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Depositional environment and diagenetic development of the Mauddud Formation in wells Am-3, WQ-3, southern Iraq

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Abstract

The Mauddud Formation of Southern Iraq was deposited within four subenvironments, shallow restricted marine, shoal, open marine, and deep marine environments in a slowely subsiding ramp setting.

The eustatic sea level changes was the main controlling factor on the position of different diagenetic environments. The basinward shift of the meteoric lense during the late highstand of each cycle caused intensive cementation of the transgressive deep and open marine fades where as the zone affected by mixing dolomitization was the result of the shoreward shift of the mixing zone after the subsequent major transgression.

الخلاصة

تتمثل بيئة ترسيب تكوين المودود في جنوب العراق بأربعة بيئات ثانوية هي: البيئة البحرية الضحلة المحصورة، البيئة الضحلة، البيئة البحرية المفتوحة والبيئة البحرية العميقة.وتمثل هذه البيئات ترسيبياً ضمن وضعاً تكتونياً يشير الى منزلق بطيء التجلس. وكان لتغيرات مستوى سطح البحر العالمي السيطرة الواضحة لأعطاء المتغيرات للبيئة التحويرية.

ان حركة عدسة المياه الجوفية بأتجاه البحر العميق وذلك في نهاية المستوى العالمي لسطح البحر من كل دورة مؤدياً الى حصول تسميت شديد مميزاً لسحنات البحر المفتوح وسحنات البحر العميقة الناتجة عن تقدم بحري. في حين الدلمتة كان سببها ازاحة بيئة الخلط نحو المنطقة الساحلية والتي كانت تعقب التقدم البحري الكبير.

Introduction

Mauddud Formation is one of many important oil-bearing formation in southern Iraq. It was described as organic, detrital, sometimes psuedo- oolitic, cream- coloured limestones, with occasional green or bluish shale streaks.

It ranges in thickness from only 6-feet, to a maximum of over 500 feets in parts of the zubair field. It overlies the Albian Nahr-Umr formation conformably, and overlain by the Ahmadi shale with a slight disconformity (1). It may reflect a neritic sometimes shoal environment.

The late Albian to the Cenomanian was the suggested age to the Mauddud formation (4), based on a detailed faunal study, he gave different biofacies for different environments.

The present study recognizes the different depositional environments, diagenetic processes and the effect of sea level fluctuations on the diagenetic development. Two subsurface sections Am-3 and WQ-3 were selected within the Mesopotamian zone in order to demonstrate the vertical and lateral changes within the depositional setting (Fig. 1)

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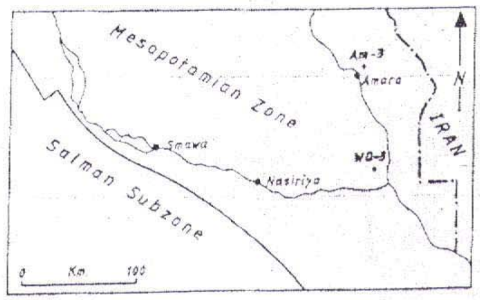

Fig. 1: Location map of the studied sections.

Petrography:

Skeletal grains constitutes the main bulk of the carbonate grains within the studied sections. They include: Orbitolinds, Miliolids, Nezzazata sp., Alveolinid, Iraqia sp., Trochospira sp., Coskinolina sp., chrysaldina sp., especially within the open marin facies and shoal at WQ-3. Numerous bioclasts and echinoderms are also abundant as well as shell fragments which dominate the main components of the tidal flat facies. Planktons on the other hand are abundant within the deep marine facies.

Non- skeletal grains are represented mainly by Peloids and restricted to the shoal facies at WQ-3.

The distribution and diversity of the skeletal grains together with the texture was determined by the wave energy, Paleowater depth as well as the position within the carbonate platform which determines the restriction of circulation m the inner parts, and the tidal flat area.

Paleoenvironments:

On th basis of depositional texture, faunal associations, and types of carbonate grains observed in the studied samples. The different facies were defined. These facies are grouped into four facies associations, they reflect the major subenvironments within the shallow carbonate Platform (Fig. 2,3).

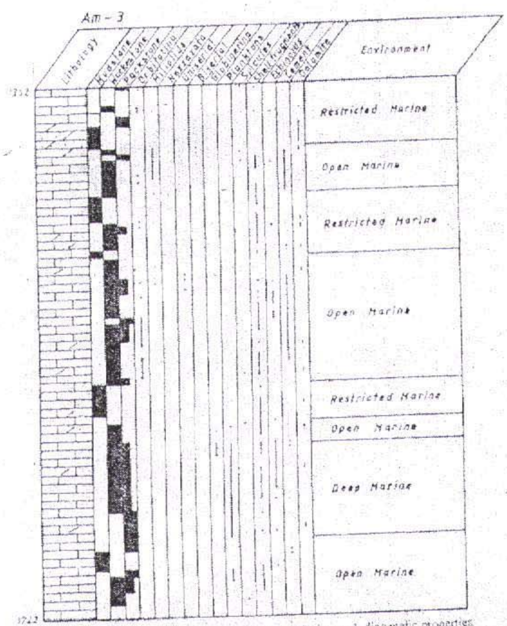

Fig. 2: Distribution of different fossils, microfacies and diagenetic properties within different recognized carbonate environments in well Am.3.

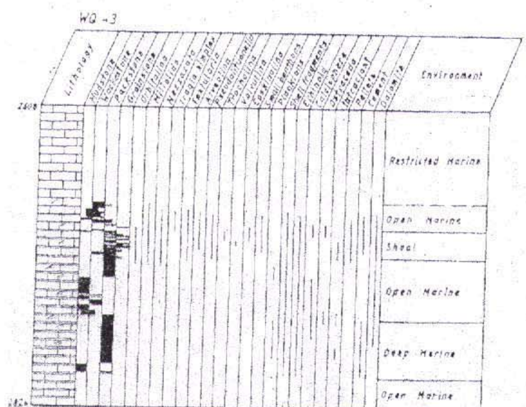

Fig. 3: Distribution of different fossils, microfacies and diagenetic properties within different recognized carbonate environments in well WQ.3.

Facies Association 1:

Non-fossiliferous mudstone, bioclastic mudstones to wackestones. This association is characterized by pure micrite as well as mudstones with few shell fragments in addition the bioclastic wackestones with abundant molluscas fragments and few orbitolinds or miliolids. Such association may reflect deposition in tidal flat to low energy shallow subtidal environment with restricted circulation.

Facies Association 2:

Fossiliferous bioclastic Packstones Bioclasts characterized this facies which was recognized at the section in WQ-3 only. Such association represents a high energy platform margin where the deposition of the shoal facies took place.

Facies Assocation 3:

Mixed fauna and bioclastic wackestones to packstones. The abundance and diversity of fauna characterizes this association, these fauna are mainly orbitolina, miliolids. Nezzazata, Textularia, Alveolina, as well as numerous bioclasts such as echinoderm fragments and shell fragments.

This association is typical to high energy deeper subtidal environment with open circulation.

Fades Association 4:

Planktonic bioclastic wackestones to Packstones. The association or planktons and echinoderm fragments as well as fine bioclasts may be interpreted as outer ramp deep marine environment.

The Mauddud formation of southern Iraq represent deposition on a shallow carbonate platform developed on a passive margin basin with constant rate of subsidence over a vast area where clastic influx was very little or non.

The depositional setting can be interpreted as a ramp characterized by gradual change from shallow to deep subtidal facies and the absence of slope deposits. In this case the carbonate production is usually greater at the inner ramp area (5). The eustatic sea level changes usually causes a shift of the different subenvironments over along distance and the relative sea level falls usually causes exposure of the inner most ramp area (6).

Diagenetic Development:

The formation was affected by many diagenetic changes, they include recrystallization. cementation, dolomatization, solution as well as the effect of compaction.

Recrystallization was intensive affecting most of the succession at both wells, calcite cement on the other hand is represented by many types of cements, namely early syntaxial rim cements, around the echinoderm fragments, but the bulk of calcite cement is drusy and blocky granular filling the pore space which is abundant in both sections (Fig. 4). This was due to the basinward shift of the meteoric lense during the late high stand of each sedimentary cycle.

Early mixing dolomitization represented by a massive dolomite interval at the upper part of the section Am-3 may be due mainly to the effect of mixing zone maintained due to the major transgression responsible for the deposition of the overlying Ahmadi formation. Late burial dolomitization is evident and less extensive reflected by scattered dolomite rhombs associated with stylolites indicating a local source.

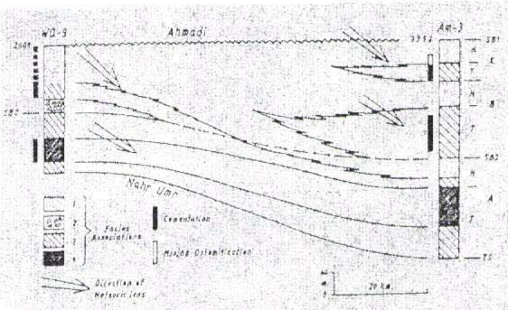

Fig 4: Stratigraphic cross section showing 3rd order cycle and diagenetic effect on the Mauddud Formation southern Iraq.

Eustatic Control on Diagenesis

The Mauddud formation of southern Iraq was developed through three third order cycles decreasing in size upward (Fig. 4) and each usually represent an almost equal episodes of transgressions and stillstands except at the section of Am-3 where the rate of subsidence is greater basin wards, these cycles reflect a relatively long transgression.

The relative sea level fluctuation greatly affected the shift and the maintenance of the meteoric lense. The basinward shift of the meteoric lense at the end of cycle A greatly affected the transgressive deep marine facies of WQ-3 causing intensive calcite cementation. The same process resulted in the precipitation of Calcite cement within the transgressive open marine facies of cycle B at both sections and cycle C at Am-3 where the basinward meteoric shift was due to the major sea withdrawl causing the unconformable upper boundary with the overlying Ahmadi Formation.

The next major transgression caused the landward shift of the meteoric lense and consequently the mixing zone which in turn affected the restricted marine highstand facies of cycle C causing intensive dolomitization to the lower part of this facies (Fig. 4).

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Conclusions:

The Mauddud Formation was deposited on a slowly subsiding ramp within four subenvironments. These environments include shallow restricted marine, shoal, open marine, and deep marine facies. Three third order cycles can be recognized at Am-3 where as only two at the rest of the section in WQ-3 which is located shoreward.

The eustatic sea level fluctuation greatly affected the shift of the different diagenetic environments: especially the meteoric and mixing

zones. The basinward shift of the meteoric zone during the late highstand of each cycle was the main cause of intensive cementation and filling of the vugs within the transgressive open marine and deep marine facies. The intensive mixing dolomitization within a small interval at the top of Am-3 was mainly due" to the shoreward shift of the mixing zones resulted from the next major transgression.

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