**IRAQI BULLETIN OF GEOLOGY AND MINING (IBGM)\
IRAQ GEOLOGICAL SURVEY (GEOSURV-IRAQ)**

Vol.19, No.2, 2023 ***p 19 – 35***

FACIES ANALYSIS AND SEQUENCE STRATIGRAPHY OF LATE CRETACEOUS AQRA FORMATION, NORTHERN IRAQ

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Received: 22/ 01/ 2022, Accepted: 19/ 02/ 2023
Keywords: Sequence stratigraphy; Late Cretaceous; Aqra Formation

ABSTRACT

Aqra Formation is a shallow marine deposit of the late – Cretaceous sedimentary cycle. According to the field lithological description, the two studied sections of the Aqra Formation are subdivided into three units. Based on sedimentological characteristics and fossils assemblage eleven facies have been recognized in both studied sections, their alternated association points to a wide range of depositional environments extended from tidal flat, back reef, reef, to fore- reef. Based on the fossil's appearance, the studied sections comprised two fossils biozone {Orbitoides media zone (part) and Liftusia morgani zone}, it is age determined to be late Campanian – Early Maastrictian in both studied sections. Sequence stratigraphic analysis, as calibrated by sedimentary facies and biostratigraphy delineated one sequence (Aqra sequence 1) of 2nd order, and their MFI correlation result with MFS studies in the Arabian platform indicated to maximum flooding stage dominated on the Arabian plate at the Latest Campanian.

التحليل السحني وطباقية التتابع للكريتاسي المتاخر تكوين عقرة، شمال العراق

نبيل يوسف محمد البنا و محمد علي مال الله الراشدي

المستخلص

يتضمن تكوين عقرة ترسبات بحرية ضحلة لدورة ترسبات الكريتاسي المتاخر، طبقا للوصف الصخري الحقلي، تقسم مقاطع الدراسة لتكوين عقرة الى ثلاثة وحدات. اعتمادا على الصفات الرسوبية والمحتوى الحياتي للصخور فقد ميزت احدى عشر سحنة رسوبية تشير الى ترسبها في بيئات تمتد من المسطحات المدية وخلف الحيد والحيد الى بيئة امام الحيد. استنادا الى محتوى صخور البحث من المتحجرات المشخصة فقد حدد نطاقين حياتيين هما {*Orbitoides media* zone (part) and *Liftusia morgani* zone} واللذان يشيران الى عمر الكامبري المتاخر الى الماسترختي المبكر. افرزت تحليلات طباقية التتابع المعتمدة على السحنات الرسوبية والطباقية الحياتية لصخور البحث تواجد تتابع واحد (Aqra sequence1) من المرتبة الثانية، وقد اظهر سطح طغيان التتابع مضاهاة جيدة مع دراسات سطوح الطغيان للصفيحة العربية، والتي تشير مجتمعة الى مرحلة طغيان عظمى اجتاحت الصفيحة العربية فترة الكامبري المتاخر.

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INTRODUCTION

The Aqra Formation (Late Campanian – Maastrichtian), represents the upper part of the Late Turonian – Danian Megasequence (AP9). The formations deposited during a transgressive – regressive cycle that covered most regions of Iraq (Dunnington, 1958), third progress after the end of broad marine transgression at Middle Campanian and concluded another phase of declining left accompanying in period (Late Maastrichtian – Danian).

The present study is based on (505 m and 540 m) thick Aqra Formation surface sections in the Amedia and Chia Gara areas respectively in north Iraq. The two sections lie on the Matien and Chia Gara anticlines. Tectonically, the study area is situated in the High Folded zone within an unstable shelf (Jassim and Buday, 2006) (Figure 1a, b and c).

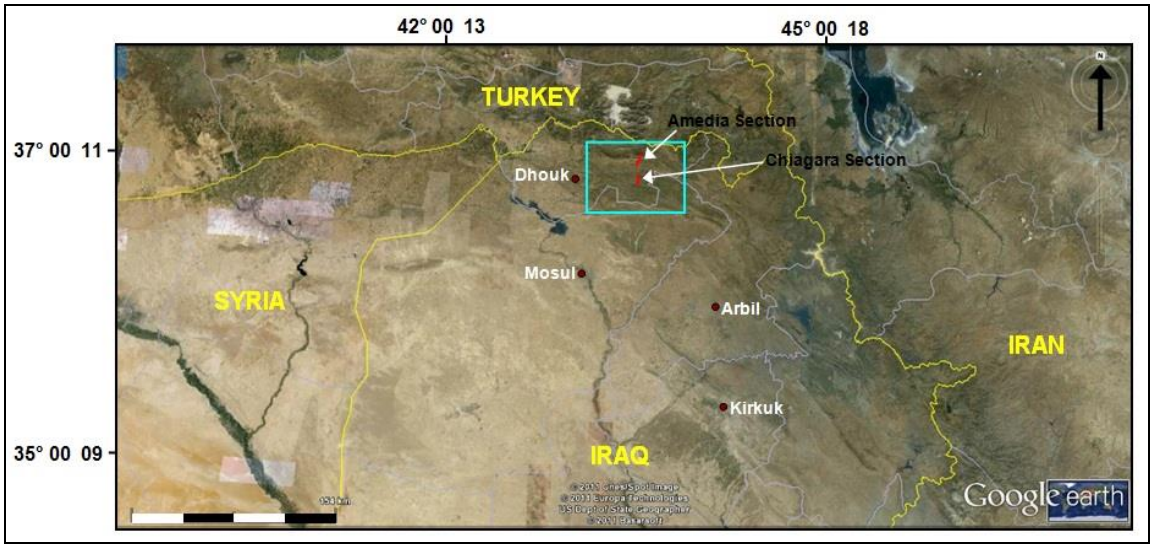

Figure 1a: Location map of Amedia and Chia Gara sections.

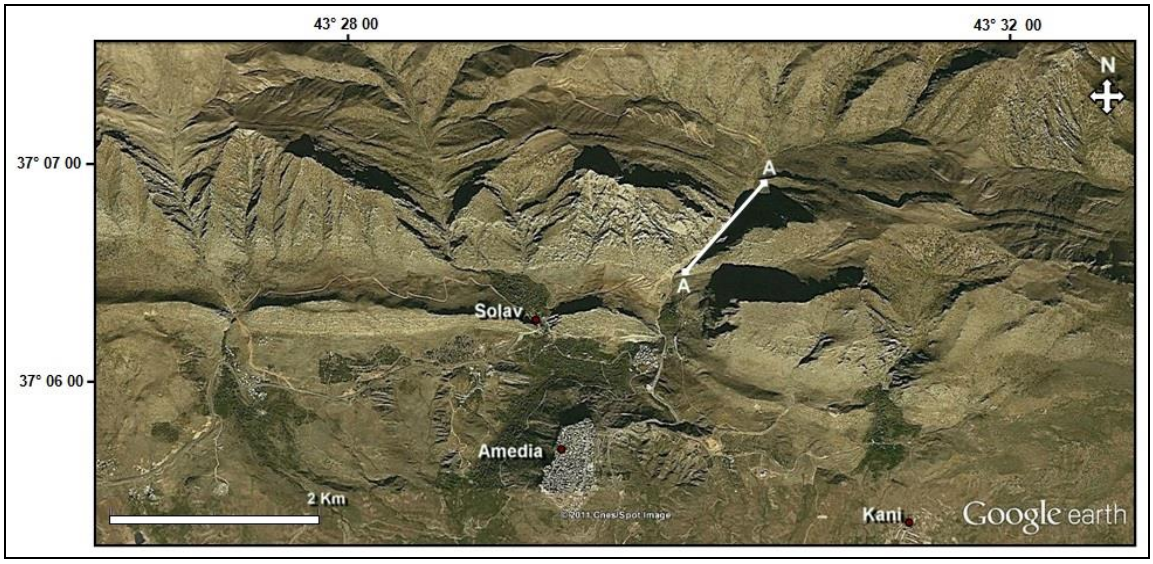

Figure 1b: Location map of Amedia section.

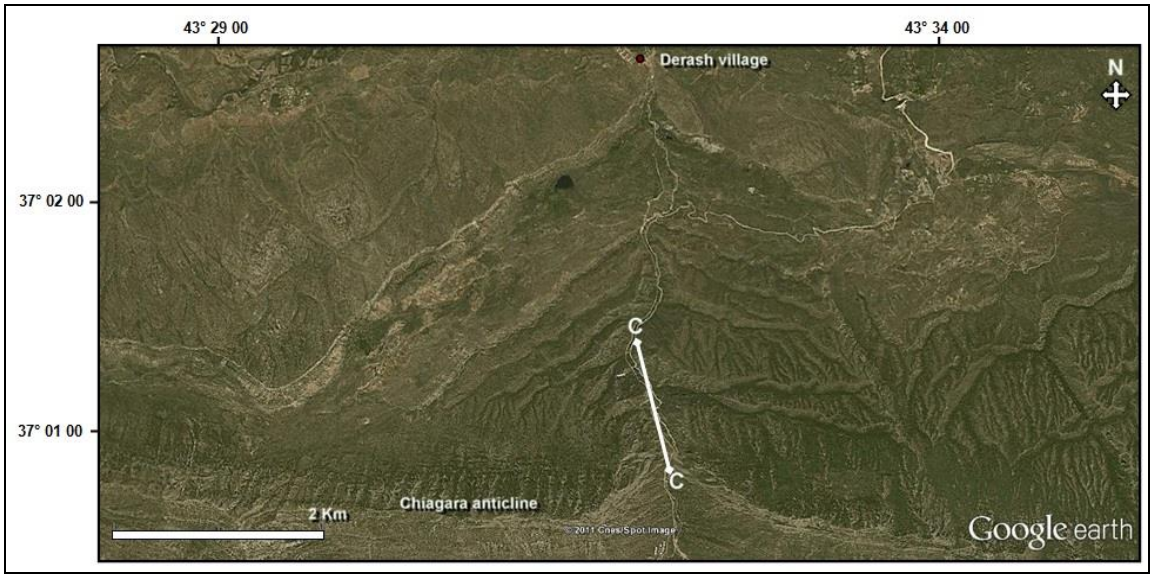

Figure 1c: Location map of Chia Gara section.

Aqra Formation consists partly of dolomitized limestone, with Rudist-Loftusia bearing massive limestone, and conglomeratic limestone locally impregnated with bitumen. The lower boundary of the formation is not exposed in the Chia Gara section, while conformable with the underlying Hadiena Formation in the Amedia section. The upper contact of the Aqra Formation is unconformable (Erosional surface) with the Gercus Formation in both studied sections. (Malak and Al-Banna 2013) subdivided the Aqra Formation in Gali Zanta Gorge (near the type section) into three units. According to the field lithological description, the studied sections of the Aqra Formation are subdivided into three units (Figure 2):

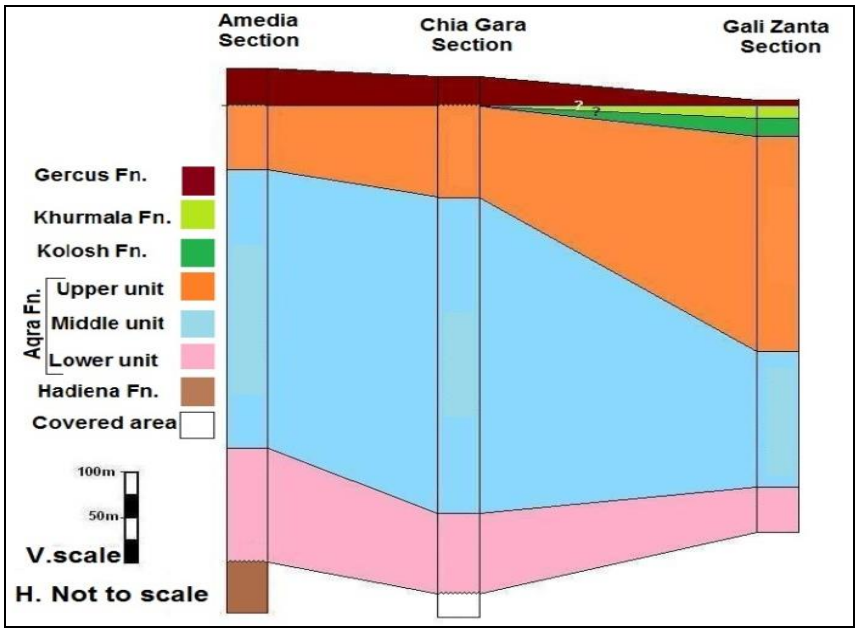

Figure 2: The Correlation diagram which shows the thickness of the Aqra Formation between the studied sections and the Gali Zanta section (Gali Zanta section, after Malak and Al-Banna, 2013).

Lower unit: This unit is about 127 m and 89 m thick in the Amedia and Chia Gara sections respectively and consists of pale brown, well-bedded (ranging between 20 and 100 cm thick) limestone enclose dolomitic limestone beds in the Amedia section. Green algae and bioturbation of *Skolithos* appeared in the middle of the lower unit followed by mollusca fossils (Figure 3).

Middle unit: It is 308 m and 350 m thick in Amedia and Chia Gara sections respectively, and appeared as a hard, white-pale brown, homogenous, massive body of limestones, intraformational conglomerates rich in rudist and rudist debris, In addition to the assemblage of *Orbitoides* and *Omphalocyclus* (Figure 4).

Upper unit: The unit consists of well-bedded limestone 70 m and 101 m thick in Amedia and Chia Gara sections respectively. It embraces thin beds of partly dolomitized limestone, these successions characterized by abundant benthonic foraminifera *(Loftusia)* (Figure 5), gastropods, and pelecypods.

METHODOLOGY

The studied sections depended on detailed field descriptions, and the collection of 184 samples from the two studied sections, thin sections were prepared in the Department of Geology/ University of Mosul, and they are used in facies analysis, sequence stratigraphic, and age determination.

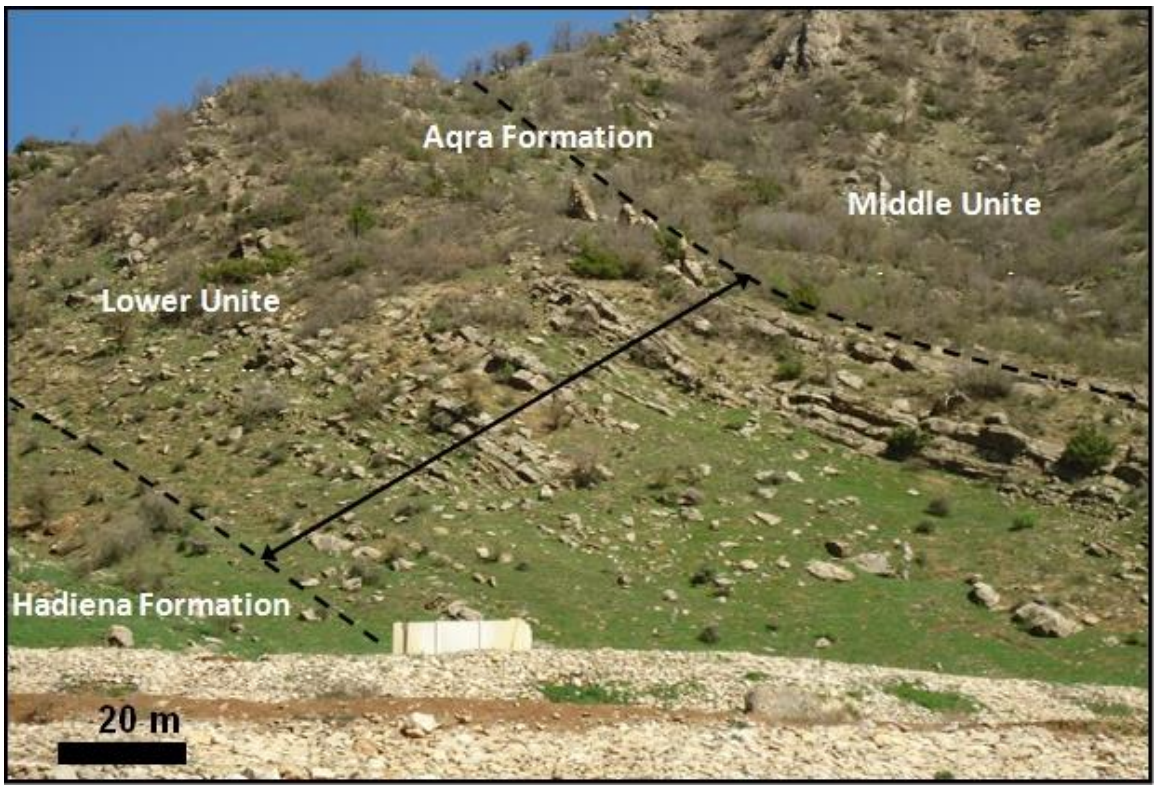

Figure 3: Lower unit (bedded) and Middle unit (massive) of the Aqra Formation in the Amedia section.

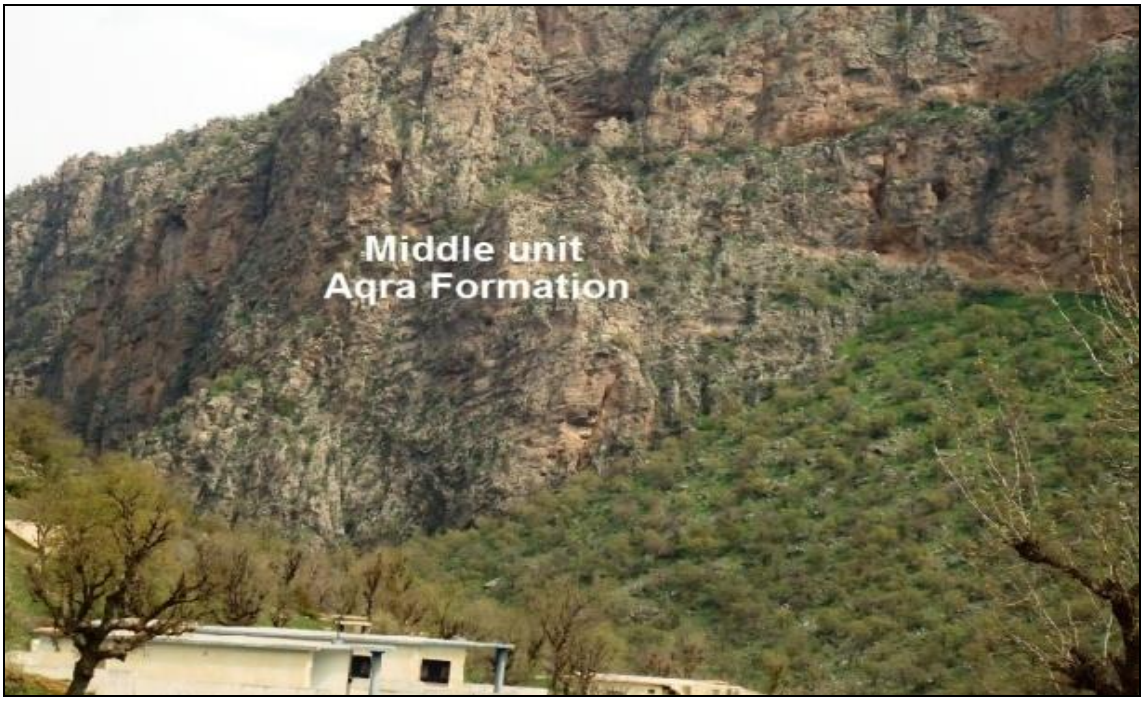

Figure 4: Middle unit of the Aqra Formation in the Chia Gara section.

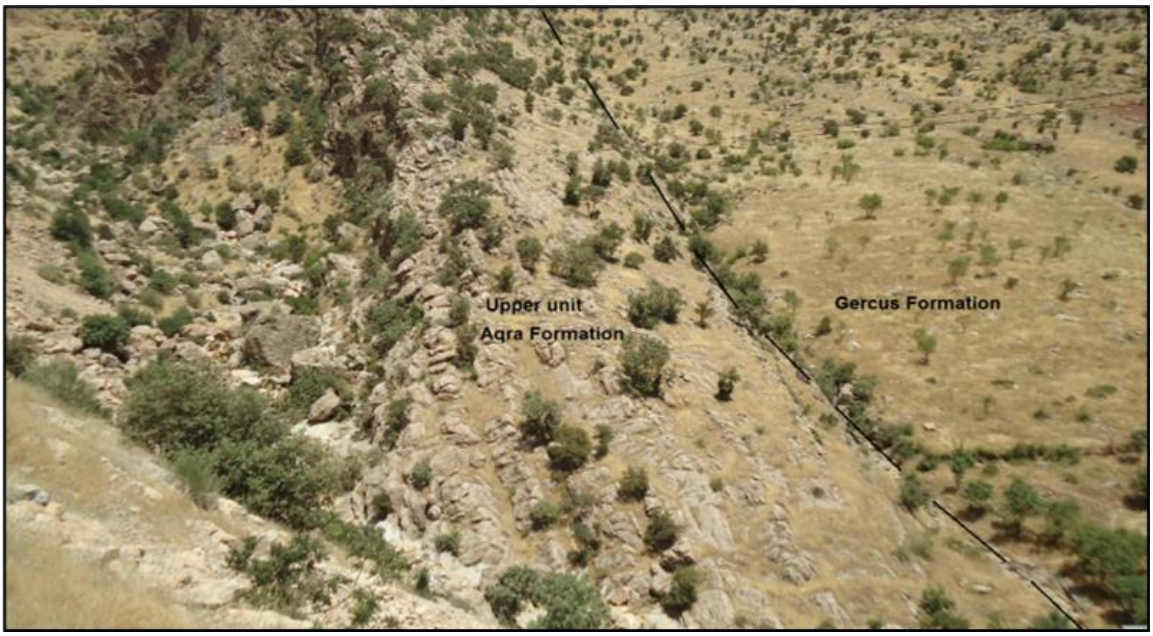

Figure 5: The upper unit of the Aqra Formation in the Amedia section.

FACIES ANALYSIS

Based on sedimentological characteristics and fossils assemblage eleven facies donated Aq1 to Aq11 and have been recognized in both studied sections, which reflect the paleoecology and bathymetry.

- **Mollsca Lime Mudstone Facies (Aq1)**

The facies have a total thickness of about 1.6 m at the lower part of the Aqra Formation in the Amedia section. The allochems reach up to 10% of the total content including

pelecypod, gastropods, and ostracod shells (Figure 6a) associated with Rotalia, echinoderm, and rare intraclasts rooted in micritic groundmass. These facies were affected by cementation (granular and drusy cement) and recrystallization of micrite to microspare. The pelecypod and gastropod live in brackish water (Brasier, 1980 and Flugel, 2004). The paleontological and lithological evidence indicated shallow brackish water of moderate circulation, coastal marine platforms, or open lagoon depositional environments (Evan, 1970; Hallom, 1976; Brasier, 1980).

- **Bioclastic Lime Mudstone Facies (Aq2)**

This facies consists of hard limestone and dolomitic limestone between 3.7 m and 44.6 m thick. The skeletal fossils remain to constitute less than 10 percent of the total content. Fossil bioclast are represented by pelecypod, gastropod, Rudist, echinoderm benthonic foraminifera, and Dasycladacea bioclasts (Figure 6b), The matrix composed of micrite, pseudo-sparite produced by recrystallization, and drusy and granular cement, also partial dolomitization affected some facies intervals product microsuture mosaic and floated rhombic textures. The bioclasts deposit in low to moderate energy that developed shallow marine environments (less than 30 m depth), indicated by abundant carbonate mud, also the presence of mollusca and benthonic foraminifera, dominated in shelf margin settings environments (Bathurst 1975; Wilson, 1975, Di Stefano and Ruberti 2000 and Flugel, 2004).

- **Green algal lime mudstone- wackestone facies (Aq3)**

The facies appeared in the lower unit of the Aqra Formation of both studied sections and in the upper part of the Chia Gara section ranging between 3 – 23 m thick, characterized by laminated, well-bedded limestone and dolomitic limestone. The allochems make up to 40% of the total content, represented by an abundance of calcareous green algae (*Cymopolia anadyomenea, Salpingoporolla dinarica, and perocalculus iranae*) (Figure 6c), in addition to *Chrysalidina, Pseudochrysalidina*, Pelecypoda, and rare bioclasts enclosed between the algal lamina. The facies were affected by cementation (drusy and granular cement), and dolomitization (Fogged and suture mosaic texture in some intervals of the facies).

The calcareous green algae dominate in the tropic and subtropic areas of shallow water of depth less than 50 m (Elliot, 1978) near the reef core or back reef (Ghose, 1977). The characteristic features of the facies indicated a tidal flat zone of carbonate platform landward depositional environment (Reineck, 1972; Di Stefano and Ruberti, 2000; Ioan and Sasaran, 2005).

- **Miliolids lime mudstone-wackestone facies (Aq4)**

This facies is hard well-bedded limestone and dolomitic limestone. Allochems attain up to 45% of the total content and consist of miliolial benthonic foraminifera such as *Pyrgo, Triloculina and Spiroloculina, Quinqueloculina* (Figure 6d), in addition to a small number of rotalia, pelecypods, and *Orbitoides* and *Dasycladacea* bioclasts. The matrix is composed of micrite. The facies were affected by recrystallization, cementation (druzy and blocky cement), and dolomitization (fogged and suture mosaic texture).

Miliolids are abundant in restricted to subrestricted marine lagoons (Brasier 1980; Di Stefano and Ruberti, 2000 and Murray, 2006) or back reefs of shallow warm water of depth less than 50 m (Bismuth and Bonnefous 1981; Scheibner *et al*., 2008). The co-occurrence of miliolids, rotalids, and pelecypods indicates shallow warm water in a restricted marine environment nearest to the coast.

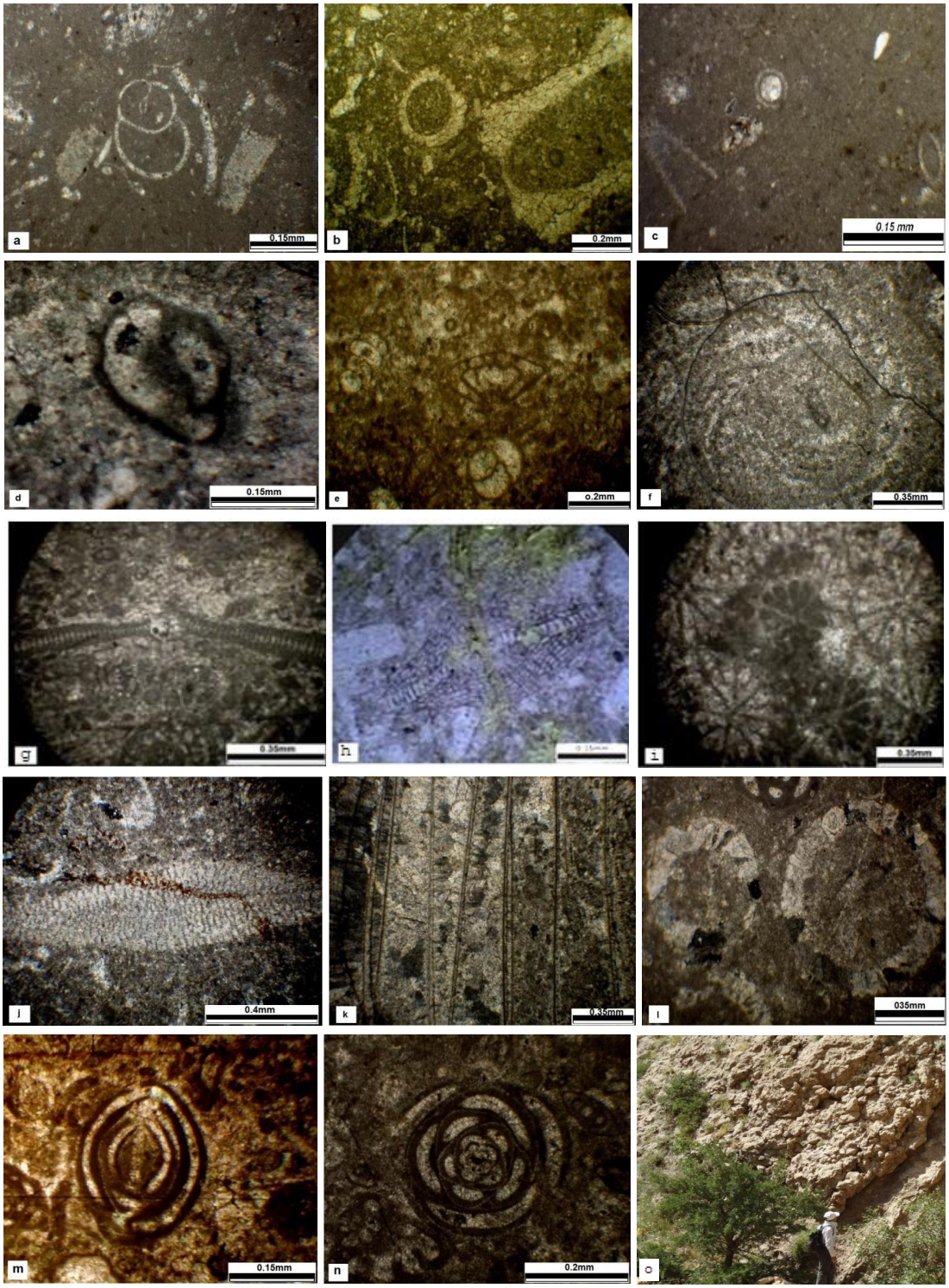

Figure 6: **a)** Gastropoda in facies Aq1, **b)** Bioclast and alge (*Cymopolia anadyomenea*) faties Aq2, **c)** Algae (*Salpingoporolla dinarica*) facies Aq3, **d)** Milliolid (*pyrgo*) facies Aq4, **e)** Benthonic foraminifera facies Aq5, **f)** *Loftusia morgani* facies Aq6, **g)** *Lepidorbitoides socialis* facies Aq6, **h)** *Omphalocyclus macroporus* facies Aq6, **i)** Coral *Dsiphllum fascicularum facies* Aq6, **j)** *Orbitoides media* facies Aq8, **k)** Rodist longitudinal section facies Aq9, **l)** Rudist transversal section facies Aq9, **m)** Milliolide *Spiroloculina* facies10, **n)** Milliolide *Quinqueloculina* facies10, **o)** Intraformational conglomerate facies Aq11.

- **Benthonic foraminiferal lime wackestone microfacies (Aq5)**

The facies appear at the upper unit of the Aqra Formation Chia Gara section reaches 29 m thick. It consists of massive hard limestone. Allochems reach up to 40% of the total content and consist of benthonic foraminifera (*Chrsalidina, Pseudochrsalidina, Dorothia, Gyroconulina columellifera, Rotalia, Dictyoconus, Nonionella cretacea*) (Figure 6e) with rare milliold green algae and bioclast, allochems rooted in pale brown micrite, spary calcite cement was recorded in the facies. The presence of *Dorothia* indicated to marine environment far from the coast (Breggren and Miller, 1989), and the co-occurrence of the recorded benthonic foraminifera in the facies point to back reef far from the coast environment (Bismuth and Bonnfous, 1981).

- ***Loftusia* lime wackestone microfacies (Aq6)**

This facies has been recorded in the upper unit of the Aqra Formation in both studied sections about 10 m thick, limestone included larger foraminifera of *liftusia* (*Loftusia minor* and *Loftusia morgani*) (Figure 6f), Orbitoides (*Lepidorbitoids socialis* and *Omphalocyclus macroporous*) (Figure 6g and h), in Amedia section coral (*Disphyllum fascicularum*) appeared in the facies (Figure 6i). The matrix consists of micrite containing blocky cement filled the vugs. *Loftusia* is a well-known genus in various Maastrichtian strata of the Middle East (Dilley, 1973; Boudagher-Fadel and David 2009, Ghanbarloo *et al.*, 2021).

(Al-Omari and Sadek, 1975) investigated the evolutionary line for the development of *Loftusia* from Maastrichtian (Aqra Formation) of Northern Iraq, they noticed that during this period, the genus exhibited a gradual increase in size (length and diameter), Loftusiids became larger and more tightly coiled during the Middle and Late Maastrichtian, with species such as *Loftusia morgani* becoming dominant during this time. The co-occurrence of *Loftusia, Orbitoids,* and patch coral indicates reef-to-back-reef environments (Henson, 1950; Al-Omeri *et al*., 1989).

- **Rudist lime wackestone facies (Aq7)**

The facies appear in the upper unit of the Aqra Formation in the Amedia section and the lower unit of the Chia Gara section reaches up to 17 m thick, Allochems dominated by intact and broken rudist shells amount to 15 – 40 percent of the total content. In addition to benthonic foraminifera (*Dorothia, Gyroconulina columellifera, Rotalia, Textularia Pseudochrsalidina, Nonionella cretacea*), milliolid and bioclast. They are rooted in the pale brown micritic matrix, containing druzy cement filling fractures. The most common rudists are *Radiolitidae,* which live in a wide range of depositional environments extending from fore-reef to coastal marine (Coogan, 1977).

The intact and broken rudist shells (rudist debris) associated with benthonic foraminifera indicated to back-reef environment (Wilson 1975; Alsharhan 1995; Flugel, 2004).

- **lime wackestone facies (Aq8)**

The facies is characterized by massive Orbitoididae-bearing limestone, rich in *Orbitoides media* (Figure 6j), *Lipidoorbitoides minor* and *Omphalocyclus macroporous* (Figure 6h) with some benthonic foraminifera (*Dorothia,Gyroconulina columellifera* and Rotalia), rudist shell debris in some intervals of the facies are recognized in the middle of Amedia section and different level of Chia Gara section, Orbitoides live in shallow tropical and subtropical seas, in areas with little or no clastic influx thrived in depth ranging between 40 m – 50 m (Gormus, 1992) in fore-reef environment (Henson, 1950; Flugel, 2004). The association of *Orbitoides* and *Omphalocyclus* reflects the environment in front of the rudist reef with a depth

ranging between 50 – 80 m. (van Gorsel, 1975; Hottninger, 1997; Hohenegger, 1999), While the presence of bethonic foraminifera (*Dorothia, Gyroconulina columellifera,* Rotalia) with rare milliolid and rudist debris in the facies point to a back reef environment (Hohenegger, 1999; Caus *et al*, 2002).

- **Rudist lime packstone microfacies (Aq9)**

These facies appeared in the middle unit of the Aqra Formation in both studied sections. Allochems are mainly represented by abundant rudist shells (*Radiolitdae*) (Figure 6k and I) and mollusca (gastropods) which abundantly appeared in the Cretaceous sediments that are associated with reef body sediments (Flugel, 2004). In addition to benthonic foraminifera (*Dorothia, Gyroconulina columellifera,* and rare milliolid). All these allochems were rooted in the micritic matrix. The facies were affected by druzy cement and dolomitization in some facies intervals.

However, rudist facies was characterized by a great abundance of rudist, which make up the reef core in shallow tropic to subtropic environments (Ross and Skelton, 1993), the intact rudist was abundant in and near the reef body, forming thick sediments of reef body, occasionally associated with rudist debris, which accumulates in shallow water under moderate to high energy condition (Alsharhan and Nairn,1993).

All the biological evidence indicated to reef body depositional environment of the facies (Tash,1973; Al-Omari *et al*., 1989; Al-Sadooni and Al-Sharhan, 2003).

- **Miliolids lime packstone microfacies (Aq10)**

The facies recorded in the lower unit of the Aqra Formation of the Amedia section, consist of hard massive limestone about 28.0 m thick, the allochems attained 60% of the total content, represented mainly by *Pyrgo, Spiroloculina, Triloculina, and Quinqueloculina* (Figure 6m and n) with rare textularia, rudist and mollusca bioclasts.

The abundant appearance of milliolid in the facies point to the back reef (subtidal) (Wilson, 1975; Flugel, 2004; Scheibner, 2008).

- **Intraformational conglomerate lithofacies (Aq11)**

The facies include different sizes of carbonate intraclasts in addition to the carbonate matrix; it appears in two and three intervals of the middle units of the Aqra Formation in Amedia and Chia Gara sections respectively, with thicknesses reaching up to 20.0 m. This facies consists of sorted intraclasts pebbles (Figure 6o), ranging between 7 cm to 40 cm in size mainly of rudist and gastropod bioclasts in the micritic matrix, as reef tulas deposit in the fore-reef environment (Wilson, 1975; Ross and Skelton, 1993; Flugel, 2004).

DEPOSITIONAL MODEL

Facies are distinguishable throughout the Aqra Formation in the two studied sections show alternated association facies of Aq1, Aq2, Aq3, A4, and Aq10 (Figure 7), in the lower part of the Amedia section point to tidal flat land ward environment (Figure 8). This is indicated by existing calcareous green algae limestone sandwich with bioclastic storm layer deposits and the presence of sessile organisms (pelecypods) (Lucia 1972; Di Stefano and Ruberti, 2000), graduated laterally to intertidal lagoon depositional environments (facies Aq4) of shallow water depth. A restricted lagoon (subtidal zone) environment may be constructed behind the rudist reef body former fair environments to sustenance abundant miliolids, rotalids, and pelecypods (facies Aq10) (Figure 7). This depositional cycle is recorded twice in the lower part of the Amedia section, then it was extended to the inner shelf environment

along the shelf margin rudist-dominated settings (facies Aq2, Aq8, Aq9, Aq11). In the Chia Gara section, the lower unit is characterized by the appearance of facies Aq3, Aq 4, Aq7, and Aq8. Facies Aq8 in this unit are represented by *Orbitoids* with large foraminifera and miliolid. The association of facies Aq3, Aq4, Aq7, and Aq8 point to the back reef deposit close to the reef margin (Figure 7).

Rudist is very abundant, in the middle part of the Amedia section (Figure 8), the rudist-dominated facies (facies Aq9) represent the rudist reef body, who pervaded by bioclast and pointed to reef-fore reef environments.

At the upper part of the Amedia section, Loftusia (facies Aq7) is abundant and interbedded with facies Aq6 bearing low Rudist (Figure 8). The presence of Loftusia, *Omphalocyclus* with patch reef point to very shallow water environments. The dope of previous results indicated reef-back reef environments (Henson, 1950; Al-Omeri *et al*.,1989). Facies Aq4 found in certain interval points to back reef tidal flat deposits (Figure 7) (Scheibner, 2008). The upper part of the Chia Gara section consists of facies Aq3, Aq4, Aq5, and Aq6, these facies collectively indicate to back reef lagoon environment.

All the attributes indicate that the Aqra Formation is characterized by an abundance of rudist and larger Foraminifera (Loftusia), in addition to calcareous green algae, gastropod, coral, and benthic Foraminifera. By relying on the evidence of sedimentary facies and fauna assemblage, we can possibly contrive the depositional model of the Aqra Formation. This model comprehends fore-reef facies of rudist debris, *Orbitoids*, and *Omphalocyclus*; reef body composed of in situ *Eoradiolites* and *Durania* rudists in addition to Loftusia and gastropods common in back reef facies; and shallow warm water of restricted marine facies indicated by presence of miliolids, rotalids, ostracods, pelecypods, and algal-dominated facies, as well as peloides occurs in abundant carbonate mud matrix (Figures 8 and 9).

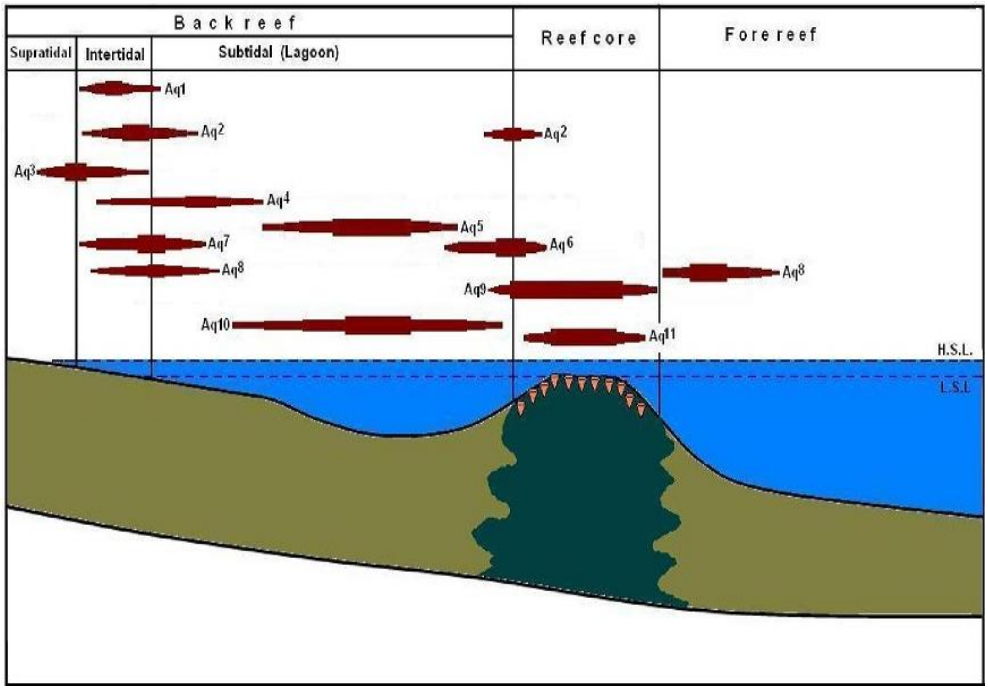

Figure 7: Sedimentary model of the Aqra Formation.

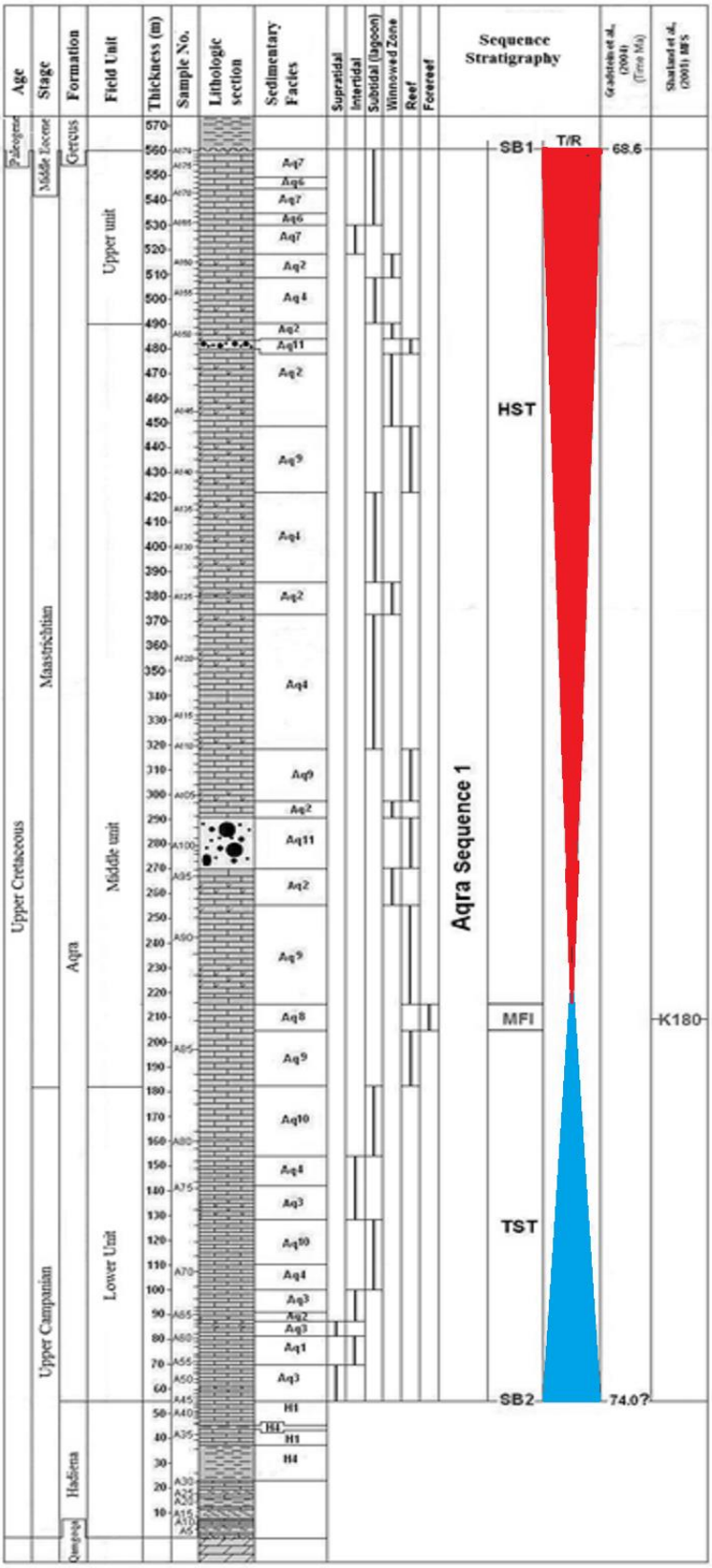

Figure 8: Sequence stratigraphy of the Aqra Formation in the Amedia section.

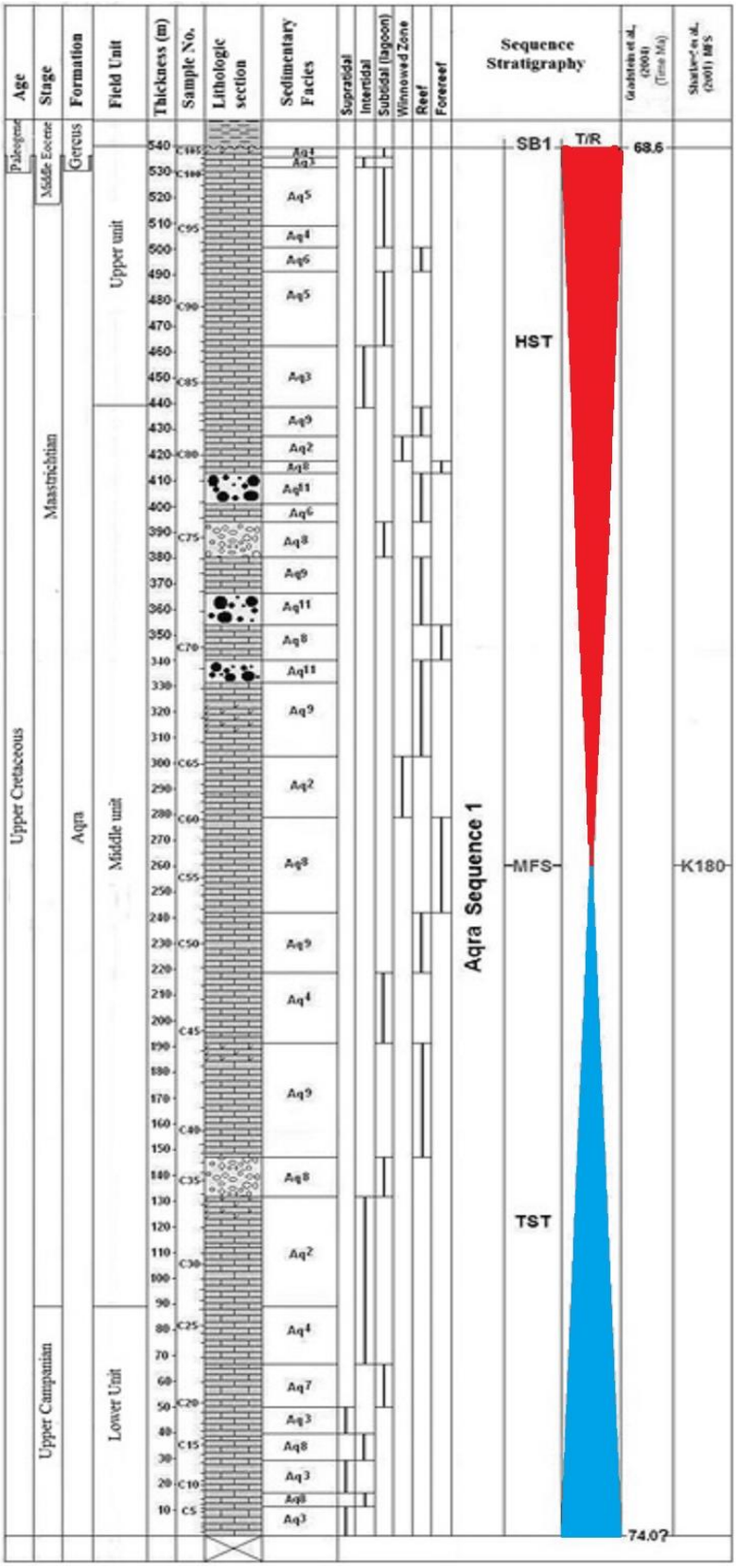

Figure 9: Sequence stratigraphy of Aqra Formation in the Chia Gara section.

AGE OF AQRA FORMATION

Based on the fossil's appearance, each studied section of the Aqra Formation comprises two fossil intervals (Figure 7), The first interval is occupied by *Orbitoides media*, and its presence determined part of the *Orbitoides media* zone at the middle unit of Amedia section and lower to middle units of Chia Gara section. This zone can be correlated with the *Orbitoides media* zone (Gorsel, 1978; Al-Mutwali, 1992; Hardenbol *et al.*, 1998) (Figure 10). Also, it can be matched with the *Globotruncana aegyptiaca* zone and the lower part of the *Gansserina gansseri* zone (Robaszynski and Caron, 1995 and Abdelghany, 2003), all of Late Campanian according to the most recent convention of the International Commission on Stratigraphy as documented in (Gradstein *et al*., 2004).

The second interval is characterized by the appearance of the *Loftusia morgani* zone at the upper unit of the Amedia section and the upper middle unit to the upper unit of the Chia Gara section. It indicated Maastrichtian age (Meric, 2000; Meric *et al*., 2001; Al-Kubaysi, 2008). The presence of *Omphalocyclus macroporus* together with *Loftusia morgani* in the studied intervals is an indication of Early–Middle Maastrichtian (Meric *et al.*, 2001; Moghdam *et al.*, 2009). According to the identification zones [*Orbitoides media* zone (part) and *Loftusia morgani* zone] the age of the Aqra Formation is Late Campanian to Early Maastrichtian in both studied sections.

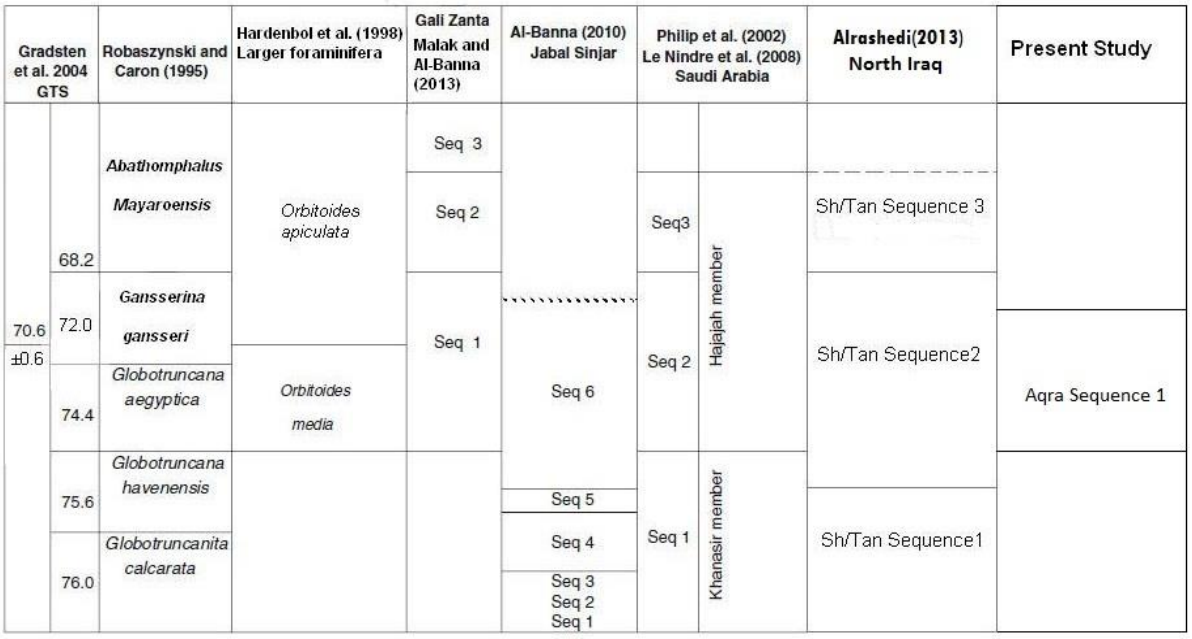

Figure 10: Correlation chart of Aqra sequence1 with Arabian plate sequence stratigraphy.

SEQUENCE STRATIGRAPHIC ANALYSIS

Sequence stratigraphic analysis, as calibrated by sedimentary facies and biostratigraphy, delineated one sequence (Aqra Sequence 1) of 2nd order was recognized in Amedia and Chia Gara sections, their depositional period is 5.6 m.y.

Aqra Sequence 1 in the Amedia section commences with conformable surface Type-2 followed by alternating beds of facies (Aq1, Aq2, Aq3, Aq4, Aq10) indicated to coastal lagoon environment which gradually progresses to subtidal-back reef close to reef body that represents by facies Aq9, all these facies collectively indicated to TST of the sequence in which the deeper facies progression away from the basin center. The MFI of the sequence is

represented by the fore-reef facies (Aq8), followed by reef deposit facies of Aq9, Aq2, and Aq11 which is pointed to the beginning of the HST, continuous drop in sea level appears by the alternating bed of facies such as Aq4, Aq2, Aq6 and Aq7 in the top of Amedia section, the upper boundary of the sequence is an erosional surface (Type-1).

Aqra Sequence 1 in the Chia Gara section starts with facies Aq3 (the lower boundary is covered) alternating with facies Aq4, Aq7, and Aq8 these facies reflect the tidal flat-lagoon environment, they represent the TST of the sequence, followed by alternating facies of Aq2, Aq4, Aq8 and Aq9, these facies collectively show continuous increasing of TST, the interval 242 – 278 facies Aq8 of the deepest environment (fore-reef) is representing the MFI of the sequence, it is followed by facies Aq2, Aq6, Aq8, Aq9, and Aq11 of the reef body deposit, their gradually decreasing in the depth of depositional environment indicated to the begging of HST, the rate of decreasing in sea level in the upper part of the section found with the appearing of the alternating association of facies Aq3, Aq4, Aq5 and Aq6, the sequence ended by erosional surface boundary Type-1.

CORRELATION WITH ARABIAN PLATE MAXIMUM FLOODING SURFACE

In Iraq (Sharland *et al*., 2001) place K175 in the basal Maastrichtian portion of the Shiranish Formation, which emplaces an age of 70.6 Ma. This age appears to correlate with the age of MSI of Aqra sequence1 at the latest Campanian, according to the most recent convention of the International Commission on Stratigraphy as documented in (Gradstein *et al*., 2004). In North Iraq, it seems possible to correlate Aqra sequence 1 with Bekhme sequence 5 (Bekhme Formation) in the Duhok area (Al-Mutwali *et al.*, 2008) and with Shiranish Formation sequence6, in the Sinjar area (Al-Banna, 2010). Also, it can be correlated with Aqra sequence1 in Gali Zanta Gorge (Malak and Al-Banna, 2013), in addition, it can correlate with Sh/ Tan sequence 2 (Sharanish – Tanjero formations) in the Bekhme area (Alrashedi, 2013) (Figure 10). In Saudi Arabia, it can be correlated with Middle Hajajah members (Aruma sequence 2) (Philip *et al.*, 2002; Le Ninder *et al.*, 2008) (Figure 10). The correlation result indicates maximum flooding stages dominated on the Arabian Plate during the Latest Campanian.

CONCLUSION

The study is based on two surface sections 505 m and 540 m thick, Aqra Formation in the Amedia and Chia Gara areas respectively in northern Iraq. The two sections lie along the Matien and Chia Gara anticlines. Aqra Formation mainly consists of partly dolomitized limestone, with Rudist-Loftusia bearing massive limestone and conglomeratic limestone locally impregnated with bitumen. According to the field lithological description, the studied sections of the Aqra Formation are subdivided into three units (lower, middle, and upper units. Based on sedimentological characteristics and fossil assemblage eleven facies donated Aq1 to Aq11 have been recognized in both studied sections of the Aqra Formation, they reflect depositional environments extending from a tidal flat, back reef, reef, and for-reef.

According to the extending of identification biozones [*Orbitoides media* zone (part) and *Loftusia morgani* zone] in the Aqra Formation its age was determined to be Late Campanian to Early Maastrictian in both studied sections.

Sequence stratigraphic analysis, as calibrated by sedimentary facies and biostratigraphy, delineated one sequence (Aqra Sequence 1) of 2nd order recognized in Amedia and Chia Gara sections. MFI of Aqra sequence1 appears to correlate with age of MFS K175 at

latest Campanian in Iraq and another part of the Arabian plate, these correlations indicate maximum flooding stages dominated on the Arabian Plate during the Latest Campanian.

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