



Purposeful scientific research is a basic pillar for the advancement of Iraq



Hartha Reservoir Quality in East Baghdad Oilfield, Iraq: An Overview and Accurate Prediction

Afnan Munther Al-Zoubadi, Abdalratha Mohammed Sahaab

Department of Petroleum Geology and Minerals, College of Science, University of Diyala, Diyala, Iraq
afnanafnanmuntherafnan@gmail.com, adbalradha@yahoo.com

ABSTRACT

Hartha Formation was studied in East Baghdad oilfield, in Baghdad governorate. Lithologically, Hartha formation contents porous limestone, high porosity limestone, compacted limestone and less quantities of shaly limestone throughout the whole sequence in all studied wells (EB1, EB3, EB5, EB6 and EB7). The upper conformable contact with Tayarat Formation and the lower contact is an unconformable with Saadi Formation. The selected well divided into three reservoir units represented by unit A, unit B and unit C based on well logs study which splitted into three insulating units (Barr 1, Barr 2, and Barr 3), as well as a higher unit represented by cap rock unit (CRU). All studied wells exhibit a good porosity values. The best reservoir unit is a unit C, which included higher of movable oils and it has high porosity values reach to more than 25%. The best well in current study is a EB1 due to it has very good reservoir quality, represented by unit A, unit B and unit C, as well as it has high value average of porosity reach to more than 25%. The movable oil is existed in all reservoir units of EB1.

1. Introduction

The reservoir characteristics of carbonate rocks are more considerable than other rock types because they store more than half of the hydrocarbons in their pores (Ali et al., 2022). Most carbonate reservoirs are created in shallow marine environments (Asaad et al., 2022). The carbonate reservoirs habitat is difficulty understood or predict due to their reservoir properties heterogeneity which mainly caused by their complex diagenetic processes and leading to complex flow network (Balaky et al, 2022).

The Hartha Formation which mainly deposited in the shallow marine carbonate setting (Al-Haj, 2020) regarded as one of the interested Upper Cretaceous carbonate units because its hydrocarbon reservoir and produce oil in many areas of the middle and western Iraq (Aqrawi et al., 2010). It was first described by Rabanit, 1952 in Bellen et al. (1959) consist of a detrital, bioclastic and glauconitic limestone, partly dolomitized and interbedded of marl and green shale. It is belonged to Upper Campanian-Maastrichtian cycle (Jassim and Goff, 2006).

Since the first description of the formation Rabanit, 1952, there are several studies conducted the Hartha Formation include the works of Owen and Naser (1958), Al-Naqib (1967), Al-Saddiqi (1972), Al-Omari and Sadek (1974), Darmain (1975), AL-Sadooni (1979), Buday (1980), Total company (1981), Jassim and Karim (1984), Al-Badri (1985), Al-Ali (1989), Al-Saadouni (2001), Al-Sammarai (2010), Bayrakdar (2011), Wafaa (2015), Oil

Exploration Company (2019) and Oil Exploration Company (2020). Most of these works focused in the sedimentological, paleontological and stratigraphical aspect of the formation. The current study gives a new perspective to the Hartha reservoir quality based re-interpreting and re-formulate the well logs results of Hartha formation at the East Baghdad oilfield.

2. Materials and Methods

This study was carried out by collecting the results of previous researchers dealing with the Hatha Formation in East Baghdad oilfield. The petrophysical properties were taken from the well logs of five selected subsurface wells (well-1, well-3, well-5, well-6 and well-7) in East Baghdad oilfield (Fig.1) from Oil Exploration Company (2020) which processed by (TechLog) software program and then interpreted to evaluate reservoir properties of the Hartha Formation.

3. Geologic Setting

Upper Campanian-Maastrichtian cycle in Iraq comprise of several stratigraphic formations. In the end of the Late Cretaceous the sea level rise and the cycle was started with a broad transgression and almost covering the whole country (Buday, 1980). The formations of this cycle are roughly contemporaneous and replace one another. Local variations in age during the Upper Campanian-Maastrichtian cycle mostly take place when facies-bound are tangled (Fig.2) (Jassim and Goff, 2006).

The study area is located in East Baghdad oil field. It is one of the giant oil fields in central Iraq that discovered by the National Oil Company through the interpretations results of the seismic survey carried out during the period (1974-1975)(OEC, 2020). East Baghdad oil field is located in the center of Iraq, 20 kilometers to the east of Baghdad's center (Al-Naqib, 1967) (Fig.1). The south area of East-Baghdad project is 120 Km² (Salman et al., 2017). The study of Total company, 1984 splits the area of east Baghdad into two major geographic zones, which separated by the Diyala River. The northern zone has two subzones (Urban subzone) and the third subzone (Area _3). The southern zone consists of two regions, the first area of which is located in the south (Area 1) and the second area of which is situated in the north (Area 2) (OEC, 2020).

The general structural features of the East Baghdad field, which reflected by the structural levels. They

are characterized by some tectonic phenomena, such as the presence of major normal faults along the northwest of southern Iraq (striking faults). As well as, the presence of other subsidiary faults, which affected by two transverse faults, namely the Diyala fault from the north and the Al-Qurna - Takhadid fault from the South (OEC, 1989).

Generally, the Hartha Formation consists of gray and green shale and organic detrital and glauconitic limestones. Locally, limestone is heavily dolomitized. Chalky limestone beds are typical. In some wells included oolitic beds. The formation that runs along the southern edge of the Mesopotamian Zone frequently contains nodules, lenses, and beds of anhydrite. In the eastern sections of the Mesopotamian Zone, where the formation transitions into the Shiranish Formation, argillaceous.

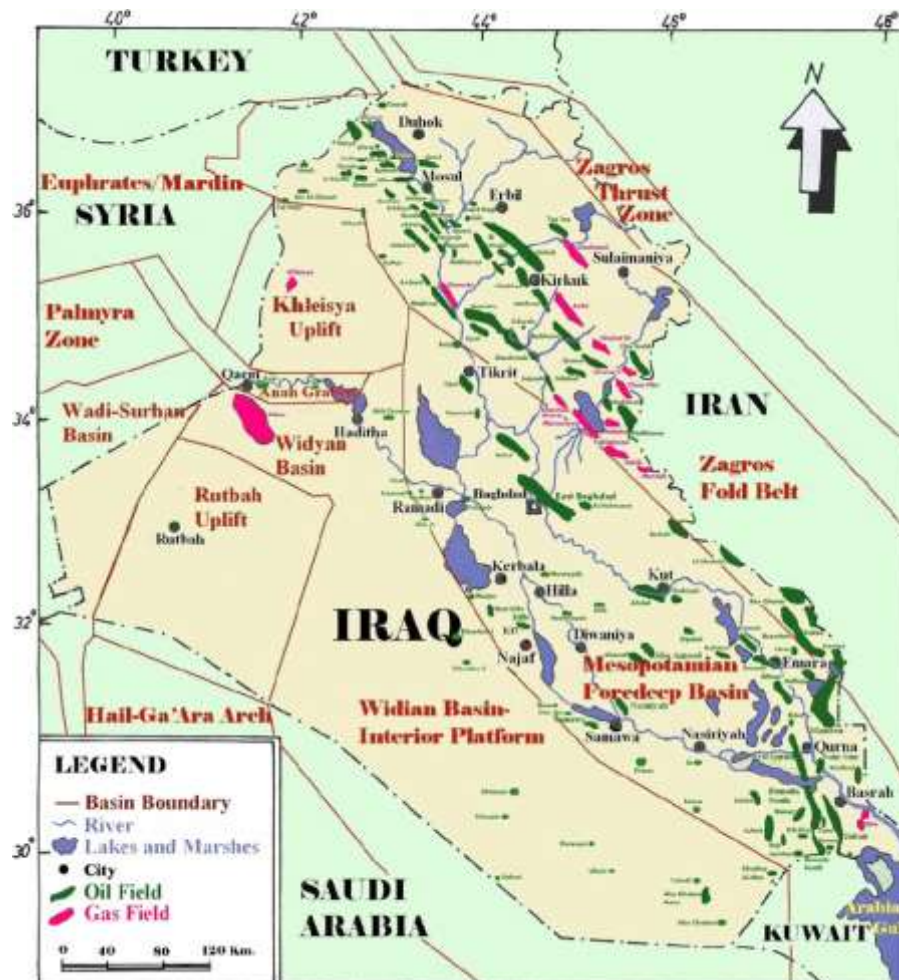


Fig.1: Location map of Iraq showing northeast Arabian Peninsula of the region Iraq with locations of basins, oil fields, and wells (after Al-Ameri et al., 2011).

limestone is more common (Bilal and Al-Zaidy, 2019). Anhydrite and oolitic limestone layers and lenses are part of the Hartha Formation, which is located in central Iraq between Ramadi and Makhul. Oolitic limestones are found in northwest Iraq (Ditmar et al., 1971).

The thickness of the formation varies due to its gradation and sometimes overlap with the Shiranish Formation. The thickness varies from 250 to 200 meters in southern Iraq and 350 meters on average in northern Iraq (Buday, 1980) . The Hartha is (1874 to 2194) meters deep, with an average thickness of 289

meters in the wells of the East Baghdad field (OEC, 2020). This difference in thickness is caused by either Because of the exposure or because it overlaps laterally and vertically with the Shiranish Formation on the other hand, to the erosion after Cretaceous era (OEC, 2013).

The Hartha Formation is equivalent with Tayrat facies in the northwest of Kuwait, and it is equivalent with some parts of the Al-Aromah group in Saudi Arabia. As far as, in the west and northwest.

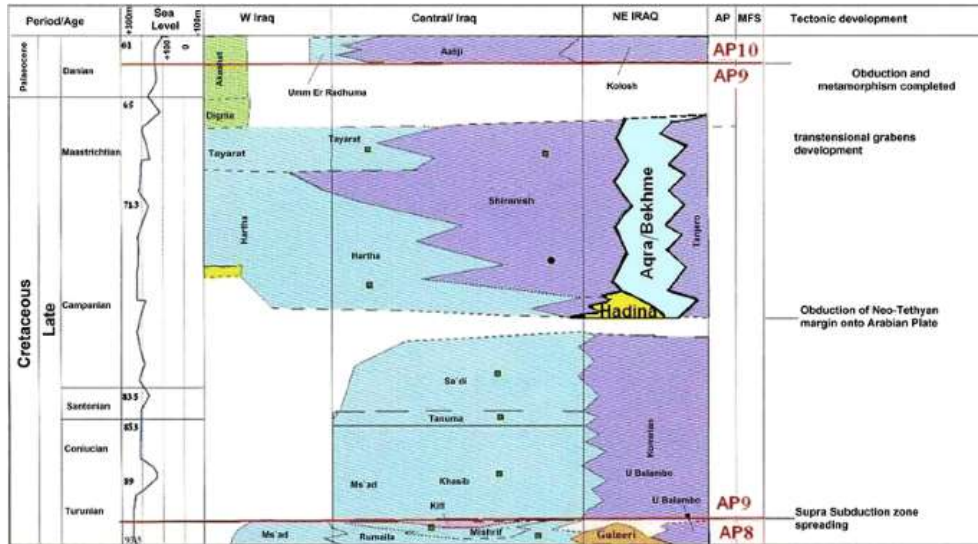


Fig. 2: Stratigraphic units during Late Campanian–Maastrichtian cycle include Hartha Formation (after Jassim and Goff, 2006).

direction, it is equivalent to some parts of the Soukhne Formation with age and facies, and the Karbogas Formation in Turkey is equivalent to it. In Qatar, the equivalent formation of the Hartha formation is the Ruilat formation, while in the northwest of Jordan it is equivalent to the Ghareb and Qatrane formations (Al-Sheikhly, 1980).

4. Results and Discussions

Based on the well logs (NL, DT, GR, and FDC), Hartha formation in East Baghdad Oil field was divided into three reservoir units (A, B, and C), which splitted into three insulating units (Barr 1, Barr 2, and Barr 3), as well as a higher unit represented by cap rock unit (CRU). (Figs.3-7) The dark color represents residual oils; the green color represents movable oils and blue color represents water saturation.

4.1 Reservoir units

The units of the Hartha Formation generally exhibit that :1- The oil is concentrated in the upper part of the unit A in all wells. 2- Unit B hasn't contain oil in wells EB3 and EB7 . The units are described as following:

Unit A:

This unit occur in all studied wells at the upper part of the Hartha Formation. It is mainly consist of limestone with very low percentages shale (clay). This unit has good oil saturation in wells EB 1, EB5, and EB6 compared with wells EB3, and Eb 7.

Unit B:

This unit composed mainly of limestone rocks. This unit is the thinnest unit in all studied wells compared to the other two units. It is site in the middle part of the formation. Oil saturation for this unit is low and it is missing in wells EB3 and EB7.

Unit C

It locates in the lower part of the formation and consist of clean limestone rocks. The thickness of this unit range from (55.5 -110 m). Oil occurs in this unit in all studied wells.

4.2 Barrier Units:

The description of the Barrier units are as follow:

Barr.1:

It is located between A and B units and composed of limestone with different percentages of shale. The thickness of this unit range from (71 -82 m). The petrophysical properties of this unit are poor so represents cap rocks that isolate between two reservoir rocks.

Barr.2

This unit is characterized by being thin (8-11.5 m) compared to other barrier units in the formation. Generally, this unit has low porosity and high density, in addition to the relatively high readings for resistivity logs. It is locate in the middle part of the Hartha Formation between B and C reservoir units.

Barr.3

It is locate in the lower part of the Hartha Formation and composed of limestone. Thickness for this barrier unit range between (14.5- 43m). The petrophysical properties of this unit are poor.

Form the above results, the deep resistance log (ILD) values are less than 10 degrees in unit A, ILD value is less than 6 degrees in unit B and it is lesser value in the unit C reach to 1.5 degree. The ILD values have an inverse relationship with oil content. For that the best reservoir unit is a unit C, which included higher of movable oils and it has high porosity values reach to more than 25%.

The best well in this study is a EB1 due to it has very good reservoir quality, represented by unit A, unit B and unit C, as well as it has high value average of porosity reach to more than 25%. The movable oil is existed in all reservoir units of EB1.

Generally, Water saturation values have high degree in the all well sections reach to 0.5 and this very clear in the all figures from EB1 to EB11-7. The C unit has a lesser value of water saturation for this reason C unit has high quality of reservoir characteristics.

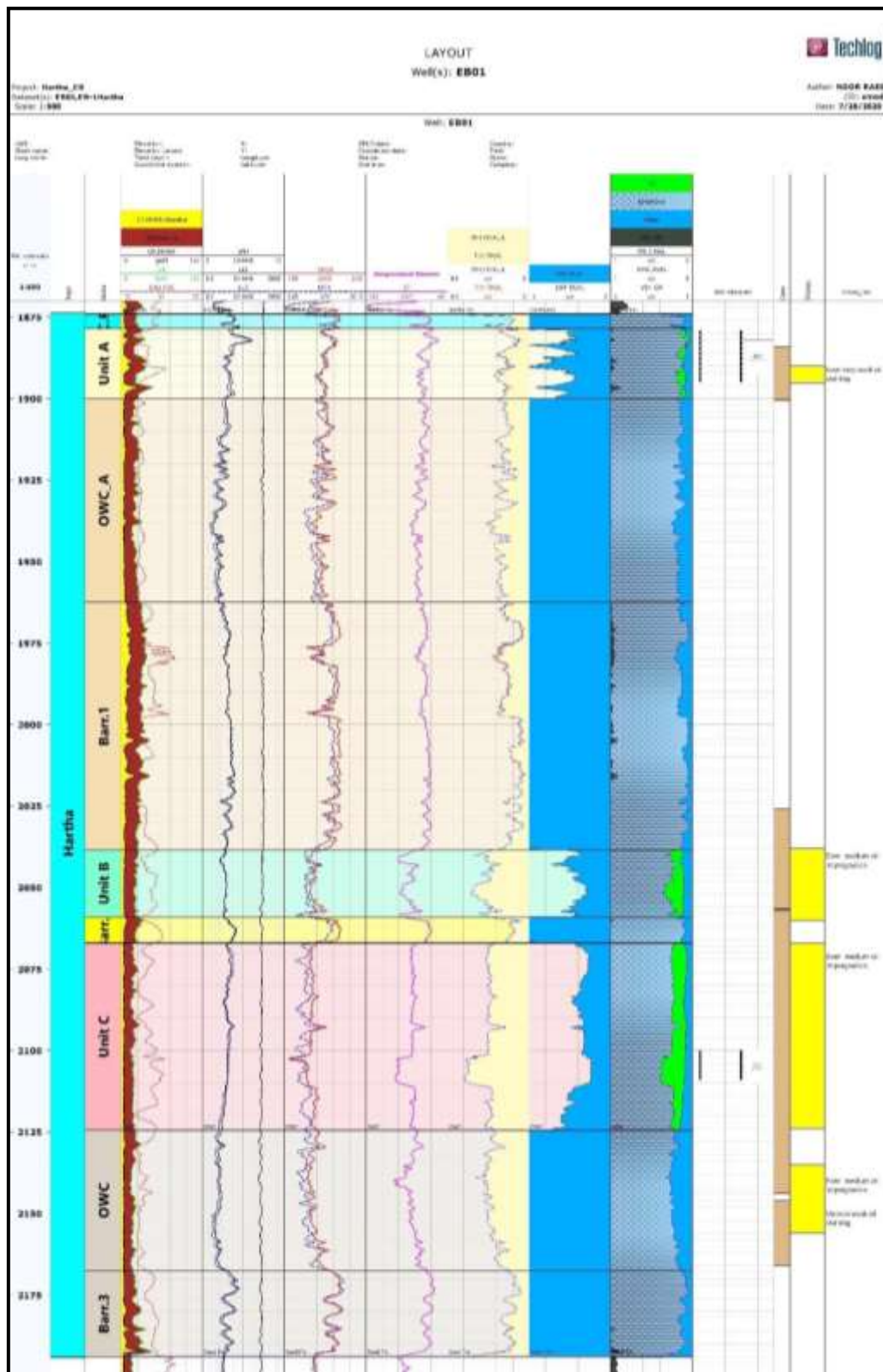


Fig. 3: Petrophysical logs of well- EB1 in the East Baghdad oil field / Hartha Formation / unpublished report of OEC,2020

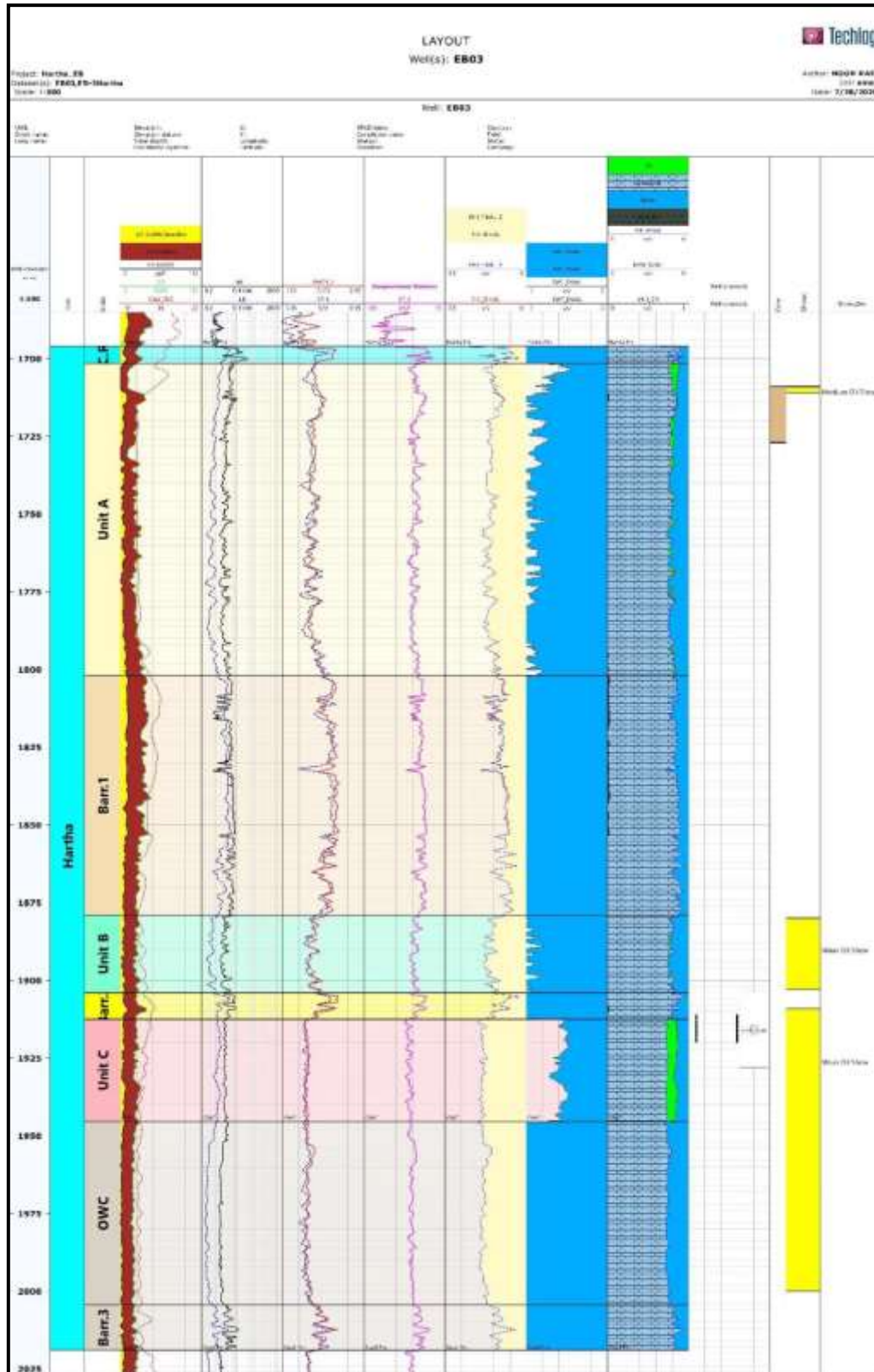


Fig.4: Petrophysical logs of well- EB3 in the East Baghdad oil field / Hartha Formation \ unpublished report of OEC,2020

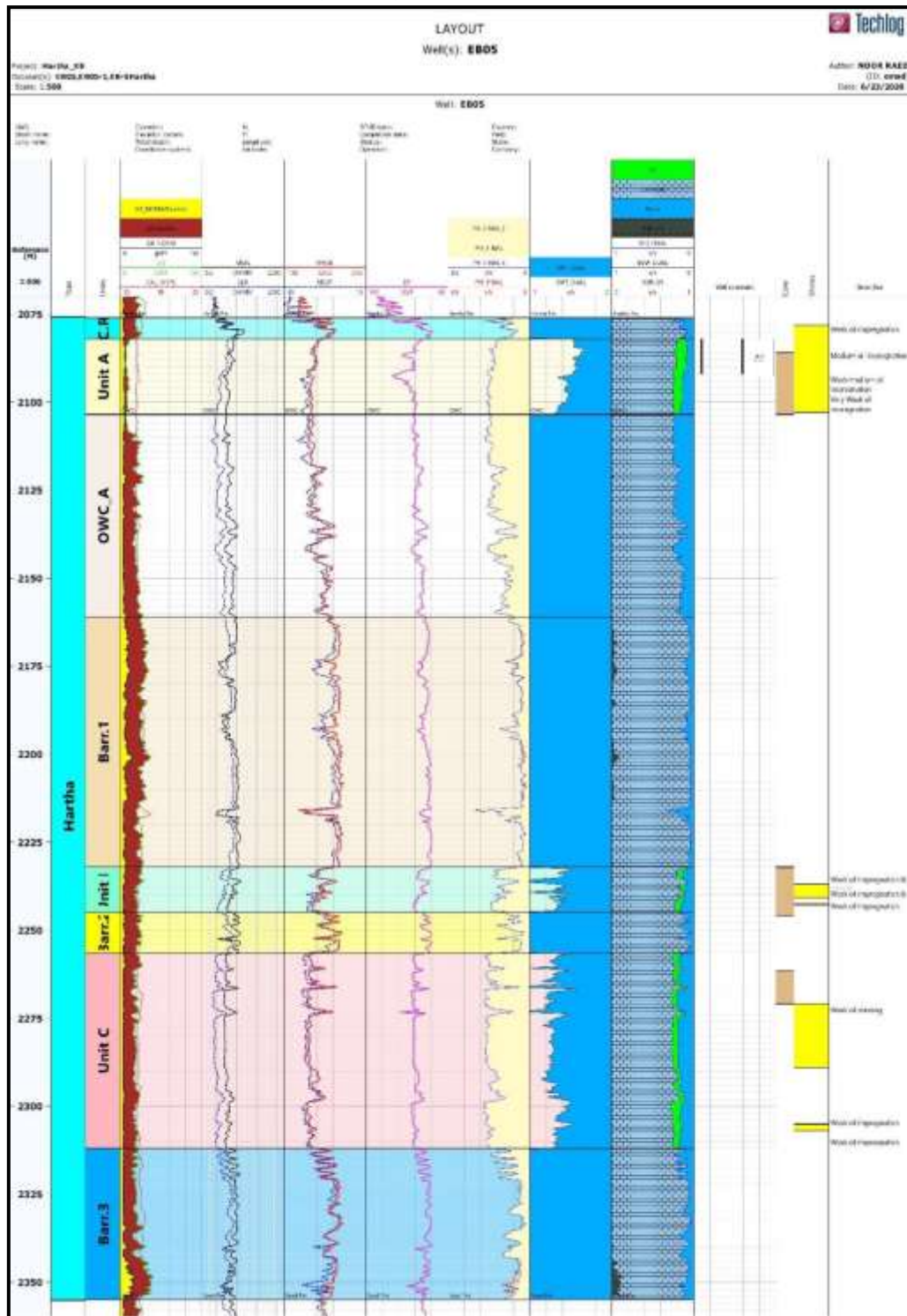


Fig.5: Petrophysical logs of well-EB5 in the East Baghdad oil field / Hartha Formation \ unpublished report of OEC,2020

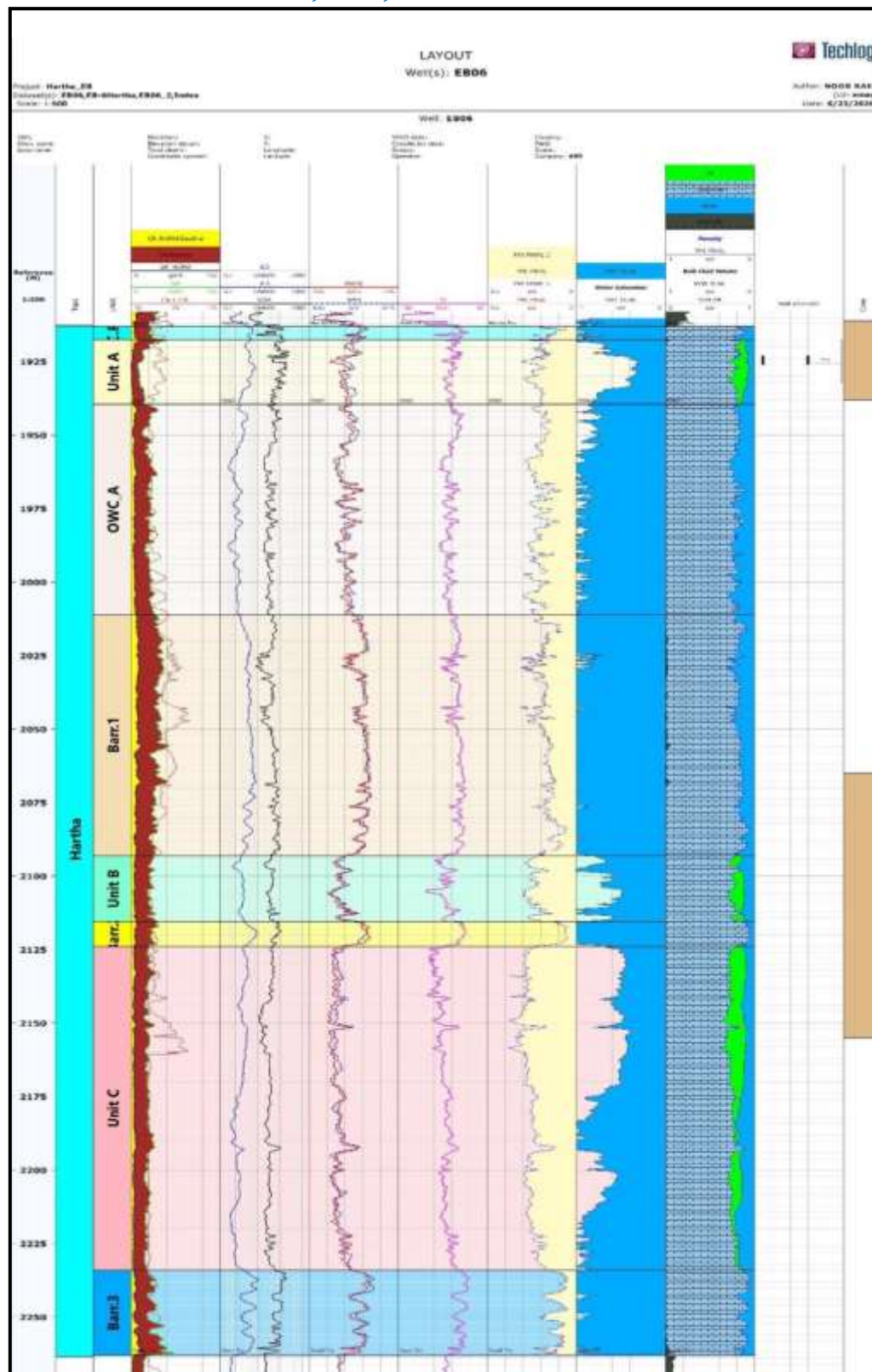


Fig.6: Petrophysical logs of well-EB6 in the East Baghdad oil field / Hartha Formation / unpublished report of OEC, 2020

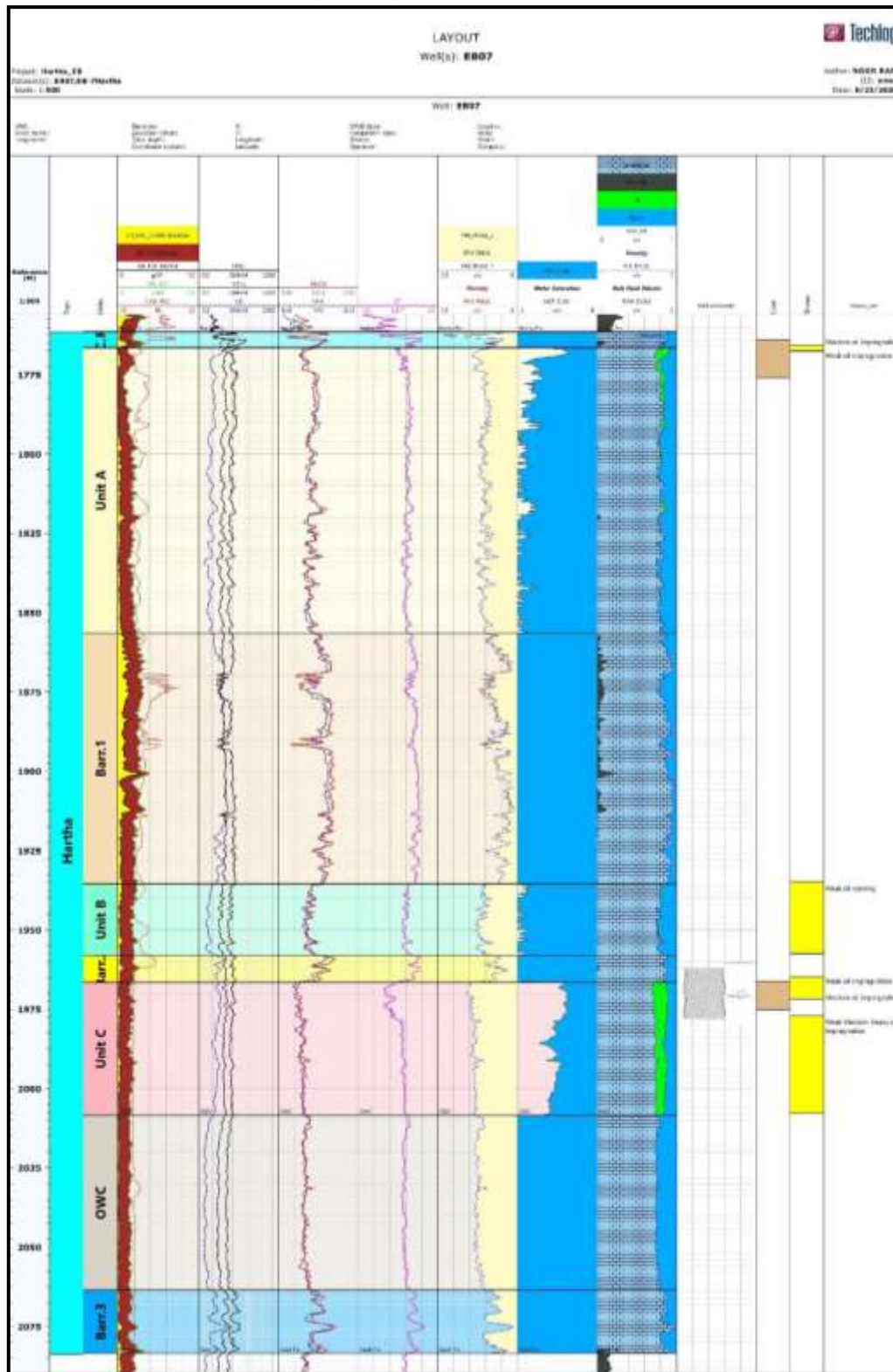


Fig. 7: Petrophysical logs of well-EB7 in the East Baghdad oil field / Hartha Formation \ unpublished report of OEC, 2020

5. Conclusions

1-Lithologically, Hartha formation contains porous limestone, high porosity limestone, compacted limestone and less quantities of shaly limestone throughout the whole sequence in all studied wells (EB-1, EB-3, EB-5, EB-6 and EB-7). The upper conformable contact with Tayarat Formation and the

lower contact is an unconformable with Saadi Formation.

3-The selected well divided into three reservoir units represented by unit A, unit B and unit C based on well logs study which splitted into three insulating units (Barr 1, Barr 2, and Barr 3), as well as a higher unit represented by cap rock unit (CRU).

2- All studied wells exhibit a good porosity values. The best reservoir unit is a unit C, which included higher of movable oils and it has high porosity values reach to more than 25%.

4- The best well in current study is a EB1 due to it has very good reservoir quality, represented by unit A, unit B and unit C, as well as it has high value

average of porosity reach to more than 25%. The movable oil is existed in all reservoir units of EB1.

Acknowledgments

The authors are very grateful to the reviewers, Editor in Chief Prof. Dr. Salih M. Awadh, the Secretary, and the Technical Editors Iraqi Geological Journal for their great efforts and valuable comments.

References

- Al-Ameri, T. K., Pitman, J., Naser, M. E., Zumberge, J., Al-Haydari, H. A. 2011. Programed oil generation of the Zubair Formation, Southern Iraq oil fields: results from Petromod software modeling and geochemical analysis. *Arabian Journal of Geosciences*, 4(7), 1239-1259.
- Al-Naqib, K.M., 1967. *Geology of the Arabian Peninsula Southwestern Iraq*. United States Government Printing Office, Washington, Professional Paper, 560-6.
- Ali, M. S., Al-Dabagh, M. M., Asaad, I. S., 2022. Determination of porosity types impressive on Butmah Formation (early Jurassic) in selected wells Northern Iraq (case study). In *AIP Conference Proceedings* (Vol. 2443, No. 1, p. 020003). AIP Publishing LLC.
- Al-Sheikhly, S. S., 1980. *Maastrichtian-upper Eocene ostracoda of the subfamily Trachyleberidinae from Iraq, Jordan and Syria* (Doctoral dissertation, University of Glasgow).
- Asaad, I. S., Omer, M. F., & Ahmed, A. M. (2022). Porosity Evolution and Microfacies Analysis of the Khurmala Formation (Paleocene-Early Eocene) from Selected Sections in Kurdistan Region, Northern Iraq Revealed by Cathodoluminescence Spectroscopy. *The Iraqi Geological Journal*, 79-98.
- Aqrabi, A.A.M., J.C. Goff, A.D. Horbury, and F.N. Sadooni, 2010. *The Petroleum Geology of Iraq*: Scientific Press, 424 p.
- Balaky, S. M., Al-Dabagh, M. M., Asaad, I. S., Tamar-Agha, M., Ali, M. S., Radwan, A. E., 2022. Sedimentological and petrophysical heterogeneities controls on reservoir characterization of the Upper Triassic shallow marine carbonate Kurra Chine Formation, Northern Iraq: Integration of outcrop and subsurface data. *Marine and Petroleum Geology*, 106085
- Bellen, R.C., Dunnington, H.V., Wetzel, R., Morton, D. 1959. *Lexique Stratigraphique International Asie, Iraq*. Vol. 3C, 10a, 333 p.
- Bilal, H., Al-Zaidy, A.. 2019. Microfacies Analysis and Basin Development of Hartha Formation in East Baghdad Oil field, Central Iraq. *Mesopotamia Foredeep, Iraq, Iraqi Bulletin of Geology and Mining*, 43p
- Buday, T., 1980. *The Regional Geology of Iraq*, Vol 1 Stratigraphy and Paleogeography. Publications of Geological Survey of Iraq, Baghdad, 445 p.
- Ditmar, V. and Iraqi – Soviet Team, 1971. “Geological conditions and hydrocarbon prospects of the Republic of Iraq (Northern and Central parts)”. Manuscript report, INOC Libraey, Baghdad. 3: 18p.
- Jassim, S.Z., Goff, J.C., 2006. *Geology of Iraq*. Published by Dolin, Prague Moravian Museum, Brno, p341.
- Owen, R.M.S., Nasr, S.N., 1958. Stratigraphy of the Kuwait-Basra Area. In: Weeks, L.G., Ed., *Habitat of Oil*, American Association Petroleum Geologist Memoir 1, Tulsa, 1252-1278.
- OEC, 1989. Geological study of Hartha Formation in East Baghdad oilfield unpublished report of OEC,2020.
- OEC. 2013. Geophysical-geological evaluation study for East Baghdad field (southern area 2) - 3D survey, Oil Exploration Company Library.
- OEC, 2020. *Geology and Geophysics Authority / Evaluation Geology Department*. An evaluation study of the heavy oils of the Hartha and Zubair reservoirs in East Baghdad oilfield, 2P.
- Salman Z. K., Fali, M. D., Hayder, H. M., 2017. Structural and Stratigraphic Study of Hartha Formation in the East Baghdad Oil Field, Central of Iraq. 2119p.