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Biostratigraphy of the Early Cretaceous Mauddud Formation in Ratawi Oilfield, Basrah Governorate, Southern Iraq

Leqaa N. Ezzulddin*, Yasamin K. Ibrahim

Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq

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Abstract

The biostratigraphy of the Early Cretaceous Mauddud Formation was studied in the Ratawi Oilfield, Basra Governorate, southern Iraq, using integrated borehole data set (core and cutting samples and well logs) in two drilled wells to analyze the biostratigraphy of the formation. One hundred eighty-three slides for both selected wells were investigated. The formation is composed of light grey dolomitized limestone and pseudo-oolitic creamy limestone with green to bluish shale. Three biozones were discriminated, these are: *Orbitolina qatarica* range zone; *Orbitolina sefini* range zone and *Orbitolina concava* range zone. The age of these biozones extends to include the Late Albian (*Orbitolina qatarica*); Late Albian-Early Cenomanian (*Orbitolina sefini*) and Early Cenomanian for (*Orbitolina concava*) zone. The fossils occurred are *Conicorbitolina conica*, Coral, gastropoda, Miliolids, *Nezzazata*, *Neoiraqia convexa*, *orbitolina discoidia*, *Orbitolina kurdica*, *Spiroluculina* sp., *trocholina* sp.

Keywords: Early Cretaceous; Mauddud Formation; Foraminifera; Biostratigraphy; Ratawi Oil Field.

الطباقية الحياتية للعصر الطباشيري المبكر لتكوين مودود في حقل رطاوي النفطي، محافظة البصرة، جنوب

لقاء ناطق عزالدين*، ياسمين خضير ابراهيم

قسم علم الأرض، كلية العلوم، جامعة بغداد، بغداد، العراق

الخلاصة

تمت دراسة الطباقية الحياتية لتكوين مودود في العصر الطباشيري في حقل رطاوي النفطي، محافظة البصرة، جنوب العراق باستخدام مجموعة من البيانات المتكاملة التي تضمنت نماذج اللباب الصخري والفتات الصخري و مجسات الابار للبئر المحفورين. لتحليل الانطقة الحياتية للتكوين تم دراسة 183 شريحة لكلا البئر. اظهرت النتائج ان التكوين يتكون حجر الكلس رمادي فاتح مع حجر الكلس كريمي اللون مع طبقات من السجيل ذو لون اخضر مائل للازرق. ثلاث انطقة حياتية تم تمييزها وهي النطاق الحياتي *Orbitolina qatarica* والنطاق الحياتي *Orbitolina sefini* و النطاق الحياتي *Orbitolina concava*، عمر هذه الانطقة هو الالبي المتأخر للنطاق *Orbitolina qatarica* و الالبي المتأخر - السينوماني المبكر للنطاق *Orbitolina sefini* و السينوماني المبكر للنطاق *Orbitolina concava*. المتحجرات المرافقة لهذه الانطقة هي *Conicorbitolina conica*, coral, gastropoda, Miliolids, Nezzazata,

*Email: leqaanatiq4@gmail.com

Neoiraqia convexa, trocholina sp orbitolina discoidia, Orbitolina kurdica,
. Spiroluculina sp.,

1. Introduction

The Mauddud Formation was first described in Dukhan well No.1 in Qatar (where it takes its name from Ain Mauddud), a locality near Dukhan, Qatar and later was revised by Sugden [1] and [2]. In its typical section in Qatar, the Mauddud Formation is described as limestone, light grey, sometimes pseudo-oolitic, with the occasional appearance of green or bluish shale streaks. The Mauddud Formation has relatively high porosity, and much of the limestone appears to be silty due to fine calcareous detrital grains [2]. The Mauddud Formation is a subsurface, generally neomorphosed and dolomitized limestone [3]. It is gradationally underling Nahr Umr, Lower Balambo, or Sarmord formations and slightly disconformable with the overlining Ahmadi Formation [4]. In its typical section, the Mauddud Formation is about 55m thick, consisting of limestone flourishing in Orbitolina and Trocholina tests [2]. The thickness of the Mauddud Formation in the south of Iraq in Ratawi well.4 is 126m, The Ratwi well.17 is 131, and it is 115 in Ratawi well 23. The thickness of the formation in the east of Iraq is about 350 – 380m. In the Northern Arabian Gulf, principally on the Saudi Arabia– Kuwait border, the formation consists of limestone ranging in average thickness of about 30.5 to 97.6 m [5]. The formation varied because the facies change from side to side and erosional truncation. It mainly contains Orbitolina – bearing limestone, regional basin margin rudist that was buildups into the offshore. The formation of exposure to many diagenesis processes such as dolomitization, dissolution, Neomorphism, and Micritization [6].

The research deals with the biostratigraphy of the Mauddud Formation and the determination its age.

The Ratawi Oilfield is located in southern Iraq (Figure 1). It is situated about 70 km northwest of Basrah and in parallel with the North Rumaila field with a distance of about 20 km. The oilfield is determined by coordinates (E 705000.4 – 696000.36 m) and (N 3394000.183 – 3373000.8 m). The field is about 27 km long and 13km wide. Many wells are drilled for some exploration and development. The presence of oil has been discreet in the reservoir formation, including Nahr Umr, Yamama, Mishrif, and Mauddud formations [7].

2. Materials and Methods

In this study, 183 core samples were collected from two wells in the Ratawi Oil field (Rt. 4 and Rt. 17), according to the changes in the lithology. Eighty-nine slides were made from Rt.4 (72 core and 17 cutting samples), and 94 slides were made from Rt.17 (78 core and 16 cutting samples). Slides were made in the Department of Geology- College of Science- University of Baghdad and the Department of Petroleum Geology and Minerals, College of Science, University of Diyala. The petrographic study includes microscopic examination of thin sections under a standard petrographic microscope to identify the fossils and estimate the Mauddud Formation's age.

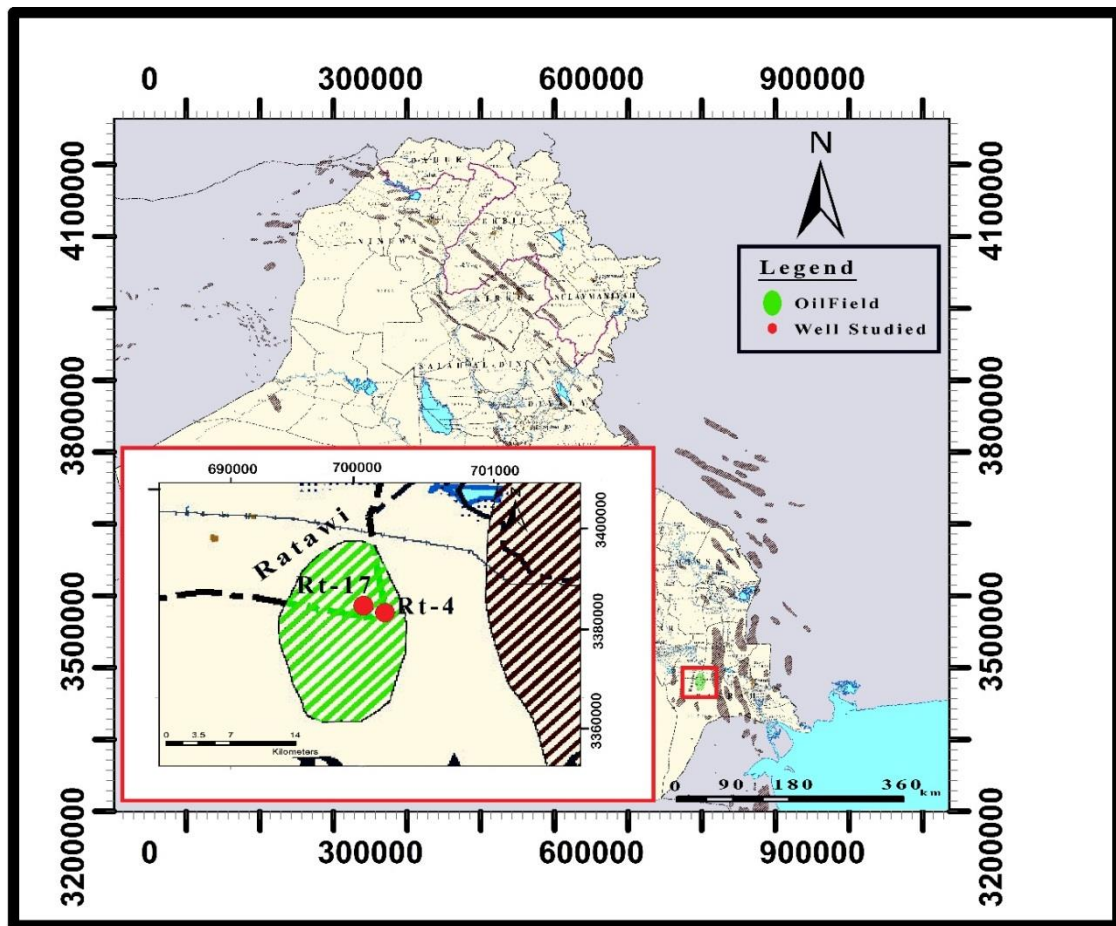


Figure 1- Location map of Ratawi Oilfield modified after [8]

3. Geological setting

The study area lies in the Mesopotamian basin on the Arabian platform's unstable shelf [9]. In the north, it is bounded by the fault of the Takhadid-Qurna transversal and in the south by the fault of Al-Batin transversal in the Basra Block. It has a uniform structural style controlled by the basement. It contains prominent N-S trend structures, which increase their amplitudes by the depth and reach 300 m at a lower cretaceous level [9]. The results of the seismic survey interpretation showed that the structure is ovoid convexity, extends toward N-S with almost symmetrical flanks, and its plunge increases with depth [7].

4. Biostratigraphy of Maaddud Formation

Based on the detailed examination of the selected thin sections, three biozones are distinguished (Figures 2 and 3) as below:

1. *Orbitolina qatarica* Range Zone

Definition: This zone was defined using the first appearance of this species as the lower limit and its disappearance as the upper limit.

Age: Late Albian.

Author: Henson (1948)

Thickness: The thickness of this zone is 34m at well Rt.4, and it is 28m at well Rt. 17

Assemblages: This zone contains *Orbitolina qatarica* Henson (Pl.1, Pic. A), as well as other fossils in Rt. 4 and Rt. 17, e.g. *Conicorbitolina conica* (D'Archiac) (Pl.1, Pic. B), Gastropoda (Pl.1, Pic. C), Echinoid (Pl.1, Pic. D), *Neoiraqia convexa* (Daniloova) (Pl.1, Pic. E), *Nezzazata simplex simplex* (Omara) (Pl.1, Pic. F), *Orbitolina discoidea* (Pl.1, Pic. G),

Orbitolina kurdica (Pl.1, Pic. H), *Pseudotextulariella* sp. (Pl.1, Pic. I), *Quinqueloculina* sp. (Pl.1, Pic. J), Rudist (Pl.1, Pic.K).

Discussion: This zone started in the Late Albian age [10] and [11]. The age of this zone was determined to be Albian in this study, and some of these occurrences were reported by several researchers (Henson, 1948). *Orbitolina qatarica* was first recorded in Qatar in the Early Cenomanian, and it was identified by [12] in the Early Cenomanian of Germany. *Orbitolina qatarica* range zone was also found in Albian of Iran, according to [13]. Loutfi mentioned this as Albian in the Saudia – Kuwait offshore area [14]. Sugden has described the *Orbitolina qatarica* range zone as originating in Qatar's Albian rocks [1]. Berthou limited this to Portugal's Late Albian to Early Cenomanian ages [15], the Late Albian of Iraq [11]; Middle Cenomanian in the Middle East [16]; Late Albian in Eastern Iraq [17], *Orbitolina qatarica* was found in Early Cenomanian of China according to [18]. Late Albian in the Northwestern Zagros fold-thrust belt so-called upper Qamchuqa Formation in North Iraq [19].

2. *Orbitolina sefini* Range Zone

Definition: This zone is signified by the first appearance data (FAD) of this species and its upper limit corresponds with the LAD of the same species.

Age: Late Albian – Early Cenomanian

Author: Henson (1948).

Thickness : The thickness of this zone is 25 m at well Rt.4, and it is 22 m at well Rt.17.

Assemblages : This zone contains *Orbitolina sefini* Henson (Pl.1, Pic. L), and other fossils in Rt. 4 and Rt. 17, e.g. *Conicorbitolina conica* (d'ARCHIAC), Echinoid, Gastropoda (Pl.2, Pic. A), *Iraqia simplex* (Pl.2, Pic. B), *Mesorbitolina* sp. (Pl.2, Pic. C), *Nautiloculina oolithica* (Pl.2, Pic. D), *Neoiraqia convexa* (Danilova), *Orbitolina discoidea*, *Orbitolina kurdica* (Henson), *Orbitolina* sp. (d 'Orbigy) (Pl.2, Pic. E), *pseudotextulariella* sp., *Pseudolitonella sayyabi* (Mohammed), *Pseudolitonella reicheli* Marie (Pl.2, Pic. F), *Quinqueloculina* sp., Rudist.

Discussion: This zone started in the late Albian age. This zone is limited to the Late Albian – Early Cenomanian boundary [10]. The species *Orbitolina sefini* was identified in Albian – Cenomanian strata. The description of the age is summarized below:

The Cenomanian in Sefin Dagh represents the Upper Qamchuqa Formation in northern Iraq [20]; *Orbitolina sefini* was also found in Late Albian of Spain, Peybernes (1976); in Portugal specified Early Cenomanian [21]. The Mauddud Formation in Southern Iraq, Late Albian – Early Cenomanian [22]; Late Albian – Early Cenomanian in the Middle East according to [16] and [11]; Late Albian – Early Cenomanian in eastern Iraq [17]; Late Albian – Early Cenomanian (Sarvak Formation) at Zagros mountains in Iran [23]; Early Cenomanian in Turkey – Manara section at Levant Margin [24]. Late Albian – Early Cenomanian in northern Iraq [25].

3. *Orbitolina concave* Zone

Definition: This zone is signified by the first appearance data (FAD) of this species, and its upper limit corresponds with the last appearance data (LAD) of the same species.

Age: Early Cenomanian

Author: (Lamarck, 1816).

Thickness : The thickness of this zone is 67 m at well Rt.4, and it is 80 m at well Rt.17

Assemblages : This zone was associated with the presence of *Orbitolina cocava* (Lamarck) (Pl.2, Pic. G), as well as other fossils in Rt. 4 and Rt. 17 e.g. *Bioconcava bentori* sp. (Pl.2, Pic. H), *Conicorbitolina conica* (D'Archiac), Coral, *Coscinoconus* sp. (Pl.2, Pic. I), Echinoid, Gastropoda , *Iraqia simplex* (Henson), *Mesorbitolina* sp., *Neoiraqia convexa* (Danilova), *Nezzazta simplex simplex* (Henson), *Orbitolina discoidia* (Henson), *Orbitolina kurdica* (Henson), *Orbitolina* sp. (d 'Orbigy), *Pseudolitonella sayyabi* (Mohammed) (Pl.2, Pic. J),

Figure 2: Biostratigraphy of the Mauddud Formation in well Rt. 4

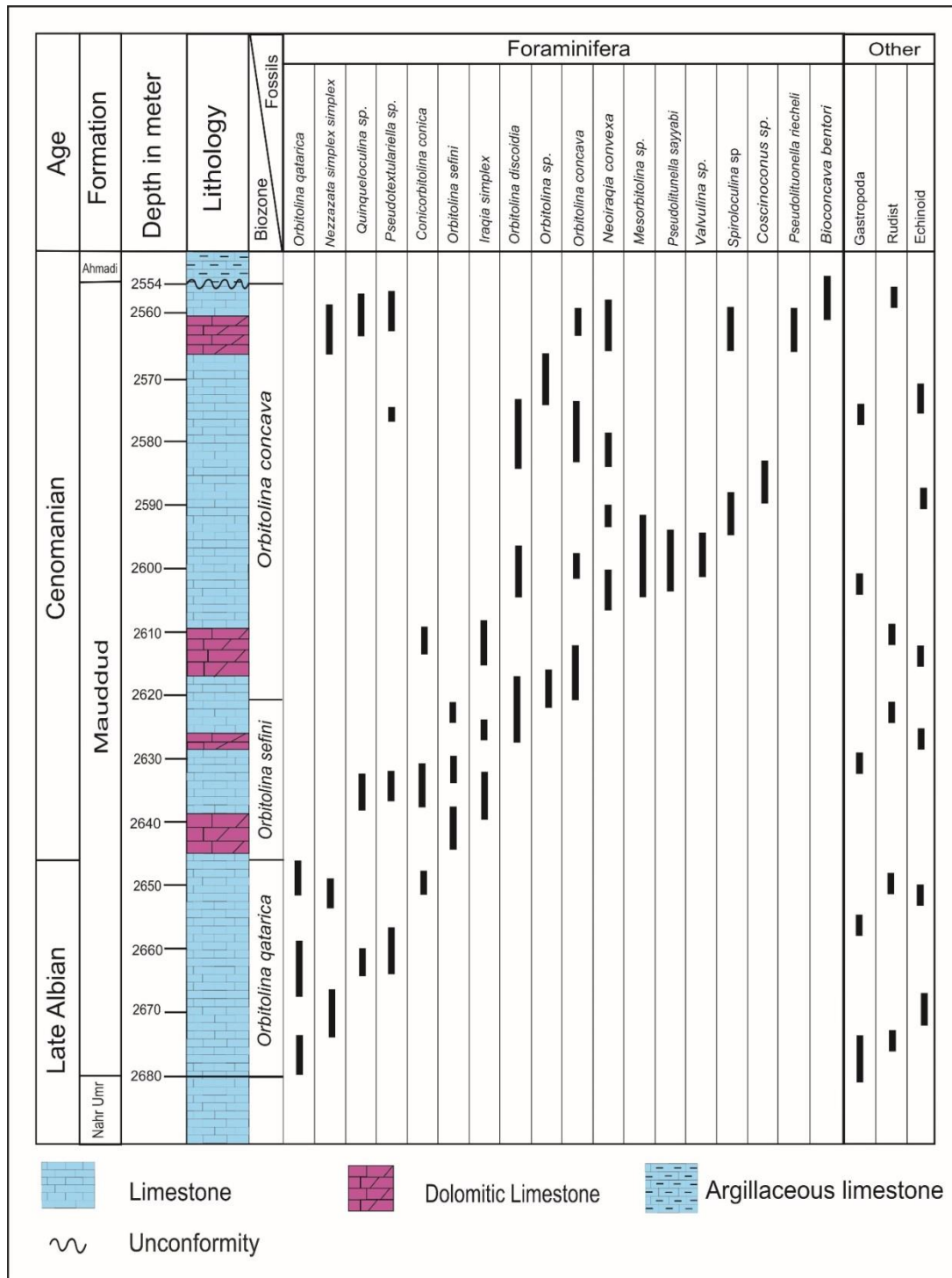


Figure 2- Biostratigraphy of the Mauddud Formation in well Rt. 4. *Pseudolituonella reicheli* Marie, *pseudotextulariella sp.*, *Quinqueloculina sp.*, Rudist, *Spiroloculina sp.* (Pl.2, Pic. K), *Valvulina sp.* (Pl.2, Pic. L).

Discussion: This zone started in the Early Cenomanian age [10], as well as Mohammed [11] specified this zone of Early-Cenomanian.

The species *Orbitolina cf. concava* (Lamarck) was described by Lamarck [26], who discovered it for the first time in the type locality during the Cenomanian age [27]. The species *Orbitolina concava* (Lamarck) was identified in Cenomanian strata in each of the following countries:

Iraq and Qatar [20], Southern France [28], Germany [12] Switzerland, Spain and Italy [29], Iran [13], Zagros [30], Iraq [11], in China [31], Eastern Iraq [17] and in the North of Iraq

(Qamchuqa Formation) [19].

Orbitolina cf. concava (Lamark) was described from Albian – Early Cenomanian rocks [32], *Orbitolina cf. concava* (Lamark) was discovered in Albian – Cenomanian rocks of France, Spain, and Qatar, according to Loeblich and Tappan [33]. It was limited to the Late Albian–Early Cenomanian age in southern Iraq, By Al-Siddiki [34]. In Iran at Sarvak Formation, according to Haftlang [35].

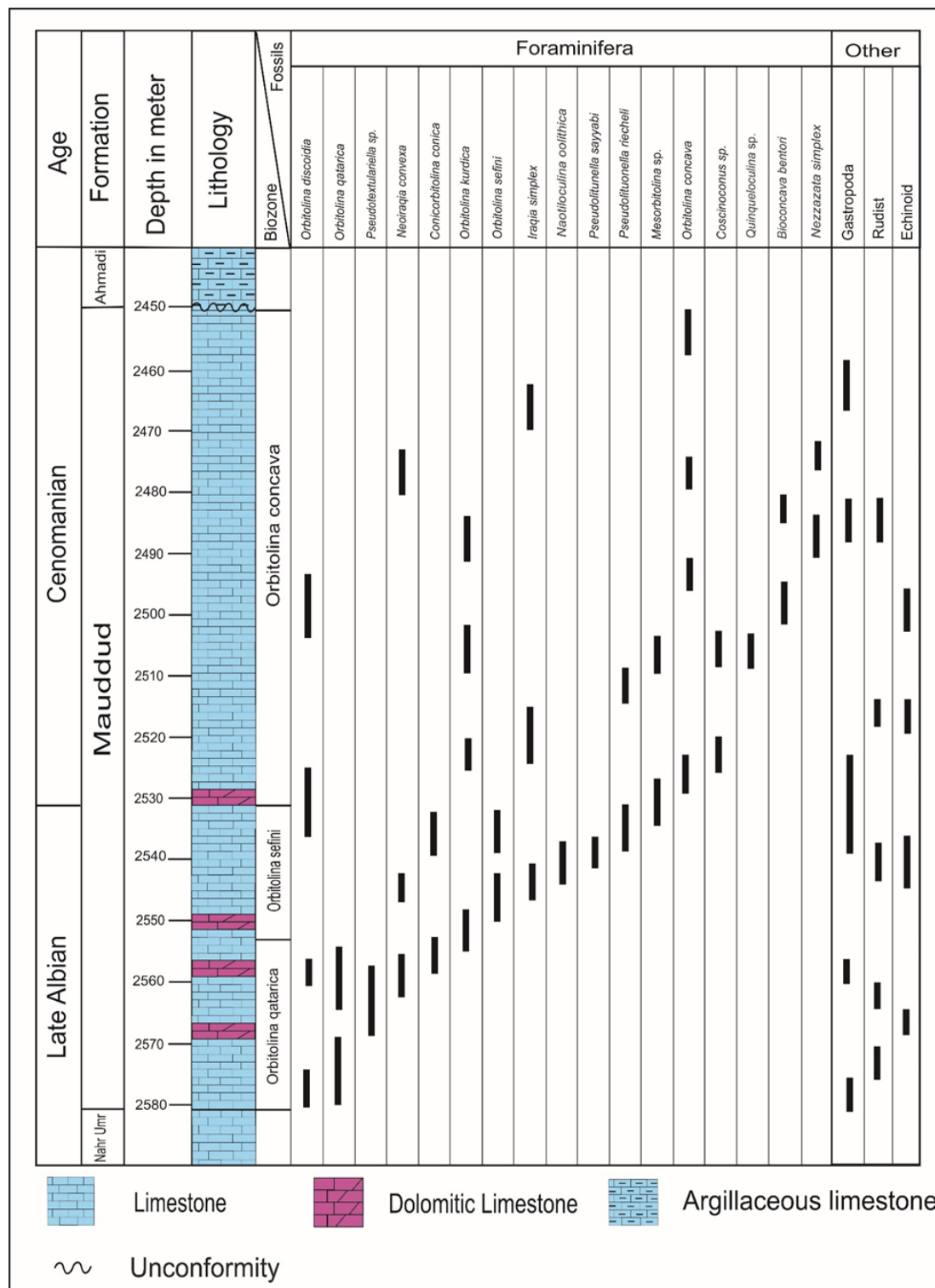


Figure 3- Biostratigraphy of the Mauddud Formation in well Rt. 17

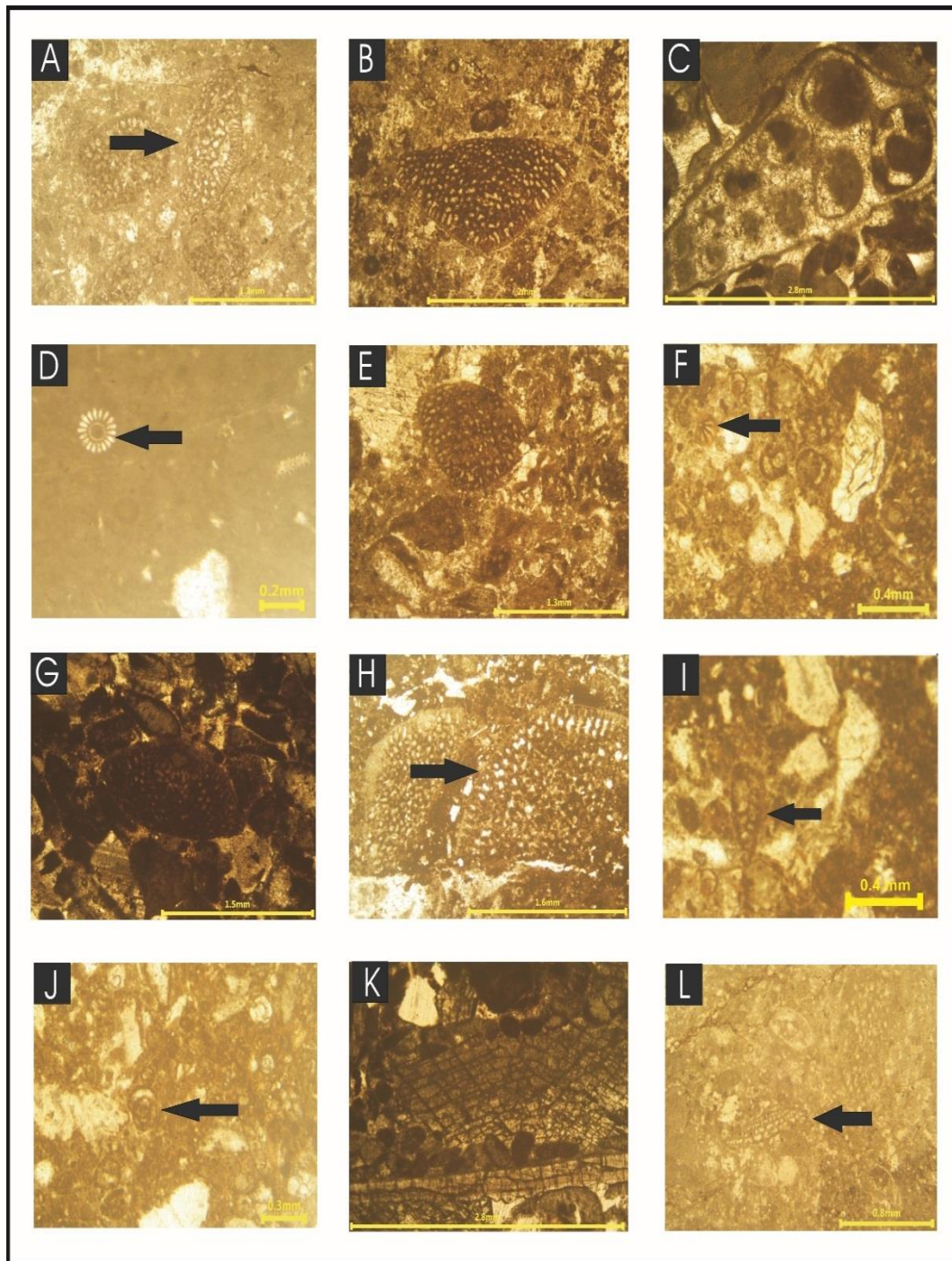


Plate 1-All pictures are from Maaddud Formation at Ratawi oil field (Early Cretaceous) A- *Orbitolina qatarica* (Henson), subaxial section Rt-4 at depth 2655m. B- *Conicorbitolina conica* (D'Archiac), vertical section, Rt-17 at depth 2552m. C- Gastropoda, Rt-4 at depth 2675m. D- Echinoid spin, Rt-17 at depth 2500 m. E- *Neoiraqia convexa* (Danilova) vertical section, Rt-17 at 2451 m. F- *Nezzazatianella simplex simplex* (Omara) axial section, Rt-4 at depth 2563.5m. G- *Orbitolina discoidea* (Gras) vertical section, Rt-4 at depth 2628 m. H- *Orbitolina kurdica*, vertical section, Rt-17 at depth 2554m. I- *Pesudotextulariella* sp. Rt-4 at depth 2562m. J- *quinqueloulina*, Rt- 4 at depth 2563 m. K- Rudist fragments, Rt-17 at depth 2535m. L- *Orbitolina sefini* (Henson) vertical section, Rt-4 at depth 2548m.

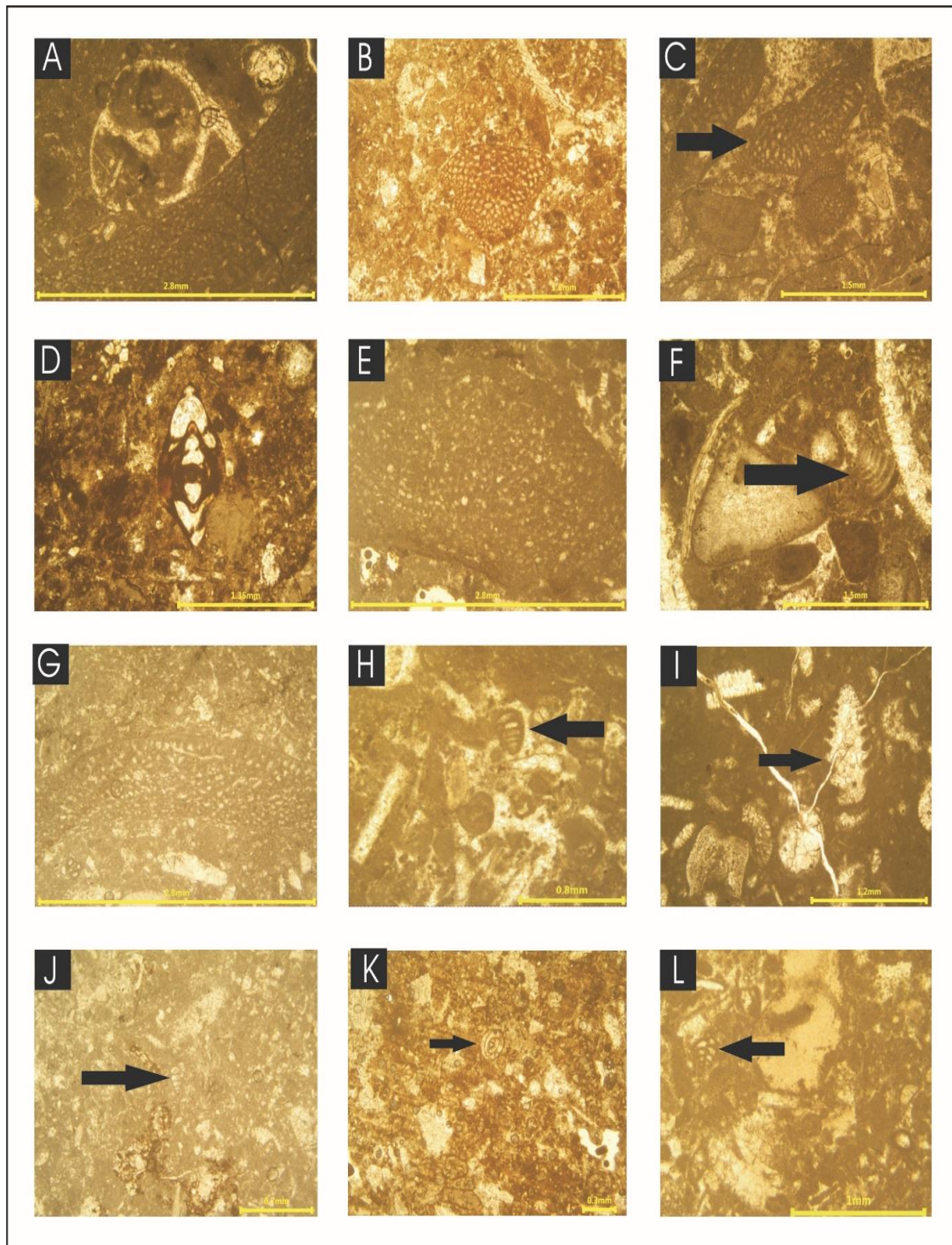


Plate 1- All pictures are from Maaddud Formation at Ratawi oil field (Early Cretaceous) A- Gastropoda fragments, Rt-17 at depth 2529m. B- *Iraqia simplex* vertical section, Rt-4 at depth 2612m. C- *Mesorbitolina* sp. Vertical section. Rt-4 at depth 2598m. d- *Nautiloculina oolithica*, vertical section. Rt-17 at depth 2543m. E- *Orbitolina* sp. (d 'Orbigy), Rt-4 at depth 2620m. F- *Pseudolituonella riecheli* (mariae), Rt-17 at depth 2518m. G- *Orbitolina conava* (LAMARK) vertical section, Rt- 4 at depth 2603m. H-*Bioconcava bentori* (Hamaoui), Rt-4 at depth 2560m. I- *Coscinoconus* sp. Rt-17at depth 2513m. J- *Pseudolituonella sayyabi* (Mohammed), Rt-17 at depth 2539m. K- *Spiroloculina* sp., axial section, RT-4 at depth 2563m. L- *Valvulina* sp. Rt-4 at depth 2600m.

5. Conclusions

A total of thirteen foraminiferal species and eight genera have been identified in the Formation. Depending on the biozones, it was found that the Mauddud Formation belongs to the Late Albian - Early Cenomanian. The biozonation and construction of the area are attributed to the abundance of fully or partially preserved biotic assemblages. The biozones as range zones are *Orbitolina concave*, *Orbitolina sefini* and *Orbitolina qatarica*.

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