structural trend of Majnoon structures are represented by an elongated anticline that have approximately a NW-SE trend (Figure-2). The Upper Campanian- Maastrichtian cycle is regarded as an important cycle, where it starts with a widespread transgression that covers almost the entire plate [4]. This has led to the deposition of neritic limestone sediments represented by Hartha Formation. The description of the type section of Hartha Formation in Zubair-3, South of Iraq, shows that the formation is composed of organic detrital, glauconitic limestones with grey and green shaly interbeds [3,5]. The thickness of Hartha Formation is changing, mainly because the formation is passing both laterally and vertically with the marly limestones of Shiranish Formation. The average thickness of the formation in south Iraq ranges between 200 and 250 m, while in northern Iraq the thickness is up to 350 m [4]. The upper contact of Hartha Formation is conformable with the Shiranish Formation while the lower contact is unconformable with the Saadi Formation and is often marked by conglomeritic basal beds [3]. The equivalents of Hartha Formation extend in the Iraqi territory and widespread in Saudi Arabia, Kuwait, Turkey and Syria, depending on the facies and age. Shiranish, Tanjero, Aqra- Bekhme and Digma formations are the equivalents to the Hartha Formation in Iraq [6,7]. Sissakian [8] recognized the presence of Safawi facies within the Hartha Formation in southwest Iraq [3]. The previous studies in southern Iraq suggested the ramp model as a depositional setting for Hartha Formation [9,10]. Therefore, the ramp setting is adopted in this study, which recognized the outer ramp, inner ramp, mid ramp, and shoal.



**Figure 2-**Structural contour map at the top of Hartha Formation in Majnoon oil field with the locations of the selected wells.

### Computer processing interpretation (CPI) and Reservoir units

The CPI for the Hartha Formation wells were completed using the IP software, with which water saturation, porosity and clay volume content were calculated, as shown in Figures-(3, 4, and5) According to the CPI results combined with facies associations interpretation, Hartha Formation is divided into five units named Hartha A1, A2, A3, B1 and B2. A1 represents the top of Hartha Formation while B2 is the bottom unit. Table-2 shows the tops of these units in the wells of study.

**Table 2-**Tops of units of Hartha Formation in the studied wells.

Well Units	MJ-1	MJ-3	MJ-11
Top of Hartha Fn.	2104m	2223m	2138m
A1	2104m	2223m	2138m
A2	2108,5m	2230.5m	2142m
A3	2125m	2261m	2182.5m
B1	2150m	2291m	2206m
B2	2169m	2324m	2231m
Top of Saddi Fn.	2209m	2362m	2249m

#### Reservoir unit A1

The unit A1 is located at the uppermost part of Hartha Formation. Although it is composed of an outer ramp facies association, the reservoir quality is various at different wells. The reservoir quality increases in wells Mj-1 and Mj-11 due to high effective porosity and moveable oil volume Figures- (3, 5). Lower reservoir quality is found in the well Mj-3 due to high shale volume and low effective porosity (Figure-4).

#### Reservoir unit A2

The unit A2 is characterized by shoal facies association, which is characterized by grain-supported microfacies with high secondary porosity. Mid-ramp facies association occurs at the middle in Mj-11(Figure-5). The high reservoir quality of unit A2 is ascribed to high effective porosity (Figure-3). Similar shoal facies of this unit have lower reservoir quality due to low moveable oil volume (Figure-4). The occurrence of mid-ramp facies association in unit A2 decreases the reservoir quality due to low porosity of mud-supported facies.

#### Reservoir unit A3

The reservoir quality of unit A3 is low due to low effective porosity, moveable oil volume, and high shale volume (Figs. 3, 4, 5). These properties are related to inner ramp facies association, which forms the main facies component in unit A3 in all studied wells.

#### Reservoir unit B1

The unit B1 has a low reservoir quality as shown by low values of effective porosity and oil volume, in addition to high shale volume Figures-( 3, 4, 5). Mid-ramp facies association is dominant in unit B1, while shoal facies association is found at the top and middle parts of the unit. The shoal facies, however, have lower shale volume and higher effective porosity, while its reservoir properties are poor due to low oil volume.

#### Reservoir unit B2

The unit B2 consists of thick succession of an outer ramp facies association. The reservoir characteristics of this unit are poor due to high shale volume and low effective porosity Figures- (3, 4, 5). However, a remarkable increase of porosity and oil volume was found at the bottom of unit B2 (bottom of Hartha Formation) at well Mj-1 (Figure-3).

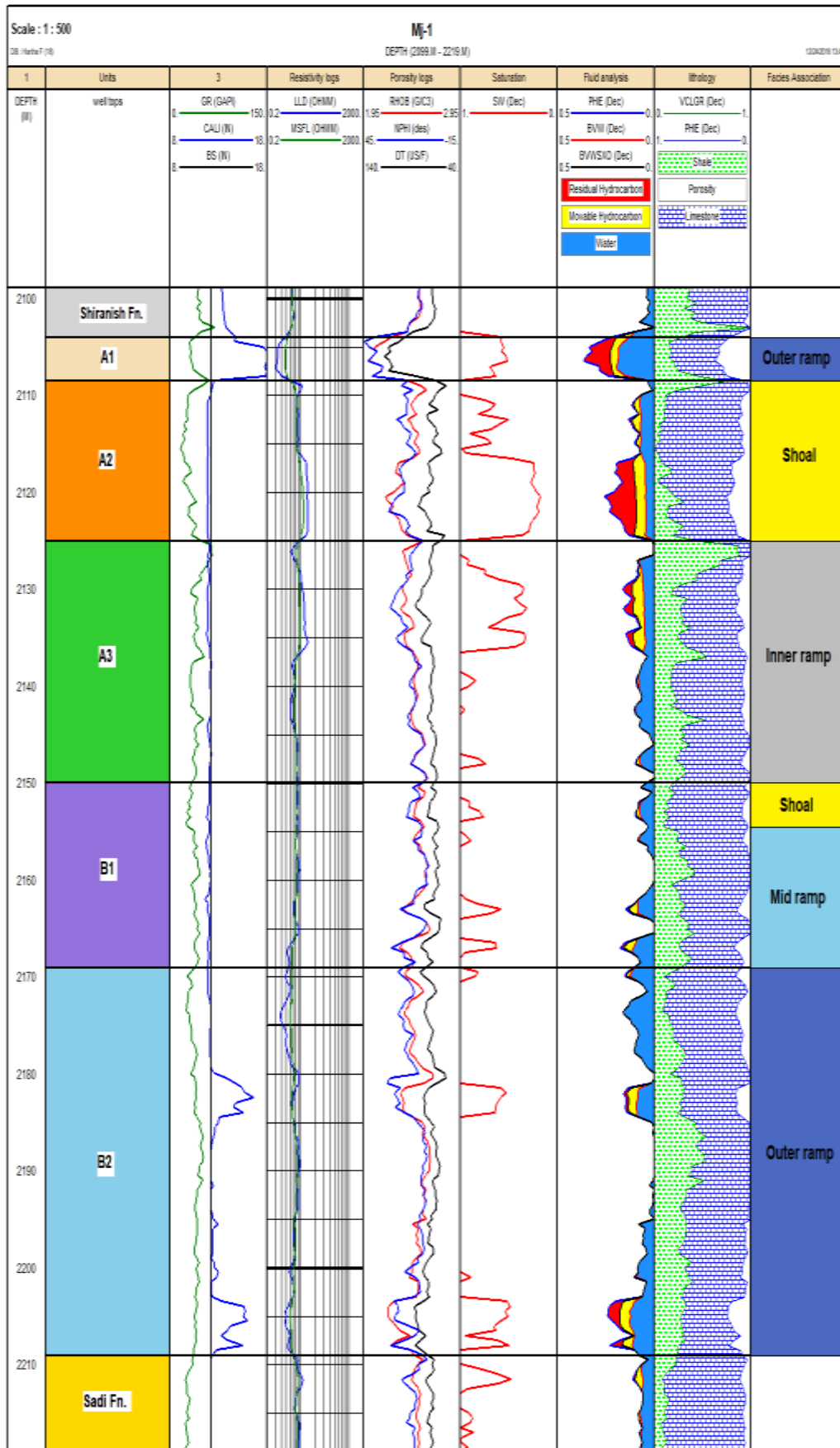


Figure 3-Computer processing interpretation (CPI) of Hartha Formation at well Mj-1.



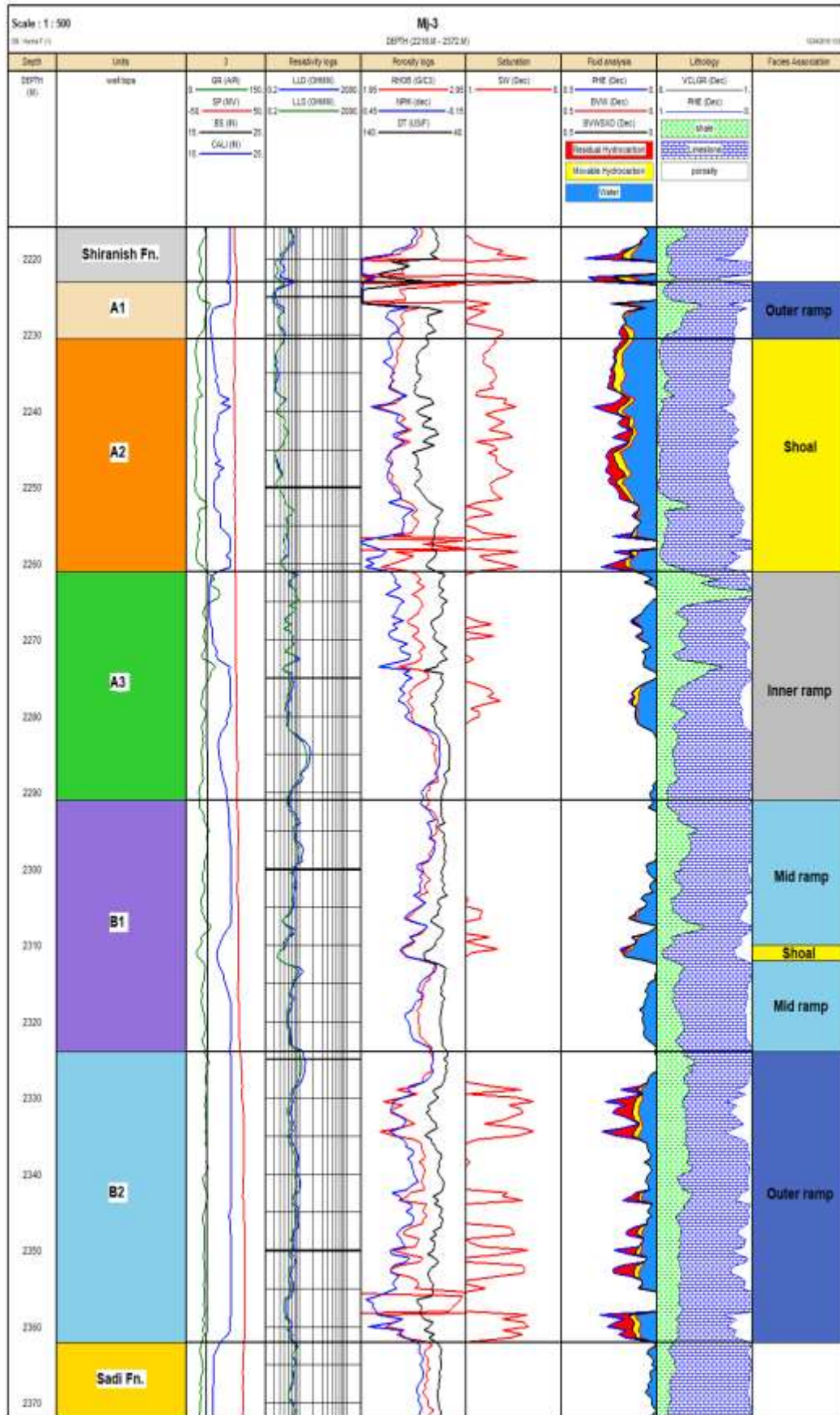


Figure 4-Computer processing interpretation (CPI) of Hartha Formation at well Mj-3.

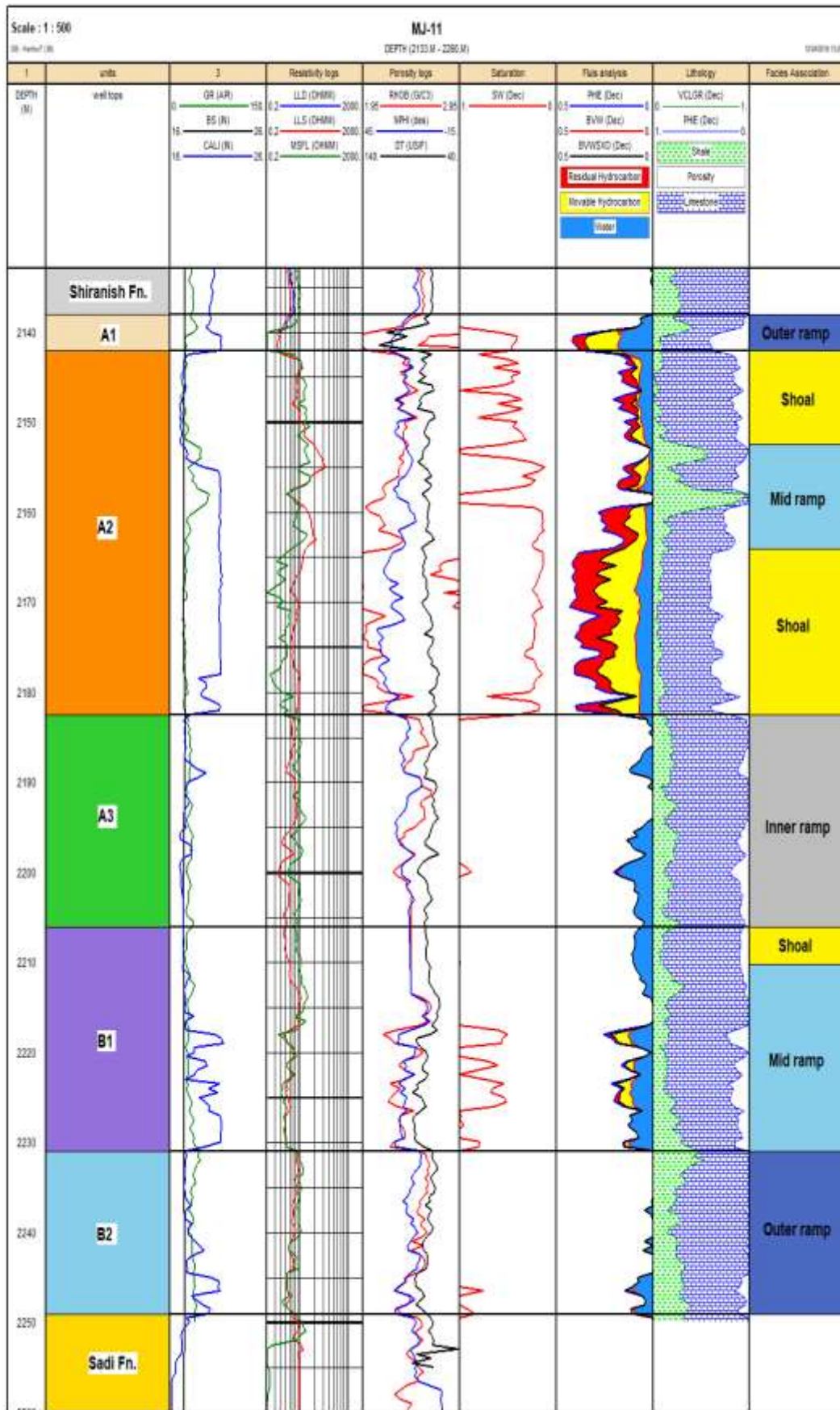


Figure 5-Computer processing interpretation (CPI) of Hartha Formation at well Mj-11.

## Conclusions

The interpretation of the CPI for the three wells shows that the Hartha Formation is divided into five reservoir units, A1, A2, A3, B1 and B2, depending on the variation of the petrophysical properties. There are four main paleo environments, the outer ramp, the mid ramp, the inner ramp, and the shoal, in which Hartha Formation is deposited. They are observed in the reservoir units, the CPI results combined with facies associations show that the unit A2 is the main producing unit because it is characterized by good reservoir properties such as high effective porosity, low water saturation, and low clay volume which is deposited in the shoal facies association. The other units of Hartha Formation have less efficient properties due to their low petrophysical properties compared to unit A2. In addition, they consist of mid and inner ramp facies associations along with an outer ramp facies association in the lower part of the formation.

## References

1. Dunnington, H.V. and Morton, D.M. **1953**. Cretaceous Oil Prospects Cretaceous Reservoir, INOC, Baghdad, Unpub. Report, p.8.
2. Al-Khafaji, A. J., Hakimi, M. H., Najaf. A. A. **2017**. Organic geochemistry characterisation of crude oils from Mishrif reservoir rocks in the southern Mesopotamian Basin, South Iraq: Implication for source input and paleoenvironmental conditions. *Egyptian Journal of Petroleum*. 14p.
3. Jassim, S. Z. and Goff, J. C. **2006**. *Geology of Iraq*. Published by Dolin, Prague and Moravian Museum, Srno, chapter four.
4. Buday, T. **1980**. *The regional geology of Iraq*, vol. 1, stratigraphy and paleogeography, Dar Al-Kutub publication house, Mosul.
5. Owen, R. M. and Nasr, S. N. **1958**. The stratigraphy of Kuwait-Basrah area. In: Weeks, L.G. (ed.): *Habitat of Oil, a symposium*, AAPG publication.
6. Bellen, V.R.C., Dunnington, H.V., Wetzal, R. and Mortan, D.M. **1959**. Lexique Stratigraphique International.
7. Sharland, P.R., R. Archer, D.M. Casey, R.B. Davies, S.H. Hall, A.P. Heward, A.D. Horbury and M.D. Simmons **2001**. *Arabian Plate Sequence Stratigraphy*. GeoArabia Special Publication 2. Gulf PetroLink, Bahrain.
8. Sissakian, V.K. **2005**. The Stratigraphy of the Exposed Cretaceous Rocks in Iraq, Iraqi Bulletin of Geology and Mining.
9. Al-Kilaby, A. J. **2017**. Sequence Stratigraphy and Reservoir Characterization of the Hartha Formation, Southern Iraq, Unpublished M.Sc. Thesis, University of Baghdad, 111p.
10. Mousa, A. K. **2015**. Stratigraphic Analysis of the Upper Campanian-Maastrichtian Succession, Buzurgan Oil Field, Southeastern Iraq, Unpublished M.Sc. Thesis, University of Baghdad, 101p.