Anomalous porosity preservation in the Lower Cretaceous Nahr Umr sandstone, Southern Iraq

Abbas K. A. Mohammed[1]

Received 17 June 2020; accepted 23 August 2020; published 5 March 2021.

Core description, well logs data, petrographic analysis and scanning electron microscope technique were conducted to unravel factors controlling the preservation of high porosity up to 25% in deeply-buried sandstones > 4 km of the Lower Cretaceous Nahr Umr reservoir, southern Iraq. The Nahr Umr Formation composed of sandstone interbedded with shale, minor siltstones and streaks of limestone. The sandstones are arenites and range from fine to coarse, and poor to moderate sorted. Parallel lamination, planer cross-bedded and lenticular bedding are common sedimentary structures found in the formation, suggesting that the Nahr Umr deposited in fluvial-deltaic to the shallow-marine environment. Cementation by syntaxial quartz overgrowth was retarded by the presence of illite coats, which was formed by the illitization of the infiltrated smectite that formed during the deposition around the quartz grains. Microquartz coats in the form of quartz crystals probably further prevented the quartz overgrowths. Thus, the porosity of Nahr Umr preserved by the illite coats and microquartz crystals, whereas, the process of K-feldspar dissolution has created secondary porosity. The stylolite formation and the quartz-calcite replacement are the main sources of silica for the precipitation of quartz overgrowth. *KEYWORDS:* Porosity preservation; quartz cement; Nahr Umr Formation; reservoir quality; sandstone reservoir.

Citation: Mohammed, Abbas K. A. (2020), Anomalous porosity preservation in the Lower Cretaceous Nahr Umr sandstone, Southern Iraq, *Russ. J. Earth. Sci., 21,* ES2001, doi:10.2205/2020ES000739.

Introduction

At greater burial depths (> 4000 m), chemical compaction, including intergranular pressure solution and the formation of stylolites, and co-eval cementation by quartz overgrowths, are the most significant reservoir quality destroying processes in sandstones [*Burley and Worden,* 2003]. Over the last decades, there has seen a growing about the role of grain-coating clay minerals and microquartz on retardation by cementation by quartz overgrowths in deeply buried sandstone reservoirs [*Bjorlykke and Egeberg,* 1993; *Lander et al.,* 2008; *McBride,* 1989; *Taylor et al.,* 2010; *Wooldridge et al.,* 2017; *Worden and Morad,* 2000; *Worden et al.,* 2012].

It is well documented that the temperature, mineralogical composition of sandstones, effective pressure and the primary lithofacies are the main factors controlling the quartz cementation [*Bjorlykke and Egeberg,* 1993; *Burley and Worden,* 2003] and thus, the reservoir quality. It is expected that quartz overgrowths to be extensive in clean substrates and quartz dominated sandstones [*Worden and Morad,* 2000].

No studies carried out on the Nahr Umr sandstone in the Noor Oilfield or the adjacent fields considering the controls on the porosities of these sandstones. Quartz overgrowth and calcite cement were found, while the compaction and the K-feldspar dissolution are the main diagenetic observed fea-

[1]Geology Department, Missan Oil Company, Ministry of Oil, Amara, Missan, Iraq

http://rjes.wdcb.ru/doi/2020ES000739-res.html

Figure 1. Structural zones and locations of most Iraqi oil/gas fields. Complied after different sources [*Aqrawi et al.,* 2010; *Al-Khafaji,* 2014; *Mohammed et al.,* 2020].

tures in the Nahr Umr Formation, East-Baghdad Oilfield [*Qaradaghi et al.,* 2008].

Prodelta, distributary mouth bar, distributary channel, distal bar and tidal channel sediments are the main primary depositional environments were recognized in the Nahr Umr Formation, East-Baghdad Oilfield [*Al-Dabbas et al.,* 2012]. The porosity of the sandstones of the Nahr Umr reaches 25% in the Nasiriya Oilfields, and the formation contains up to 68 million ton of oil (STOIIP) [*Al-Khafaji,* 2014].

Understanding the role of clay minerals in preserving and/or reducing the reservoir quality is crucial. Therefore, it is important to enhance our understanding of the role of the clay-coating minerals around the quartz grains, and hence, reservoir quality preservation. This study will unravel the origin of the anomalously high porosity in the deeply buried sandstones in the Nahr Umr reservoir, Noor Oilfield, southern Iraq (Figure 1).

Geological Background

Most of the petroleum accumulations of the southern and central of Iraq trapped in the buried anticlines of the Mesopotamian Basin, The Stable Shelf [*Jassim and Goff,* 2006; *Owen and Nasr,* 1958] (Figure 1). The basin is covered by the Quaternary fluvial-plain sediments and contains the largest petroleum accumulations in Iraq [*Aqrawi et al.,* 2010]. The Noor Oilfield is located in the southern Iraq, about 17 km northeast of the Amara City within the Stable Shelf, Mesopotamian Basin (Figure 1). The anticline of the field has a NW–SE trend, representing a gentle anticline of about 15 km wide and 30 km long. The succession contains the Nahr Umr sandstone buried at depth of $>$ 4100 m (Figure 2).

The Early Cretaceous Nahr Umr sandstones are producible reservoirs in southern and central Iraq. The formation is widely extended in the Arabian Gulf, including Qatar, Oman, Bahrain, and Kuwait. However, their sandstones vary laterally and vertically [*Alsharhan,* 1991, 1994]. Within the Mesopotamian Basin, the Nahr Umr Formation conformably overlies the Shu'aiba Formation and underlies the Mauddud Formation. The shale beneath the Mauddud Formation seals the Nahr Umr reservoir [*Bellen et al.,* 1959].

The Missan Oil Company's final well reports of the Noor Oilfield have shown that the Nahr Umr Formation is around 200–220 m thick (MOC). The Nahr Umr Formation is subdivided into two members, the upper member is limestone and the lower is sandstone representing a transgression event. The lower unit contains fine-medium-coarse grained sandstone interbedded with shale and siltstone with the presence of streaks limestones. This is interpreted as a fluvial sequence deposited in a shallow marine-deltaic influenced by an aeolian effect [*Aqrawi et al.,* 2010; *Al-Dabbas et al.,* 2012]. The average depth of the Nahr Umr is about 3930–3950 m, while, the sandstone depth exceeds 4099 m (Figure 2). The Nahr Umr Formation is buried deeper toward the Iranian borders to the eastern of Missan Governorate such as in the Buzurgan, Faqui, and Abu Ghirab Oilfields.

Materials and Methods

A detailed core description was carried out on the 37 m cored intervals of the Nahr Umr sandstone collected from the well NO-13, Noor Oilfield. The core description was based on the visible properties of the sedimentary rocks such as lithology, sedimentary structures, color, grain size, sorting, and shape. Well logs data set of 5 wells including GR, DT, RHOB, NPHI, and LLD were processed, and effective porosity log was calculated as follows:

The clay minerals have an effect on porosity, which was corrected and the effect of the shale was subtracted using the following equation:

$$\text{Porosity}_{\text{eff.}} = \left(\frac{\rho_{\text{ma}} - \rho_{\text{b}}}{\rho_{\text{ma}} - \rho_{\text{fl}}}\right) - V_{\text{sh}}\left(\frac{\rho_{\text{ma}} - \rho_{\text{b}}}{\rho_{\text{ma}} - \rho_{\text{fl}}}\right)$$

where $\text{Porosity}_{\text{eff.}}$ is the effective porosity used in Figure 3, ρ_{ma} is the matrix density which assumed to be quartz (2.65 g/cm^3). ρ_{b} is the log density reading, and ρ_{fl} is the fluid density which assumed to be oil (0.9 g/cm^3), V_{sh} is shale volume.

V_{sh} was obtained using the Larionov's equation for the old sediments as below:

$$V_{\text{sh}} = 0.33(2^{2\times \text{GRI}} - 1)$$

where GRI (Gamma Ray Index) calculated using the gamma ray logs as follows:

$$\text{GRI} = \frac{\text{GR}_{\text{log}} - \text{GR}_{\text{sand}}}{\text{GR}_{\text{shale}} - \text{GR}_{\text{sand}}}$$

where GR_{log} is the gamma ray log reading, GR_{sand} is the gamma ray reading in the sand (the lowest gamma ray reading), and GR_{shale} is the gamma ray reading in the shale (the highest reading).

Table 1. Depth of Samples, Codes and Effective Porosity (see Figure 3 for Samples Locations)

Sample code	Depth (m)	Effective porosity (%)
S1	4104.9	12.5
S2	4106.5	12.2
S3	4116.2	23
S4	4117.2	15.7
S5	4125.4	9.5
S6	4128.5	10.5
S7	4131.7	10
S8	4132.7	16.3

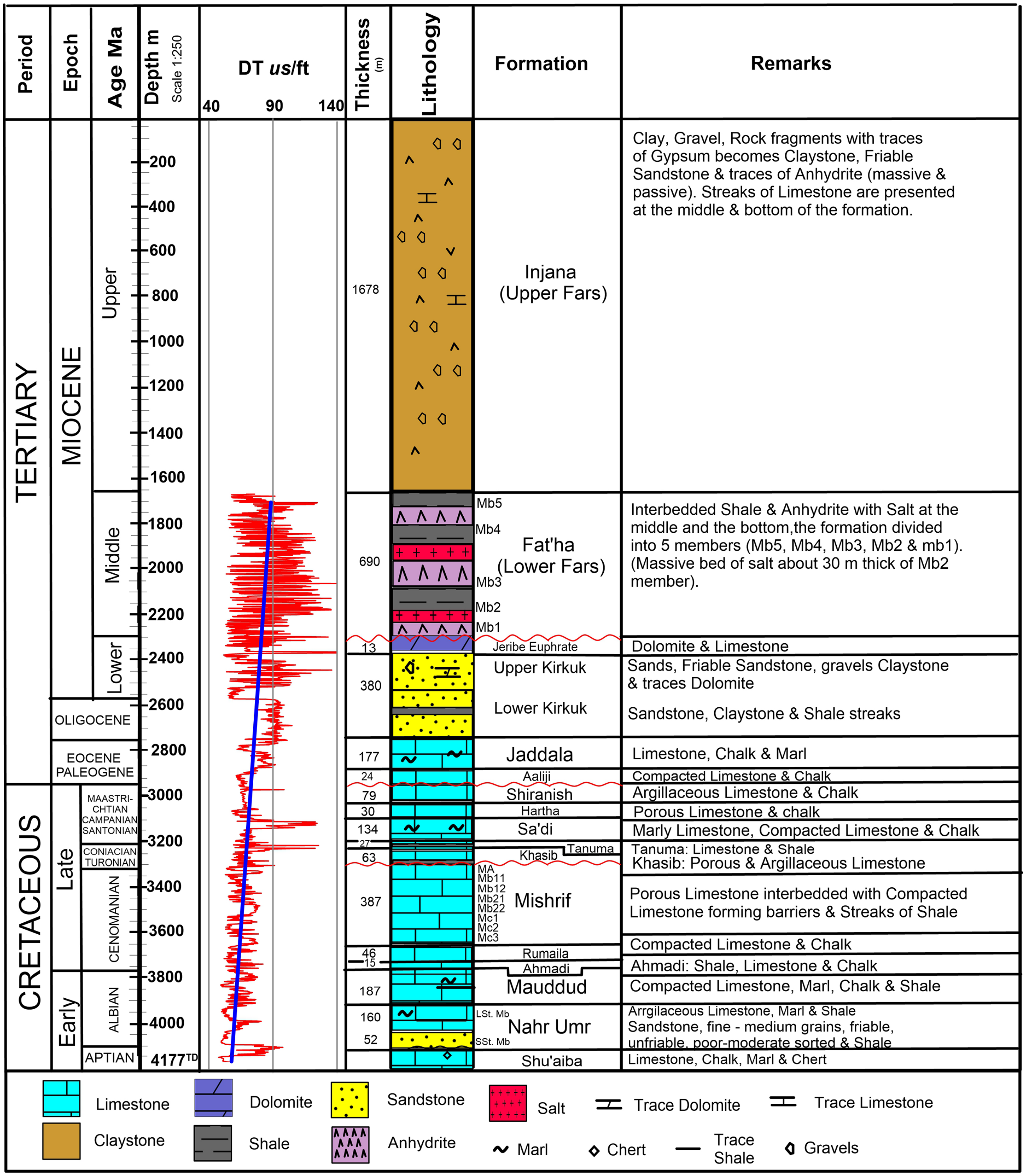

Figure 2. Generalized stratigraphic column of the well NO-13, Noor Oilfield, showing the age, depth, and thickness of each formation, sonic (DT) log which relatively reflects the compaction trend from depth 1680–4176 m (adapted from [*Mohammed et al.*, 2020]). Sixteen wells were drilled in the Noor Oilfield, 6 of them were penetrated the Nahr Umr Formation at depth exceeds 4000 m. The temperature exceeds 100°C at the top of the formation in the well NO-13 and up to 103°C at the main sand member at a depth of 4099 m.

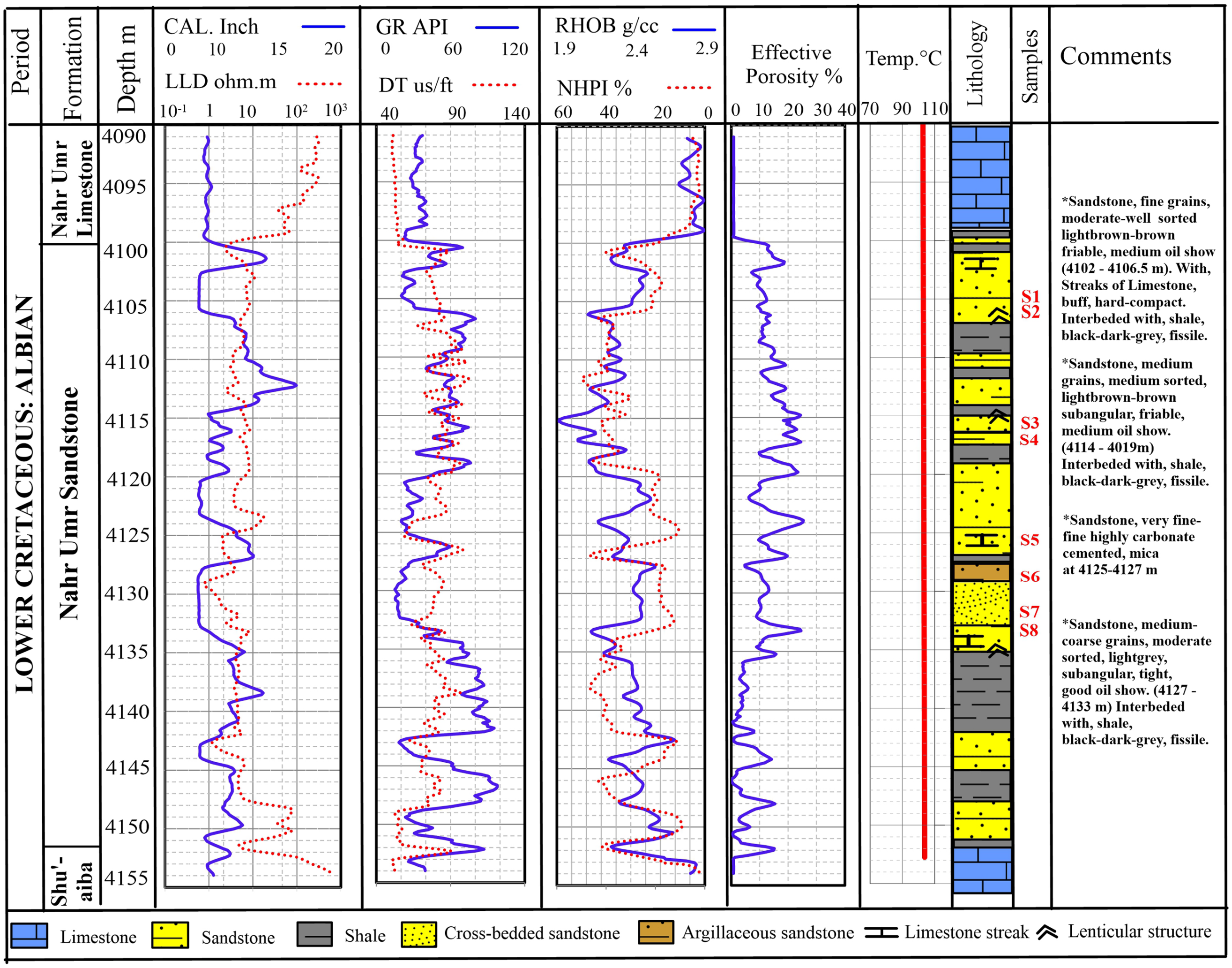

Figure 3. A summarized core description and wireline logs of the Nahr Umr presenting depth of each sample collected. Caliper (CAL), LLD (deep resistivity), gamma ray (GR), sonic (DT), density (RHOB), neutron (NPHI), temperature (Temp), and the effective porosity logs.

Eight samples were selected from the cored sections correspond to different facies with different effective porosity (Figure 3). The exact depths at which the samples were taken are shown in Table 1. To detect the petrographic features of the samples, thin sections were prepared and examined under the polarizing microscope of the Clastic Sedimentary Division, Geology Department, Basrah Oil Company BOC. To investigate further the micro properties and their controls on porosity, the scanning electron microscope device in the Physic Department, College of Sciences, University of Basrah was conducted on the selected samples.

Results

Core description, petrography coupled with well logs were used to present the core finding of this study as below.

Framework Grain Composition and Diagenetic Features of the Sandstones

The sandstones of the Nahr Umr Formation are interbedded with black to dark grey shales and rarely with siltstone and streaks of limestone. Parallel lamination, planer cross-bedding, and lentic-

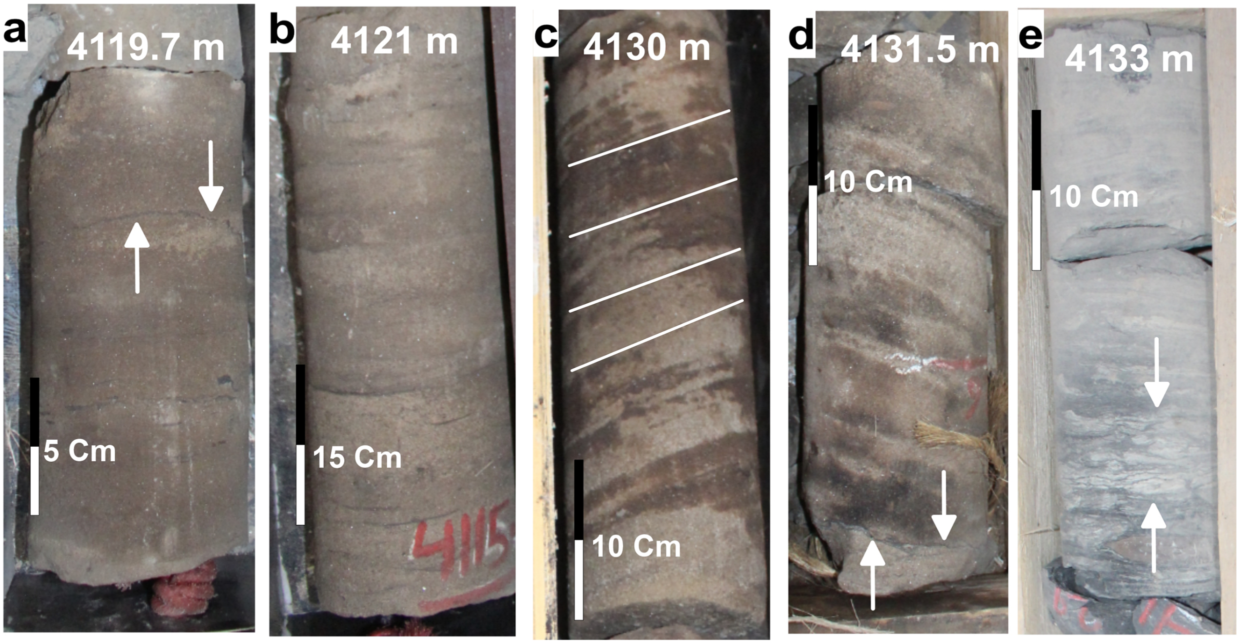

Figure 4. Sedimentary structures of the core samples. a – stylolite formation in parallel laminated sandstone (white arrows). b – parallel laminated sandstone with mud drapes. c – well-preserved planer cross-bedded sandstone. d – stylolite formation in low angle cross bedded sandstone (white arrows). e – sandy lenticular structures in the mudstone (white arrows). Depth of each sample is showing inside each photo.

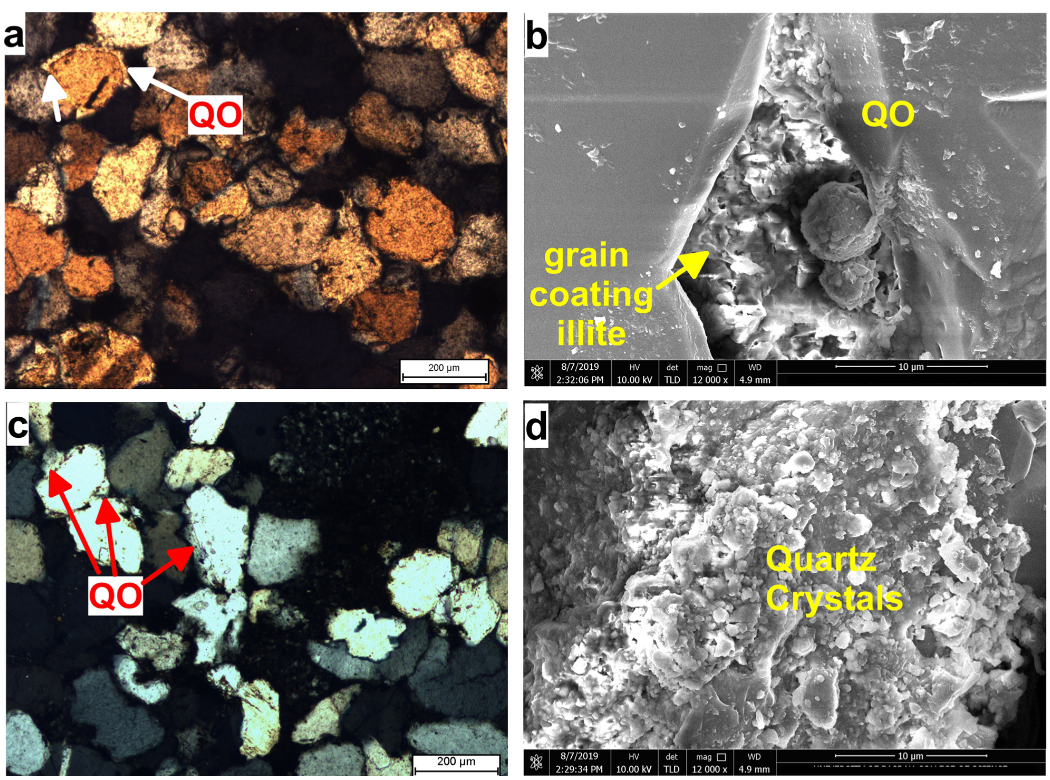

Figure 5. Petrographic features of the S1 and S2. a and c – crossed polarized light (XPL) images show quartz overgrowth (QO) in the S1 and S2 respectively. b – SEM image shows grain coating illite covered by quartz overgrowth, the spherical stuff might be pyrite (S1). d – SEM image shows quartz crystals coating grain (S2).

ular bedding are presented sedimentary structures (Figure 3 and Figure 4). The framework grains are dominantly quartz-rich, and thus the sandstones are quartz-arenite (Figure 5, Figure 6, Figure 7, and Figure 8). The quartz grains are abundantly fine to medium-grained at the middle and the top of the formation, and occasionally coarse grains at the bottom. The grains are poorly to moderately sorted, and rarely well sorted, and dominantly sub-angular and sub-rounded shaped. The sandstones are composed mainly of monocrystalline quartz with a trace amount of polycrystalline quartz, and rare K-feldspars (Figure 5, Figure 6, Figure 7, and Figure 8). The porosity curve shows that porosity varies between different sandstones, some intervals with the Nahr Umr sandstones recorded effective porosity up to 25% (Figure 3). Effective porosity ranges from 9.5 to 24.5% between the different specimens, where S3 corresponds to the highest recorded effective porosity (Table 1).

Minor quartz cement is presented at the top of the succession (S1 and S2) with the amount of $< 2\%$ (Figure 5). Interestingly, the investigation of intervals (S5, S6, S7, and S8) shows no evidence of quartz cement (Figure 6 and Figure 7). Grain-coating illite is presented in many intervals, with the absence of the quartz overgrowths in the same intervals (Figure 5b and Figure 6b). Quartz crystals coat detrital quartz grains are presented in some intervals (Figure 5d, Figure 6d and Figure 7b). Non-developed stylolite formation (pressure solution) is observed (Figure 4a, Figure 4d and Figure 6c). Etched (dissolved) grains are presented in some examined samples (Figure 6e and Figure 8f). K-feldspar shows some evidence of dissolution (Figure 6a and Figure 7c). Carbonate cement (possibly dolomite or ankerite) is also presented and dominated in some intervals with an amount of about 40% and 10% (Figure 6f and Figure 7e).

Discussion

The Nahr Umr sandstone succession is interpreted as a fluvial channel influenced by shallow marine and deltaic systems [*Aqrawi et al.,* 2010; *Al-Dabbas et al.,* 2012]. Lithology composed of sandstones inter-bedded with shales and siltstones with the presence of the cross-bedded, parallel laminated sandstones, and lenticular (Figure 3 and Figure 4). The occurrence of the planner cross bedding, parallel laminated sandstones and lenticular bedding together suggest a fluvial-deltaic to shallow-marine. The presence of the shale beds (clay) with the silty parallel sandstones along with the occurrence of the limestones streaks suggests a higher water leg, and represents pro-delta deposits. The planner cross-bedding fining up at the middle part of Nahr Umr sandstone suggests a distributary mouth bar deposits, whereas, the presence of the lenticular bedding indicates to tidal effects along with the association of finer sandstones and shale beds suggest distal bar deposits.

The porosity of the Nahr Umr formation varies with lithology variation and the diagenetic process (Figure 3). Where, cleaner and coarser sandstones recorded the highest effective porosity, while, shale rocks, argillaceous (muddy) sandstones and carbonate cemented sandstones intervals recorded the lowest porosity values. It can be stated that K-feldspar and carbonate cements dissolution in some intervals has generated secondary (intragranular) porosity in the Nahr Umr sandstones (Figure 6a, Figure 6g, Figure 7c, and Figure 7f).

Although the sandstones of Nahr Umr Formation are deeply buried, the extensive quartz overgrowths are absent, with a minor amount that presented at the top of the Nahr Umr sandstone (Figure 5). Some sandstones intervals shown evidences of illite coats around the detrital quartz grains with the absence of the quartz overgrowth in the same intervals, suggesting that these grains coating illites hindered the quartz overgrowths (Figure 5b and Figure 6b), this is also concluded by [*Storvoll et al.,* 2002]. It has been noticed that the illite coating grains are presented in deltaic intervals unlike the fluvial sediments, suggests that the illite could have a depositional origin. It is further observed that these illites around the quartz grains are not sheets-like morphology, suggesting that they could be infiltrated smectite origin. Whereas, illites sheet morphology are kaolinite origin [*Tang et al.,* 2018]. Illites can also be released from the K-feldspar and kaolinite reactions during burial [*Burley and Worden,* 2003]. Where, minors dissolved/etched K-feldspar observed in this study (Figure 6a, Figure 6e and Figure 7f). However, the authigenic illite formed in the Nahr Umr by a diagenesis process from the infiltrated smectite origin is likely. The primary depositional environment of the Nahr Umr Formation interpreted to represented chan-

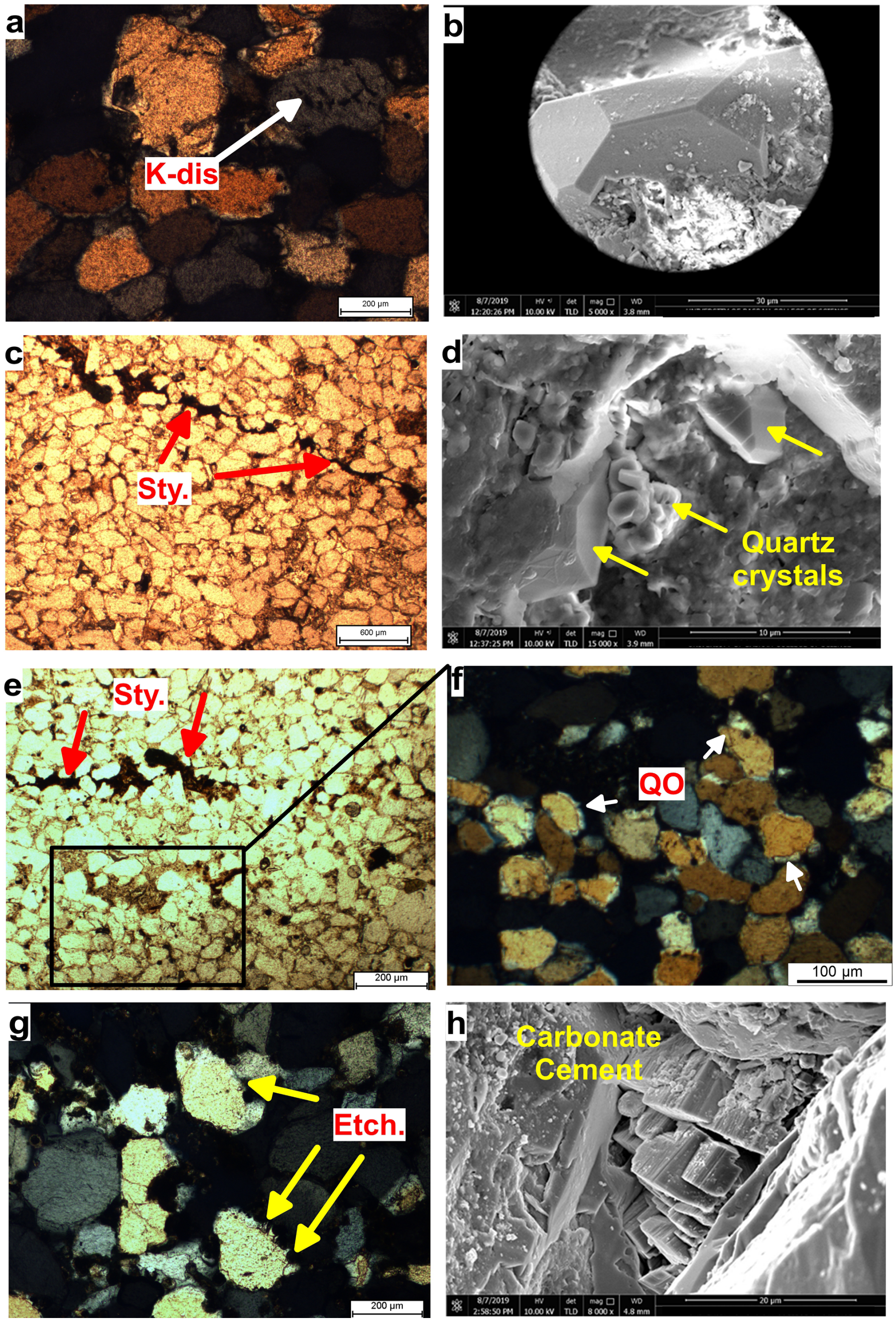

Figure 6. Petrographic features of the S3 and S4. a and c – show K-feldspar dissolution and stylolite formation in S3 (XPL and PPL respectively). b – SEM image shows grain coating illite covered by quartz overgrowth, spherical part shows pyrite (S3). d – SEM image showing crystals of quartz and illite (S3). e – plane polarized light (PPL) image showing stylolite formation (S3). f – enlargement XPl image to the rectangle in e showing quartz overgrowths just few micrometers to the stylolite formation. g – PPL image shows etched K-feldspar (red arrows) (S4). h – carbonate cement (dolomite/ankerite) (S4).

nels deposits and shallow water to deltaic (tidal) influence. The pro-delta sediments in can produce a high amount of smectite in a similar depositional environment [*Poulos et al.*, 1996]. Therefore, it is possible that smectite originated from the primary depositional environment.

Another possible factor that prevented the quartz overgrowth in the Nahr Umr sandstones is the

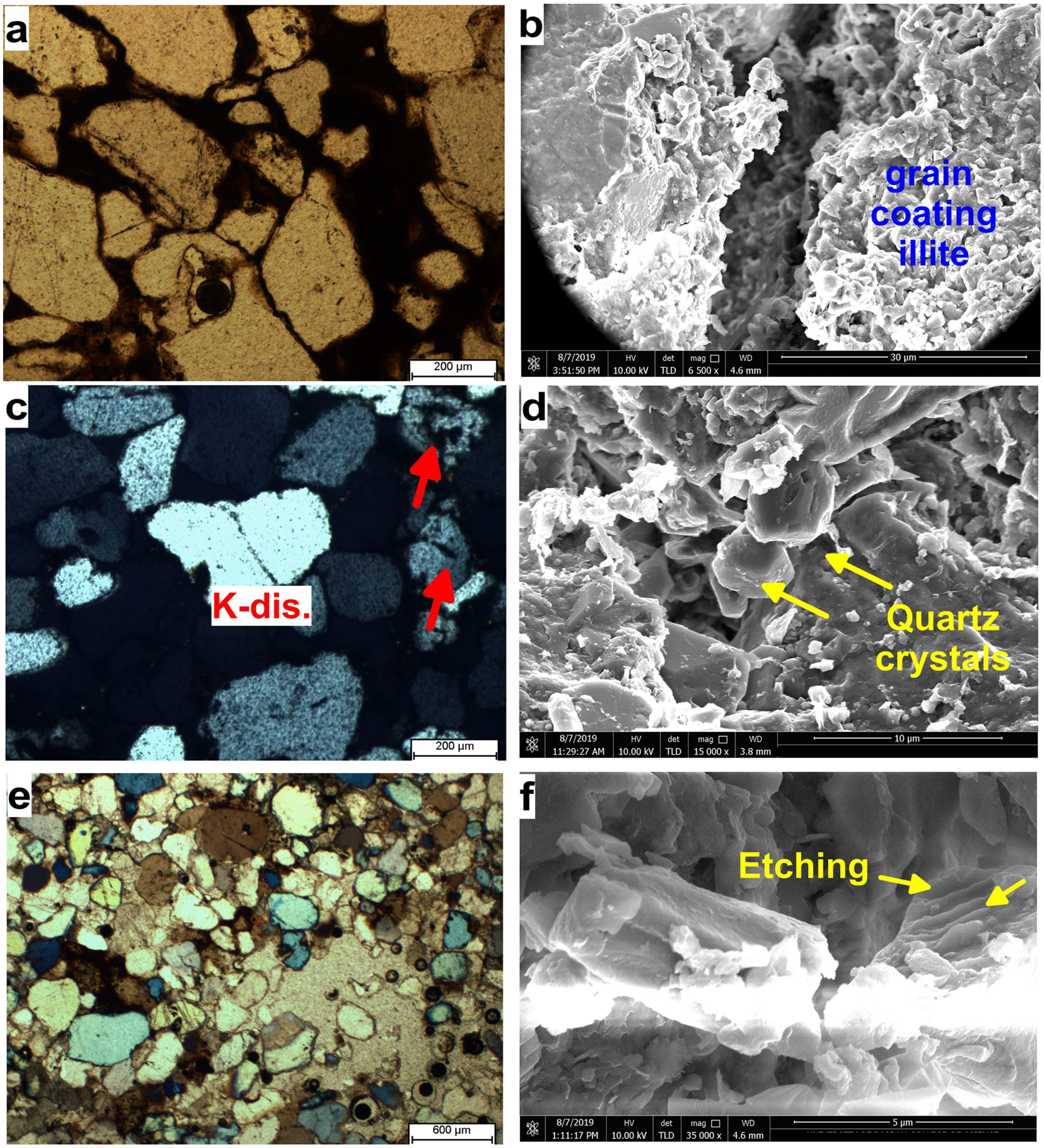

Figure 7. Petrographic features of the S7 and S8. a – PPL image shows the clay abundance in sandstone (S6). b – SEM image shows possible grain coating illite (S6). c – XPL image shows K-feldspar dissolution in the S7. d – SEM image shows micro-quartz and illite (S7). e – XPL image shows the carbonate cement (S8). f – SEM image shows etched (dissolved) grain (S8).

quartz crystals that coat some parts of quartz grains in some observed intervals (Figure 5d, Figure 6d and Figure 8b), suggesting that the porewater was high silica supersaturated. However, the mechanism of forming these crystals remains uncertain. It should be mentioned that these quartz crystals are occasionally associated with illites. The microcrystalline quartz crystals grown between quartz grains prevented the quartz overgrowth in the Nahr Umr sandstones and maintained porosity high. The same finding was concluded by [*Worden and Morad,* 2000].

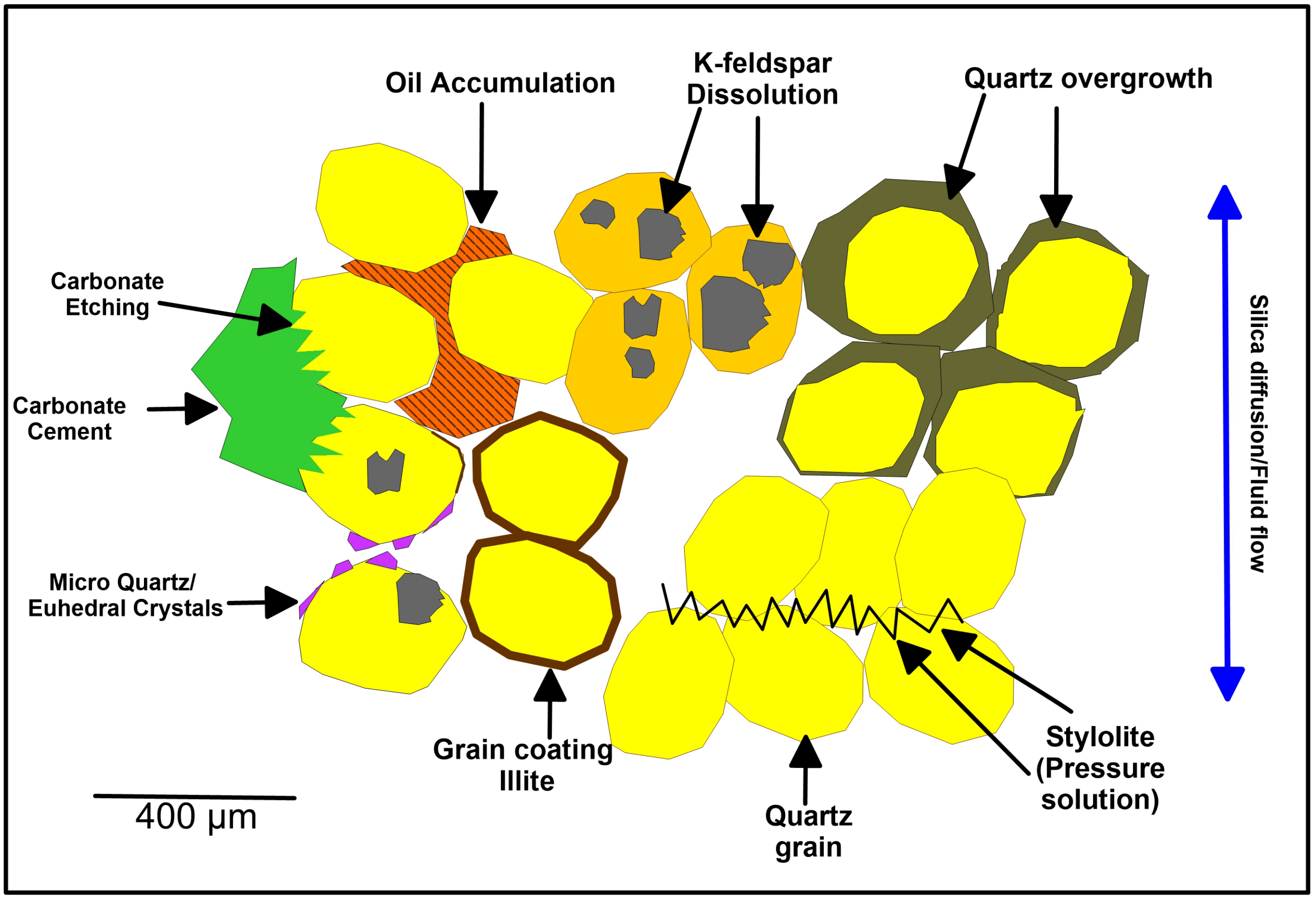

Figure 8. A conceptual schematic diagram showing the diagenetic features observed in the Nahr Umr sandstone.

Some quartz overgrowths participated just a few micrometers from the pressure solution (stylolite) sites (Figure 6c, Figure 6e and Figure 6f), proposing that quartz overgrowth occurred later after pressure solution (late diagenesis). It also believed that the dissolved materials caused by pressure solution sourced the silica for participation around the detrital grains.

Furthermore, it is observed that stylolite relatively occurred parallel to the bedding (Figure 4a and Figure 4d), meaning that the vertical pressure (overburden) is the responsible stress for the occurrence of stylolite formation. This provides evidence that the Nahr Umr Formation is in a stable tectonic setting (no large dipping angles and/or faults). The etching occurred in the Nahr Umr sandstone between the carbonate cement and detrital quartz grains (Figure 6g and Figure 7f). No quartz cement has been observed in the sites of the carbonate cement. Dolomite/ankerite cement in the Nahr Umr Formation is believed to has formed early after the deposition of the Nahr Umr sandstones (Figure 6h, Figure 7e and Figure 7f). The silica-carbonate replacement is another possible source the silica, with fluid to flow and permeable media to transfer the silica from its source into the precipitation sites. This finding was also concluded by [*Al-Dabbas et al.*, 2012; *Qaradaghi et al.*, 2008].

A conceptual schematic diagram can be drawn to illustrate the key features observed and findings of this study (Figure 8), it can be clearly stated that the quartz overgrowth and carbonate (dolomite/ankerite) cements are the main authigenic minerals precipitated in the Nahr Umr Formation. The stylolite formation (pressure solution) and the calcite-quartz replacement are the sources of silica. The grain coating illite and the quartz crystals are factors preventing quartz overgrowth and preserved porosity in the Nahr Umr sandstone.

Conclusions

This study is summarized many findings such as shown here:

- The Nahr Umr sandstones are generally quartz arenites, fine to coarse-grained, poorly to moderately sorted, argillaceous and calcareous in some parts. Sandstones with black to dark grey fissile shale with the occurrence of the siltstone and streaks of limestone were deposited in a fluvial-deltaic to shallow marine environment.
- The K-feldspar dissolution and etching process have helped in the formation of the secondary porosity in the Nahr Umr reservoir.
- The Nahr Umr reservoir is dominated by the dolomite/ankerite cement with minor amount of quartz overgrowth.
- The main sources of silica are the pressure solution (stylolite formation) formed as a response to the chemical compaction, and quartz-carbonate replacement.
- The authigenic grain-coating illite and the quartz crystals are factors preventing quartz overgrowth in the Nahr Umr sandstones and preserved reservoir quality.

Acknowledgments. The author would express his sincere to the Missan Oil Company for their permission to complete this work. This work could not be done without the suggestions and comments of Prof. Dr. Sadoon Morad (Khalifa University). Special Thank to Prof. Dr. Moutaz Al-Dabbas (University of Baghdad), and Dr. Ibrahem Mohammed (Al-Mufeed Company) for their continuous motivation, and the respected reviewers for their valued comments to improve the paper.

References

Al-Dabbas, M. A., J. A. Al-Jassim, A. I. Qaradaghi (2012), Siliciclastic deposit of the Nahr Umr Formation, sedimentological and depositional environment studies, central and southern Iraq, *Arabian Journal of Geosciences*, *6,* 4771–4783, **Crossref**

Al-Khafaji, A. J. (2014), The Mishrif, Yamama, and Nahr Umr reservoirs petroleum system analysis, Nasiriya oilfield, Southern Iraq, *Arabian Journal of Geosciences*, *8,* 781–798, **Crossref**

Alsharhan, A. S. (1991), Sedimentological interpretation of the Albian Nahr Umr Formation in the United Arab Emirates, *Sedimentary Geology*, *73,* 317–327, **Crossref**

Alsharhan, A. S. (1994), Albian Clastics in the Western Arabian Gulf Region: a Sedimentological and Petroleum-Geological Interpretation, *Journal of Petroleum Geology*, *17,* 279–300, **Crossref**

Aqrawi, A. A., J. C. Goff, et al. (2010), *Petroleum Geology of Iraq*, Scientific Press Ltd, Beaconsfield.

Bellen, R. C. Van., H. V. Dunnington, et al. (1959), *Lexique Stratigraphique International. vol. III, Asie, Fascicule 10a, Iraq*, Centre National de la Researche Scientifique, Paris.

Bjorlykke, K., P. K. Egeberg (1993), Quartz cementation in sedimentary basins, *American Association of Petroleum Geologists Bulletin*, *77,* 1538–1548, **Crossref**

Burley, D. S., R. H. Worden (2003), *Sandstone Diagenesis: The Evaluation of Sand to Stone*, Blackwell, Madlen. **Crossref**

Jassim, S. Z., J. C. Goff (2006), *Geology of Iraq*, Dolin and Moravian Meseeum, Prague.

Lander, R. H., E. E. Larese, L. M. Bonnell (2008), Toward more accurate quartz cement models: the importance of euhedral versus noneuhedral growth rates, *American Association of Petroleum Geologists Bulletin*, *92,* 1537–1563, **Crossref**

McBride, E. F. (1989), Quartz cement in sandstones: a review, *Earth Science Reviews*, *26,* 69–112, **Crossref**

Mohammed, A. K. A., J. K. Radhi, S. Z. ALi (2020), Well Logs data prediction of the Nahr Umr And Mishrif Formations in the Well Noor-10, Southern Iraq, *Iraqi Geological Journal*, *53,* No. 2A, 50–67, **Crossref**

Owen, R. M., S. N. Nasr (1958), Stratigraphy of the Kuwait Basrah area, *Habitat of Oil, Weeks L. G. (ed.)* p. 1252–1278, American Association of Petroleum Geologists Bulletin, Tulsa.

Poulos, S. E., M. B. Collins, H. F. Shaw (1996), Deltaic sedimentation, including clay mineral deposition patterns, associated with small mountainous rivers and shallow marine embayments of Greece (SE Alpine Europe), *Journal of Coastal Research*, *12,* No. 4, 940–952.

Qaradaghi, A. I., B. M. Abdul-Kareem, et al. (2008), Petrography, diagenesis and depositional environment of Nahr Umr Formation, from selected wells in Central Iraq, *Iraqi Bulletin of Geology and Mining*, *4,* No. 1, 67–94.

Storvoll, V., K. Bjørlykke, et al. (2002), Porosity preservation in reservoir sandstones due to grain-coating illite: a study of the Jurassic Garn Formation from the Kristin and Lavrans fields, offshore Mid-Norway, *Marine and Petroleum Geology*, *19,* No. 6, 767–781, **Crossref**

Tang, L., J. Gluyas, S. Jones (2018), Porosity preservation due to grain coating illite/smectite:

Evidence from Buchan Formation (Upper Devonian) of the Ardmore Field, UK North Sea, *Proceedings of the Geologists' Association*, *129,* No. 2, 202–214, **Crossref**

Taylor, T. R., M. R. Giles, et al. (2010), Sandstone diagenesis and reservoir quality prediction: models, myths, and reality, *American Association of Petroleum Geologists Bulletin*, *8,* 1093–1132, **Crossref**

Wooldridge, L. J., R. H. Worden, et al. (2017), Biofilm origin of clay-coated sand grains, *Geology*, *45,* 875–878, **Crossref**

Worden, R. H., S. Morad (2000), *Quartz Cementation in Sandstones*, BlackwellScience, Malden. **Crossref**

Worden, R. H., M. W. French, E. Mariani (2012), Amorphous silica nanofilms result in growth of misoriented microcrystalline quartz cement maintaining porosity in deeply buried sandstones, *Geology*, *40,* No. 2, 179–182, **Crossref**

Corresponding author:

Abbas K. A. Mohammed, Geology Department, Missan Oil Company, Ministry of Oil, Amara, Missan, Iraq. (goldengeo.87@gmail.com)