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FACIES ANALYSIS AND STRATIGRAPHIC DEVELOPMENT OF THE NAHRUMR FORMATION IN LUHAIS OIL FIELD, SOUTHERN IRAQ

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ABSTRACT

The Clastic succession of NahrUamr Formations is deposited during the Albian stage within the Early Cretaceous epoch. The present study includes the facies analysis and stratigraphic development for the NahrUmr Formation in three boreholes (Lu-1, Lu-3, and Lu-12) within the Luhais oil field. Two types of successions are observed within the NahrUmr Formation; the first is the upper part which characterized by shale dominated rocks and the second (lower part) is characterized by sand dominated rocks. Five major lithofacies are recognized in this succession as follow:-well sorted quartz arenite lithofacies; poorly sorted quartz arenite lithofacies; poorly sorted graywacke lithofacies; sandy shale lithofacies and shale lithofacies. Four facies associations (depositional environments) are distinguished in the NahrUmr Formation, they are: fluvial channel, shoreface, delta plain, and distributary channels. The microfacies analysis and reconstructed the paleo environments for the Albian basin in the studied area has contributed to determine two stages of the deposition: -

The first stage is showed clear when the facies development from the fluvial channel to the shore face association facies within the sand dominated unit of NahrUmr Formation (lower unit). This succession is representing transgression system tracts (TST), which was ended with appeared the shale lithofacies within the well sorted quartz arenite facies to mark the maximum flooding surface (mfs). The deposition was continued during still stand sea level to develop at last to delta plain association and start the second stage.

The second stage is started with the delta plain in Lu-3 and Lu-12 but the distributary channel in the Lu-1 which represent high-stand system tract (HST) within the upper unit. This pattern of deposition (HST) continued until a change in depositional environment from delta plan to a distributary channel in all studied wells to became TST. The clear change in the lithofacies from the shale dominated (delta plain association) to sand dominated lithofacies to became high maturity fine grained sandstone (distributary channel), that onset to sea level rise. Therefore, the upper part of the upper unit is representing the TST, which it was continue to deposition of the Mauddud Formation during the sea progress.

Keywords: Facies analysis,Stratigraphic development, NahrUmr Formation, Luhais Oil Field, Southern Iraq.

1. INTRODUCTION

The Clastic succession of NahrUamr Formations is deposited during the Albian stage within the Early Cretaceous epoch. The present study includes the facies analysis and stratigraphic development for the NahrUmr Formation in three boreholes (Lu-1, Lu-3, and Lu-12) within the Luhais oil field. The study area is located in the Southern Iraq within the Mesopotamian basin at the stable shelf. The studied oil field is located in the southern desert, about 90 km south-west of the city of Basra, which lies about of 50 km southwest of the Northern Rumaila oil field (Fig.1).

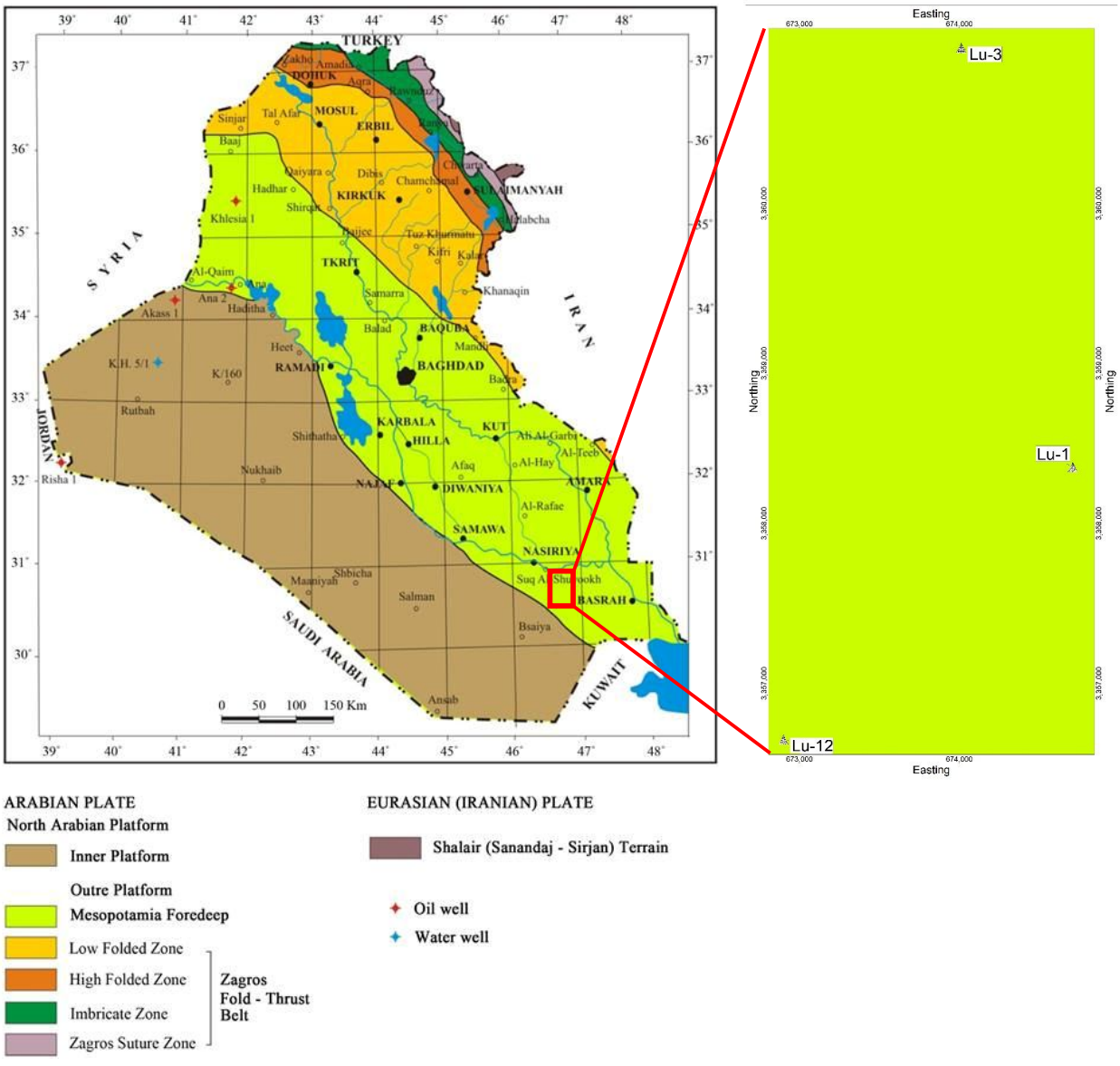


Fig. 1: Location of Study area with tectonic subdivisions by (Fuad, 2014)

The NahrUmr Formation was defined by Glynn Jones in 1948 (Bellen et al., 1959) from the NahrUmr structure in South Iraq. The two major depocentres in central and South Iraq correspond to areas which received clastics from the Rutba Uplift and the Arabian Shield. In its type area in Southern Iraq, the NahrUmr Formation comprises black shale bedded with medium to fine grained sandstones with lignite, amber, and pyrite (Bellen*et al*., 1959). The proportion of sand in the formation increases towards the Salman Zone.

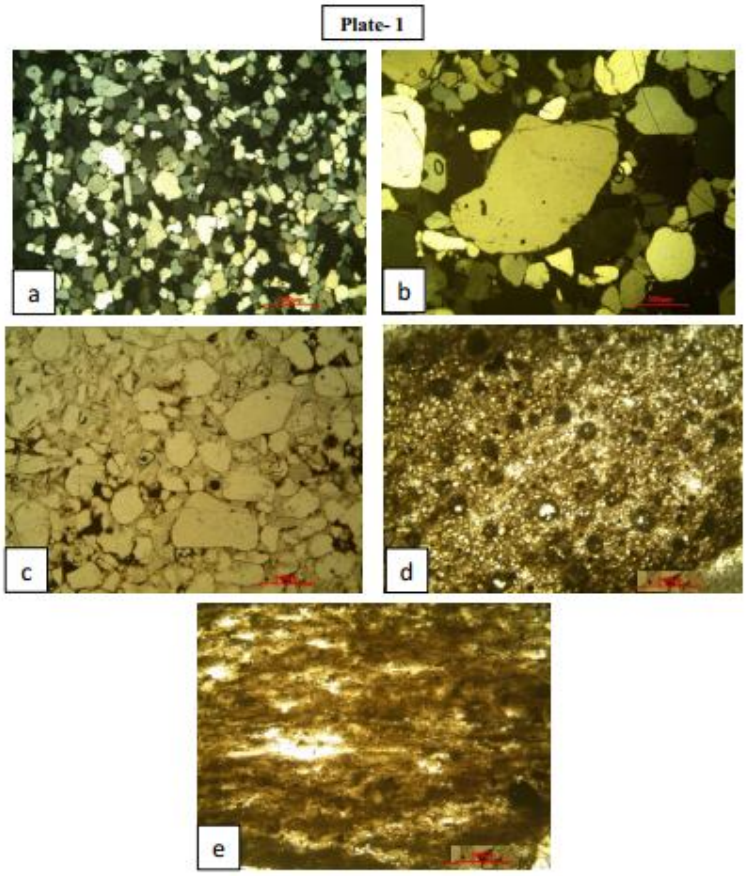
The lower contact of the NahrUmr Formation, according to Bellen*et al*. (1959) is conformable and gradational. However, in Kuwait, Douban and Medhadi (1999) recognized a 6 Ma age break at the base of the Burgan Formation (NahrUmr-equivalent). The upper contact is generally conformable. However, in the Butmah structure the NahrUmr Formation is disconformably overlain by the basal conglomerate of the Mushorah Formation (Jassim and Goff, 2006).

In order to understand the geological and stratigraphic settings of this formation in the study area, it is necessary to take into account the most important previous studies that dealt with this succession in the neighboring fields. Amanj *et al*. (2008) are recognized six main depositional environments for the NahrUmr Formation in central Iraq: Prodelta; distal bar; distributary mouth bar; distributary channel; over bank and tidal channel. Al-Zaidy and Amer (2015) are suggested four depositional environments of NahrUmr Formation in Wset Qurna oil field: bay fill; delta plain; delta front; and braided river.In Nasiriyah oil field four facies associations were distinguished in the NahrUmr Formation, they are: deltaplain; prodelta; bay fill; and distributary channels; with abundant the shale dominated rocks (Al-Zaidy and Khudhair, 2018).

Facies Analysis and Paleoenvironments of NahrUmr Formation

Two types of successions are observed in NahrUmr Formation; the first is the upper unit which characterized by shale dominated rocks and the second is the lower unit which characterized by sand dominated rocks. There are five major lithofacies were recognized in the succession of the NahrUmr Formation according to the petrographic observation with gamma ray and spontaneous potential well logs to determine the pale environment.

1. **Well sorted quartz arenite Lithofacies (1):-**Its represents the fine grained well sorted sand dominated rocks with sub-angular to sub-rounded grains shape (Plt.1a). The sandstone in this facies is composed of more than 90% of quartz to classify according to Folk (1973) as quartz arenite sandstone. This appeared in the lower unit as very low gamma ray values with box shape of gamma ray and spontaneous potential logs (Fig.2).
2. **Poorly sorted Quartz arenite Lithofacies (2):-**Its represents wide range of grain size of sandstone (fine-coarse) and well-rounded to sub-rounded grain shape, within the sand dominated rocks (Plt.1b). The sandstone in this faciesis contains of more than 90% of quartz to classify as quartz arenite which appeared in the lower part of the lower unit.This characterized by poorly sorted, very low gamma ray values which increasing upward with funnel shape of gamma ray log (Fig.3).
3. **Poorly sorted graywacke Lithofacies (3):-**This lithofacies is represents the muddy sand dominated rocks which mainly composed of quartz mineral. Its characterized by poorly sorted graywacke sandstone (Plt.1c), with moderate values of gamma ray (funnel shape). This lithofacies is appeared in the upper unit of the NahrUmr Formation, addition to mudy parts of the lower unit (Fig.3).
4. **Sandy shale Lithofacies (4):-**This facies is appeared in the shale member as sand lenses, which characterized by high gamma ray values with funnel shape. The main composed of thisfacies is shale dominated rock with quartz grains angular shape (Plt.1d).
5. **Shale Lithfacies (5):-**This facies is represents the upper unit of NahrUmr Formation. Its characterized by main composed of shale (Plt.1e), with high gamma ray values with bell shape (Fig.3).



a. Well sorted fine to medium graind Quartz arenite Lithofacies (Lu-3(2568m))
b. Poorly sorted Quartz arenite Lithofacies (Lu-3(2606m))
c. Poorly sorted graywacke Lithofacies (Lu-12(2595m))
d. Sandy shale Lithofacies (Lu-3(2510m))
e. Shale Lithfacies (Lu-1(2553m))

Associated Facies and Depositional environments

Four facies associations (depositional environments) are distinguished in the NahrUmr Formation, they are: fluvial channel, shoreface, delta plain, and distributary channels. Theseare distinguished according to Coleman, and Prior (1981),Serra (1987), Van Wagoner et al, (1992), Emery and Myers (1996) and Malcolm Rider (1999).Additional touse the GR, SP and DT logs with the resistivity log (LLD)to determine the minor lithologic change and general trend of grain size.

Lower unit:-

The main composed of this unit is sandstone with thin beds of shale to divided this unit into two parts, the upper most is sand dominated and the lower part is consisting of shale dominated rocks (Fig.2). This unit is characterized by low gamma ray and negative SP values with abundant of coursing up-ward (Box shape), this pattern is observed too with the resistivity and sonic logs (Fig. 5). The main lithofacies in this unit are well sorted quartz arenite lithofacies (I) andpoorly sorted quartz arenite (II) in the upper part. While the lower part is characterized by poorly sorted graywacke lithofacies (III).This sequence is interpreted to form in a fluvial channel for the lower part and the sandy, wave- or fluvial-dominated shore face where the rate of deposition equals the rate of accommodation for the upper part (Fig.2).

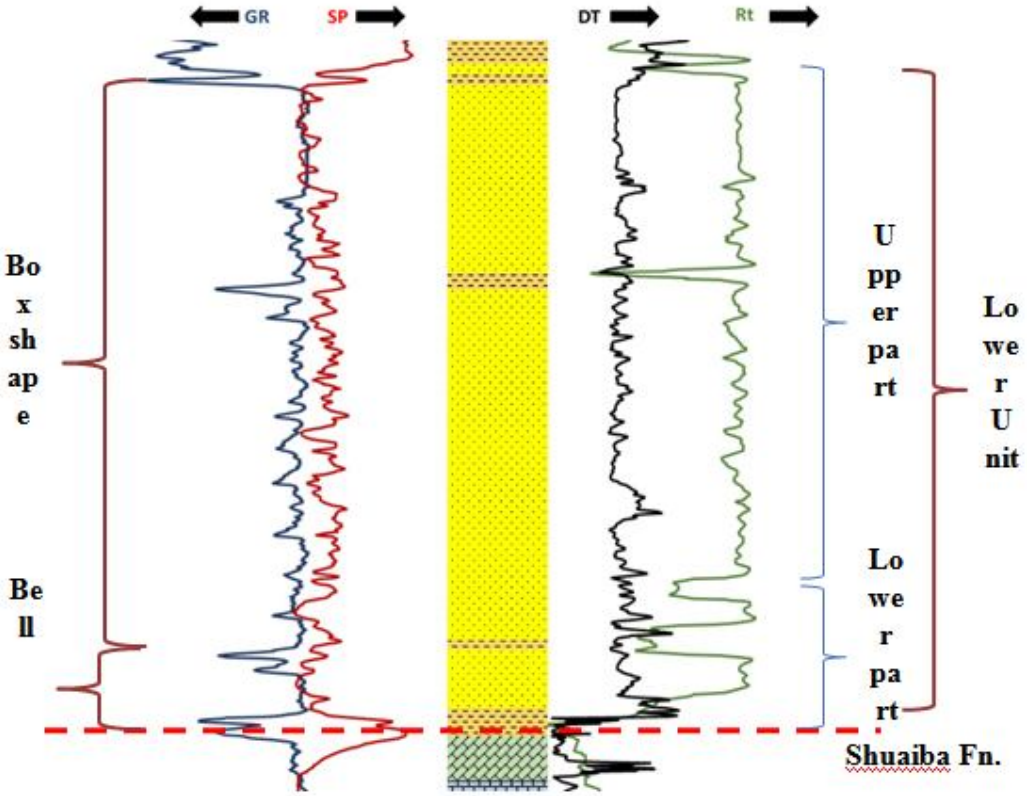


Fig. 2: Variety of GR and SP log vs. DT and Rt log shapes with lithology for the lower unit of The Nahr Umr Formation (Lu-3).

Upper unit:-

The main composed of this unit is shale with sandstone inter layers addition to high amount of organic matters (hydrocarbon) and pyrite. Thickness of this unit is more than 100m in Lu-1 and Lu-12 and 85m in Lu-3. This unit is characterized by high gamma ray and positive SP values, and according to the patterns of these logs and the different behavior of the sonic and resistivity logs there are two parts in this unit; the first is fining up-ward (Bell shape) in the lower part of this unit, and coursing up-ward (Funnel shape) in the upper part(Fig. 3). The lower part of this unit is characterized by abundant of greywacke poorly sorted lithofacies (III), sandy shale and shale lithofacies (VI, V), while the upper part is sandstone dominated rocks with a fine grained good sorting quartz arenite lithofacies (I) (Fig.3).The lower succession is matching with the delta plain associated facies to developed upwared to distributary channel associated facies.

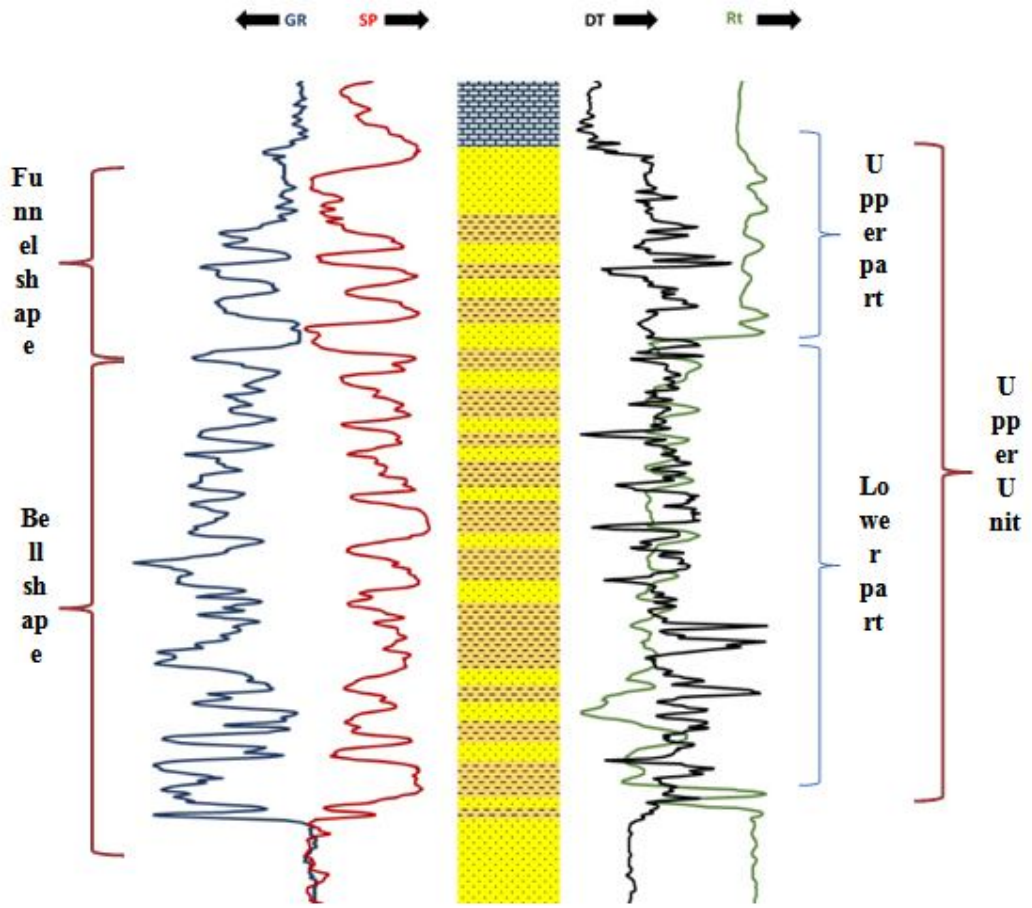


Fig. 3: Variety of GR and SP log vs. DT and Rt shapes with lithology for the upperunit of The Nahr Umr Formation (Lu-2).

Stratigraphic development

The studied succession represents third order sequence which deposition during the Albian stage within the Early Cretaceous epoch. During the deposition of the NahrUmr Formation, the siliciclastic shelf followed a cyclical pattern of evolution from the foreshore depositional mode to fluvial mode. A sequence boundary type-I separates the carbonate inner shelf of Shuaiba Formation from the fluvial of the lower unit of NahrUmr Formation (Figs. 4, 5, 6).

From the microfacies analysis and reconstructed the pale environments of the Albian basin in the studied area; there are two stages of the deposition: -

The first stage is showed clear when the facies development from the fluvial channel to the shore face association facies within the sand dominated unit of NahrUmr Formation (lower unit) (Fig.4, 5 and 6). This succession is representing transgression system tracts (TST), which was ended with appeared the shale lithofacies within the well sorted quartz arenite lithofacies to mark the maximum flooding surface (mfs). The deposition was continued during still stand sea level to develop at last to delta plain association and start the second stage.

The second stage is started with the delta plain in Lu-3 and Lu-12 but the distributary channel in the Lu-1 which represent high-stand system tract (HST) within the upper unit. This pattern of deposition (HST) continued until a change in depositional environment from delta plan to a distributary channel in all studied wells to become TST. The clear change in the lithofacies from the shale dominated (delta plain association) to sand dominated lithofacies with high maturity fine grained sandstone (distributary channel), that onset to sea level rise (Fig. 4, 5 and 6). Therefore, the upper part of the upper unit is representing the TST, which it was continue to deposition of the Mauddud Formation during the sea progress.

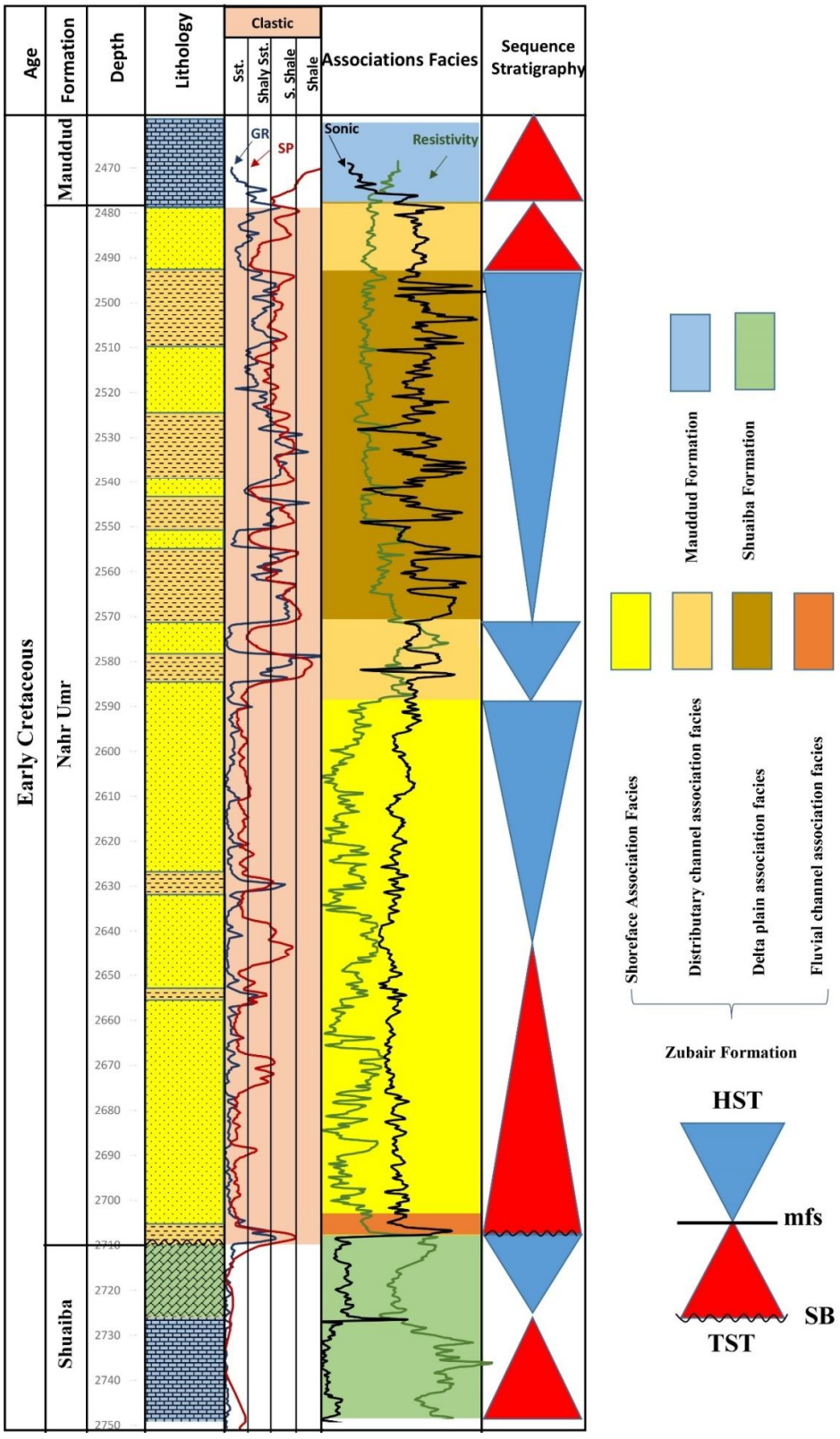


Fig. 4: Stratigraphic columnar section of well Lu-1

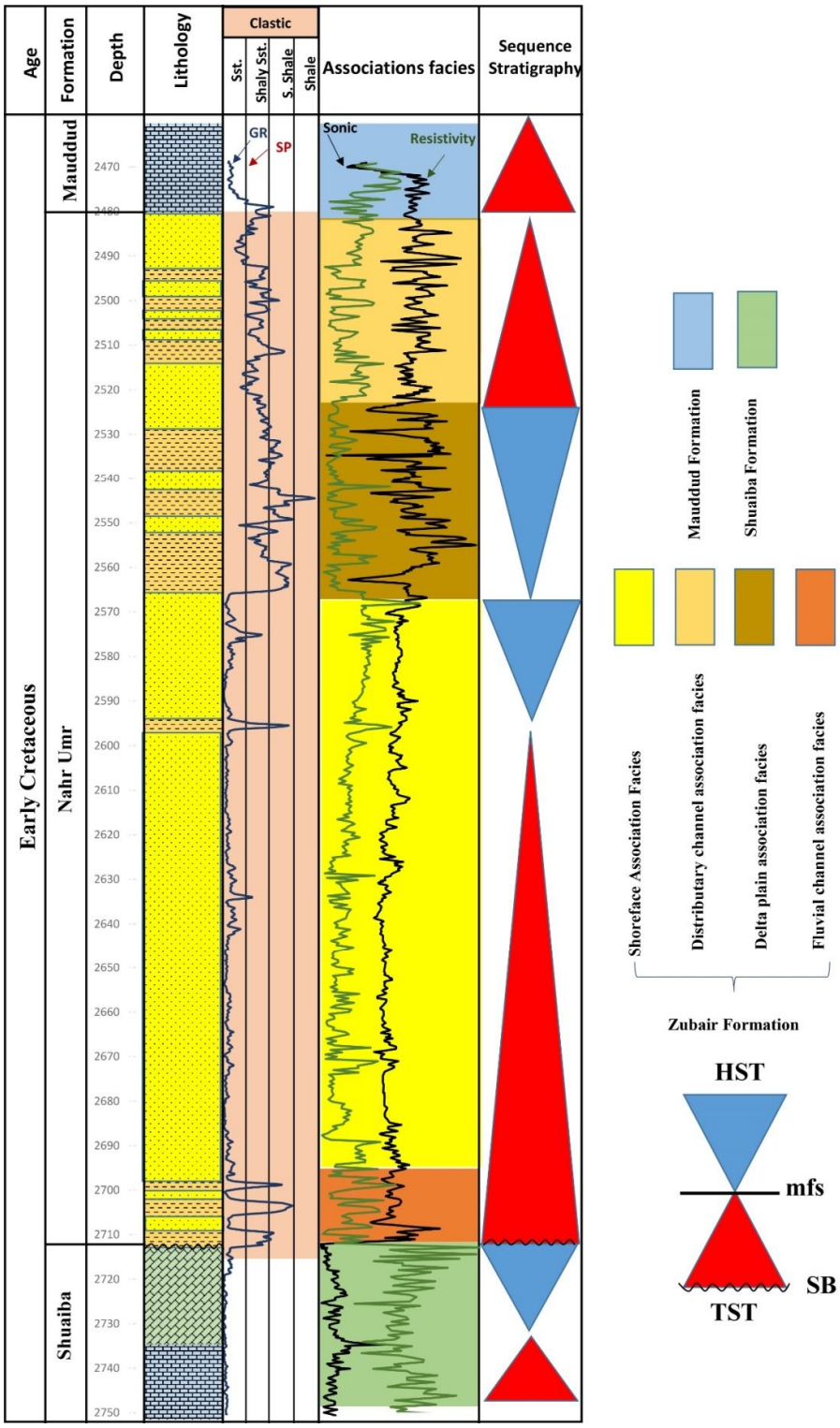


Fig. 5: Stratigraphic columnar section of well Lu-3

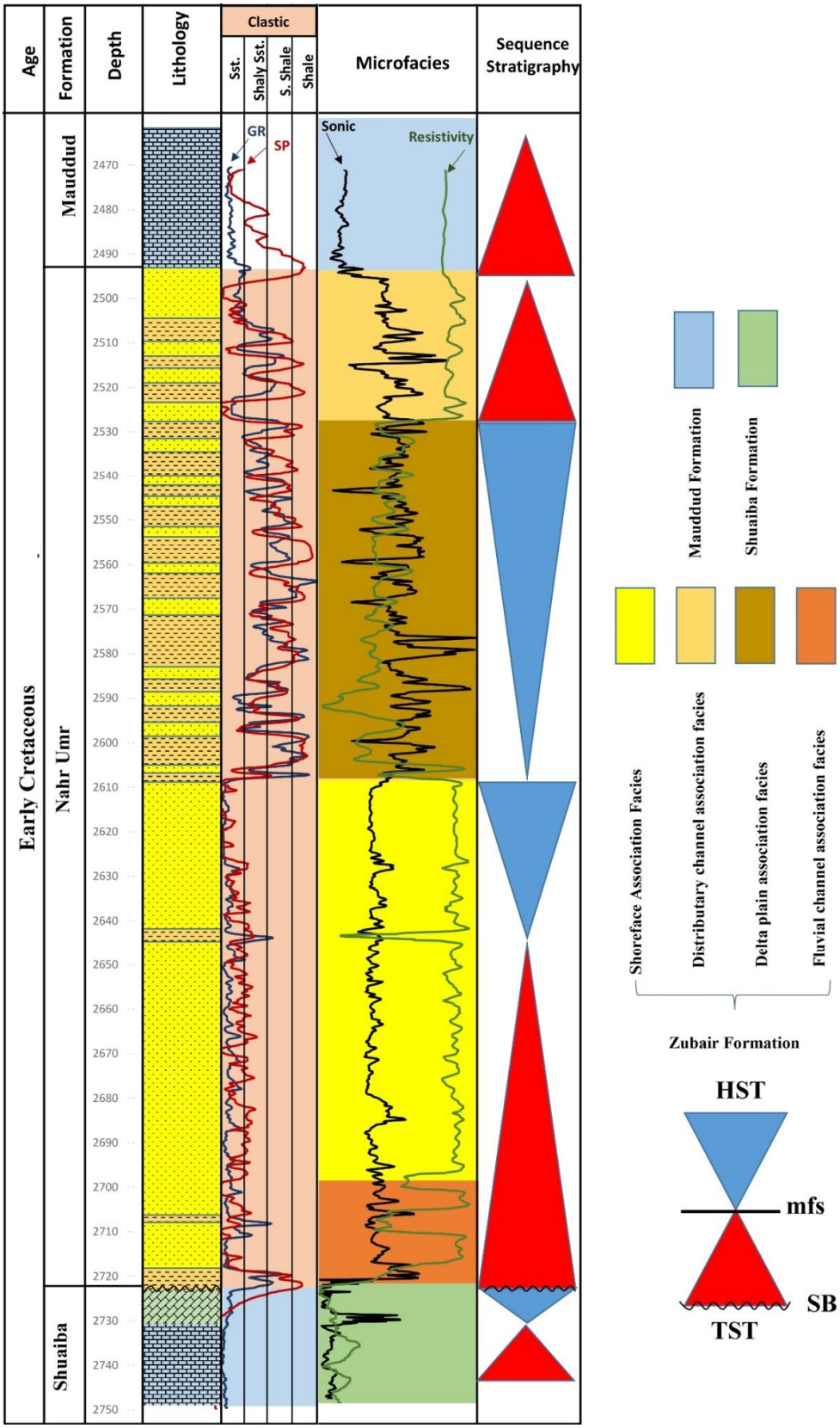


Fig. 6: Stratigraphic columnar section of well Lu-12.

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