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Formation evaluation and seismic interpretation of the Jurassic sedimentary section in the Matruh concession, North Western Desert, Egypt

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THE PRESENT study deals with the evaluation of petrophysics for reservoir and source rock throughout constructing structure depth maps for the picked horizons of the Jurassic section and identifying the elements of the petroleum system. The petrophysical results exhibited that the Jurassic reservoirs show the presence of sandstone with some calcareous cement in all studied wells. Results of well log analysis of the Upper Safa reservoir showed that the thickness of the net effective pay in the studied area ranges between 28 and 70 ft., with an average effective porosity of 9%, an average hydrocarbon saturation of 78%, and an average permeability of 33 mD. However, the Lower Safa reservoirs in the study area have a net effective pay range in thickness between 29 and 60 ft., an effective porosity of 8.9%, and a hydrocarbon saturation of 75%. The geochemical characteristics of the source rocks were evaluated to identify the organic richness, types of organic matter, depositional environment, and maturity of the Jurassic source rocks based on the Rock Eval-6 pyrolysis analysis (TOC, S1, S2, Tmax, HI, and OI) for seventy (70) ditch samples penetrated by five wells in the study area. Results show that the Upper Safa source rocks are located in the late to overly mature stages and lie in the gas generation stage, while the Lower Safa source rocks are located in the early to overly mature stages and lie in the gas and oil generation stages. The main identified reservoirs in the area are toped and sealed by the intra-formational shale intervals within the reservoirs themselves, and the main traps are developed and controlled by the area structure. The current study used the above-mentioned techniques of integrating geochemical and geophysical methods to identify the main petroleum systems of the Jurassic sediments in the study area. The detailed analysis of the Upper and Lower Safa reservoirs provides a comprehensive understanding of the petrophysical properties, which are crucial for assessing the reservoir quality and potential. The calibration with measured samples ensures the reliability and accuracy of the well-logged interpretations.

Keywords: Seismic Interpretation, Source Rocks Evaluation, Jurassic Sequences, and Formation Evaluation,Westeren Desert, Egypt.

1. Introduction

Sedimentation in the study area was controlled largely by tectonics. The historical record indicates that sub basins in the north western part of Egypt developed as a rift basin, presented a rapid subsidence during the Middle and Late Jurassic periods, which persevered until the early Cretaceous period. **(Metwalli, 2018).**

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Many of the emerging lands of Northern Egypt were submerged by the newly formed Tethys in Jurassic period. North Africa has been moved toward Europe in the Late Cretaceous and Early Tertiary, resulting in the development of fault displacement, elevation, and folding of the North Western Desert along the trend of the Syrian Arc System (ENE-WSW). Moreover, rifting events resulted in the creation of current sub-rift basins, which align in a southwest to northeast orientation and filled with shallow marine and terrigenous derived sediment **(Bosworth et al., 2015 and Guiraud et al., 2005).** The Matruh basin, which is one of these sub rift basins underwent inversion throughout the Late Cretaceous to Early Cenozoic period, resulting in the formation of fault propagation folds oriented towards the NNE direction, which were intersected by normal faults oriented towards the NW direction **(Moustafa, 2008).**

The important of the present study is to integrate the seismic interpretation, petrophysics, and geochemical analysis, to evaluate the on situ dual formation, which act as source and reservoir across the studied basin at North Western Desert through applying these multi approaches on the 7 wells of the current study. **1.1.**

Location

The study area is in the northwestern part of the Western Desert of Egypt, about 50 Km south of the Mediterranean coast, between latitudes 30º 48`and 31º 06` N, and longitudes 27º 09` and 27º 28` E. It covers about 967 Km^2 **(EGPC, 1992) (Fig. 1).** The study area was discovered by drilling well 3. The finding of this well led to the discovery of the whole Field contains the studied wells, which produces gas and condensate from the Upper and Lower Safa reservoirs. The location of the studied wells are as the following: (well.1 at X:739613mE, Y:304537mN; well.2 at X:738845mE, Y:304250mN; well.3 at X:738841mE, Y: 303753mN; well.4 at X:738007mE, Y: 306049mN; well.5 at X:742137.6mE, Y: 302512.5mN; Well.6 at X: 738 761.88 m E, Y : 298 891.92 mN; Well.7 at X:733102.3mE**.**

1.1. Geologic Setting

The structural development of Egypt was influenced by multiple tectonic events that reactivated the pre-existing four primary structural trends in the basement rocks , namely N-S, NE-SW, ENE-WSW, and E-W, as recognized by (**Hantar, 1990).** The sedimentary basins in the Western Desert have a complex geologic history that dates back to the Pre-Cambrian era. During the Pan-African orogenic events and before the onset of Hercynian orogeny, the major fault zones control the geological formations and created the conditions for the later basins evolution, including the deposition of continental clastics and shallow marine carbonates. The Hercynian orogeny led to the creation of intracratonic sags and rift basins. The Tethys Ocean was formed during the Late Palaeozoic to early Mesozoic period, and erosion occurred, which caused the Palaeozoic rock layers to become thinner in the north of the western desert and overlap around the basement highs **(Guiraud et al., 2005).** The Khatatba Formation sedimentary sequences found in many sub-basins of the Western Desert. It lies directly above the Palaeozoic Unconformity. This formation consists of a mixture of Sili clastic materials and contains reservoir sandstones around its base, which often contain oil and gas **(Keeley et al., 1990).** The Khatatba Formation consists of organic-rich shales that are frequently found in layers above and below each other that serve as seals, preventing the escape of hydrocarbons. Consequentially, this formation represents a typical petroleum system where hydrocarbons are generated, trapped, and stored. Traps of the Khatatba Fm are mostly faulted anticlines that generated in the Early Cretaceous due to Rifting reactivation **(Bosworth et al., 2015, Yousef et al., 2023).**

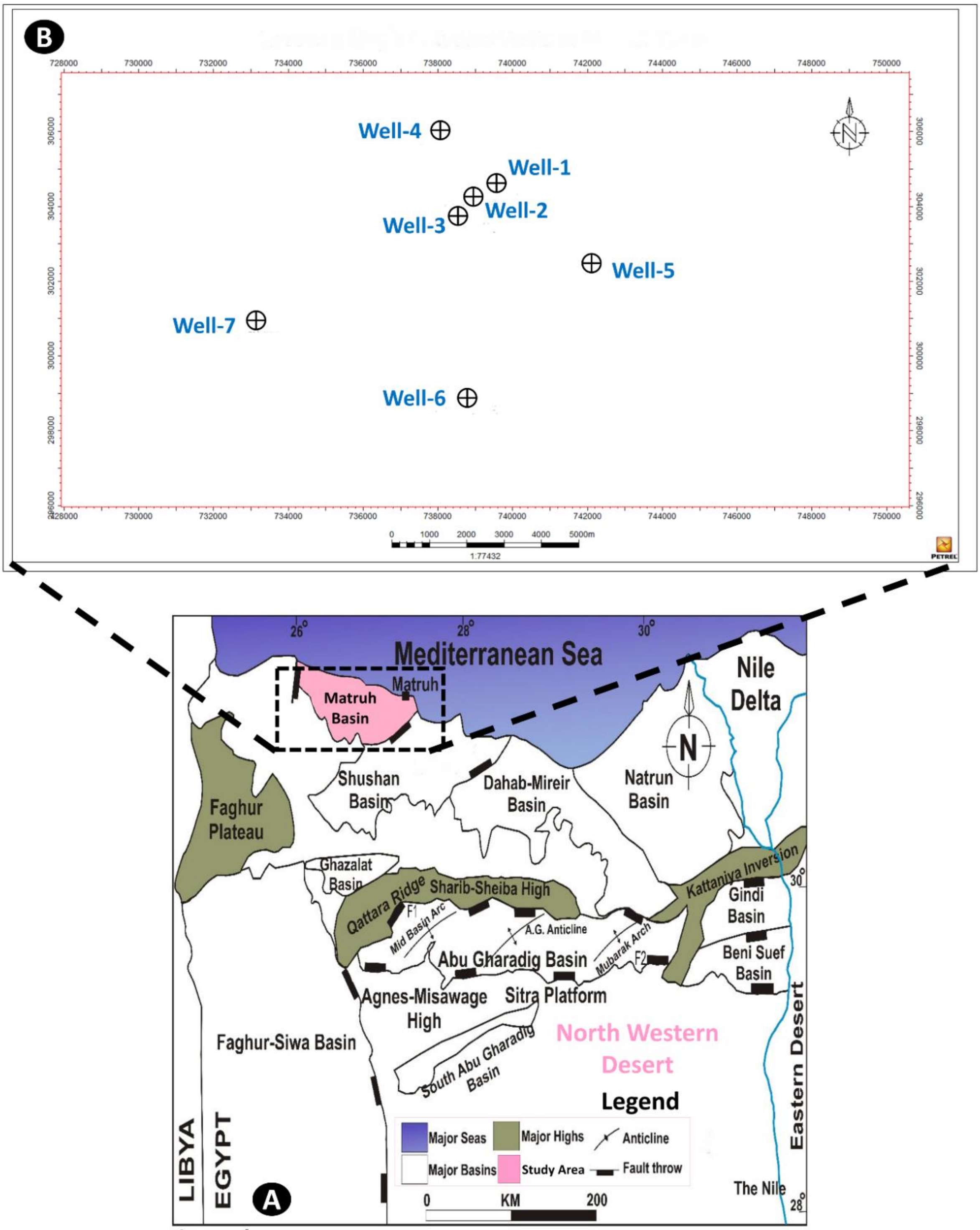

Fig. 1. (A). Location map of North Westerns Desert showing the main basins, structural features and the location of the study area and studied wells (modified after EGPC, 1992 & Mansour at al., 2022). (B): Base map generated in Petrel software shows the location of the studied wells.

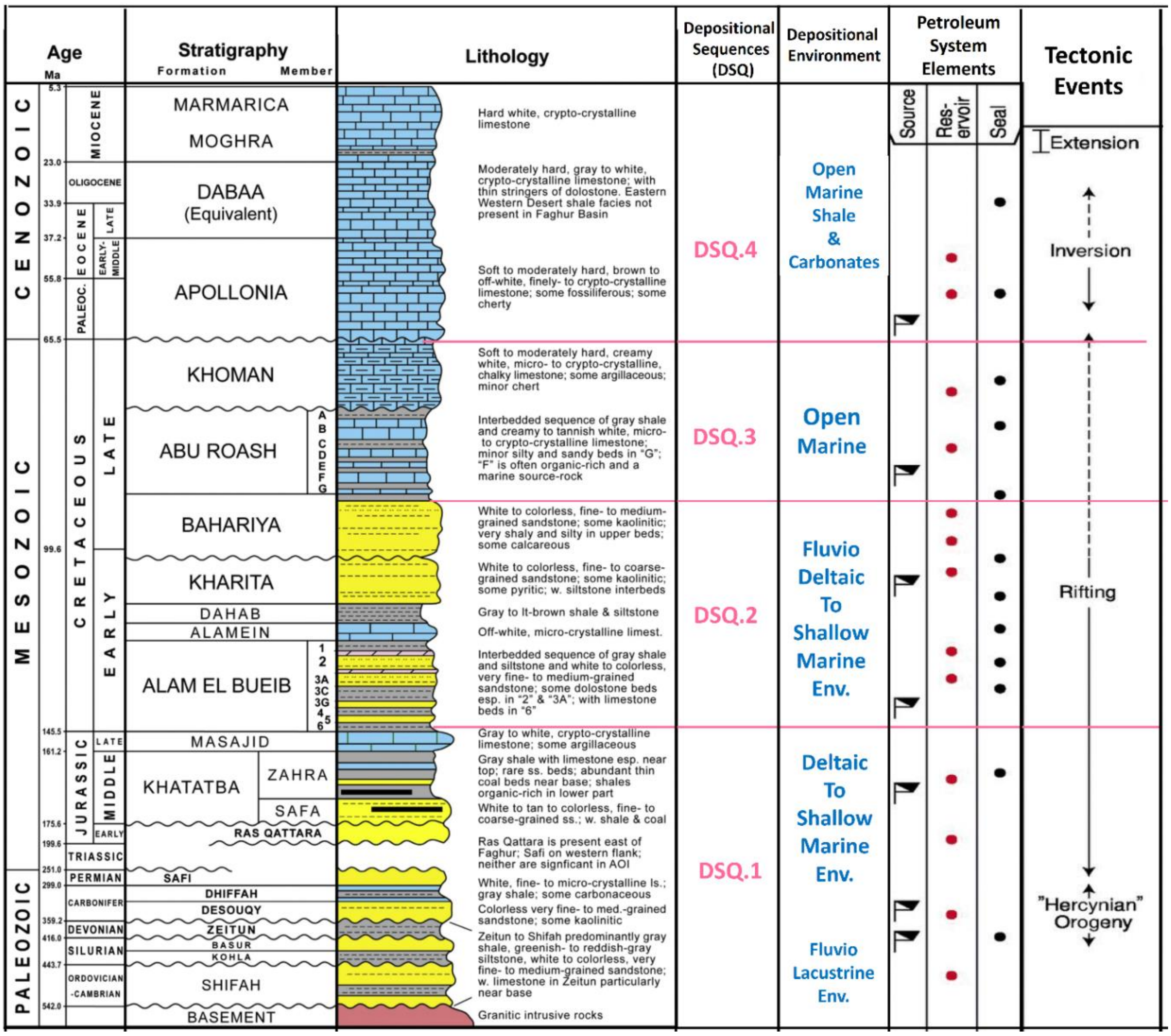

Fig. 2. General stratigraphic column Egypt Western Desert showing the main tectonic events, depositional sequences cycles, and depositional environment (modified after Schlumberger 1995, Abrams. et al., 2016, & Ali, 2024, a).

3. Materials and Methods

3.1. Data

A number of 7 wells were available from the EGPC, their coordinates are shown in the location map at (Fig.1). A number of 70 drilling cutting samples were available from 5 wells and have been analysed for geochemical analysis to evaluate the source rock by estimating the Total Organic Carbon (TOC,) kerogen type, and hydrocarbon potential of these wells. The samples were selected to cover the Jurassic section and the investigated section ranges in thickness from 2123 ft-2925ft across the studied wells. The wells are located in the north-western of north western desert, and namely from well-1 to well-7 at coordinates illustrated in (**Fig.1**). The wells have been drilled to reach a total depth of 16300 ft. Wireline logs of (GR, Calliper, Porosity logs, Resistivity, PEF, Sonic logs), for the 7 wells were available and used in formation evaluation by estimating the petrophysical properties of the target formation. Spectral GR was available in one well (well-5) and used in identifying the clay types through Schlumberger lithology cross plots. For seismic interpretation work, a number of twenty two 2D seismic lines and check shot for three wells were available to construct the average velocity maps, TWT maps, and adjusted depth structure maps along the investigated section.

3.2. Formation Evaluation

Various types of geophysical data were analyzed to identify the lithology, organic richness, and petrophysical parameters of the Jurassic samples in the studied well, as illustrated in the workflow **(Fig. 3).** Lithology, volume of shale, porosity, and water saturation were determined following the methodology of **Clavier et al., (1984), Asquith et al., (2004), Hakimi et al., (2012), Al-Areeq and Alaug (2014), Osli et al., (2018), and Ali, (2024, a).**

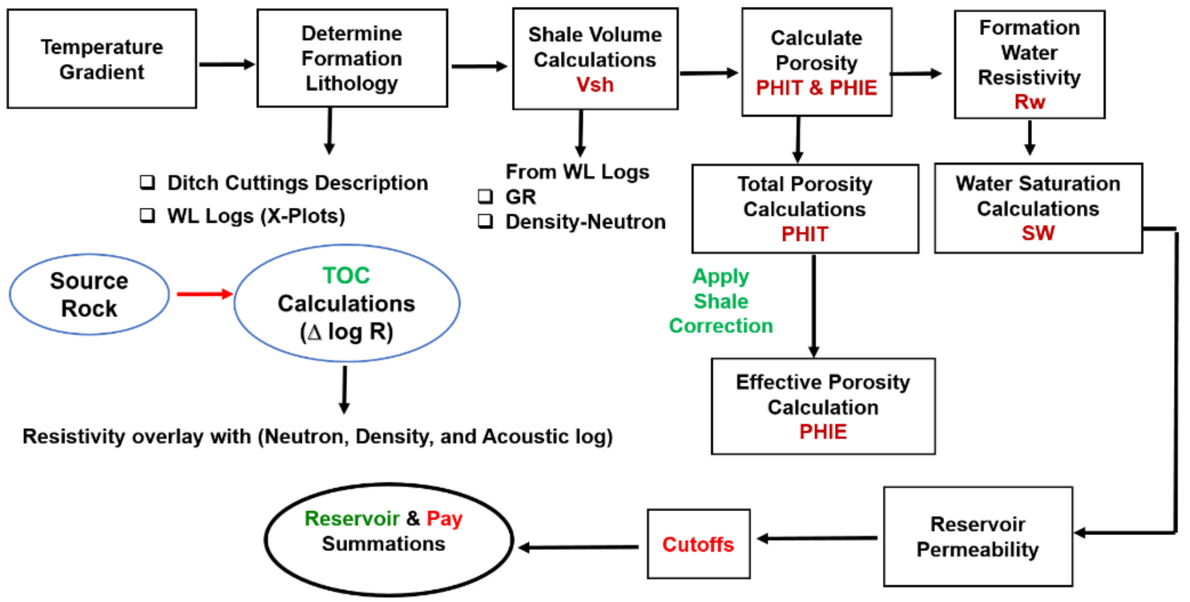

Fig. 3. A workflow chart showing the steps followed for Jurassic section Formation Evaluation in the studied wells (after, Ali, 2024, a & b).

3.3. Seismic Interpretation

The initial stage in seismic interpretation, *seismic well tie*, is to estimate a link between seismic reflections and stratigraphy. Some wells have sonic log (i.e. formation velocity) and formation density logs, at least across the intervals of interest, using these logs; it is feasible to create a synthetic seismogram displaying the seismic response for correlation with the real seismic data. In addition, some wells have Vertical Seismic Profiling (VSP) data, which is produced by producing surface seismic waves using a seismic generator, these waves are recorded by geophones in the well. This method has the ability to produce more exact linkage between well and seismic data **(Bacon et al., 2003).** Tying between seismic data (in time) and well data (in depth) helps to find (seismic reflections) that corresponds to geological formations. There are basically two methods used to tie the seismic data and geological features, the first is using check shot data (time depth relation), and the second using synthetic seismogram. The first method is the simplest but least accurate **(Badley, 1987).** In current study, the second method has been applied and synthetic seismogram has been constructed in three wells, one of them is illustrated in (**Fig.4**). After tying seismic lines with the tops of well logs, picking horizons and fault segments have been done and illustrated in **(Fig.5).**

Depth conversion enables the transformation of seismic data from the time domain to the depth domain (**Brown, 2004**). This process follows interpretation since seismic measurements are taken in time, whereas well data are measured in depth. The velocity was obtained using a check shot survey and transformed utilizing the Petrel 2017.3 software by making velocity maps and depth conversion maps to move the data between domains **.**Velocity maps are used to convert two way time to depth, in order to construct the structure depth maps for the Jurassic section.

3.3. Rock-Eval pyrolysis and total organic carbon (TOC) content

A 0.5 gm weight was extracted from each sample of the 70 cutting drill samples and subjected to a two-step washing process using distilled water and a dichloromethane (DCM) solution. The extracted portion was then analyzed using the LECO C230 equipment to measure the weight percentage of total organic carbon (TOC wt. %). Samples with a total organic carbon (TOC) weight percentage more than 0.5 were subjected to an open system programmed Bulk Rock-Eval pyrolysis utilizing the Rock-Eval 6® Pyro-Analyzer. Additional information regarding the Rock-Eval pyrolysis technique and its specific parameters (S1, S2, S3, HI, and OI) can be found in the publication by **(Behar et al., 2001).**

3.4. TOC delta log R calculations from well Log

Passey et al., (1990) described the resistivity-porosity overlay approach used to determine the TOC. The exhibited curves are arranged in a manner that results in their alignment in the non-source area. The interval between these curves is typically termed as the delta log R and is utilized for the detection of intervals rich in organic matter. The calculation of organic richness may be achieved by applying a combination of resistivity and one of the porosity logs, such as sonic, density, or neutron. The total organic carbon (TOC) for the analyzed wells are then calibrated with the measured TOC. More details regarding implementing the Passey et al. (1990)'s technique is illustrated in **(Ali, 2024, a).**

4. Results and Discussions

4.1. Seismic Interpretation

The seismic data interpretation underwent various stages. Initially, identifying the formation tops, which obtained from the composite logs, and graphically represent them on the synthetic seismograms of some wells to find the miss tie between these wells and the seismic sections. This interpretation encompassed the entire study region, traversing all seven wells. The interpretation proceeded through a series of processes, beginning with the selection of horizons, followed by the estimation of faults, the correlation of faults, the determination of fault heaves, and finally contouring.

Synthetic Seismogram

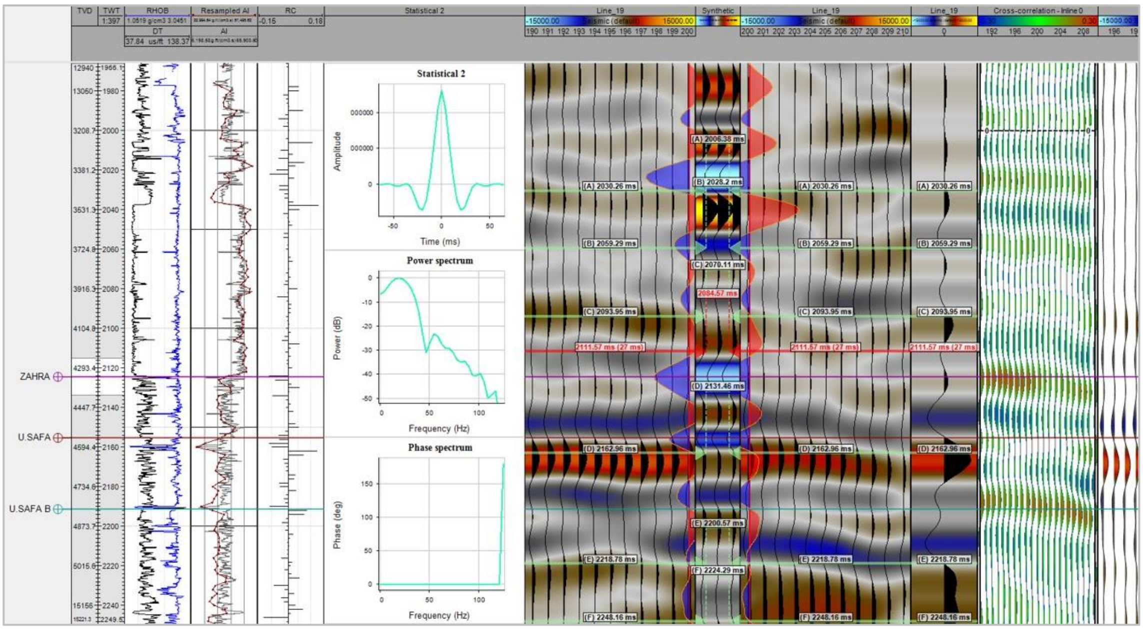

Fig. 4. Synthetic seismogram at well-1, shows seismic to well tie for the studied formation (generated in Petrel 2017.3 software).

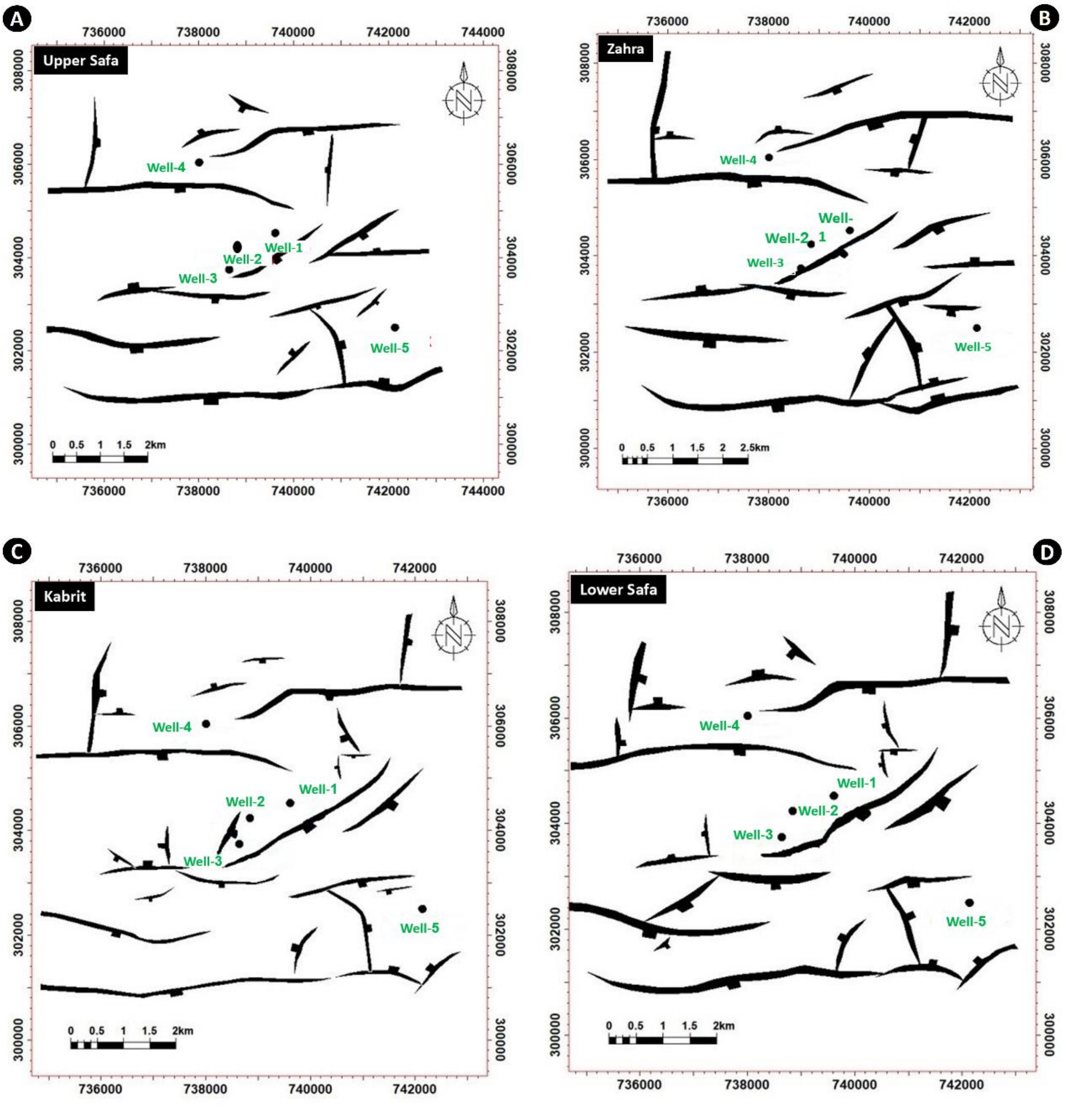

Fig. 5. Interpreted Faults patterns of the 4 members of Khatatba Fm from the given seismic data (generated in Petrel 2017.3 software).

The Jurassic Thickness

Many cross sections across the studied wells have been taken to identify the thickness of each unit in the Jurassic section. A base map show the location of the taken cross sections is shown in **(Fig.6).**The Jurassic sediments cross plots through the studied wells showed that thickness increases in the North-East direction and penchout in the NW direction, as shown in **(Figs. 7, 8, 9). Table (1**) illustrate the thickness of each unit in the Jurassic section along the studied 7 wells.

Table. 1. Jurassic section thickness along the studied 7 wells in the area.

WELL	Formation Name	Thickness (Ft.)	Jurrasic Section
Well-1	MASAJID	828	2123
Well-1	ZAHRA	229	
Well-1	U.SAFA	757	Khatatba Section
Well-1	KABRIT	28	1296
Well-1	L.SAFA	281	
Well-2	MASAJID	843	Jurrasic Section
Well-2	ZAHRA	217	2345
Well-2	U.SAFA	754	Khatatba Section
Well-2	KABRIT	28	1502
Well-2	L.SAFA	503	
Well-3	MASAJID	837	Jurrasic Section
Well-3	ZAHRA	216	2925
Well-3	U.SAFA	747	Khatatba Section
Well-3	KABRIT	24	2088
Well-3	L.SAFA	1101	
Well-4	MASAJID	819	Jurrasic Section
Well-4	ZAHRA	269	2319
Well-4	U.SAFA	698	Khatatba Section
Well-4	kabrit	37	1500
Well-4	L.SAFA	496	
Well-5	MASAJID	807.95	Jurrasic Section
Well-5	ZAHRA	290	2585
Well-5	U.SAFA	685	Khatatba Section
Well-5	kabrit	36	1777.05
Well-5	L.SAFA	766	
Well-6	MASAJID	779	Jurrasic Section
Well-6	ZAHRA	210	2655
Well-6	U.SAFA	709	
Well-6	KABRIT	26	Khatatba Section
Well-6	L.SAFA	932	1876
Well-7	MASAJID	806	Jurrasic Section
Well-7	ZAHRA	215	2409
Well-7	U.SAFA	731	Khatatba Section
Well-7	kabrit	35	1603
Well-7	L.SAFA	622	

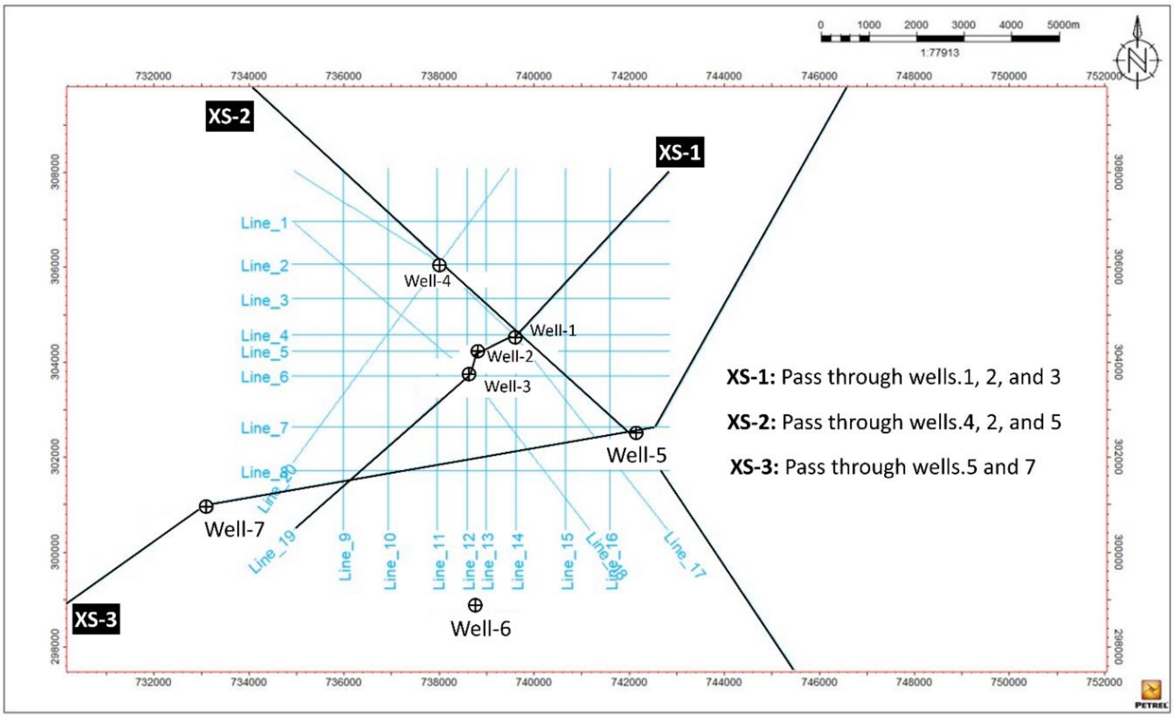

Fig. 6. Location map of the three cross sections (XS-1, SX-2, SX-3) taken across the study area (generated in Petrel software).

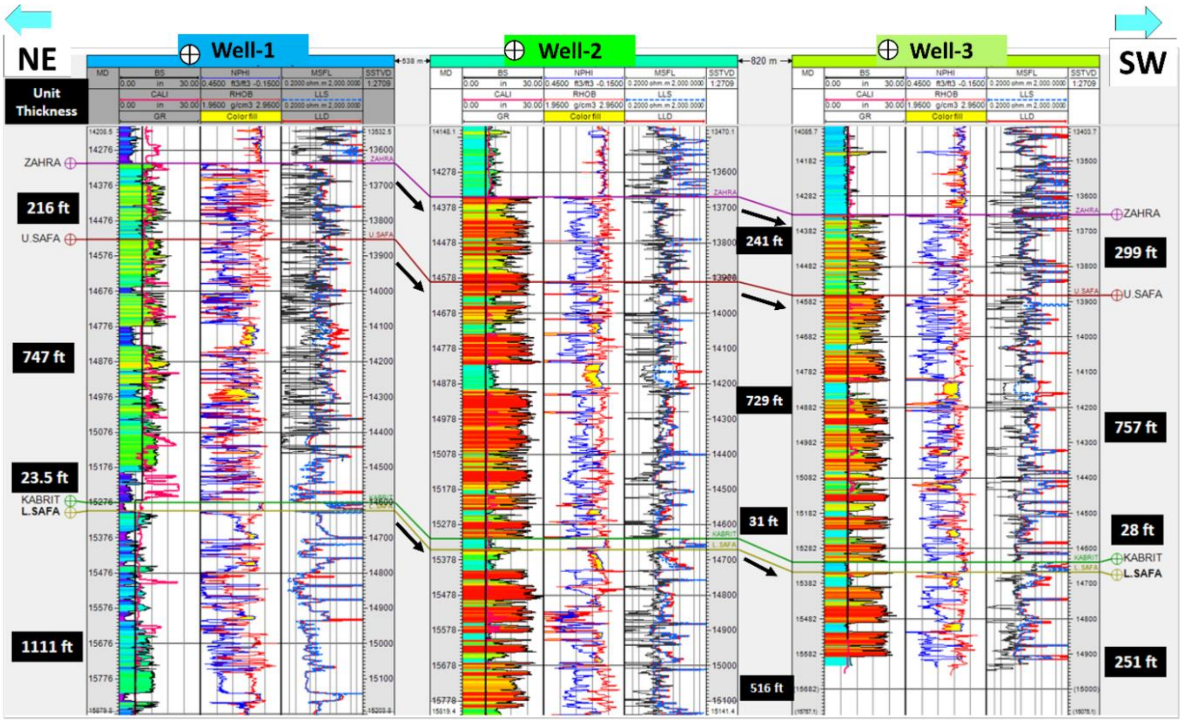

Fig. 7. Cross Section XS-1 in the direction of NE-SW show the thickness of all the layers of the Jurassic section are decreasing in the SW-direction.

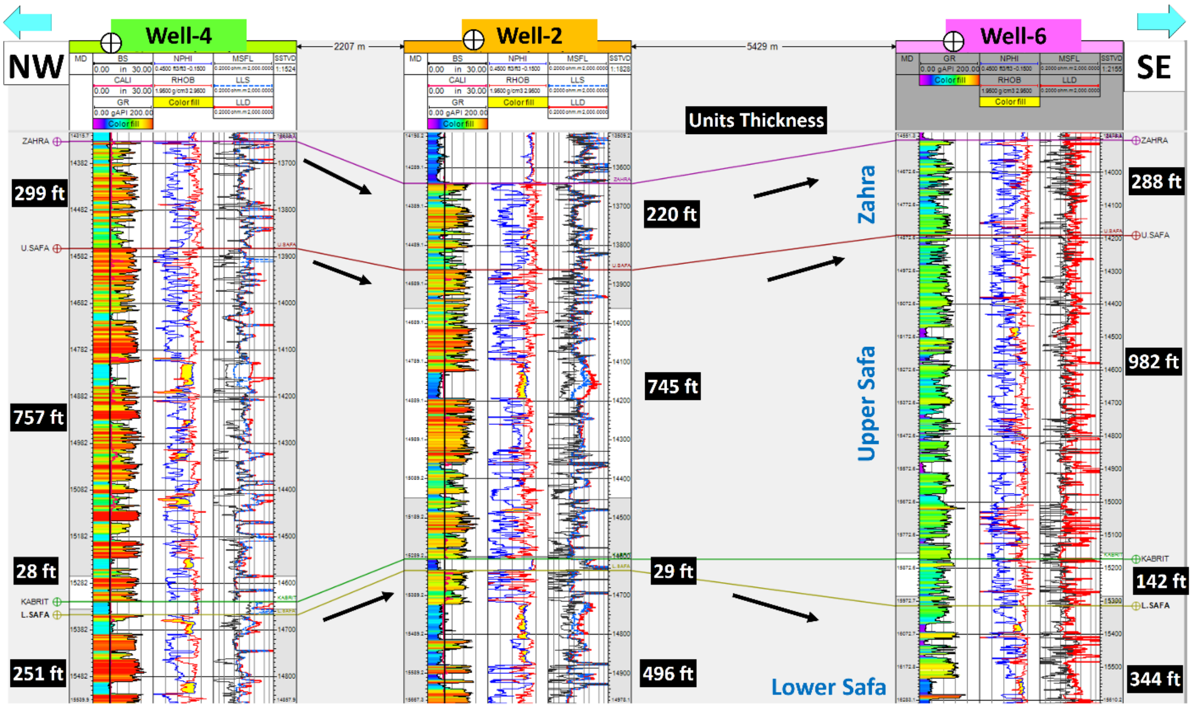

Fig. 8. Cross Section XS-2 in the direction of NW-SE. A graben structure is observed in the current cross section, which is dissected by a group of normal faults on the structure depth map.

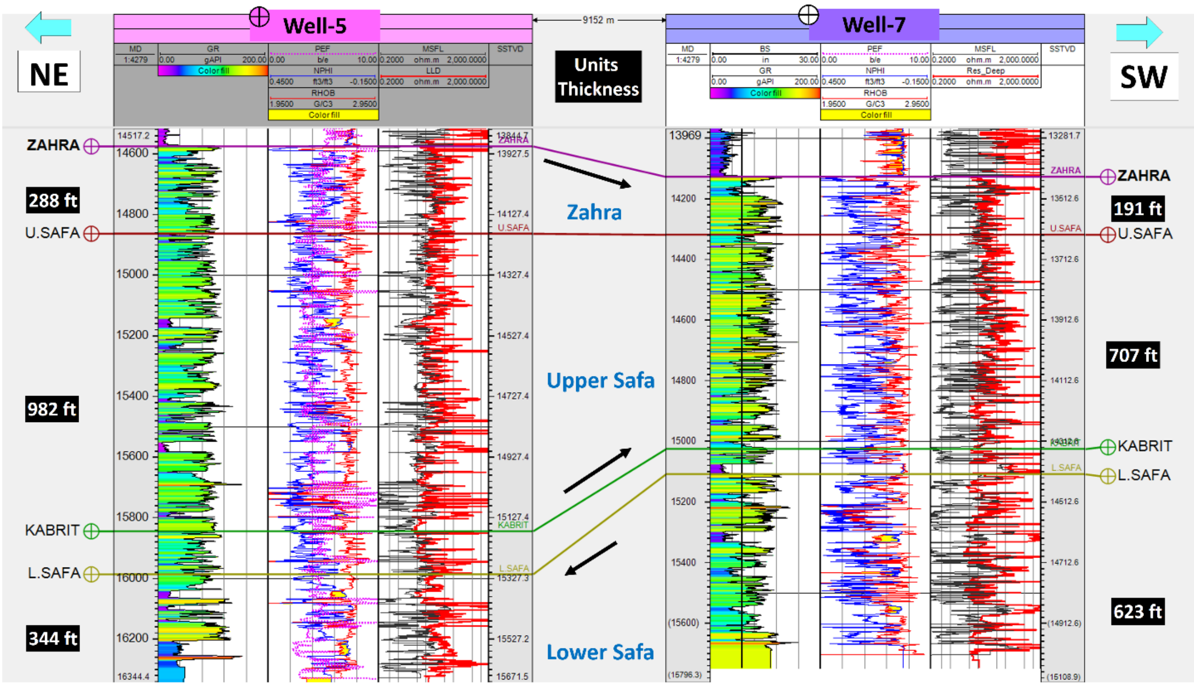

Fig. 9. Cross section XS-3 pass through well 5 and well 7 show that Upper Safa member penchout in SW direction, while the lower Safa member thickness decrease in NE direction.

The average velocity, depth conversion, Two Way Time and Depth Structure Map of the upper Jurassic Masajed Formation is illustrated in **(Fig. 10).**

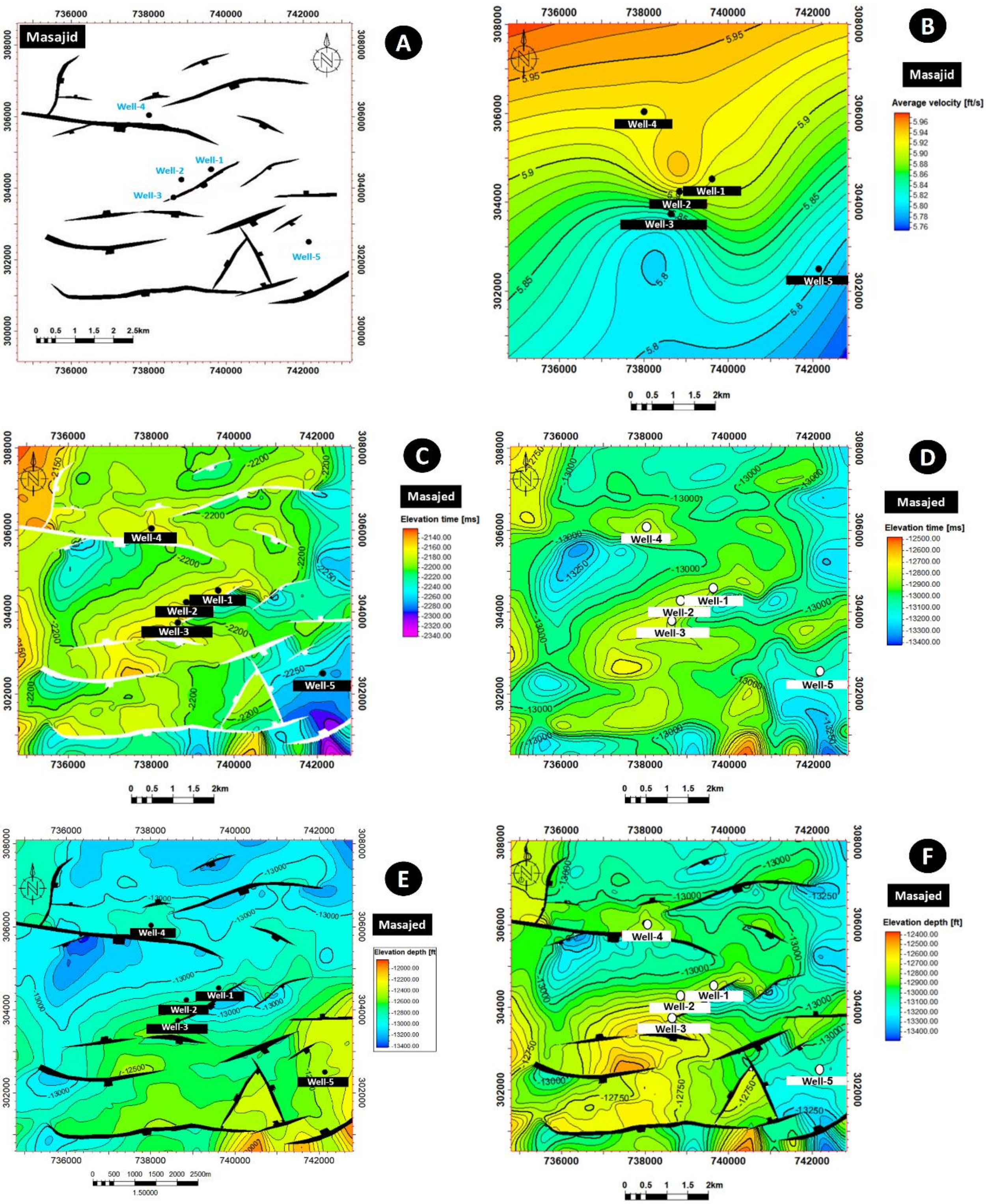

Fig. 10. Upper Jurassic Masajid Fm. (A): Faults Patterns, (B): Average Velocity map for Masajid horizon C.I =0.01ft/m.sec, (C): TWT structure map of Masajid horizon, C.I.: 10 ms, (D): Unfaulted depth map, (E): Converted structure depth map, (F) Adjusted structure depth map.

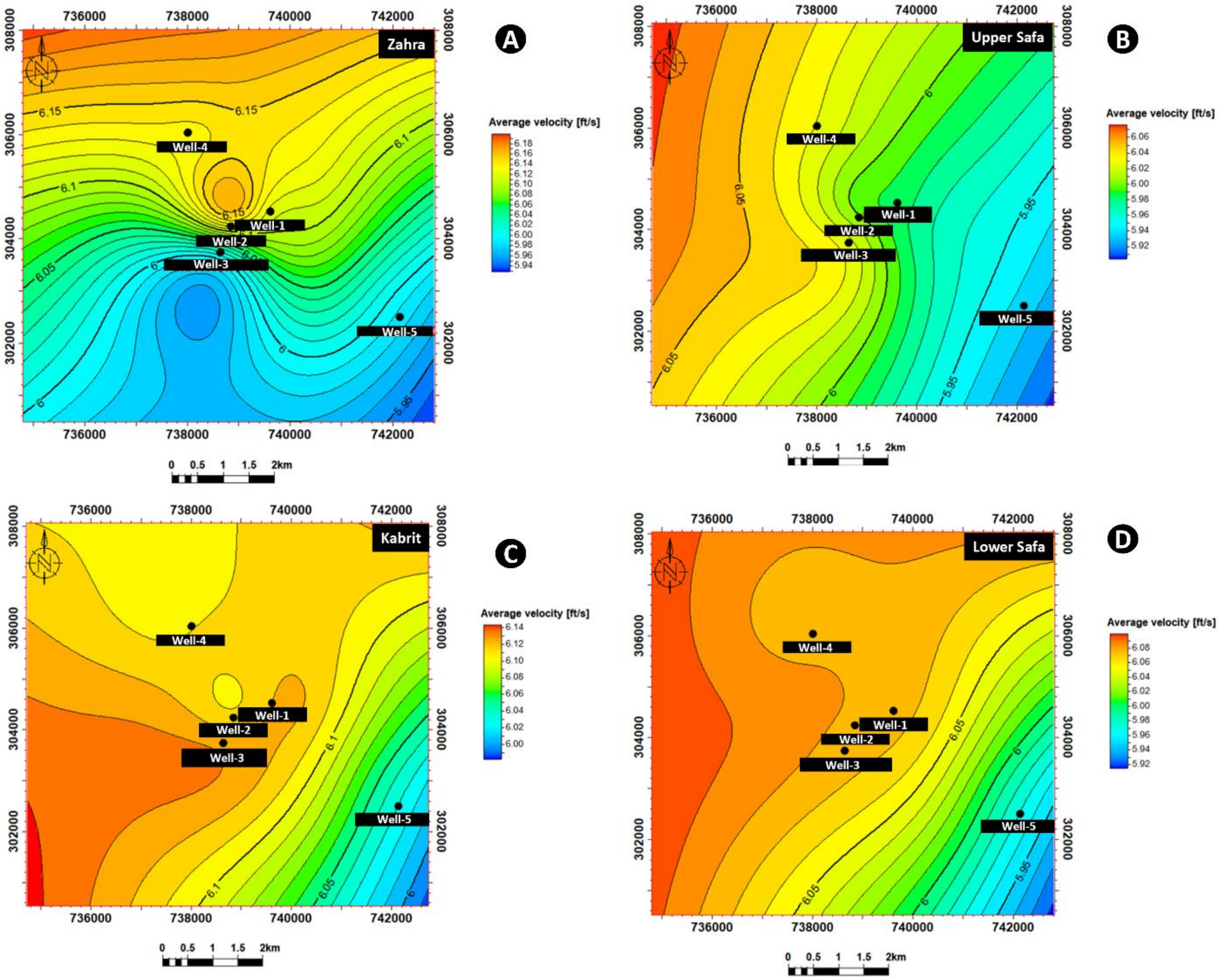

Fig. 11. Average Velocity map of the 4 members of Khatatba Formation. Contour Interval C.I=0.01ft/m.sec.

The interpretation of twenty two 2D seismic lines in the study area led to the identification of five important reflectors which are Masajid, Zahra, U.Safa, Kabrit and L.Safa. The average velocity, TWT maps and structure depth contour maps that reflect the complex structure setting of the study area have been constructed from the interpreted reflectors **(Figs.10-17).** The analysis of the study region reveals a consistent trend of increasing overall thickness towards the west, influenced by the area's structural characteristics. Conversely, the thickness declines and reaches its minimal value in the southwestern part of the study area.

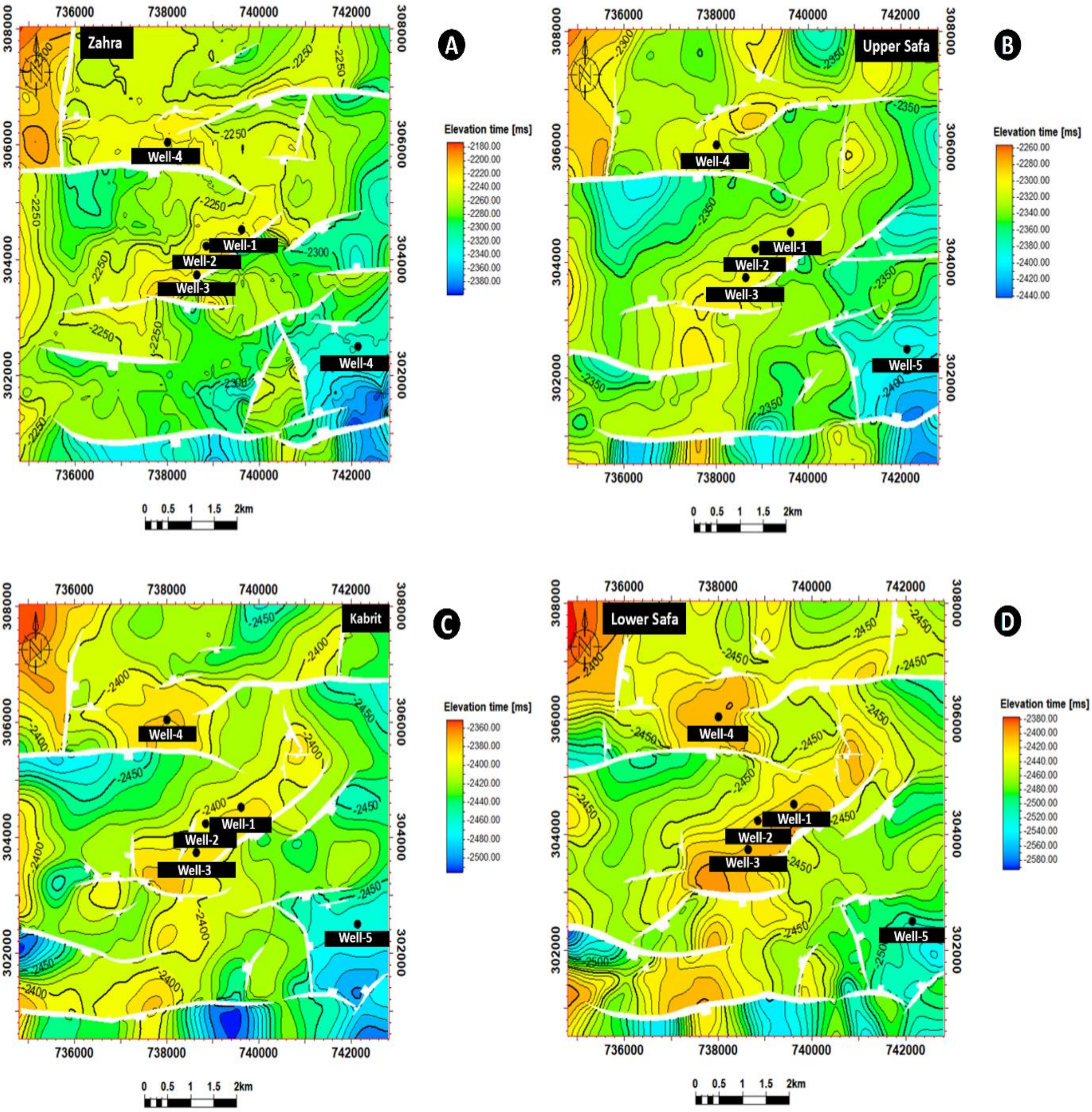

Fig. 12. Tow Way Time (TWT) maps of the 4 members of Khatatba Formation covering the studied wells in the area of study. C.I=10ms.

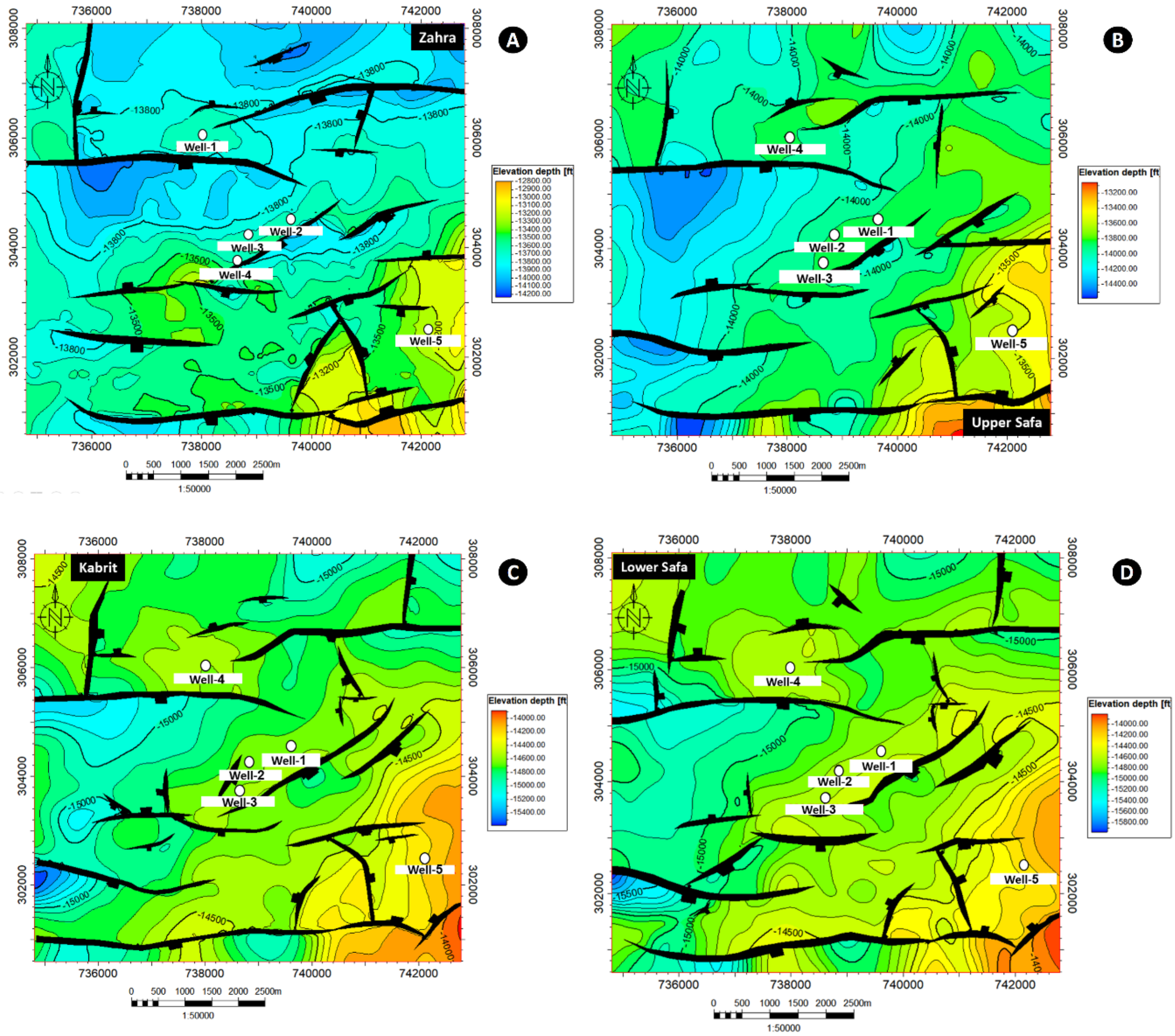

Fig. 13. Adjusted structure Depth map (Faulted) cover the studied wells in the area of study.

4.2. Geochemical Evaluation

The geochemical evaluation of the Jurassic sediments in the study area consists of two steps. In the laboratory, we apply rock-eval pyrolysis to the cutting drill samples to determine the geochemical parameters, including TOC, S1, S2, HI, Tmax, OI, and so on, of the studied wells (wells 1–7) representing Jurassic sediments. The second step is to calculate the total organic content (TOC) in the seven wells in the northern part of the Western Desert using the delta log R technique (**Passey et al., 1990, 2010**) and calibrate the geophysical output with the measured values of the analyzed samples. Both OI versus HI and TOC versus S2 plots show that the Lower and Upper Safa and Zahra members of the Khatatba Formation in the studied wells have a gas-prone kerogen type III, with minor type-II (**Figs. 15 & 16**). The relatively high OI values for the Jurassic section's samples may be attributed to the mineral matrix effect.

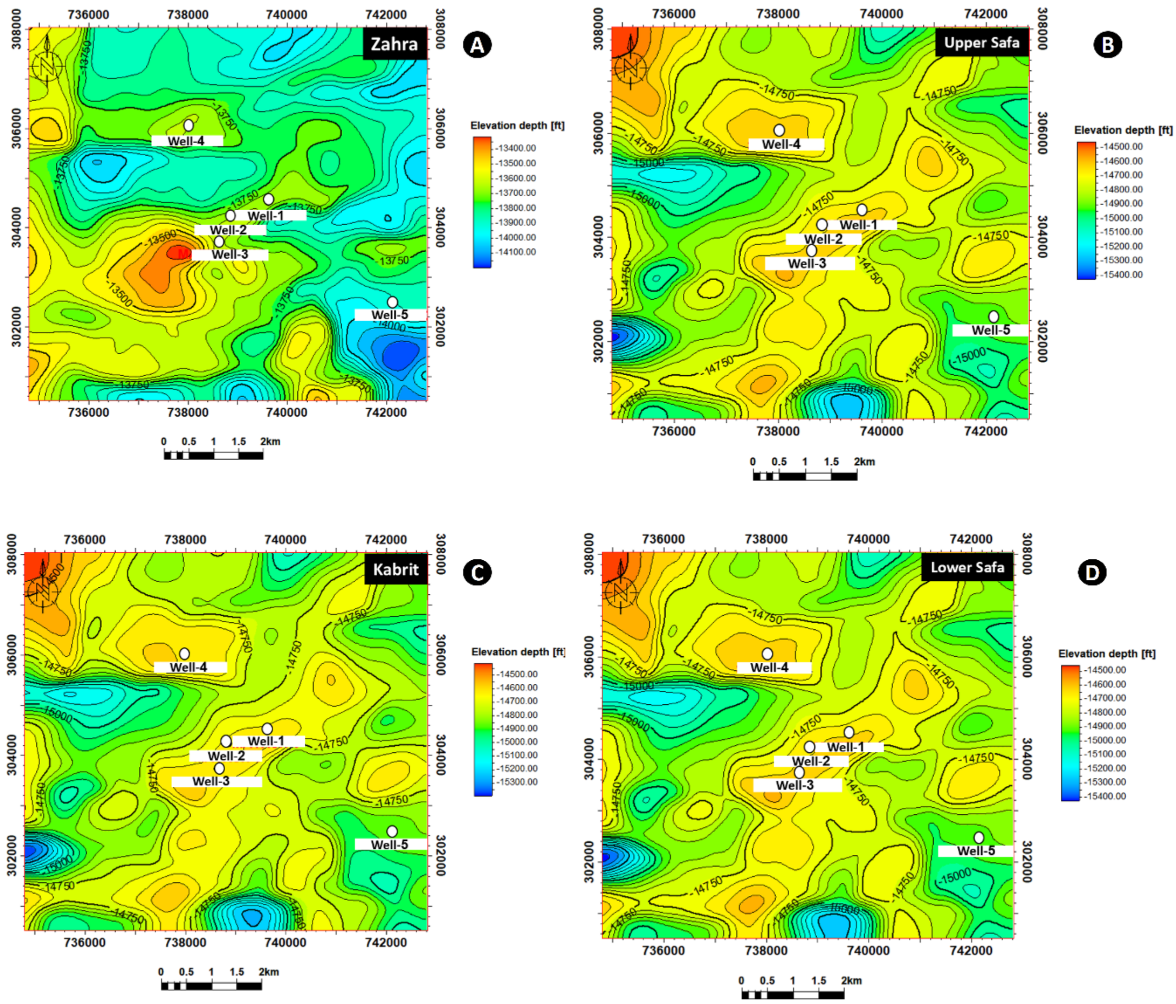

Fig. 14. Adjusted structure Depth map (un-faulted) cover the studied wells in the area of study.

4.2.1. Source Rock (SR) Evaluation

The Early–Middle Jurassic Upper and Lower Safa Shales are the main source rocks for hydrocarbon generation and expulsion for the Jurassic reservoirs in the study area. The analysis of ditch samples from the five wells reveals that the Upper and Lower Safa Shales exhibit very good SR. The average measured TOC values for the Upper Safa source rocks are 3.44 wt.%, 2.83 wt.%, 2.24 wt.%, 8.55 wt.%, and 2.4 wt.% in well-1, well-2, well-4, well-5, and well-7, respectively. Similarly, the TOC values for the Lower Safa source rocks are 2.42 wt.%, 3.31 wt.%, 12.3 wt.%, 5.58 wt.%, and 4.6 wt.% in well-1, well-2. Both of these source rocks are type III with minor mixed-type (II-III) kerogen, which indicates the capability of gas generation with a low amount of oil (Fig. 16). The average Tmax values in the five wells range from 464 to 470 °C and 430 to 468 °C for the upper and lower Safa source rocks, respectively. In addition, vitrinite reflectance (%Ro) values of 1.33 to 1.5% and 1 to 1.36% for Upper and Lower Safa source rocks, respectively, According to Peter's classification (1986), the Upper Safa source rocks are located in the late to overly mature stages and lie in the gas generation stage, whereas the Lower Safa source rocks are located in the early to overly mature stages and lie in the gas and oil generation stages.

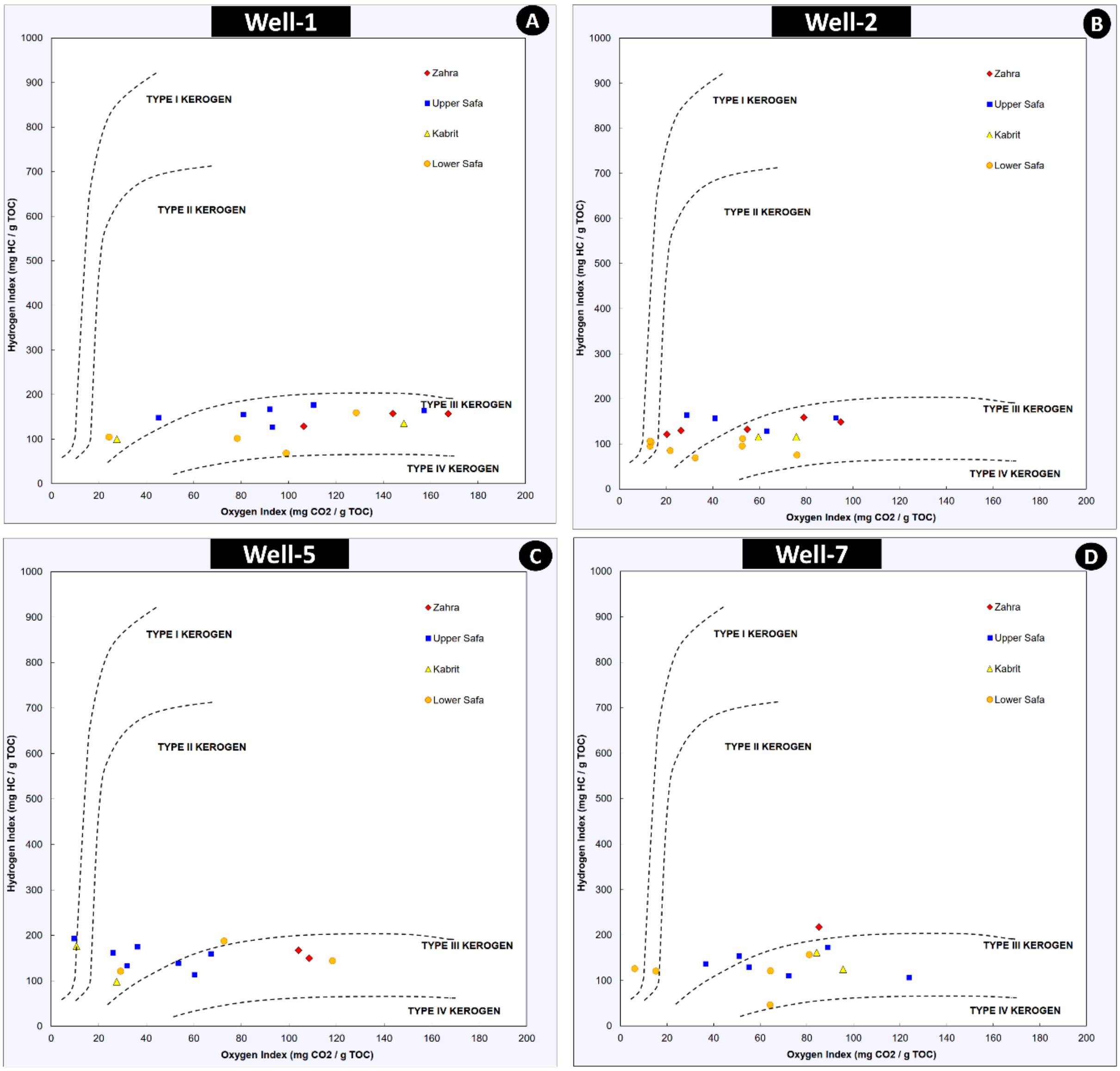

Fig. 15. Van Krevlen Diagram (HI versus OI Cross plot) illustrating the Oxygen Index versus Hydrogen Index showing kerogen type of the middle Jurassic section in the studied wells.

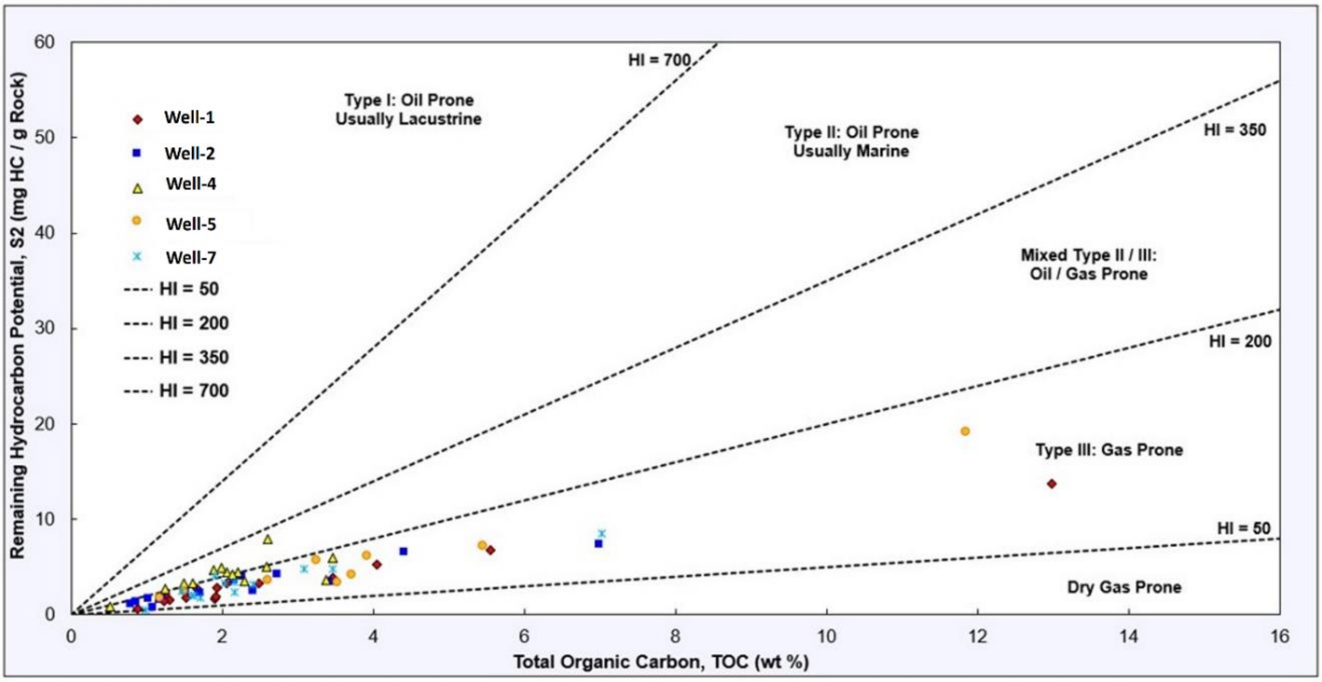

Fig. 16. Cross plot of measured Total Organic Carbon (TOC %) versus remain hydrocarbon potential (S2) Show the kerogen types of the Jurassic section.

4.2.2. Reservoir rock

The petrophysical evaluation of the Jurassic section in the area of study, which has been done for seven wells in the northwestern desert, was carefully analyzed and showed that there are two main reservoirs, the Upper and Lower Safa reservoirs. The results of all petrophysical parameters that were calculated from well logs and calibrated with the measured samples from the 7 studied wells are illustrated in **(Figs.17-23)** and tabulated in **Table 2**.

4.2.3. Petroleum system elements

Traps in the study area are developed by faults direction and mainly structural traps. Based on the constructed structure depth maps consisting of two main fault blocks, the first one is the two up-thrown fault block, in the East-West direction, and the second fault block is the 3-way dip closures and take the NE-SW direction. The Jurassic reservoirs' seals are generally the intra-formational shale intervals of Upper and Lower Safa members themselves, while, the shales of Zahra member and the carbonates of Masajid Formation act as overburden. The 4 elements of petroleum system, (source-reservoir, seal, trap), are complete in the Khatatba formation. It is important to emphasize that each unit of Khatatba Formation, Upper Safa and Lower Safa act as a complete petroleum system.

4.2.4. Petrophysical Evaluation

Density - Neutron Cross plots have been used to identify the lithology as a first step in the petrophysical evaluation. Using the procedures explained in (**Ali et al., 2023; Ali, 2024, a & b**), all the petrophysical properties for the current studied wells have been estimated. The effective porosity

(PHIE_D) in the studied wells reaches the maximum value of (15%) in well-3 at Upper Safa sand reservoir towards the north-western direction, and the minimum value of (3%) in well-5 at NE direction of the study area. Highest permeability (PERM) in column 4 at table.2 appears in the sand reservoir of Upper Safa at well-1, followed by the sand reservoir of Lower Safa at well-2. The Lower Safa sand reservoir in well-5 appear to be a tight reservoir, where it's total porosity (PHIT), (PHIE_D), and (PERM) are 5%, 3%, and 1.03mD respectively. It is important to highlight that because of the high Vshale (Vsh-GR%), Arches' equation has not been applied in the following calculations, and the Indonesian equation, which called Archie's Indonesian, as it serves for the shale effect in its first part and for the clean formation effect (Archie's term) in the second part.

$$\frac{1}{R_t^{1/2}} = \frac{V_{sh}^{(1-V_{sh})/2}}{R_{tsh}^{1/2}} + \frac{\phi N\text{–}D^{m/2}}{a\, R_w^{1/2}}\, S_w^{n/2}$$

Where, R_{tsh} = The deep resistivity reading in shale bed.

Table. 2. Petrophysical Evaluation of the two sand reservoirs in the Jurassic section.

WELL	Reservoir	ZONE_NAME	PERM	PHIE_D	PHIT	SH	SW	VSH_GR
WELL-1	SAND	U.SAFA	92.84	0.13	0.11	0.79	0.21	0.56
	SAND	L.SAFA	65.83	0.10	0.10	0.80	0.20	0.44
WELL-2	SAND	U.SAFA	20.79	0.07	0.15	0.75	0.25	0.77
	SAND	L.SAFA	80.31	0.12	0.11	0.80	0.20	0.84
WELL-3	SAND	U.SAFA	21.99	0.15	0.13	0.81	0.19	0.33
	SAND	L.SAFA	25.66	0.09	0.08	0.62	0.38	0.13
WELL-4	SAND	U.SAFA	43.85	0.08	0.09	0.76	0.24	0.44
	SAND	L.SAFA	27.42	0.08	0.09	0.61	0.39	0.28
WELL-5	SAND	U.SAFA	10.42	0.06	0.07	0.49	0.51	0.41
	SAND	L.SAFA	1.03	0.03	0.05	0.61	0.39	0.26
WELL-6	SAND	U.SAFA	22.30	0.08	0.08	0.57	0.43	0.23
	SAND	L.SAFA	22.27	0.09	0.09	0.57	0.43	0.26
WELL-7	SAND	U.SAFA	19.09	0.06	0.07	0.48	0.52	0.37
	SAND	L.SAFA	23.24	0.06	0.08	0.77	0.23	0.25

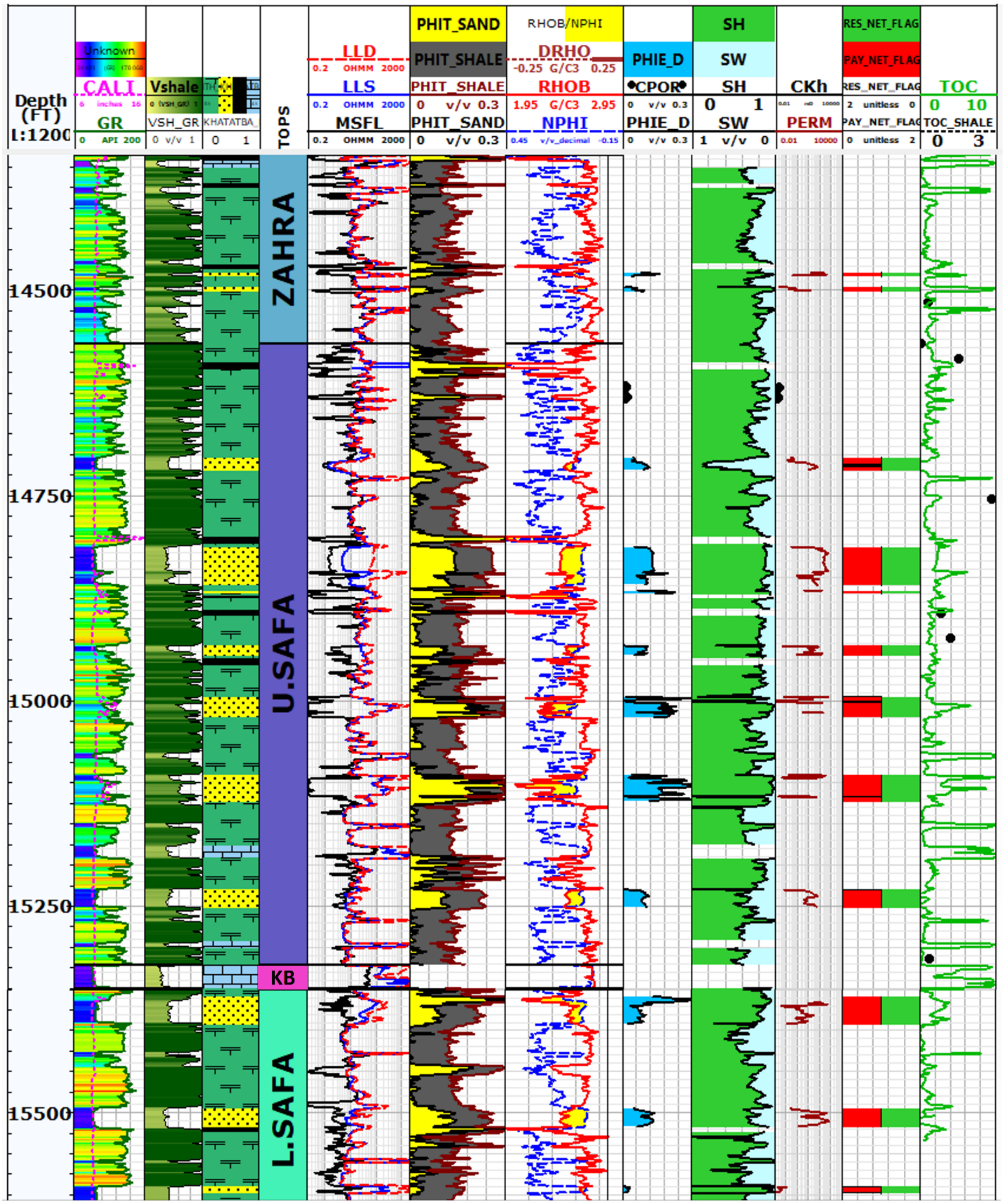

Fig. 17. Well-1 petrophysical evaluation of the middle Jurassic Khatatba Fm. Good match appears in last track between the calculated TOC from well log and the measured TOC.

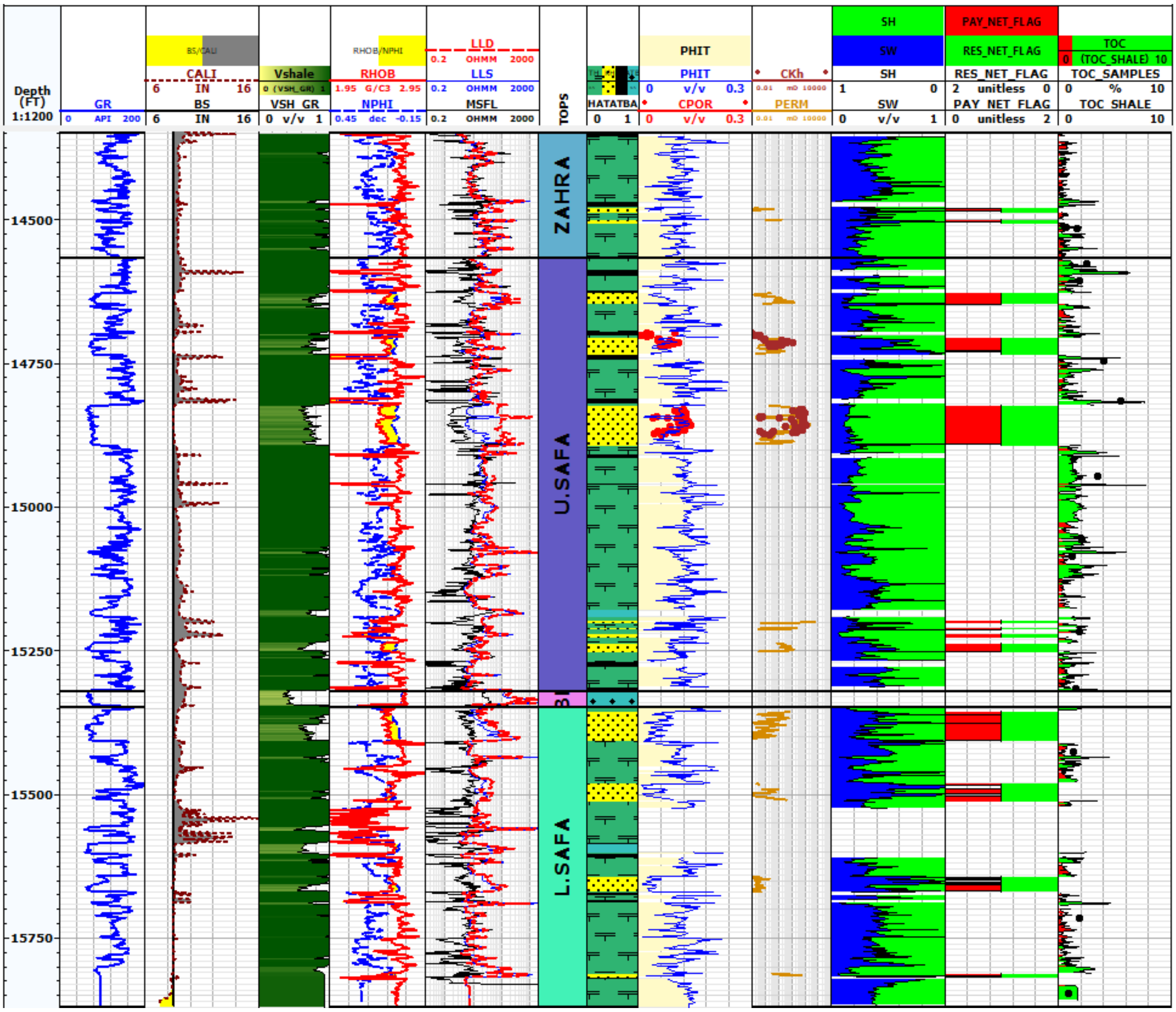

Fig. 18. Well-2 Petrophysical Evaluation of the middle Jurassic Khatatba Fm. Excellent match between the estimated total porosity from well log and the measured core porosity, in track (8). The estimated permeability from logs is in great match with the core measured permeability in track (9).

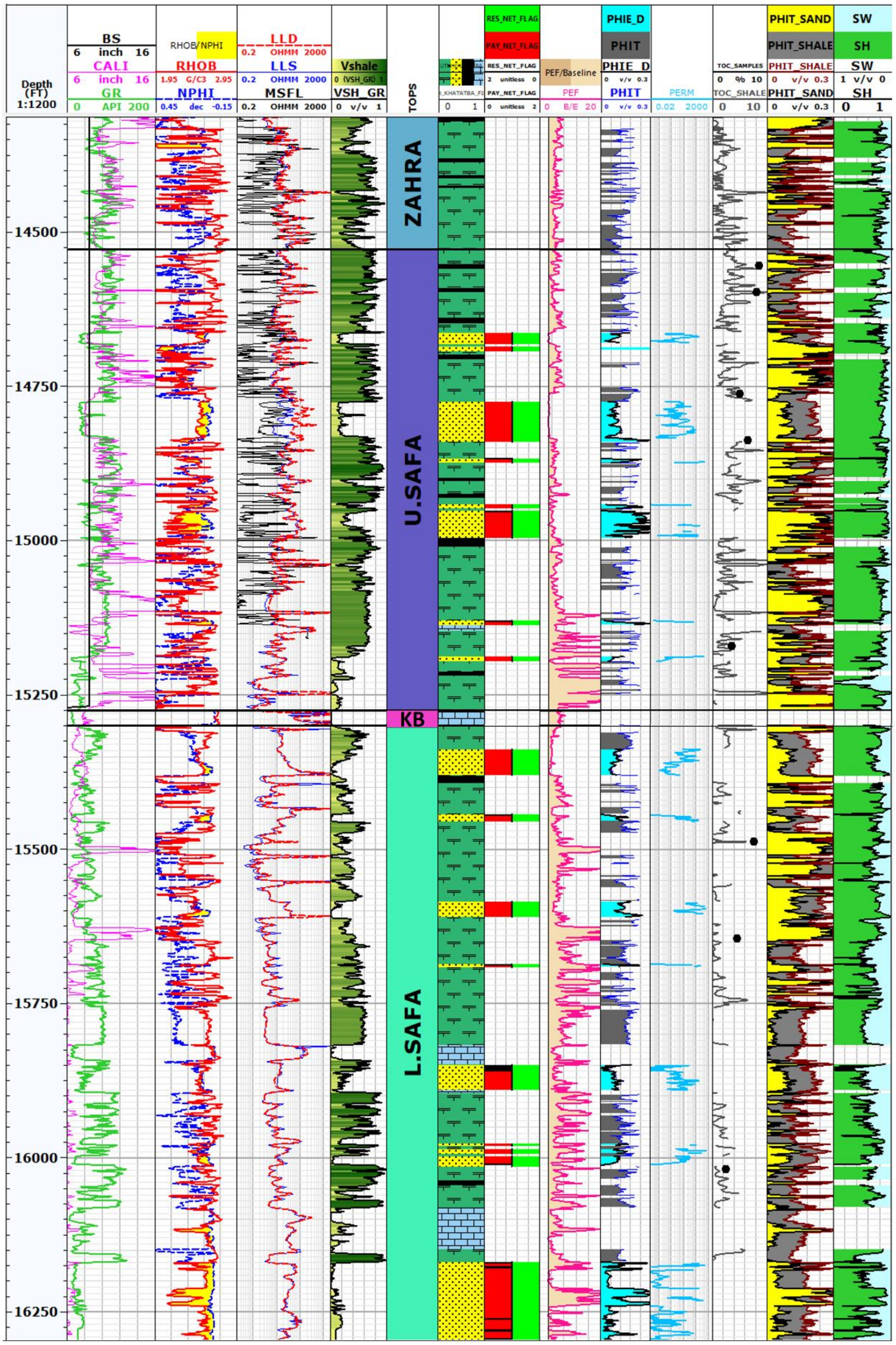

Fig. 19. Well-3- Petrophysical Evaluation of the middle Jurassic Khatatba Fm. Good match between the estimated TOC from well logs and measured TOC appears in track (11).

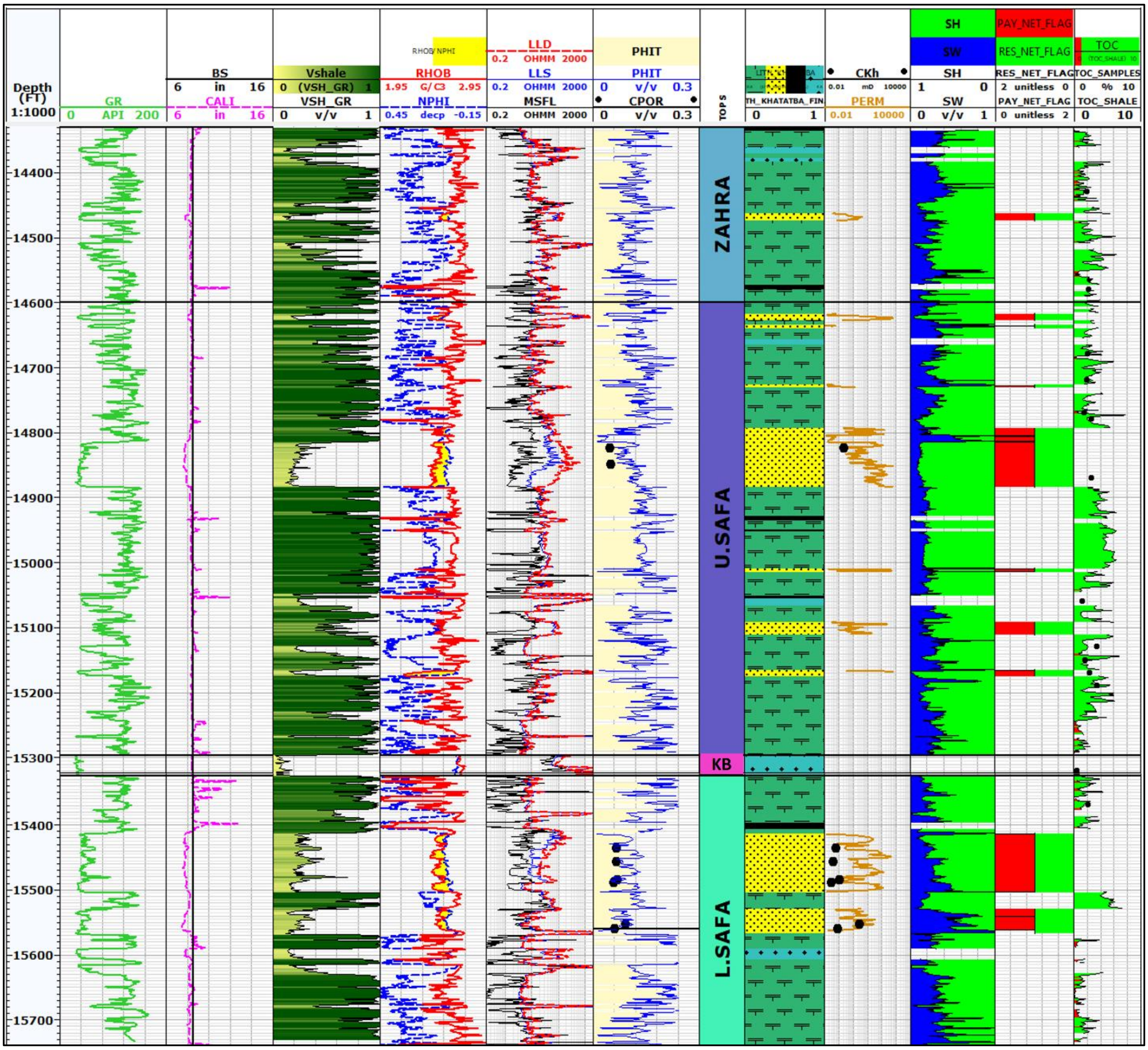

Fig. 20. Well-4- Petrophysical Evaluation of the middle Jurassic Khatatba Fm. Good match appears in track (7) between the estimated porosity from log and the measured core porosity, and in track (10) between estimated permeability from logs and the core measured permeability.

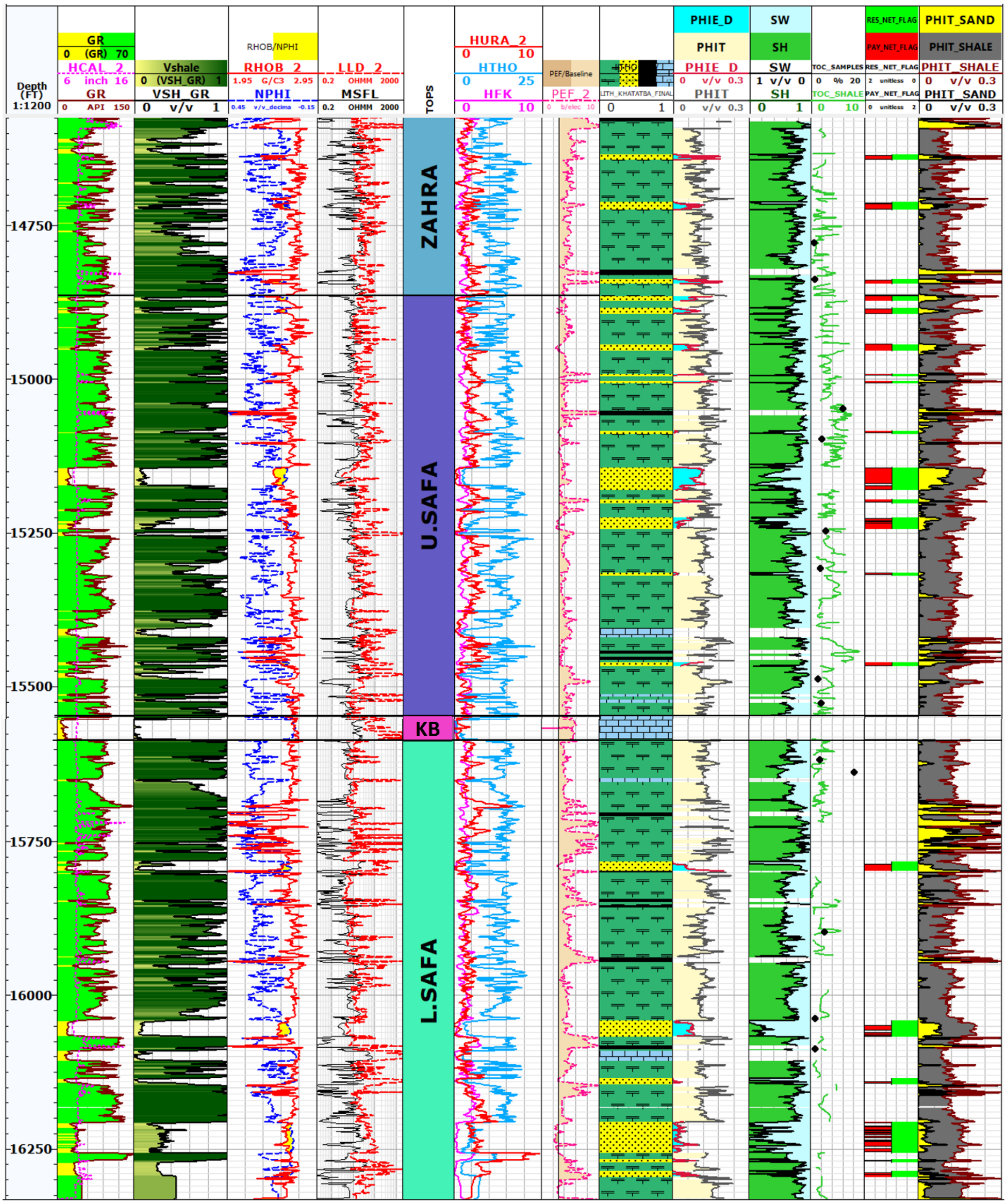

Fig. 21. Well-5- Petrophysical Evaluation of the middle Jurassic Khatatba Fm. Good match between the calculated and measured TOC in track (12).

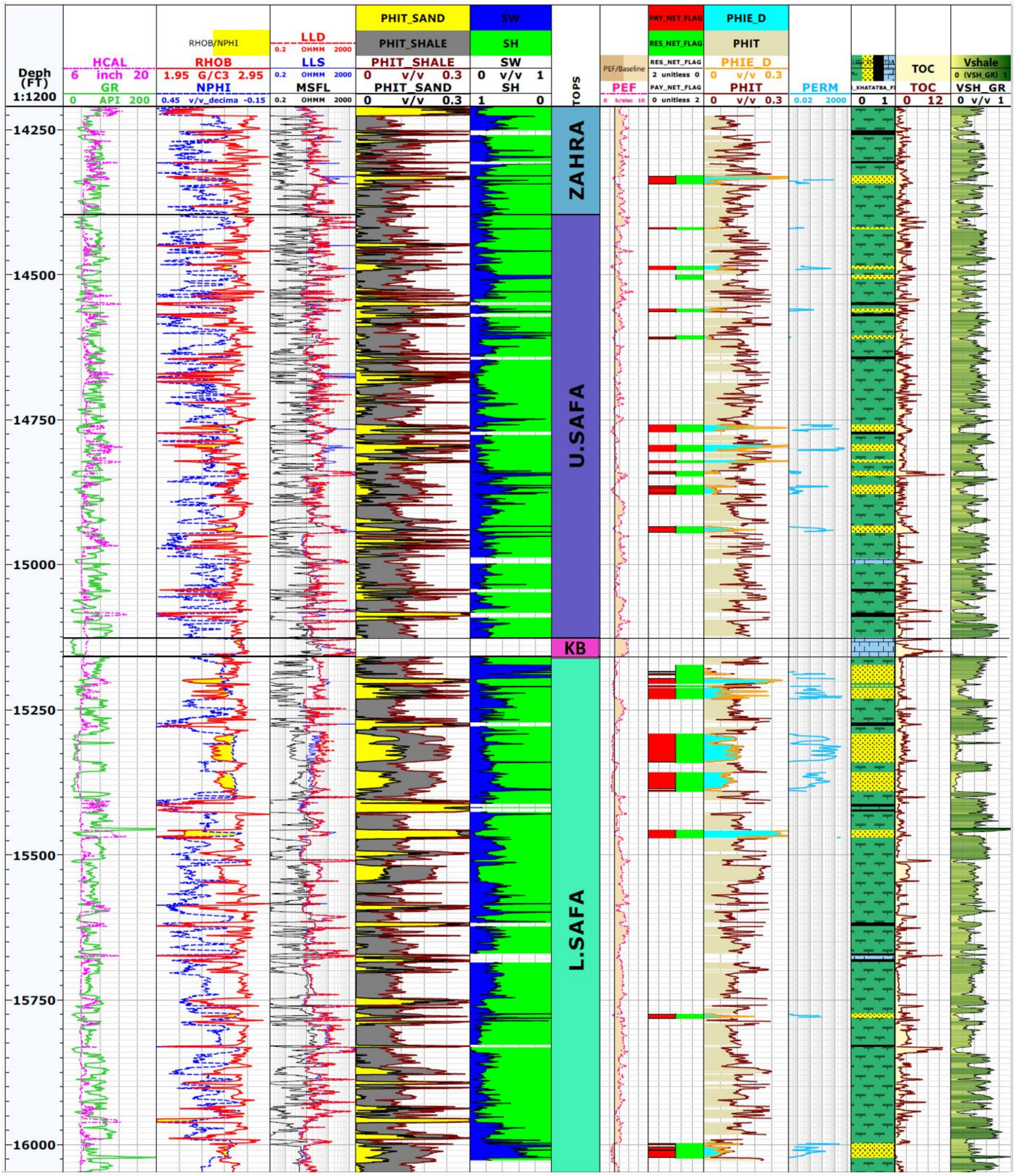

Fig. 22. Well-6- Petrophysical Evaluation of the middle Jurassic Khatatba Fm.

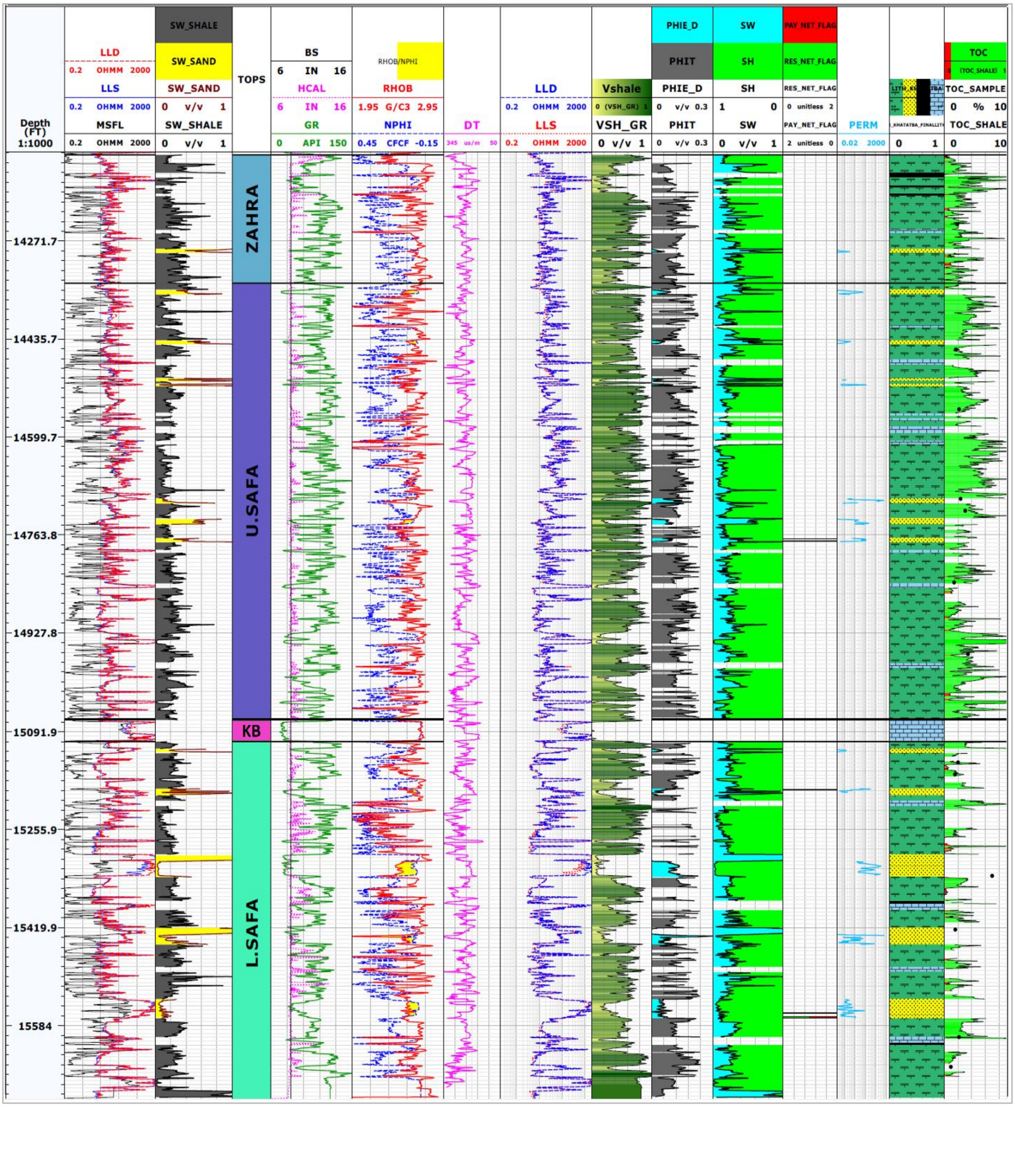

Fig. 23. Well-7- Evaluation of the middle Jurassic Khatatba Fm.

Conclusions

- Integrated organic geochemical and seismic interpretation were made on the Jurassic Section of north western desert through 7 wells located in Matruh concession, to investigate its petroleum system elements. Results indicate that the Khatatba Formation shows obvious in situ dual source and reservoir characteristics. This is related to the oscillations in sedimentation, which resulted in alternating deposition of organic-poor coarse clastic reservoirs during semi-humid conditions and deposition of organic-rich fine clastic and carbonate source rocks during semi-arid conditions. This behavior of sediments alteration was interpreted from GR and Density-Neutron logs.
- Hydrocarbon charge at the location of the studied wells believed to be sourced from the mature Khatatba shale source rock intervals**,** which top up the clastic reservoirs. These source rocks are now thermally mature to generate mostly gaseous hydrocarbons, which is confirmed by the maturation proxies and actual shows in the mud log. The thermal maturation of these source rocks was connected to the tectonically driven subsidence events, which were related to the Late Jurassic and Cretaceous Tethyan rifting.
- The geochemical analysis of Jurassic sediments revealed that the Zahra, U.Safa, and L.Safa formations exhibit high levels of total organic carbon (TOC) and maturity values. Additionally, based on the wells locations there is a consistent pattern of increasing TOC content in the sediments as one moves from the North to the North-East direction, which aligns with the trend of increasing thickness observed in the Jurassic sediments at the study area.
- The prospect area has direct access to mature source rocks within the studied part of the north western desert, which contains the mature Middle Jurassic Khatatba Formation source rocks. The varying petrophysical characteristics and geomechanically complications of the Upper and Lower Safa sandstone reservoirs necessitate studying other parts in the Matruh concession to better understand their regional hydrocarbon production potential.
- For future development in the area, shale intervals in the 7 wells consider also as shale gas pay zone, which can be identified in the studied wells using basin related cut-offs, where gas shale reservoirs are characterized by high to moderate Gamma Ray (GR) values (>70 API), moderate resistivity (>10 ohm.m) which may indicates the presence of hydrocarbon, moderate Average Brittleness (>0.3), and High TOC (>2%).
- **Consent for publication**: Author declares her consent for publication.

Conflicts of Interest:

Author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Contribution of Author:

Author certify that she contributed to the current article to be included as the main corresponding author. She worked on the concept, design, laboratory preparation and investigation of samples, data analysis, drawing illustrations, tabulating data, and finally writing and revision of the manuscript.

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تقييم التكوين والتفسير الزلزالي للجزء الرسوبي الجوراسي في منطقة إمتياز مطروح، شمال غرب الصحراء ، مصر

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تتناول الدراسة الحالية تقييم بتروفيزياء المكمن والصخور المصدرية من خلال إنشاء خرائط عمق البنية للآفاق المختارة للجزء الجوراسي وتحديد عناصر النظام البترولي. أظهرت النتائج البتروفيزيائية أن الخزانات الجوراسية تظهر وجود الحجر الرملي مع بعض الأسمنت الجيري في جميع الآبار المدروسة. أظهرت نتائج تحليل سجل الآبار لخزان الصفا العلوي أن سمك المنبع الصافي الفعال في المنطقة المدروسة يتراوح بين ٢٨ و٧٠ قدمًا بمتوسط مسامية فعالة ٩٪ ومتوسط تشبع هيدروكربوني ٧٨٪ ومتوسط نفاذية ٣٣ ملي دارسى. ومع ذلك، فإن خزانات الصفا السفلية في منطقة الدراسة لها نطاقات دفع فعالة صافية في السُمك بين ٢٩ و٦٠ قدمًا، وتصل المسامية الفعالة إلى ٨,٩٪ ويصل تشبع الهيدروكربون إلى ٧٥٪. تم تقييم الخصائص الجيوكيميائية لصخور المصدر لتحديد الثراء العضوي وأنواع المواد العضوية والبيئة الترسيبية ونضج صخور المصدر الجوراسية بناءً على تحليل التحلل الحراري Rock Eval-6 (TOC وS1 وS2 وTmax وHI وOI) لسبعين (٧٠) عينة فتاتية مخترقة لعدد ٥ آبار في منطقة الدراسة. تظهر النتائج أن صخور مصدر الصفا العلوي تقع في المراحل المتأخرة إلى الناضجة وتقع في مرحلة توليد الغاز، بينما تقع صخور مصدر الصفا السفلي في المراحل المبكرة إلى الناضجة وتقع في مرحلة توليد الغاز والنفط. تم تحديد الخزانات الرئيسية المحددة في المنطقة بواسطة الفواصل الصخرية داخل التكوينات بداخل الخزانات نفسها، والمصائد البترولية الرئيسية تم تطويرها والتحكم فيها بواسطة البنية التركيبية للمنطقة. استخدمت الدراسة الحالية التقنيات المذكورة أعلاه لدمج الأساليب الجيوكيميائية والجيوفيزيائية لتحديد أنظمة البترول الرئيسة في الرواسب الجوراسية في منطقة الدراسة. يوفر التحليل التفصيلي لخزاني الصفا العلوي والسفلي فهمًا شاملاً للخصائص البتروفيزيائية، والتي تعد بالغة الأهمية لتقييم جودة الخزان وإمكاناته. وتضمن المعايرة باستخدام العينات المقاسة موثوقية ودقة التفسيرات المسجلة جيدًا.