Tectonical history of Arabian platform during Late Cretaceous An example from Kurdistan region, NE Iraq

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Abstract

New simplified tectonic models and depositional history of Late Cretaceous rocks are established in a part of Zagros Orogenic Belt that is located in the Northeastern Iraq. These rocks constutes the most important Cretaceous oil reservoir in the Middle East. The dependent tools are petrography, field study and the concept of drowning phases. This concept is relatively new and accurate in explanation of development of carbonate sequences growth and termination. The columns of both carbonate and clastics rocks of the area are divided into three phases of drowning:
1- Pre-drowning phase of reefal limestone which is represented by Qamchuqa Formation which is equivalent to Mauddud and Shuaba formations (Early Cretaceous) in the south Iraq and in the Gulf. 2- Transitional phase of pelagic limestone and marl deposition which is transitional to post drowning phase during which Gulneri Shale and Dokan limestone Formations (Cenomanian-Turonian) are deposited. 3- Post drowning phase of deep carbonate sedimentation during which Kometan Formation (Santonian-Campanian) and 4- Burial Phase in which Shiranish and Tanjero Formations (Maasstrichtian) are deposited by which Arabian Platform was covered by siliciclastics sediments and main carbonate sedimentation was ended during Campanian. These phases, as resulted from tectonics of Zagros, can replace the complex previously assigned tectonic and depositional history of the area during Later Cretaceous. The application of the phases revealed nearly a continuous history of deposition in foredeep during Early Cretaceous and foreland basin during later ages.
This continuous sedimentation is opposite to previously cited episodic sedimentation in the Cretaceous basins. Moreover than that, the occurrences of the previously mentioned subaerial cycles of erosion (unconformities) are not ascertained. The previous cycles had segmented the rocks and history of the area into several separated and unrelated tectonic events that occurred in different basins. According to the above cycles and unconformities the tectonic setting and depositional history of the whole northwestern Iraq assumed be violent during compete time span of the Late Cretaceous by which basin isolation and uplift and erosion occurred. The above ideas are amended and the unconformable boundaries are changed to conformable ones. Consequently, in the present study, a new tectonic history and model are established for Cretaceous which agree with field observation and existed lithofacies.

Keywords: *Arabian platform, Kurdistan region, Iraq, Tectonic cycles, Petrography*

1. Introduction

The tectonic and depositional history the Arabian Platform was under intense study during Cretaceous, especially the part that is located in the Kurdistan Region, Northeastern Iraq. Bellen et al., (1959) have showed, by chronostratigraphy column, many unconformities between formations such as Qamchuqa and Bekhme, Dokan and Qamchuqa, Qamchuqa and Kometan, Dokan and Gulneri, Gulneri and Kometan, Kometan and Shiranish and Tanjero Formation with Kolosh Formation (Fig. 1). Buday (1980) has divided the rocks of the Late Cretaceous in to several cycles and subcycles on the basis of break in sedimentation and tectonic phases. These cycles are mainly established on the basis of the unconformities of Bellen, et al (op.cit.).

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These cycles are associated with widespread regression and subaerial erosion, some of which were prevailed in all Iraqi territory. These cycles are as follows:
According to Buday (1980) the depositional processes from Cenomanian to Maastrichtian is generally divided in to the following three subcycles in Iraq:
1. Cenomanian–Early Turonian Subcycle, during which Rutba, Ahmadi, Mishrif, Dokan and Upper Balambo Formations are deposited.
2. Turonian–Early Campanian Subcycle in which Kometan, Gulneri, Khasib, Tanuma, and Sadi Formations are deposited
3. Late Campanian– Maastrichtian Subcycle, during which Shiranish and Tanjero Formations are deposited.
In the studied area, the unconformities that are resulted from these subcycles are not identified in the field and in the lab, the only one that recognized in the studied area is that during which about 500m of conglomerate (as proximal sediments of Tanjero Formation) is deposited during Lower Maastrichtian (see Karim, 2004; Karim and Surdashy, 2005a and 2005b).

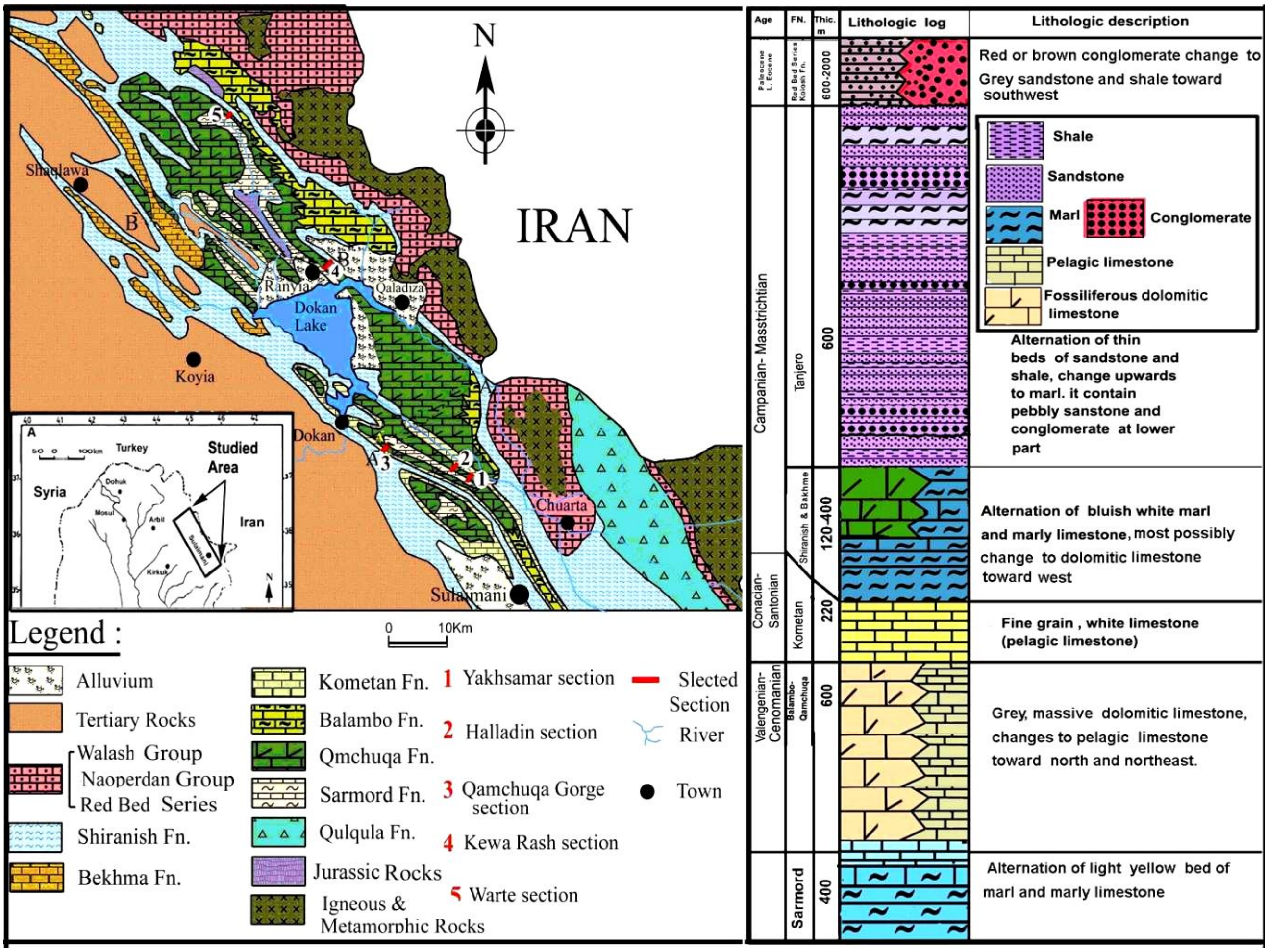

Fig. 1. Right) Location and geological map of the northeastern Iraq (modified from Sissakian, 2000) showing location of the studied section. Left) general stratigraphic column of the northeastern Iraq.

Unfortunately, nothing is mentioned about this important unconformity by Buday (op. cit). According to the cycles and unconformities of Buday (op.cit) and Bellen, et al., (op.cit.), the depositional history of the whole northwestern Iraq were assumed to e violent during compete time span of the Late Cretaceous by which basin isolation and uplift and erosion occurred. This intense tectonism is also shown by Numan (1997) who has put the sediment of the Turonian and Campanian, two tectonically different basins in Iraq. The first one is the northeastern basin which was diverging basin with midoceanic ridge and high igneous activity. This basin is located between Katarash and Walash volcanics (Fig. 3). The second basin is converging one and located to the northwest of the first one. This basin is consisted as occanic floor on which Qulqula Radiolarite and Tanjero formations are deposited.

According to Bellen et al., (1959), the Dokan (Cenomanian) limestone comprises the sediments of an intra Cenomanian transgression, and follows upon an eroded surface which was dictated by post-Albian or Late-Albian regression. They added that it is followed by the Gulneri Shale (Turonian), which contains the sediments of a later transgression, following a second probably intra-Cenomanian regression. Kometan comprises the sediments of a Turonian transgression following a very early Turonain emergence. According to this author, two transgression and regression occurred during deposition of both Dokan and Gulneri Formations. They meant by regression and transgression that intense tectonic uplift (equivalent to the type one sequence boundary) and subsidence occurred as can shown from Late Cretaceous chronostratigraphic column (Fig. 2). But as we see in the present study both formations are deposited during one transgression.

Buday (1980) gave abnormal ideas about basin of Gulneri Formation "*occupies a somewhat peculiar position within the Turonian-Lower Campanian Subcycle, because it is separated by breaks from the underlying Cenomanian and the overlying Turonian units. It generally represents the sediments of a relic sea, existing between the regression of the Cenomanian* *and the transgression of the Turonian.. Based on the evidence of the high bitumen content and a dwarfing of the fossils, the environment of the formations was euxinic."*

The author means by Relic Sea that it deposited during tectonic uplift by which most area become terrestrial and only Relic Sea remained in which Gulneri Formation was deposited. But as can be seen later, the formation is deposited in the same basin of Kometan and Shiranish Formations during transgression. The field observation showed that, in the studded area, it is possible to cancel these unconformities and cycles and consequently, changing the tectonic development of the studied area. These changes are the aim of this study which mainly depends on the field study with the aids of petrographic and paleontologic analysises of the Upper Cretaceous outcrops. For ascertaining the most controversial issue, selected samples are sent to France (University of Madam Curie) for nanofossil analysis.

2. Recent Modification

In recent years many works are published by which many modifications are introduced to the tectonic and stratigraphy of Iraq. Karim (2004) found an unconformity at the lower part of Tanjero Formation and located at the base of very thick succession of conglomerate (about 500m thick).This unconformity is not mentioned previously. Sharbazhery (2008) proved, by biozontion that across the boundary of Tertiary-Cretaceous there is no missing age including Danian. Karim et al., (2008) studied the contact between Shiranish and Kometan Formations in six different sections and refused the previous unconformable contact on which the Late Campanian–Maastrichtian subcycle is established. Ameen and Karim (2008) studied the unconformity between Qamchuqa and Bekhme formations and have is changed to it conformable one. Previously, this unconformity is estimated to be about 18 million years between the two formations bybBellen et al., (1959) which extended from Cenomanian to Upper Campanian (Fig. 2). Ameen (2008) changed the unconformity between Qamchuqa with both Kometan and Dokan to conformable one.

Karim et al., (2007) showed the possibility of concurrent deposition of the molasse and flysch sediments in same basin as lateral facies of each other during Late Cretaceous and Paleocene in Northeastern Iraq. Taha (2008) refused the previous unconformable upper and lower contact of Gulneri Formation and assumed it as conformable with Dokan and Kometan formations respectively. He refused the Gulneri and Dokan formations as deposits of small and euxinic basin that are bounded by unconformity from all sides as assigned by Bellen et al., (1959).

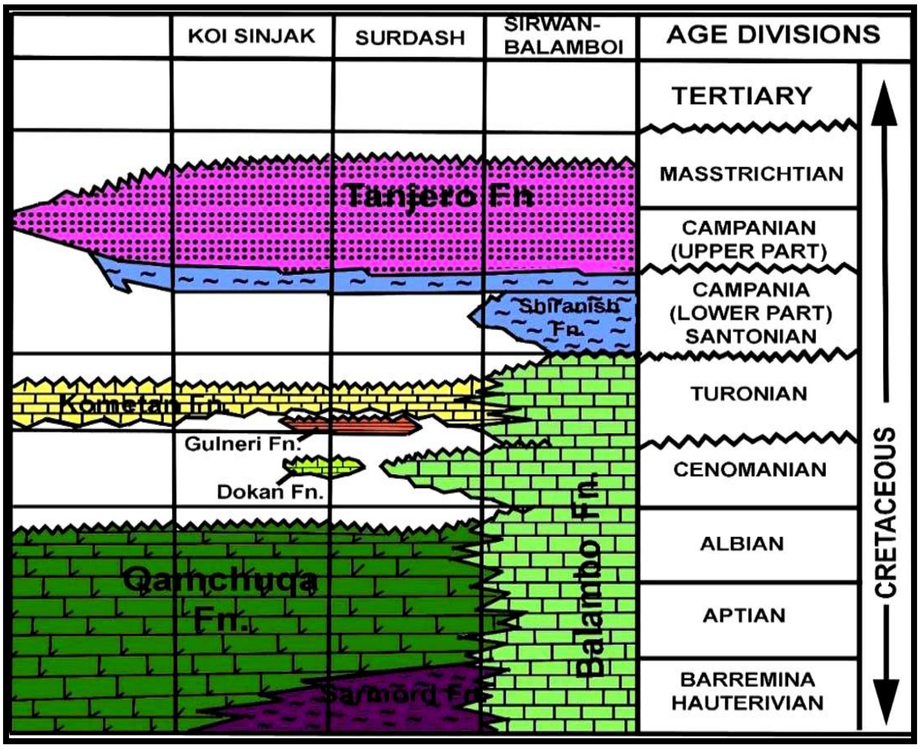

Fig. 2. Previous ideas of presence of several unconformities and tectonic cycles as shown Time expanded stratigraphic column of the Late Cretaceous (Bellen, et al., 1959) showing that both Dokan and Gulneri Formations are bounded by unconformably from all sides.

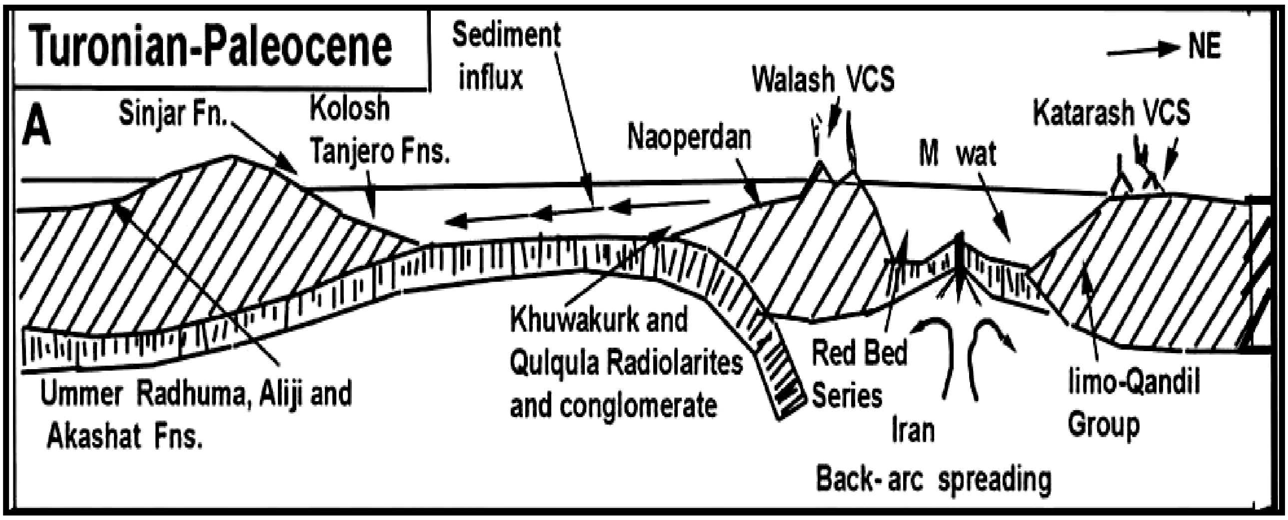

Fig. 3. The tectonic model of Numan (1997) in which Upper Cretaceous units (Kometan, Dokan, Gulneri and Shiranish Formations are not indicated.)

Depending on the above ideas by which nearly all previous unconformities are amended to conformable ones. It is possible to establish and draw a new tectonic history and model of the Late Cretaceous. The removing of the unconformities enables the present study to remove the cycles and combine all formations in one large foredeep or foreland basin with nearly a continuous history of deposition in contrast to previous episodic deposition in the studied area. The previous cycles had segmented the rocks and history of the area into several separated and unrelated tectonic events that occurred in different basins.

3. New Tectonic History of Late Cretaceous

To start construct the basin, it must be started from known historical event that predates or postdates the Late Cretaceous during which Dokan, Gulneri, Kometan and Shiranish Formations are deposited. As known steps, the Maastrichtian tectonic and depositional history is well studied, in the studied area, by Karim (2004), Karim and Surdashy (2005a and 2005b). This is true for Lower Cretaceous (Valanginian-Cenomanian) which has been studied in similar manner by Ameen (2008). The starting is from early Late Cretaceous tectonic set-up and continuous to combining it with that of Maastrichtian going through Turonian-Campanian.

According to Ameen (2008), during Cenomanian, the shallow marine reefal limestone of Qamchuqa Formation was depositing in the studied area which was making up northwestern margin of the Arabian platform. During Late Cenomanian the studied area began to change from shallow marine facies (Qamchuqa Formation) to deeper water facies (Kometan Formation). Although the deepening was rapid but there was a transitional facies between the two end members and represented by Dokan and Gulneri Formations. The transitional facies such as Dokan Formation has the intermediate characteristics between Kometan and Qamchuqa Formation. According to Ameen (2008) this environment change is attributed to approach of the huge column of radiolarites and ophiolites to the Arabian Platform. These rocks are formed accretionary prism in front of the southwest advancing front of Iranian plate, (Fig. 7). Under the load of the accretionary prism, the previous forebulge on which Qamchuqa Formation was deposited tectonically subsided (Fig. 4 and 8). By this subsidence Kometan Formation began to deposit.

Before deposition of Kometan Formation, and during deposition of Dokan Formation, the lagoon sediment, as a part of the lagoonal facies of the Qamchuqa Formation, was suffered from submarine erosions. This erosion is attributed to the subsidence of the barrier (reef core, which before subsidence protected the lagoon from open marine wave and current). The product of this erosion was deposited as Gulneri Shale Formation during drowning of the Arabian platform. After the deposition of this formation, the platform had transformed to deeper water and in which planktonic foraminifera and lime mud are deposited simultaneously as Kometan Formation.

In the studied area, this type of deposition, by local erosion, is aided by two characteristic of the Gulneri Formation. The first one is that Gulneri Formation consists mainly of marl and marly limestone in addition to some shale (Taha, 2008).

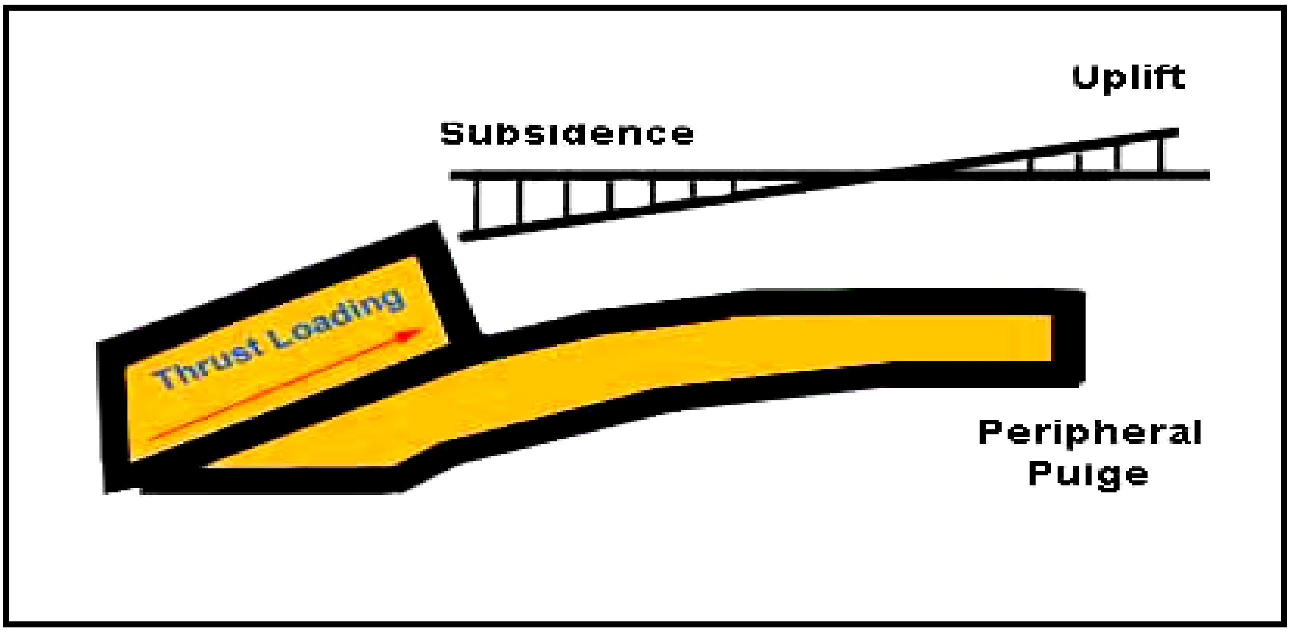

Fig. 4. Mechanic of forebulge generation by thrust loading (Einsele, 2000) which can be used as justification for drowning (subsidence of the Arabian Platform during Cenomanian)

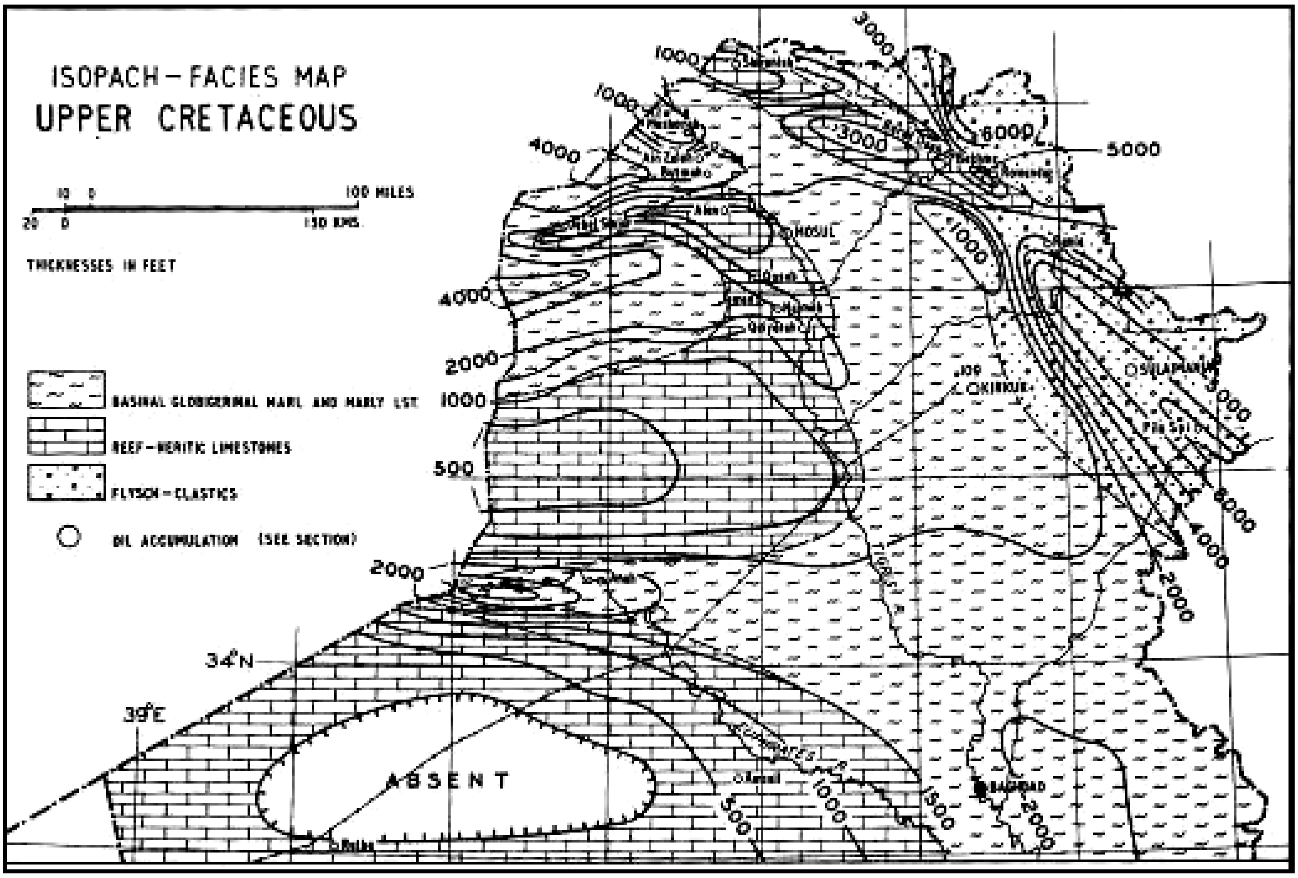

Fig. 5. Isopach facies map of Late Cretaceous (Dunnington, 1958) shows migration of reefal limestone to western Iraq from northeastern Iraq from Early to Late Cretaceous. This migration possibly is related to forebulge retreat and drowning of the studied area.

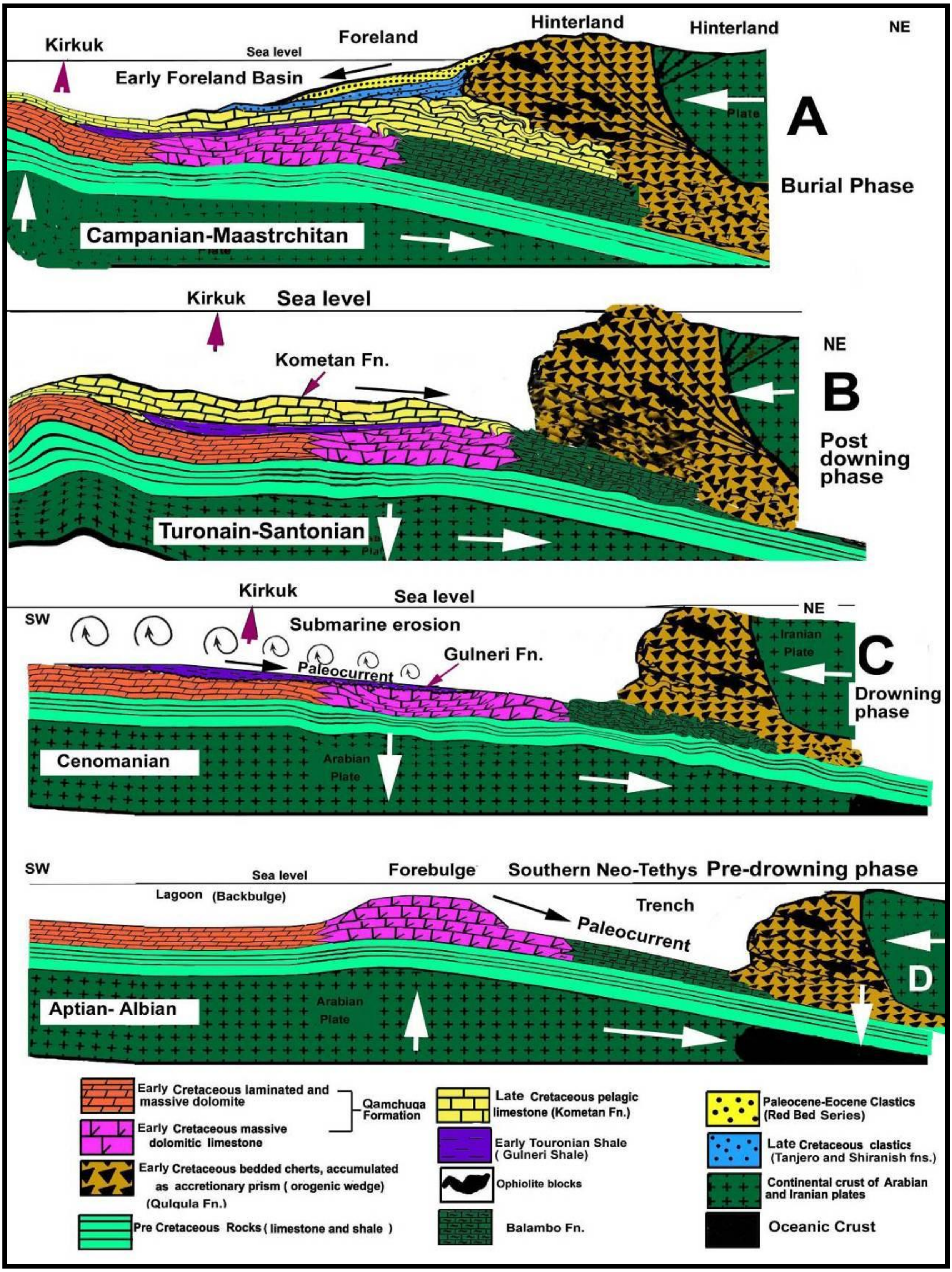

Fig. 6. Combination of tectonic, depositional history of Early and Late Cretaceous basin as considered in this study. A: From Karim and Surdashy (2005b), B and C: Model of Present study in which drowning phases and submarine erosion can be observed. D: From Ameen (2008).

The shale and the marl are deposited during high rate of submarine erosion while marly limestone is deposited during quiescence of erosion. Later, during deep burial the marly limestone beds are changed to ball and pillow-like structures that most possibly assigned previously as conglomerate by Bellen et al., (1959). The second is that toward southwest (toward the lagoonal limestone) the thickness of Gulneri Formation increases such as in Kirkuk which is reaches about 20m (Buday, 1980; Sarraj, 2007). In addition to these subsidence and erosions, the studied area was relatively calm and no important tectonic events were taking place during Early Late Cretaceous except further drowning. Due to the subsidence, the reefal limestone in the studied area stepped back towards northwest and southwest which reach the west Baghdad areas during Maastrichtian (Fig. 5).

3. Major Events of Late Cretaceous

According to Ameen (2008), inside Iran and near to the present location of Sanandaj-Sirjan belt, the oceanic part of the Iranian and Arabian plates had collided and divergent boundary is generated by which Iranian plate obducted over Arabian one during Berremian. By this obduction, the previously deposited radiolarites and scraped off ophiolites had begun to accumulate in the trench between the two plates forming accretionary prism. Between the prism and Balambo Formation the radiolarites were continuously deposited in the trench (Fig. 12 D). He added that during Valanginian to Cenomanian, the accumulation and southwest migration of the wedge (or prism) were continuous. This forced the basin of Qamchuqa Formation to subside and uplift in different times under the effect of loading and relaxation (when principles of basin analysis of Allen and Allen, 1990 and Einsele, 2000 are used). This oscillation can be seen in the field in the form of the alternation of lagoonal and reefal limestone or dolostone.

After the deposition of Kometan Formation, the two continental parts of the Iranian and Arabian Plates were collided. Slightly before collision, the trench was filled with scraped off sediments (radiolarites and ophiolites). These materials are uplifted and thrown onto the continental part of the Arabian Plate. The uplifted and over–thrown materials have formed positive land in the suture zone of the two plates. According to Karim (2004) Karim and Surdashy (2005b, due to this colliding, the studied area was transformed from passive margin to active Early Zagros Foreland Basin. According to these authors, Shiranish, Tanjero and Kolosh Formations are deposited in this foreland basin. They added that the collision changed the accretionary prism to source areas (orogenic belt) for Late Cretaceous sediments such as Shiranish and Tanjero Formations. The best evidence for this collision is deposition of about 500m of gravel and boulder conglomerate that can be seen at Chuarta, Mawat and Qandil areas during Maastrichtian.

4. Drowning of Arabian platform

In the studied area and during Cenomanian, one of the important events was occurred and represented by drowning (subsiding) of the Northeastern margin of the Arabian Platform (or northeastern margin of the Arabian Plate). This drowning is started relatively rapidly and imposed great role on the stratigraphy of the studied area which manifested by deposition of Dokan, Gulneri and Kometan formations. The first two formations are assigned as sediments of transition from normal platform (Qamchuqa Formation) to deeper drowned platform (Kometan Formation). The Arabian platform is mainly consisting of carbonate, therefore the development of the platform is discussed in term of the drowning phase which is modern issue in the field of sedimentology, stratigarphy and tectonics (see the works of Kendall and Schlager, 1981; Galewsky, 1989; Schlager, 1991; Blomeier and Reijmer, 1999; Catunenue, 2006).

5. Drowning In Literature

The drowning of carbonate is inability of the platform to keep pace with the rate of relative sea level rise which is a well known phenomenon in carbonate platforms (Kendall and Schlager, 1981). Platform drowning may occur in various tectonic settings: foreland basins (Robertson 1995; Galewsky 1989), extensional basins (Bice and Stewart 1990). According to (Tucker, 1991), drowned platforms are ones which is relatively rapid sea-level rise, so that deeper water facies are deposited over shallow water facies and many pelagic limestones were deposited in these situation. (Mutti et al., 2005) have mentioned that platform drowning can be controlled by many factors, including rapid eustatic sea-level raise, crustal subsidence, ecological stress, water temperature, upwelling of cold deep water and the rate of sediment production and removal.

Carbonate productivity is related to water depth, if there is an abrupt relative sea level rise due to tectonic subsidence or eustatic sea level changes and an area which had formerly been a site of shallow marine carbonate deposition may become too deep for the production of much sediment. This is called the drowning of a platform (Nichols, 1999). Einsele (2000) referred to the drowning as give-up phase of the carbonate platform with sea level change. According to Catunenue (2006), the drowning represents the final stage in the evolution of a carbonate platform, prior to the return to a clastic dominated environment. Once the platform is drowned below the photic limit, filling of the available accommodation during subsequent highstand normal regression may only be achieved by means of siliciclastic progradation.

6. Phases of Drowning

According to Schlager (1991), Kendall and Schlager (1981), the drowning may be resulted from decrease of nutrient supply and oxygenation and from increase of Salinity, predation and siliciclastic input. The drowning of the Arabian is most possibly resulted from tectonic subsidence and can be subdivided into four phases according to the resulted depositional environments and facies. The drowning phases of the Northeastern margin of the Late Cretaceous Arabian Platform can be established depending on the existing lithology, fauna and the facies of the stratigraphic units which are described in detail by (Ameen, 2008; Taha, 2008). For decoding the characteristic and timing of these phases, the works of Kendall and Schlager (1981), Reading (1986), Blomeier (1999), Schlager (1991) and Galewsky, (1989) are applied to Arabian Platform.
1- Pre-drowning phase (Qamchuqa Formation). 2- Transitional phase (or transition to post drowning phase) which is represented by Gulneri Shale and Dokan limestone formations. 3- Post drowning phase (Kometan Formation).
4- Burial Phase: Siliciclastics prograding on the Arabian Platform which is represented by Shiranish and Tanjero formations.

7. Pre-drowning phase

In this phase the Arabian platform (as represented by Qamchuqa Formation in the studied area) was growing continuously and there is balance between growth in photoic zone and subsidence (or sea level rise). This phase is called Type C (Keep up-upbuilding and outbuilding of shallow water carbonate) by Kendall and Schlager (1981) which can be applied to Qamchuqa Formation.

8. Platform interior

The succession that is deposited on the platform top characterized by limestone/marl alternations, which are separated by distinct exposure surfaces. The marls are usually badly exposed and the lateral varying limestones consist of pelletal or bioclast wackestones, mudstones with possible algal mats and horizontal lamination. These primary patterns are frequently destroyed by bioturbation, resulting in an irregular arrangement of the components and the formation of stromatactis-like structures that are filled with micrite and or blocky cements.

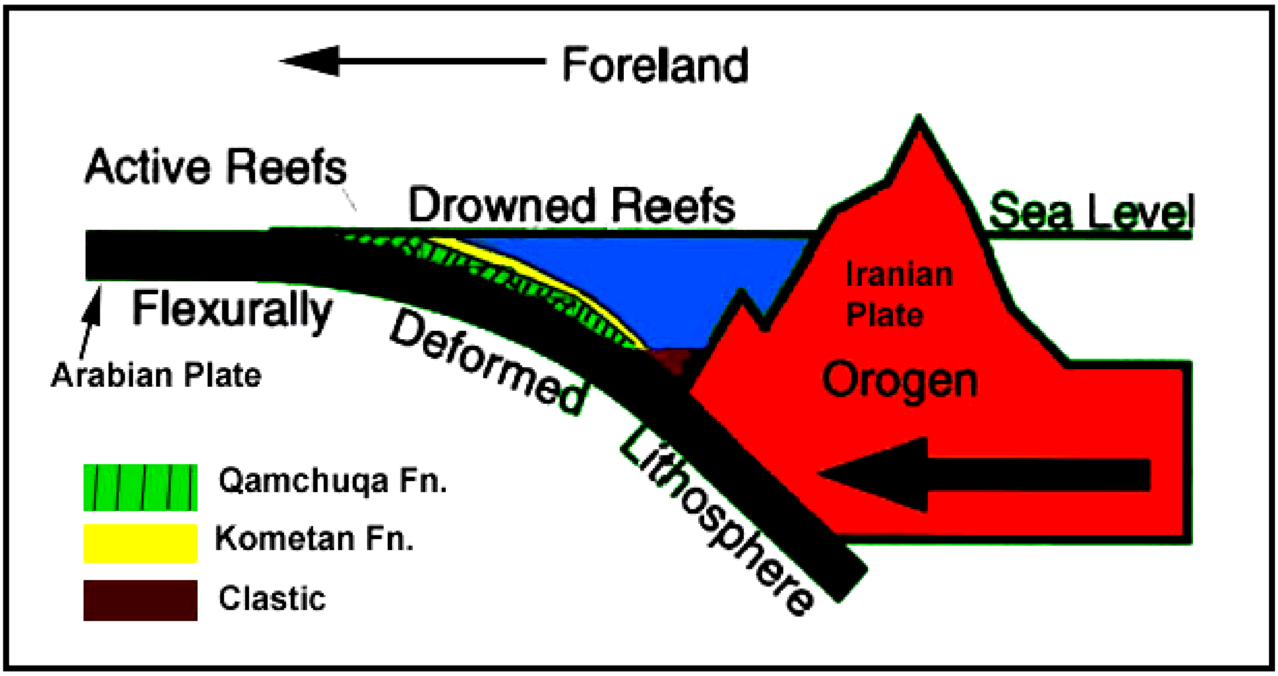

Fig. 7. Tectonic drowning of the carbonate platform by flexure of continental lithosphere under the load of overriding plate (Galewsky, 1989) which can be applied to the Kometan Formation with some modification.

These characteristics can be applied on the lagoonal limestones of Qamchuqa Formation which are discussed in detail sedimentologically by Ameen (2008). He cited that these limestones are deposited behind a reef on the Arabian Platform interior (Fig. 8). The facies that are found by this latter author are benthonic foraminifera and algal mudstone and wackstone with chert nodules on the bedding surfaces. These facies are those that are related to relatively deep platform interior lagoon but he did not found inertial facies of the lagoon in the studied area.

9. Platform slope

The pre-drowning succession of the middle slope section is characterized by thick-bedded, coarse-grained and poorly sorted limestones. The carbonates all can be assigned to grain- to packstones, rudstones, flotstones). The arenitic to ruditic components are dominated by shallow marine bioclasts. On the toe of slope, the succession consists of medium-bedded marls and limestones with two different microfacies type. These characteristics can be applied to the reefal and fore reef facies of Qamchuqa Formation that are discussed in detain by Ameen (2008). He cited that these limestones are deposited on the reef of the Arabian Platform margin (Fig. 8). The facies that are found by him are bioclast and ooids grainstone (or packstone), floatstone, bindstone and rudstone (Fig. 9).

10. Transitional phase (Syn-drowning phase)

This phase is resulted from the complete failure of a reef or platform to keep pace with a relative rise of sea level so that it leaves the realm of shallow water carbonate sedimentation becoming submerged below the euphotic zone. The process is complete only when neritic carbonate production has ceased and truly deep-water conditions have been established (Kendal and Schlager, 1981). This phase is very clear in the field and in the thin sections as there are about 5m of the oligostiginal limestone with few beds of glauconites which is represented by Dokan Limestone Formation and about 1.5 of marly and marly limestone (Gulneri Formation) (Fig. 11). These two formations are transitional between shallow marine Qamchuqa Formation and deep marine Kometan Formation; therefore they represent the transitional phase to post-drowning. The gradual but relatively rapid change from shallow marine to deep water facies is represented by facies characterized by properties that are intermediate between the two end members.
Previously, Buday (1980) assumed the Gulneri Shale as sediment of relict sea. But, in this study, it is considered as sediments of large shallow basin which was covered Arabian platform. In the studied area the sediments of the syn-drowning phase consist of the pelagic and hemipelagite facies of Dokan and Gulneri formations respectively. The sediments of the syn-drowning phase sequence are characterized by the deposition of specific low diversity biofacies. They represented by Oligostegial and dwarfed forams (Fig. 10). It is worth to mention that the sediment of this phase does not exist in all areas of the northeastern Iraq. In some areas the drowning was so rapid that the sediment of this phase is not exist or very thin such as Rawandoz area.

11. Post- drowning phase (Kometan Formation)

According to Kendall and Schlager (1981), within all successions the sediment fabric and microfacies reflect a uniform depositional environment across the entire platform. Fine grained limestones containing pelagic organisms point to sedimentation within an open marine, deep marine environment below storm wave base. Extensive bioturbation of all sediments reflect oxic bottom waters as well as continuous pore water circulation within the sediment. In the studied area, this facies is represented by fine grain, occasionally, bioturbated limestone of Kometan Formation (Turonian L.Campanian). This formation is deposited on drowned Arabian Platform which represented by deposition of the deep-water facies of Globogerinoids bearing limestone on shallow water facies of Qamchuqa Formation passing through transitional lithology which represented by Dokan and Gulneri Formations (Fig. 11). According to Kendall and Schlager (1981) vertical transition from shallow platform to deeper water facies of the post drowned phase may be abrupt or graduation.
It may be marked by basal lime sands and gravels that result from migration of a higher- energy transgressive environment over the low energy platform interior. As the studied area is represent mainly the Arabian platform margin, therefore, only the shales or marls (Gulneri Shale Formation) are existed but it is possible that lime sand and gravel sand can be found in the platform interior in the Low Folded Zone. This is added by Dunnington (1958) who showed an erosional surface above and below the Turonian marls and limestones in the Kirkuk area (Fig. 6). The case of drowning similar to Qamchuqa Formation and deposition of Kometan Formation is mentioned by Einsele (2000) who stated that drowned or subsided carbonate platforms may be referred to as Pelagic Carbonate platforms (Kometan Formation). At an intermediate depth between shallow water and true pelagic carbonate deposition, the platforms are still

exposed to current action. He farther added the sediments overlying older carbonates or other rocks therefore tend to become discontinuous and interrupted by intervals of omission and erosion (sharp contact below Gulneri Formation). They are characterized by irregular bedding and nodular appearance, red color, ferromanganese nodules, corrosion surfaces and hardgrounds with sessile fauna.

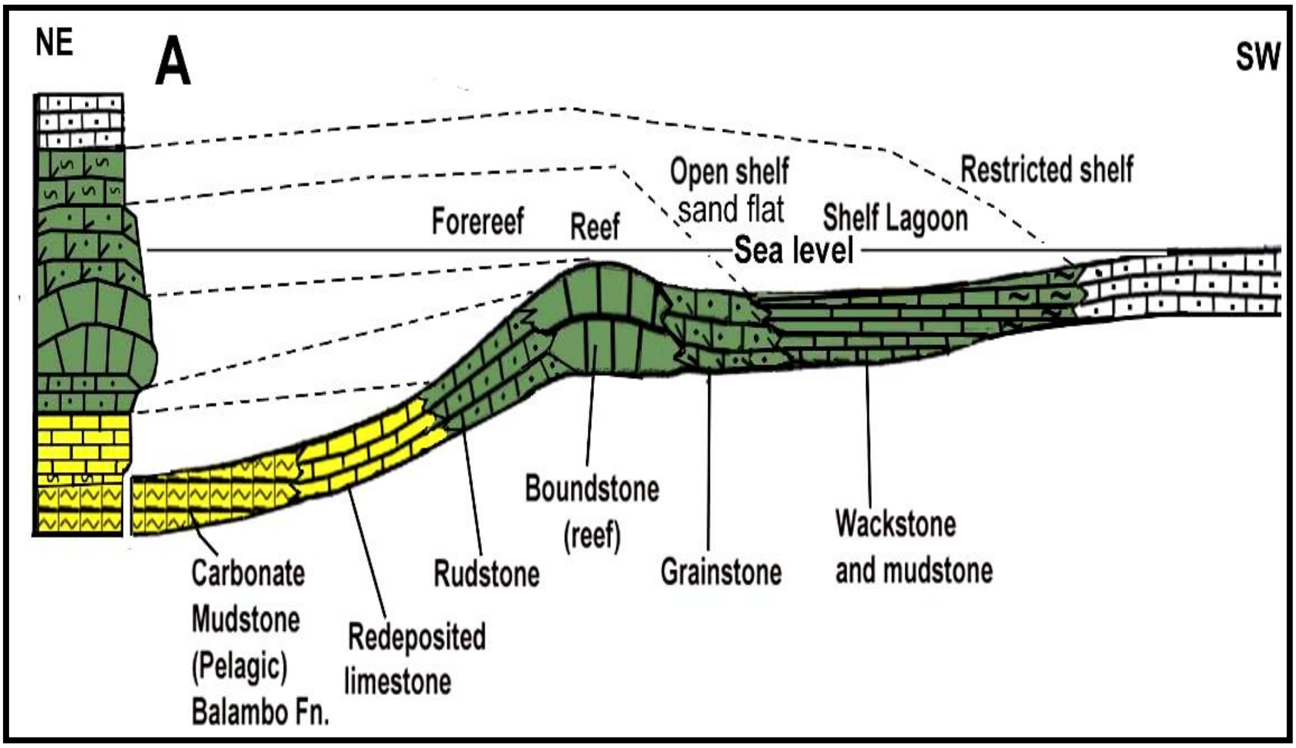

Fig. 8. Environmental and topographic distribution of the rocks of Qamchuqa Formation by Ameen (2008). These rocks represent pre-drowning facies.

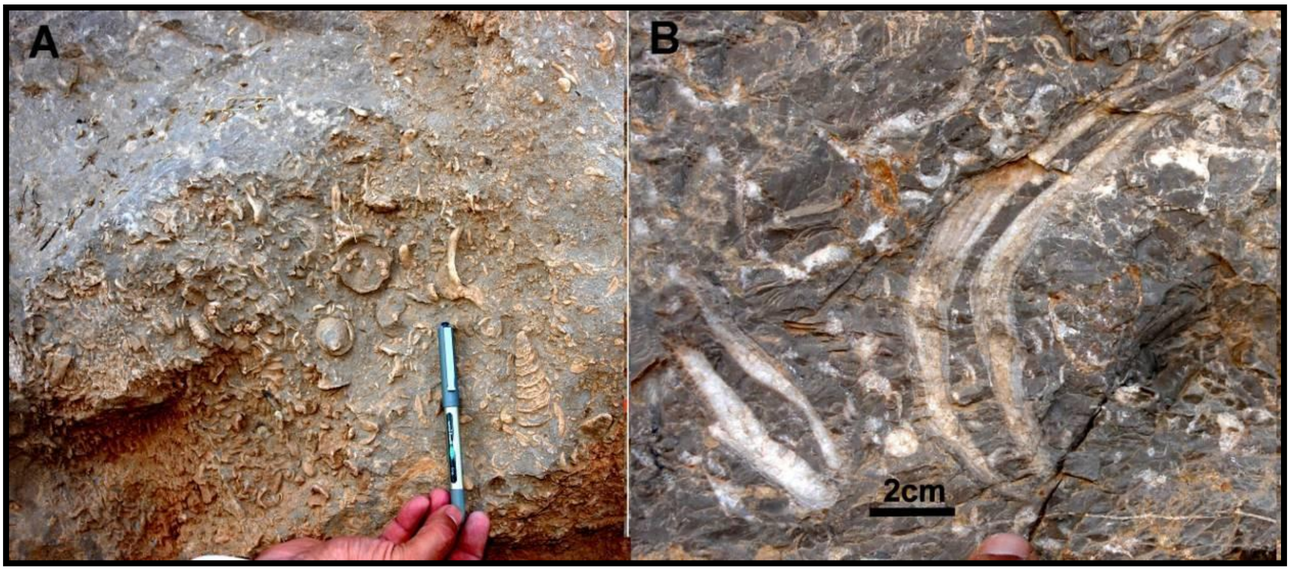

Fig. 9. Pre-drowning facies of the Arabian Plate (Qamchuqa Formation), A) coarse bioclastic rudstone with gastropod skeletons. B) Rudist (radiolitids) floatstone.

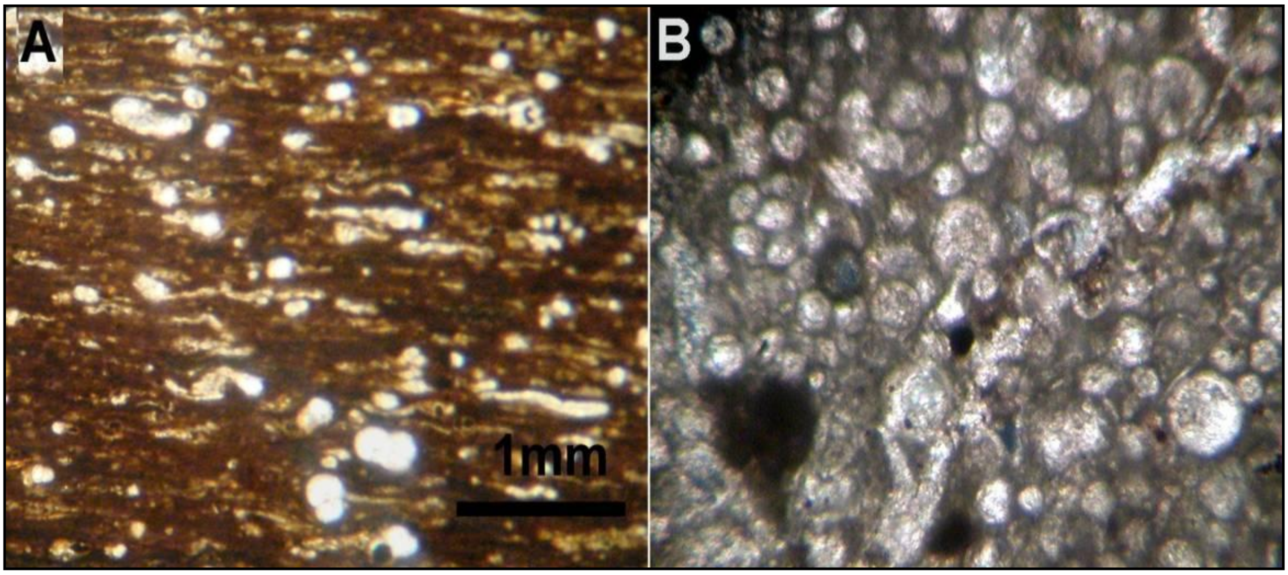

Fig. 10. Syn-drowning facies of the Arabian Platform A) Calcareous shale with dwarfed and deformed planktonic forams (Hemipelagite) of Gulneri Shale Formation. B) Oligosteginal bearing limestone.

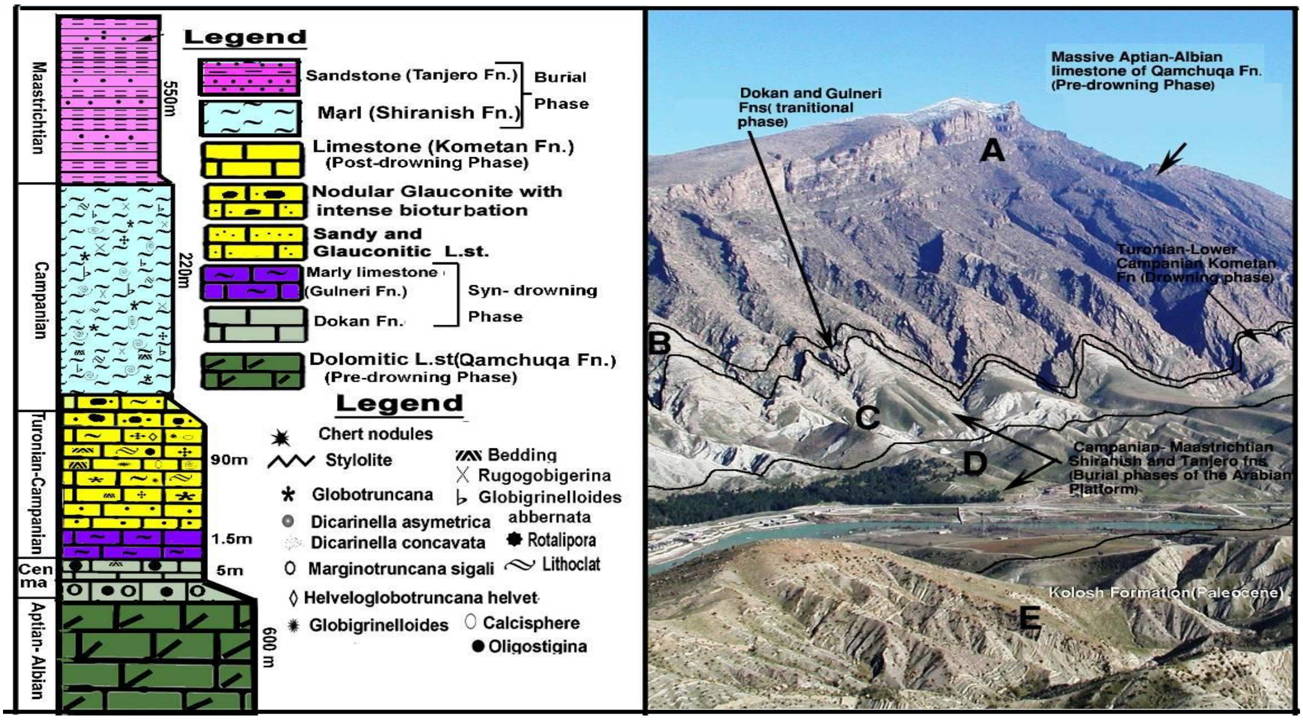

Fig. 11. Stratigraphic column (right) and photo (left) of southwestern limb of Sara anticline in Dokan area showing the representative rocks of the four drowning phases of the Arabian Platform. A) Aptian-Albian reefal limestone of Qamchuqa Formation (Pre-drowning phase). B) Cenomanian-Turonian pelagic limestone and marl of Dokan and Gulneri Formation (Syn-drowning phase). C) Late Turonian-Campanian deep pelagic limestone of Kometan Formation (post-drowning phase). D and E) Burial phase of the Arabian Platform by siliciclastics sediments of Shiranish, Tanjero, Kolosh formations.

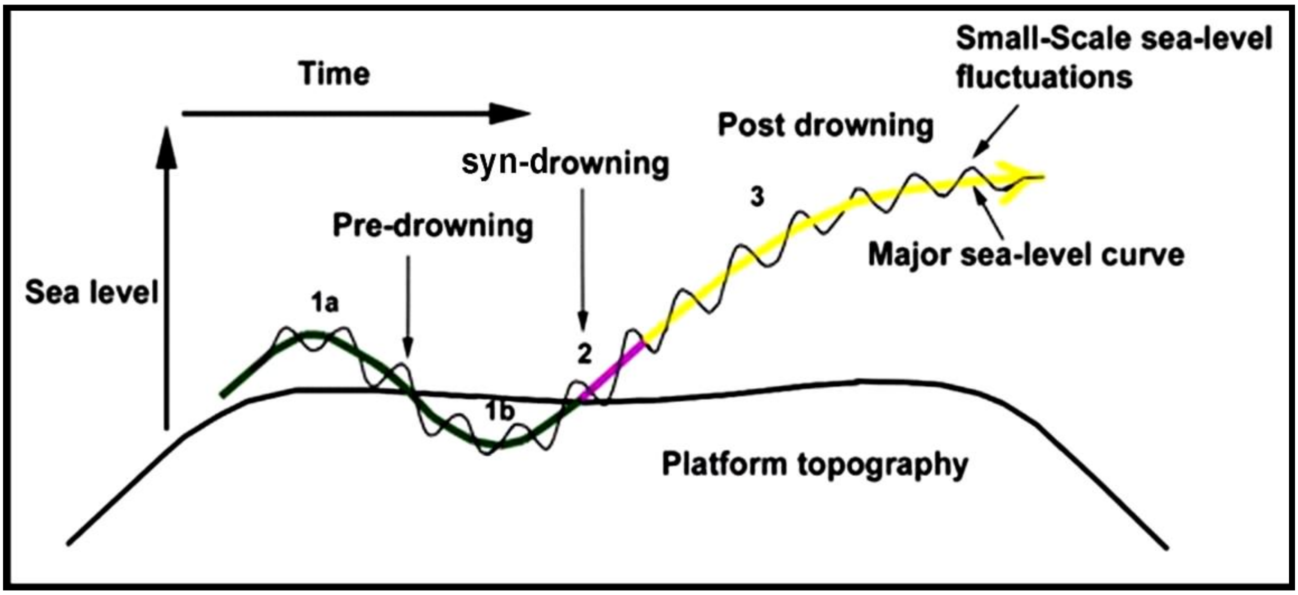

Fig. 12. Sea-level variations and drowning phasess. 1a) Pre-drowning phase and carbonate production within platform interior (lagoonal facies of Qamchuqa Formation). 1b) Pre-drowning phase and sea-level subaerial exposure of the platform (reefal facies of Qamchuqa Formation). 2) Renewed flooding of the platform top at the beginning of the syn-drowning phase (Dokan and Gulneri Formations). 3) Gradual transition to deep-marine sedimentation during the post-drowning phase (Kometan and Shiranish Formations) (Modified by Blomeier and Reijmer, 1999).

12. Burial Phase: Siliciclastics prograding on the Arabian Platform

The age of this phase is Middle Campanian (as dated by nanofossils in this study) which coincides with the first appearance of clastic sediments on the Arabian platform in the studied area. The first arrival is represented by the lower part of Shiranish Formation which consists of marl and marly limestone. In this study, this formation assigned as clastics is depending on the many authors that are assumed marl and marly limestone as slope and basin plain distal turbidite facies(hemipelagite), among the these authors we mention: Reading, 1979; Blatt et al,1980; Mial,1990; Einsele, 2000. Dunnington (1958) showed that both Shiranish and Tanjero Formations change both laterally and vertically to each other (Fig. 6 and 11). In recent years Karim (2004), Karim and Surdashy (2005a) and Karim et al., (2008), discussed in detail how both deposited and derived from one source area of the Early Zagros Foreland basin (Fig. 6).

Therefore, the first influx of the Shiranish Formation is suggested, in the present study, as the beginning of clastic burial of the Arabian Platform. After deposition of the hemiplagite the pure clastic of Tanjero Formation is deposited which shows gradual increase of grain size caliber from clay to bounders. The influx of the clastics was associated with the main tectonic event of Zagros Fold-Thrust Belt during which the orogenic belt is generated from which the clastics of both formations are derived. This clastic burial over the Arabian Platform is due to continental Arabian and Iranian plate colliding by which the paleocurrent direction is changed from northeast to southwest direction (Karim and Surdashy, 2005a). The sediment influx (paleocurrent) was from southwest during deposition of Gulneri and Kometan Formations. But, when the Iranian plate is thrusted over the Arabian platform, the direction of sediment transport, in studied area was changed toward southwest as indicated by black arrows in the (Fig. 6).

Field study and literature review show that both the drowning and burial phases are not isochronous when the neighboring areas are considered. In Arbil and Dohuk areas the Arabian platform, in the same tectonic position as the studied area, remained not drowned and not covered by clastic till the Maastrichtian. This can be seen in the recent study of Abwai and Hammondi (2006) whom inferred that the age of the most upper part of Bekhme Formation (Arabian platform) is Upper Campanian and Shiranish Formation is Maastrichtian. Dunnington (1958) showed that southwest migration of neritic limestone which appeared in the Qaiyarah area in the Fig (5). Ameen (2008) discussed the problem of the remaining these areas no submerged as compared to the studied area. He attributed the remaining of the Arabian platform, in the Dohuk area, not drowned to diverting of depositional axes toward north during Upper Cretaceous and to irregularities of the tectonic front of Iranian plates.

According to these facts a tectonic and depositional historical model is drown which shows the drawing phases and combined with the closure of the Southern Neo-Tethys. This closure had started from Early Cretaceous and finished at end of Late Cretaceous. This is done depending on literature and result of the present study taking in the consideration the boundary condition outside the studied areas. In this connection, Schlager (1991) mentioned that the drowned platforms are covered by pelagics, hemipelagics or terrigenous siliciclastics. These sediments (or rocks) are equivalent (in the present study) to Kometan, Shiranish and Tanjero Formation respectively.

The present tectonic setting of the Zagros Fold–Thrust belt is also considered in the studying the tectonic history of the Arabian platform. This setting shows many thrusted sheets of older rocks over newer ones. Now, Qulqula Radiolarian Formation (radiolarites and pelagites) can be seen thrusted over the Arabian Platform as can be seen in the sections to the in the Qandil mountains and Halabja Areas. When the thrusted sheets that are enclosed in the sections are balanced or returned back to their approximate original position, a crude tectonic model of the Early Cretaceous can be envisaged.

13. Conclusions

New simplified tectonic models and depositional history of Upper Cretaceous rocks are established depending by dividing the rock columns of the northeastern Iraq into four phases of drowning:

1-Pre-drowning phase (Qamchuqa Formation). 2- Syn-drowning phase or transitional to post drowning phase (Gulneri Shale and Dokan limestone Formations). 3-Post drowning phase (Kometan Formation) and 4-Burial Phase which is resulted from siliciclastics prograding on the Arabian Platform (Shiranish and Tanjero Formations). These phases, as resulted from tectonic of the area, can replace the complex previously assigned tectonic and depositional history during Later Cretaceous. The new model revealed nearly a continuous history of deposition in foredeep or foreland basin in contrast to previous episodic deposition in the studied area with the absence of the previously assigned unconformities.

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