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Paleoenvironments and Sequence Stratigraphy of the Turonian-Lower Campanian Succession at Majnoon Oil Field, Southern Iraq

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Abstract

The Turonian-Lower Companian succession at Majnoon Oil Field is represented by the Khasib, Tanuma, and Saadi formations. Four major paleoenvironments were recognized within the studied succession, there are: Shallow open marine environment, shoal environment, deep marine environment, and basinal environment. They reflect deposition on a carbonate platform of homoclinal ramp setting. The studied succession represents two second order supersequences (A) and (B). Supersequence (A) includes both the Khasib and Tanuma formations. The Saadi Formation represents cycle (B). These second order cycles can be divided each into two third order cycles, This subdivision may reflect the effect of eustacy being the major controlling factor of cycles development in the area of very gentle slope and low rate of subsidence. Further subdivision into fourth order cycles may reflect the minor relative sea level fluctuations due to the change in gradient in the vicinity of the shoalbodies where the water depth is lower and sensitive to any subtle changes in relative sea level.

Keywords: Carbonate Facies, Paleoenvironments, Sequence Stratigraphy.

البيئات القديمة والتتابع الطباقي لدورة التورينيان– الكامبانيان المتأخر في حقل مجنون النفطي جنوب العراق

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الخلاصة

تمثلت دورة التورينيان– الكامبانيان المتأخر في حقل مجنون النفطي جنوب العراق بتكوينات الخصيب، تنومة، وسعدي. تم تمييز أربعة بيئات رئيسية ضمن التتابع قيد الدراسة، وهي، بيئة البحر المفتوح الضحلة، بيئة الحاجز المتضحل، البيئة البحرية العميقة، البيئة الحوضية العميقة. تعكس هذه البيئات ترسيب في منطقة المنزلق . التتابع المدروس يمثل دوره من الدرجة الثانية (A) و (B). الدوره (A) تشمل كل من تكوين الخصيب و تكوين التنومة. أما تكوين السعدي فيمثل الدورة (B). هذه الدورات من الدرجة الثانية يمكن ان تقسم الى عدد من الدورات من الدرجة الثالثة بسبب تأثير تغير مستوى سطح البحر العالمي و هو العامل الرئيسي المؤثر على تطور التتابع في منطقه قليله الأنحدار و ذات معدل تجلس قليل. يمكن تقسيم هذه الدورات ذات الدرجه الثالثه الى عدد من دورات الدرجه الرابعه، و يعزى ذلك الى التغيرات الجانبيه في الأنحدار قرب الحاجز المتضحل حيث يتوضح تأثير التغيرات الدقيقه لمستوى سطح البحر.

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Introduction:

The Turonian-Lower Campanian succession in the Mesopotamian basin is represented by a complete sedimentary cycle of the Khasib, Tanuma, and Saadi formations. Majnoon oil field is located at Southern Iraq approximately 60 Km. Northwestern of Basra city, extending North to Missan province. Five boreholes were studied, these are: MJ-1, MJ-3, MJ-4, MJ-4, MJ-5, MJ-7 figure-1. The present study involves microfacies analysis, environmental interpretation, and sequence development.

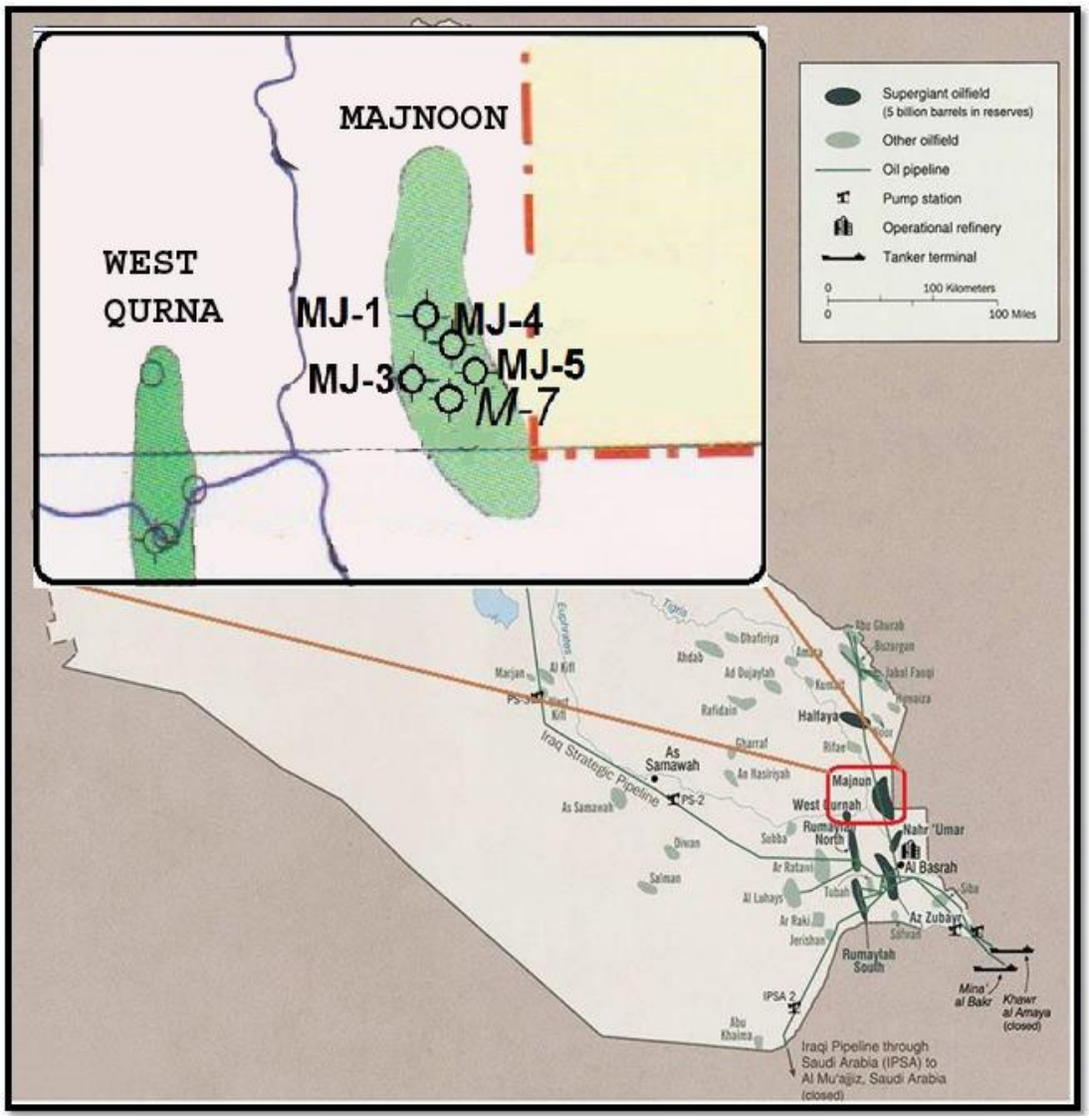

Figure 1- Location Map of the study area.

The Khasib Formation is the most proximal unit of the Late Turonian-Early Campanian Succession. It was defined by [1] at Zubair 3 well. The thickness of the Khasib Formation is highest in Southern Iraq (225 m in Zubair oil field). Fossils are relatively rare in the type section. In other wells relatively rich assemblages occur [2]. *Oligostegina* is abundant throughout. [3] suggested the formation is of Late Campanian age. However [4] argued that the formation is of Turonian-Early Campanian age. The species *Globotruncana lapparenti* is consistent with a Turonian age. The Tanuma formation was also defined by [1] in well Zubalr-3 in Southern Iraq. The thickness of the formation in Southeast Iraq reaches 60 m but wedges out in all directions. The Tanuma Formation was deposited in a restricted shallow basin, in a partly euxinic environment. According to [1] the formation is of Late Senonian in age and according to [3] the fauna appears to justify a Late Campanian age. [4] Suggested Turonian-Early Campanian age. The Tanuma Formation usually conformably overlies the Khasib Formation.

The Saadi Formation is the youngest, thickest, and most widespread formation. The type section was also defined by [1] from well Zubalr-3. The definition and age of the formation was modified by [4]. They included parts of the Pilsner Formation in the Saadi Formation, [1] assigned a Late Senonian age to the formation. [3] Suggested a Late Campanian age. The Turonian-Early Campanian succession is restricted to the Mesopotamian Zone and the Jezira Subzone but may have been more extensively distributed prior to the Intra Senonian erosion. The lower part of the megasequence is represented by the Khasib, Tanuma, Saadi, and Kometan formations. The upper part of the megasequence is represented by the Hartha, Tayarat, Digma, Aqra, Bekhme, Shiranish, Tanjero and Hadiena formations figure-2.

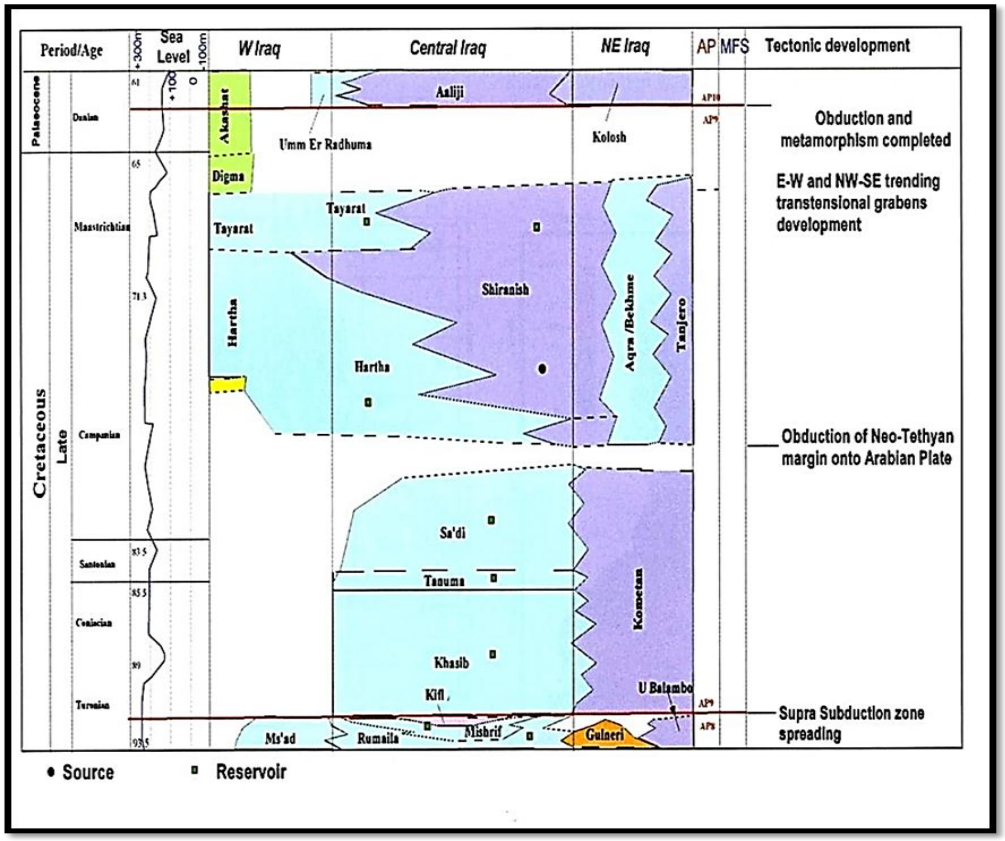

Figure 2- Stratigraphic correlation of the Late-Early Turonian-Danian Megasequence [5]

Microfacies and Pleoenvironments

Four major paleoenvironments were recognized, these are: shallow open marine environment, shoal environment, deep marine environment, and basinal environment figure-3.

The shallow open marine environment consists mainly of foraminiferal bioclastic wackestones and wackestone to packstone. The foraminiferal bioclastic wackestone is the most dominant in the Saadi Formation at different intervals; it is characterized by the abundance of benthonic foraminifera, shell fragments, and echinoderm fragments. The foraminiferal bioclastic wackestone to packstone is less common and recognized in small intervals. It is characterized by benthonic foraminifera, small bioclasts, and echinoderm fragments. This may represent deposition within inner to mid-ramp setting where continuous carbonate production took place [6], As a result a keep up carbonate sequence was developed characterized mainly by grain rich- mud poor texture.

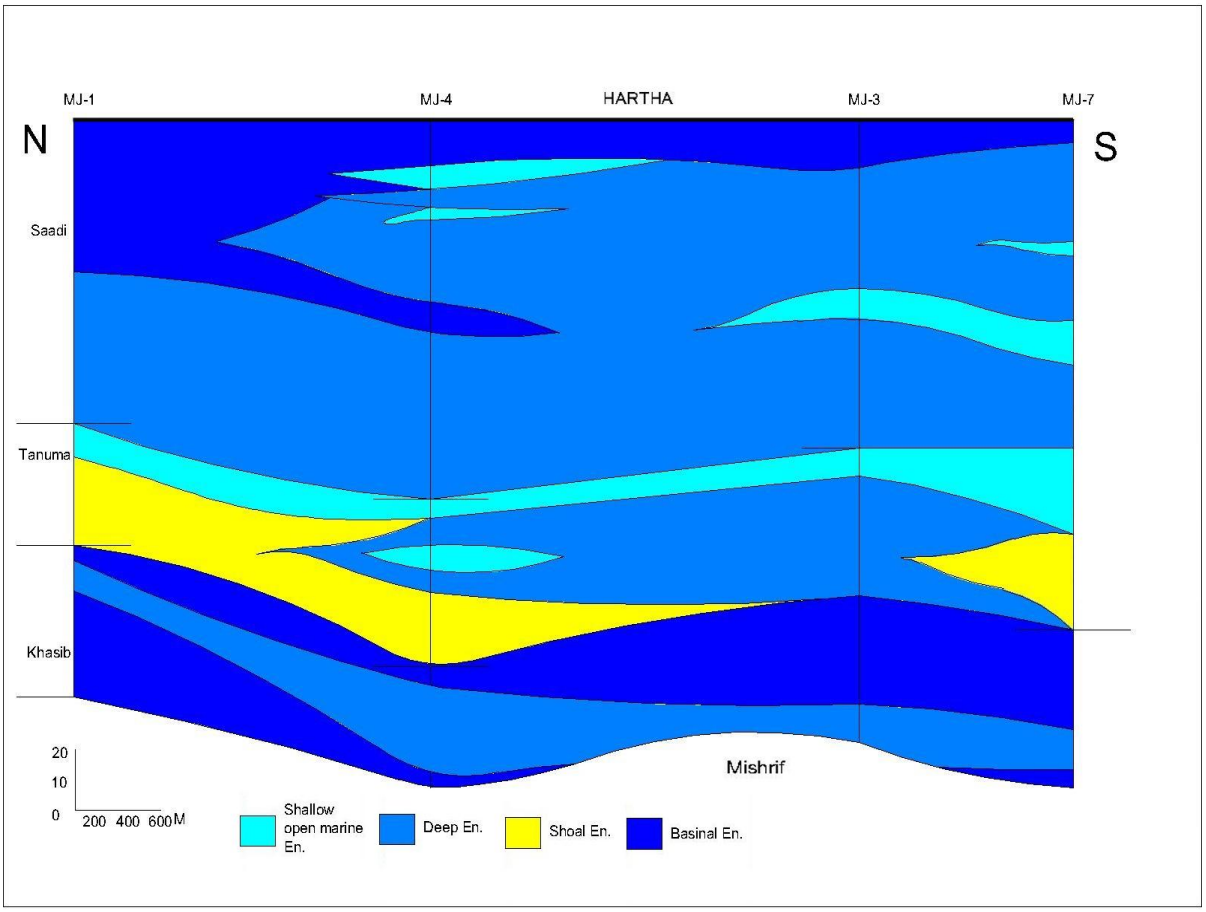

Figure 3- Stratigraphic cross section of the Turonian-Lower Companian succession in the study area.

The shoal facies form in a high energy environment within the mid ramp area. It is the most important facies within the Tanuma Formation. It consists of medium to coarse grained pelloids and ooids (Ooidal packstones to grainstone).

The deep marine environment is recognized within the Khasib and Saadi formations. This environment is represented by:

Bioclastioc planktonic wackestone, Bioclastic planktonic packstone, Bioclastic planktonic mudstone, Bioclastic planktonic mudstone to wackestone, and Bioclastic planktonic wackestone to packstone. They are characterized mainly by *Hetrohelix*, *Globigerina*, and *Hedbergella*, as well as bioclasts of diverse organisms. Such facies are typical of deep ramp setting [6].

The Basinal facies are most common in the Saadi and Khasib formations and very small intervals were recognized within the Tanuma Formation, it is represented by:

Planktonic mudstone to wackestone, Planktonic wackestone, and Planktonic wackestone to packstone. They are characterized mainly by *Hetrohelix, Globigerina*, and *Hedbergella*.

Depositional Setting

The nature of microfacies and facies stacking pattern suggests a ramp setting for the studied succession. Such setting may have developed during the early stages of the Turonian-Late Campanian platform development. It is characterized by thick separate and discrete shoals of the mid- ramp, the shallow water deposits pass gradually downward without a break into deeper and then into basinal facies. The aggradational to retrogradational nature of the succesion may suggest a homoclinal ramp setting [6].

Sequence Development

The studied succession represents two second order supersequences (A) and (B) figure-4. These cycles are assymmetrical and can be divided each into two third oreder cycles, supersequence (A)

include both the Khasib and Tanuma formations where the Khasib Formation represent the transgressive systems tract (TST) consisting of relatively thin basinal facies followed by thick deep marine facies, bounded below by Type one sequence boundary (SB1). The top of the Khasib Formation consist of a transgressive basinal unit and the Tanuma Formation which represent the Highstand systems tract (HST) of cycle (A). It consists mainly of shoal facies overlain by shallow open marine facies. This parasequence can be divided into three fourth order cycles (A2a, A2b, A2c) figure-4A. The Saadi Formation is represented by cycle (B) where the transgressive systems tract (TST) consist of a succession of deep and basinal facies constituting most of the thickness of the formation as at MJ-1 figure-4A whereas the Highstand systems tract (HST) is represented mainly by the shallow open marine facies at the top of the formation and continued upward through the lower part of the Hartha Formation. This can also be divided into a number of fourth oreder cycles (B1a, B1b, B1c, and B2a, B2b) figure- 4B. The subdivision into third order cycles may reflect the effect of eustacy being the major controlling factor on cycle development in an area of gentle slope and low rate of subsidence. The subdivision into fourth order cycles may reflect the minor relative sea level fluctuations due to the change in gradient in the vicinity of the shoalbodies where the water depth is lower and sensitive to any subtle change in sea level.

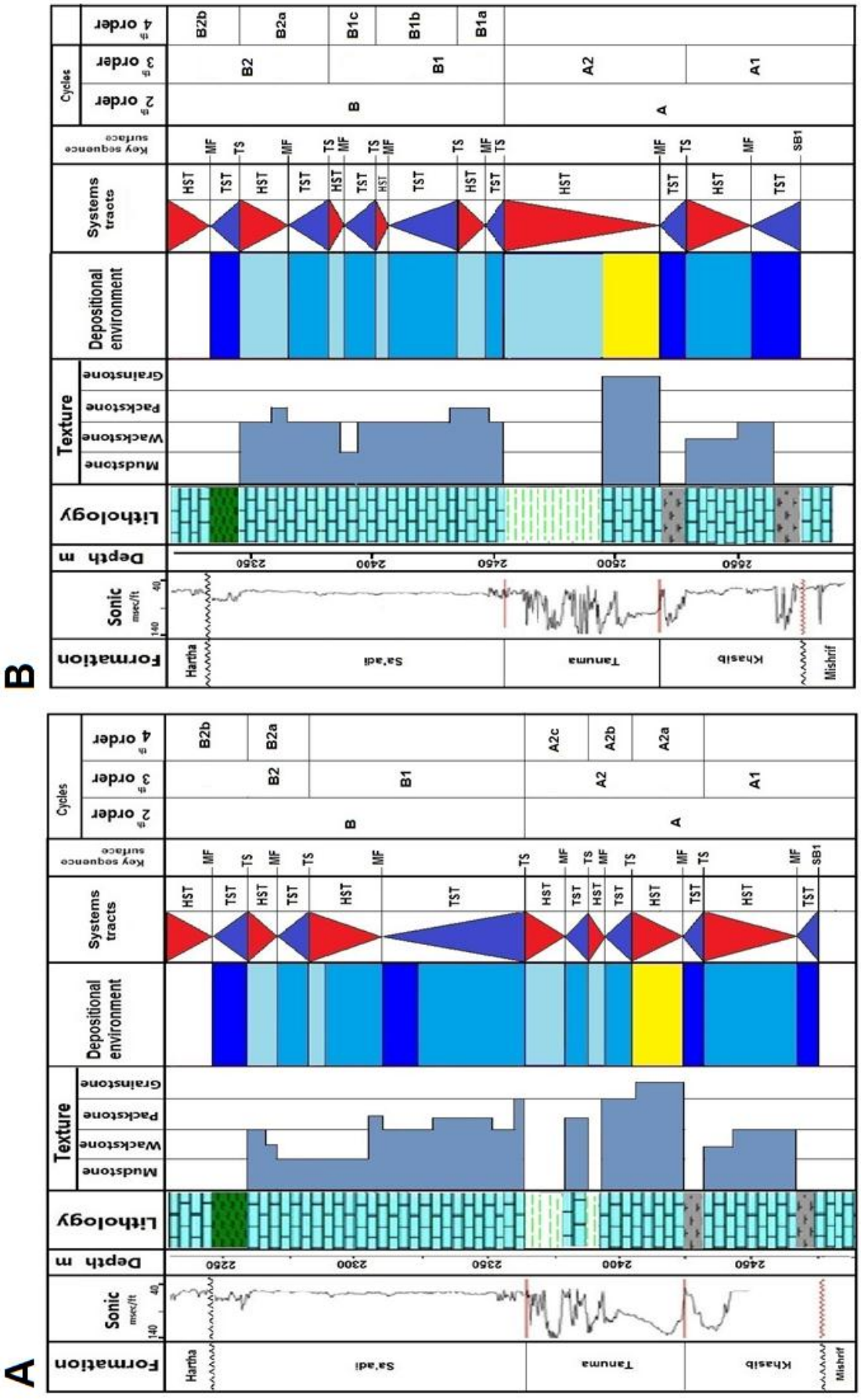

Figure 4-: Sequence stratigraphic subdivisions at **A-** MJ-4 , **B-** MJ-5.

Conclusions:

The Turonian-Lower Companian succession at Majnoon Oil Field is represented by the Khasib, Tanuma, and Saadi formations. This succesion was deposited within different subenvironments of a gently sloping carbonate platform of a homoclinal ramp setting; these environments include: shallow open marine, shoal, deep marine, and basinal environments. The studied succession represent two second order supersequences, They can be divided into a number of third order cycles reflecting the effect of eustacy being the major controlling factor on cycle development in an area of gentle slope and low rate of subsidence. Further subdivission into fourth order cycles may be due to the changes in gradient in the vicinity of the shoals where the water depth is lower and sensitive to any subtle change in sea level, In this case minor relative sea level fluctuations produced these cycles.

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