

# Sequence Stratigraphy of the Lower Jurassic Formations in Key Hole, 5/4 - Western Iraq

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## ABSTRACT

The Lower Jurassic Siliclastic – Carbonate Succession of Western Iraq is represented by Ubaid, Hussinyiat and Amij formations. It was subdivided into several microfacies that are distinguished on the basis of their depositional texture. Five distinct depositional settings were recognized: fluvial, restricted marine, shallow open marine, inner barrier and Shoal. Based on microfacies and sequence stratigraphic study, five third order sequences in K.H.5/4 were identified. These cycles were divided into eight asymmetrical fourth orders, their asymmetry reflects the imbalance between the rate of sea level fluctuations and rate of subsidence and low sediment influx.

## Introduction

The lower Jurassic Succession is cropping out in western Iraq along main valleys (Fig.1). This succession represented by carbonate Ubaid Formation, siliclastic-carbonate Hussinyiat and Amij formation. In subsurface sections, these formations are present in K.H5/9 and K.H5/4 and lies within the Stable Shelf of Iraq [1, 2,3]. [4] described the Ubaid Formation for the first time consisting of dolomite rocks with chert nodules, marl to marly dolomitic limestone interbedded with clastic rocks in K.H5/9 [5]. [6] gave the name Hussinyiat to the upper part of Ubaid Formation. This is composed of two units the lower consist of interbedded of clay, silt and sandstone, while the upper unit consists of dolomite with fossiliferous in places. [7] named Amij Formation for the rock sequence along wadi Amij, consisting of lower clastic unit (cycles of clay, silt and sandstone) and the upper carbonate unit composed of dolomite, sandy dolomite and marl. The main objectives of this paper are to:

- 1-Describing and interpreting the depositional environments of the Ubaid, Hussinyiat and Amij formations in K.H5/4.
- 2-Interpretation the origin of sequences that developed in the studied Key Hole

## Stratigraphy of K.H. 5/4

The thickness of Ubaid Formation in K.H 5/4 is about 117meters, the lower 30 meters consisting of dark grey dolomitic limestone and dolomite interbedded with marl fossiliferous in the middle part (bivalves and gastropods). Followed by marly dolomite and dolomitic limestone. Overlain by 20 meters of interbedded of white to yellow, medium to coarse sandstones. This is followed by 45 meters of fossiliferous dolomitic limestone, with thick bed of dark grey dolomitic limestone and some sand in the upper part. This Formation is underlain by upper Triassic Zor Horan Formation. Hussinyiat Formation had a thickness of about 37 meters, starts with 13 meters of fine to medium sandstone, interbedded with red to brown clay and silty clay.(lower clastic unit). Overlain by 25 meters of upper carbonate unit, consisting of grey dolomite and dolomitic limestone with some shell fragments of pelecypoda. The uppermost part becomes more sandy. Amij Formation consisting of about 60 meters (clastic unit) of multi cycles of clay, silt and sandstones, overlain by grey dolomitic limestone, dolomite. The upper part contains some fossils especially mollusk, which overlain unconformably by Cenomanian Rutba Formation .

## Facies Analysis

According to detailed description of 145 thin sections of K.H. 5/4, different microfacies and lithofacies were recognized, they reflect different depositional environments which are:

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### **-Ubaid Formation**

- 1-Restricted marine environment: Represented by dolomitized mudstone, fine crystalline with some shell fragments and sands. (Fig. 2, A)
- 2-Inner barrier environment: This environment is represented by dolomitic peloidal wackstone to packstone, (Fig. 2, B) consisting mainly subrounded peloids with unclear internal structure, most of them believed to be formed by micritization of allochems, especially ooids and bioclastics [8]. Some shell fragments of mollusks are also common. The peloids represent more than 60% in depth 351 meters, sand appear in some places.
- 3-Fluvial deposits: includes sandstone with red to brown mudstone, this may indicate progradation of flood Plain facies in the proximity of the shoreline.

### **-Hussinyat Formation**

- 1-Fluvial deposits: Consist of red clay, grey sandstone and varied color sandy clay (flood plain facies), which reflect deposition in approximal setting in the absence significant subsidence.
- 2-Restricted marine environment: Represented by mudstone, few shell fragments were observed in depth 226-232 meters, with some sands recognized in depth 247-250 meters. (Fig. 2, C).
- 3-Shallow open marine environment: This includes dolomitic bioclastic wackstone, contain shell fragment of different type of fossils especially mollusk, slightly dolomitized.
- 4-Shoal environment: This is represented by oolitic wackstone to packstone with some shell fragments and composed of oolite with dolomitized calcite cement which reflects deposition in a high energy environment (Fig. 2, D). [9] mentioned that this type is probably linked to increased tidal influence and/or shallow marine currents as increased water depth during marine transgression.

### **-Amij Formation**

- 1-Fluvial deposits: It consists of varied color laminated clay, interbed with siltstone, silty clay with different color in the upper most part of this unit.
- 2-Restricted marine environment: It represented by dolomitized mudstone with some sand grains in the lower part at depth 160-166 meters (Fig. 2, E). This microfacies reflects deposition within restricted bays and bounds where quiet slow deposition took place along tidal area [10].

3-Shoal environment: This type of environment includes oolitic wackstone which show various form of oolite (rounded to sub rounded), with concentric layer around nuclei. This microfacies is dolomitized, dolomitic rhombs is clear in matrix.

### **Sequence Stratigraphy .**

A sequence is defined as a conformable succession of genetically related strata, bounded at the top and bottom by unconformities and/or their correlative conformities [11]. The unconformities are defined as surfaces of erosion or non-deposition and represent a significant time gap. The major control on deposition is the relative sea-level variation and tectonic subsidence, particular deposition system tracts are developed during specific phase of the sea-level changes curve: lowstand (LST), transgressive (TST), and Highstand (HST) system tracts. The transgressive or upward-deepening portion of sequences (transgressive System Tract, TST) ends with the maximum flooding surface that records the deepest water depth attained for each sequence. The regressive or upward-shallowing portion of sequence (High System Tract, HST) ends at the sequence boundary, which records the effects of minimum long-term accommodation [12, 13] In this study, distribution of lithofacies and microfacies for sequence stratigraphic interpretation were used. The sediments at K.H.5/4 which belongs to Liassic age can be divided into five third order cycle. Fig.(3) Ubaid Formation consist of three major cycles 1, 2 and 3. Cycle 1 represent the lower part of Ubaid Formation (HST) of restricted marine environment. This is overlain by cycle 2 which is asymmetrical and show short period of sea level rise, followed by dolomitized mudstone facies of High system tract. Overlain by inner barrier environment of dolomitic peloidal wackstone to packstone facies, bounded above by mfs. Dolomitic mudstone facies of restricted marine environment which show long episode of stillstand, represent HST overlies the mfs. The boundary between cycle 2 and 3 above is type 2 sequence boundary SB2, because the sequence boundary shows no clear sub aerial exposure. Cycle 3 is thick and asymmetrical consisting of fluvial facies which represent a minor fall of sea level, this is followed by dolomitized mudstone and peloidal packstone facies of restricted to inner barrier marine environment represent transgressive system tract (TST), overlain by HST of restricted marine environment. This cycle is bounded above by type 1

sequence boundary SB1. Cycle 4 represent Hussinyat Formation which is consist of short episode of sea level fall where fluvial facies deposited (LST), followed by two episode of transgressive and highstand system tracts which include restricted, shallow marine, and shoal environments of the upper carbonate unit of Hussinyat Formation. Cycle 5 of Amij Formation separated from underling cycle by SB1, show thick fluvial deposits of lower clastic unit (LST), overlain by carbonate facies of TST and HST represented by restricted marine and shoal environments. The upper part of cycle 5 characterized by short episode of stillstand (HST), and separated the overlying Rutbah Sandstone Formation by type 1 sequence boundary SB1

### Conclusion

The studied succession lies on the eastern flank of the Hail-Rutba Arch within the most stable part of the area. In such area where the tectonic subsidence was at its minimum, the eustatic component was the main controlling factors on facies stacking pattern. The succession was deposited through eight fourth cycles. These cycles are asymmetrical reflecting an imbalance between sea level rise and rate of subsidence producing the shallow marine conditions favorable for carbonate production. The varying rate of clastic-carbonate succession where imbalance between clastic influx and accommodation produced such cyclicity. Forced regression due to sea level fall have caused progradation of fluvial facies and formation of formation of exposure surfaces.

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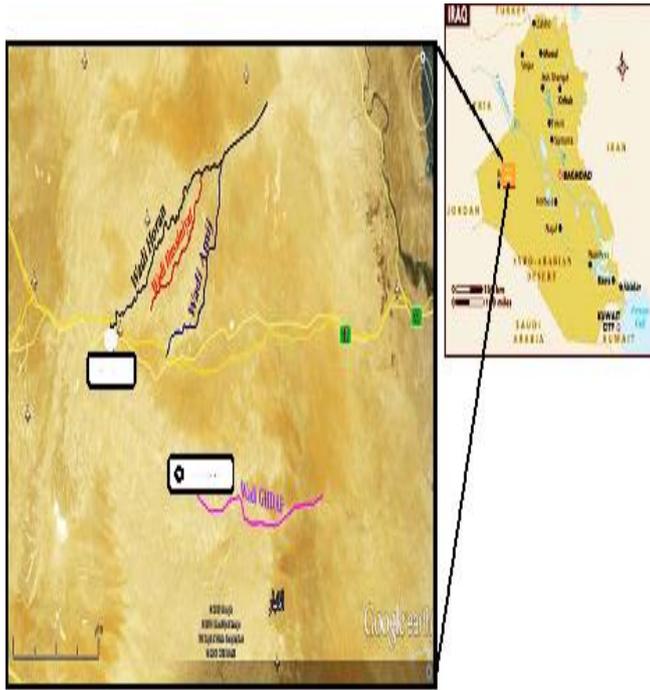


Fig. 1: Location map of the studied Key Hole, Western Iraq.

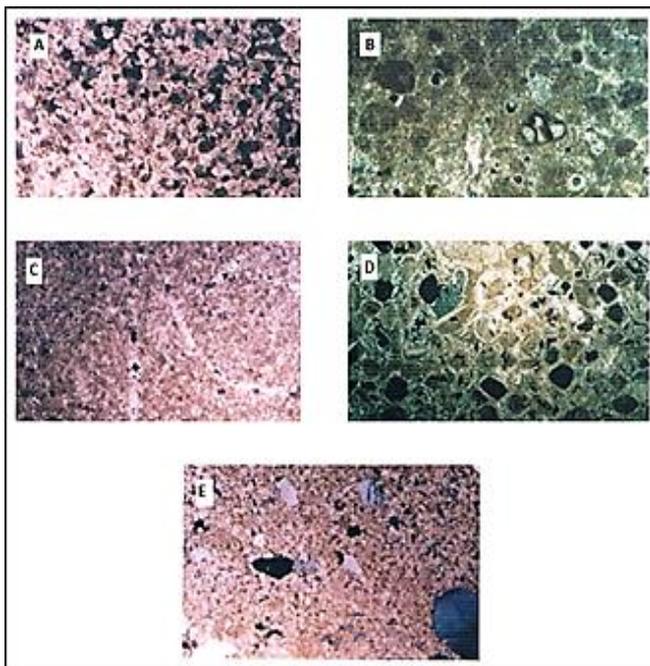


Fig.2: (A) Dolomitized mudstone, fine crystalline dolomite, Ubaid Fn. 40 X.  
 (B) Dolomitic peloidal wackestone to packstone. Amij Fn. 10 X.  
 (C) Mudstone, few shell fragments. Hussiniyat Fn. 10 X.  
 (D) Oolitic wackestone to packstone, Hussiniyat Fn. 10X.  
 (E) Dolomitized mudstone with some sand grains. Amij Fn. 10 X.

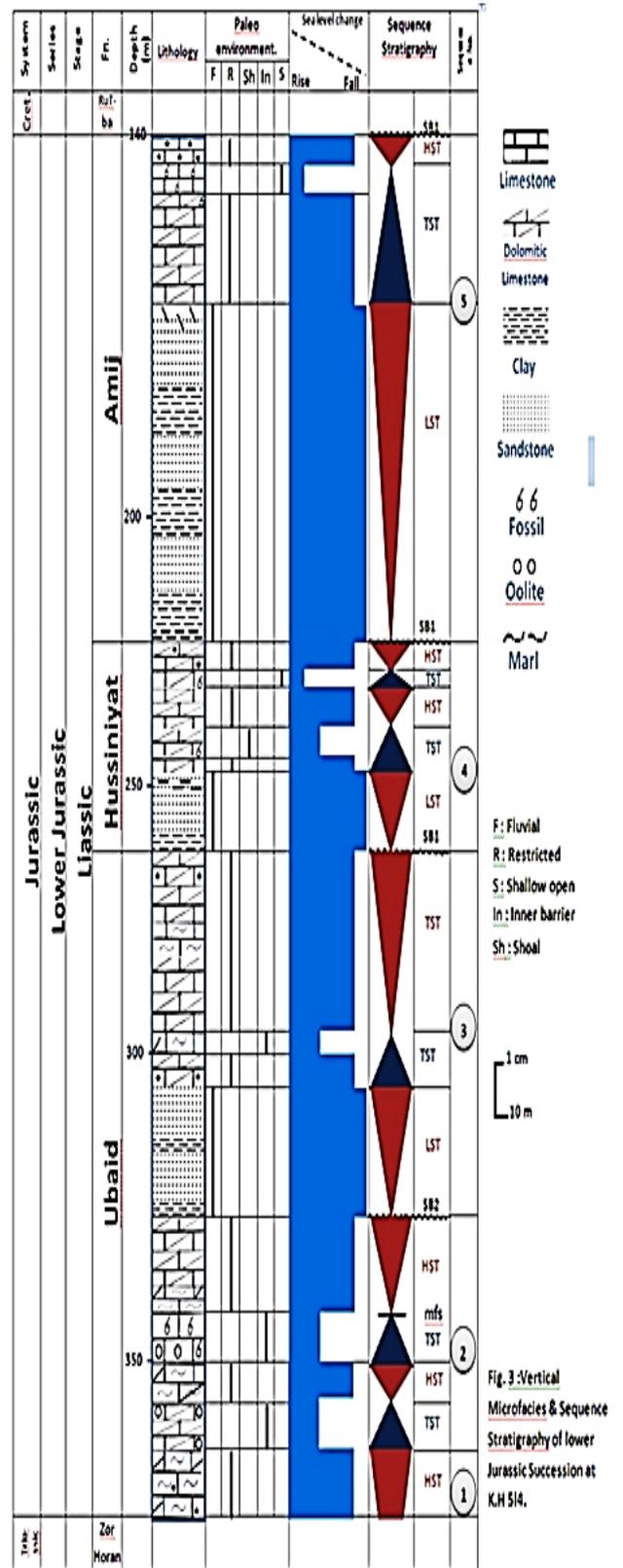


Fig. 3: Vertical Microfacies & Sequence Stratigraphy of lower Jurassic Succession at K.H 514.

## الطباقية التتابعية لتكوينات الجوراسي الاسفل في البئر 4/5 غرب العراق

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### الخلاصة

يتمثل تتابع الجوراسي الأسفل غرب العراق بتكاوين العبيد والحسينيات والعامج، والتي مثلت بعدد من السحنات الرسوبية الدقيقة ، لقد تم تحديد خمسة بيئات ترسيبية متمثلة بالبيئة النهريّة والبيئة داخل الحاجز والبيئة الحاجزية، وبالاعتماد على السحنات الدقيقة تم تحديد خمس دورات ترسيبية ذات المرتبة الثالثة في البئر 5/4. هذه الدورات قسمت الى ثمانى دورات ترسيبية ذات المرتبة الرابعة عكست العلاقة بين التغيرات في مستوى سطح البحر.