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NEW SEDIMENTOLOGIC AND STRATIGRAPHIC CHARACTERISTICS OF THE UPPER BOUNDARY OF QAMCHUQA FORMATION (EARLY CRETACEOUS) AT NORTHWEST OF ERBIL, KURDISTAN REGION, NE/IRAQ

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ABSTRACT

The contact between Qamchuqa (Early Cretaceous) and Bekhme (Late Cretaceous) formations is studied in the field and laboratory. On the basis of lithology, the contact is described and analyzed in four different sections. In all four sections the result of the study showed gradational boundary, two of four sections (Zante gorge and Perse Mountain) are barren of conglomerate, breccias or erosional surfaces, so the contact seems to be conformable in the field. The other two sections (outlet and inlet of Bekhme gorge) contain beds of apparent conglomerate (or conglomerate–like masses), which in the present study are inferred to be not depositional, but diagenetic in origin. They are secondary ball and pillow structures, which formed during burial by tectonic or lithostatic stress. In the inlet of the Bekhme gorge section, there is a mass of breccias (about 1.5m thick), which is located 10m above the ball and pillow beds. This breccia is not depositional as it consists of extremely angular clasts of limestone. These clasts are believed to be tectonic in origin and derived from younger beds above the contact, which is not more than 20m higher from their location. The clasts are transferred to this location possibly reverse fault across Great Zab River.

In contrast to previous studies, the contact suffered from deepening relative to the overlying and underlying Bekhme and Qamchuqa formations, respectively. This is manifested by green marl, marly limestone, limestone bearing planktonic forams and breccias. The soft succession at the boundary (about 30m thick) is most possibly deposited during the previously suggested gap or unconformity.

خصائص سوبية و طباقية جديدة للحد العلوي لتكوين قمجوقة (الكريتاسي المبكر) شمال شرق اربيل- اقليم كردستان ، شمال شرق العراق

بختيارمحمد امين و كمال حاجي كريم

الملخص

درس الحد الفاصل بين تكويني قمجوقة (الكريتاسي المبكر) وبخمة (الكريتاسي الاعلى) من الناحيتين الحقلية والمختبرية . وقد تم وصف وتحليل اربع مقاطع صخارية في مناطق مختلفة. و في جميع هذه المقاطع تبين بان الحد الفاصل قد يكون و سطح توافقي،حيث يظهر بشكل واضح، بان مقطعي كلي زنطة وجبل بيرس خاليين من المدملكات والبريشيا او اي سطح للتعرية.و المقطعين الاخرين في مدخل ومخرج كلي بخمة ،حيث توجد طبقات تشبه المدملكات. اسبت الدراسة الحالية بان هذه الطبقات ليست مدملكات و انما هي تراكيب كروية و وسائدية ذات اصل تحويري وليست رسوبية و تكونت من خلال عمليات الدفن العميق. وفي مقطع مدخل كلي بخمة توجد كتلة من البريشيا بسمك 1.5 م والتي تقع تحت الطبقة الكروية والوسائدية بمسافة 10 م.وان هذه البريشيا ذات اصل تكتوني و ليس رسويي حيث تحتوي على فتات من الحجر الجيرى ذات زواية حادة ، و ان مصدر هذا الفتات هو من الصخور الاحدث الواقعة فوق الحد الفاصل بمسافة لا تتجاوز 20 م. حيث نقل الفتات من هذا الموقع، على الارجح، نقلت على الارجح بواسطة الفالق العكسي المحتمل تواجده.

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ان الحد الفاصل بين تكويني قمجوقة وبخمة قد تاثرت بعمليات التعمق النسبي للحوض الرسوبي و ليست نهوضا كما ذكر سابقا .و يظهر هذا من خلال وجود الطفل الاخضر والحجر الجيرى الذى يحتوي على الفورامينيفراالطافية و بريشا. ان التتابع الناعم في الحد الفاصل (بسمك 30 م) قد ترسبت، على الارجح، اثناء عدم التوافق القترح سابقا.

INTRODUCTION

According to Bellen *et al.* (1959) the type section of Bekhme Formation is located in the Bekhme Gorge in the High Folded Zone (Fig.1). It consists of nearly same lithology as of Qamchuqa Formation According to the all previous studies, the Qamchuqa Formation is overlain by Bekhme Formation unconformably. Bellen et al (1959) mentioned the occurrence of polygenetic and basal conglomerate and breccias (about 10m thick) between the two formations. He mentioned that the conglomerate represents a gap, which extends from Late Albian to Early Campanian. Buday (1980) mentioned that the contact is as a rule unconformable due to occurrence of conglomerate at base of Aqra-Bekhme Formation. Recently Al-Qaradaghy (1989), Al-Qayim and Shaibani (1995), Omar (2006), and Jassim and Golf (2006) have mentioned unconformable contact too.

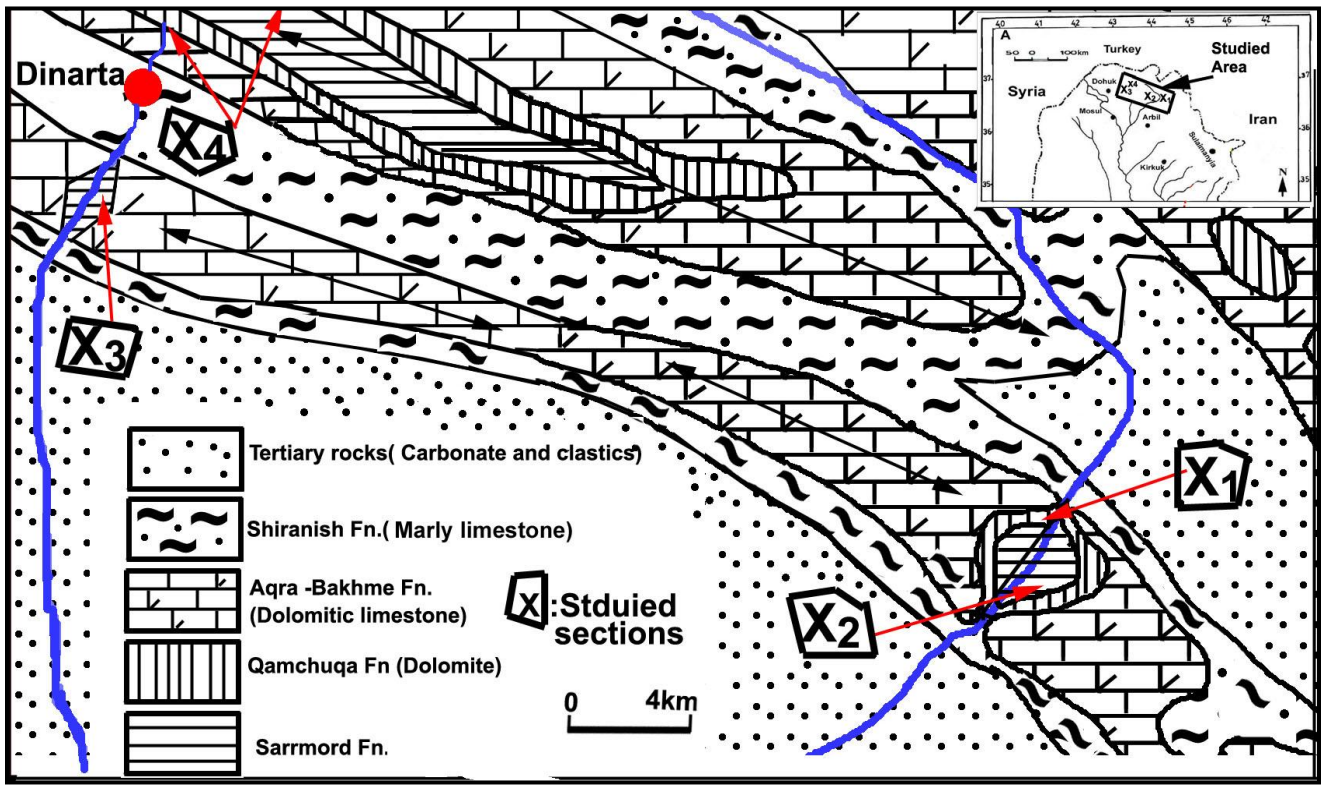

Fig.1: Location map and simplified geological map of the studied area (Modified from Sissakian, 2000).
X1, X2, X3, X4, are studied sections of
Bekhme gorge inlet and outlet, Zanta and Perse sections respectively.

LITHOLOGY AND STRATIGRAPHY OF THE BOUNDARY

Recently and during fieldworks, new observations are recorded in many different localities that show that shows a probable conformable boundary between the two formations. Considering the basin analysis of northern Iraq, the boundary, in all observed sections, seems to be continuous in deposition while yielded more or less similar lithologies (Fig.2). The nature of the boundary is relatively soft, which consists of marl, marly limestone, white and nodular beds of limestone with breccia. To explain why this contact was assigned, previously by all authors, as unconformable and repeatedly mentioned and ascertained to be represented by basal conglomerate, the following eight points must be taken into consideration:

The first point is, at the type locality of Aqra–Bekhme Formation, breccias and conglomerate-like beds of limestone are observed by present authors (Fig.3).These beds, most possibly, are those "sedimentary breccias and basal conglomerates" that are mentioned by Bellen *et al.* (1959) at the base of Bekhme Formation. The approximate location of the breccias and basal conglomerate as given by Bellen et al. (1959, p.61) has latitude (36^{o} 41^{-} $45^{=}$) and longitude (44^{o} 16^{-} $30^{=}$) which is located by GPS. These two lithologies are associated with bluish white marl and milky marly limestone. Field and laboratory studies showed that the observed breccias are not sedimentary but tectonic and occur at one section out of four. This section is located at the right side (down stream) of the inlet of the Bekhme gorge at the contact of the two formations and along the bank of Greater Zab River (Fig.4A). The development of the breccias (Fig.5) is attributed to a reverse fault that extends across the riverbed and both sides of the gorge, directly at the south of the proposed dam site. The clasts of the breccias are extremely angular (show no transportation) and derived from the nearby beds (such as finely laminated and massive limestone clasts). The parent rocks of these clasts are located at younger level than the breccias, which is located no more than 20m far from the place of the breccias that are transported to. The most obvious evidence for the fact that the clasts are not sedimentary, is that their parent rocks (layers) are located, stratigraphically, at higher level (have younger age) than the stratigraphic position of breccias. The younger stratigraphic position of the parent rocks of the breccias is very clear along the inlet of the Bekhme gorge. When one crosses 300m, from the upper part of Bekhme Formation to lower part along the stream, three beds (each 10cm thick) of grey laminated limestone can be observed in their depositional place near the contact (Fig.4A). After that, blocks of breccias appear at 20 meters above the laminated limestone. The breccias contain clasts (2-5cm in width) of same lithology of the laminated limestone (Fig.4A). It appears that the movement along of the fault has transferred the clasts of the breccias to horizons stratigraphically older than the original parent rocks of the clasts. Consequently, the clasts are lithified to form fault breccias. The resting of the block in the zone of the boundary between the two formations is attributed to softness of the boundary, which can act as a host for foreign bodies. The marly boundary is cited by Bellen et al. (1959) and Sissakian and Youkhana (1984) was seen by the present authors in all sections as shown in the (Figs. 2 and 4).

The second point is the conglomerate that is described by Bellen et al. (1959) and seen by the present authors is not sedimentary in origin. They are ball and pillow-like structures which are formed by the pressure due to presence of alternation of competent limestone beds with incompetent beds of marl (Fig.8).The origins of these conglomerate-like structures (ball and pillow) are described in detail by Karim (2006) in the Tanjero and Kolosh formations. He found these structures in sandstones, limestones and in igneous rocks too in the Sulaimanyia Governorate showing more than 10 photos and diagrams to explain the development of these structures by stress during burial (Fig.10 as an example). Tucker (1991, p.163) mentioned that pelagic limestones (present marl and marly limestone) are characterized by nodular structure which surrounded by pressure solution clay seems. The photo that given by him is highly resembles those recorded in present paper.

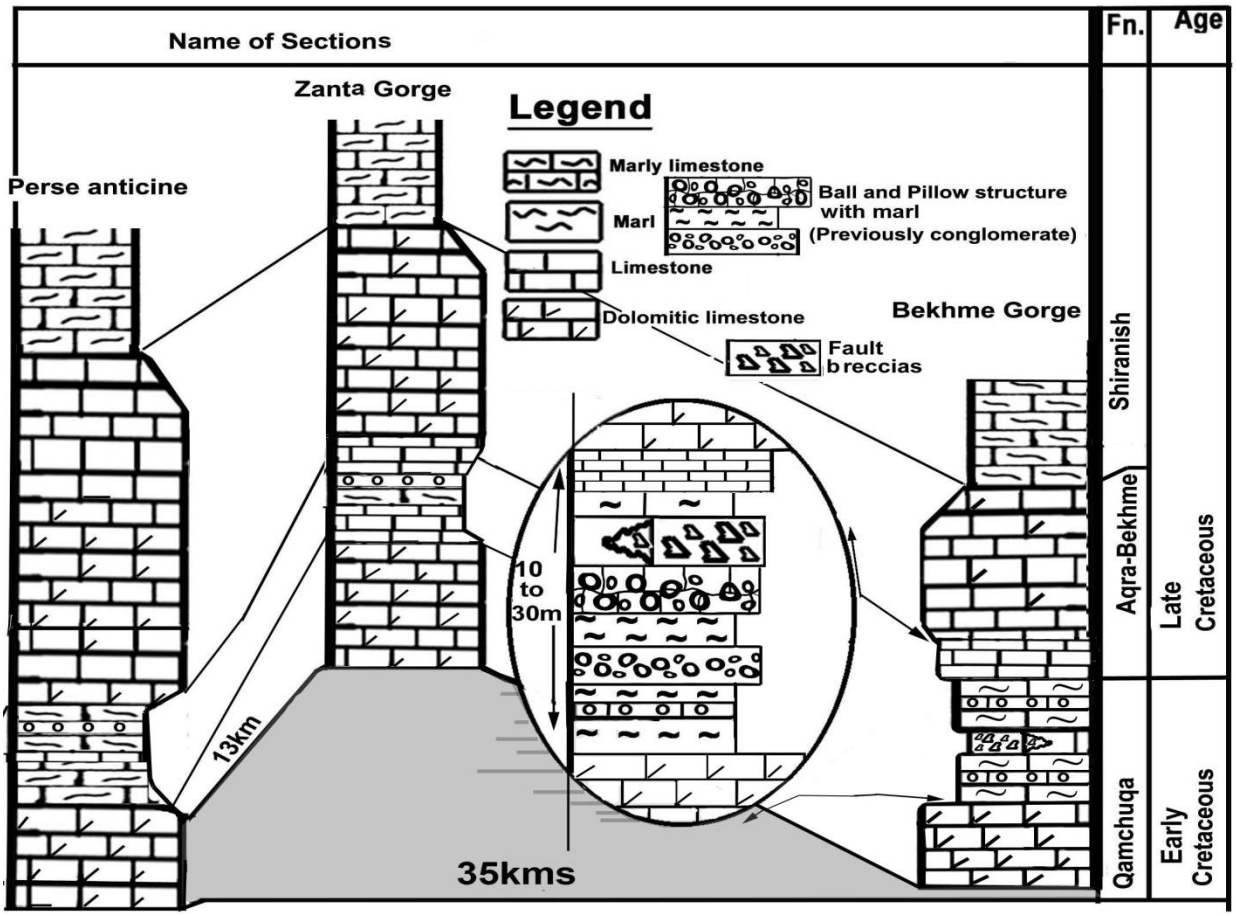

Fig.2: Conformable boundary between Qamchuqa and Aqra-Bekhme formations at three different sections in Bekhme and Zante gorges and Perse anticline.

Fig.3: Boundary between Qamchuqa and Aqra–Bekhme formations at two different sections which are showing secondary ball and pillow- like structures that previously might be assigned as depositional conglomerate.
A) Bekhme outlet and B) inlet (according to stream flow direction).

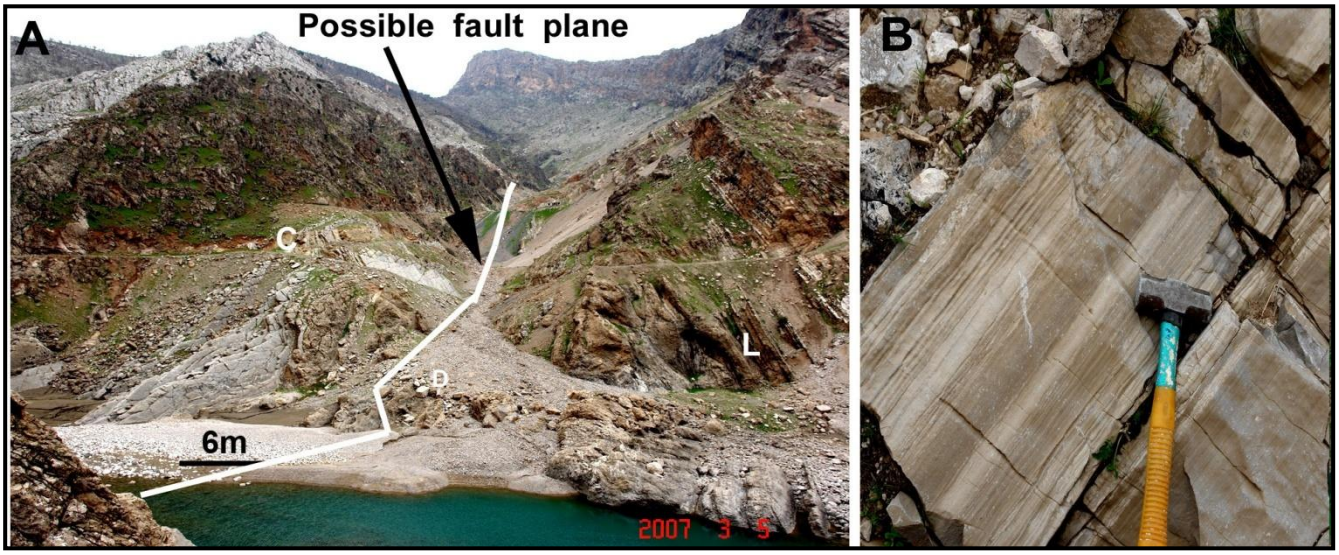

Fig.4: A) Boundary between Qamchuqa and Aqra–Bekhme formations at Bekhme inlet (according to stream flow direction) showing location of Ball and pillow-like structures(**C**), breccias (**D**). The trace of possible reverse fault is indicated across the valley surface by white line.
B) The close up photo of laminated limestone beds (**L**).

Fig.5: Extremely angular fault breccia between Qamchuqa and Aqra–Bekhme formations at the left side of inlet of Bekhme Gorge.
A) The clasts are all derived from nearby laminated beds.
B) All clasts are white thin beds of limestone that are located at the higher stratigraphically level.

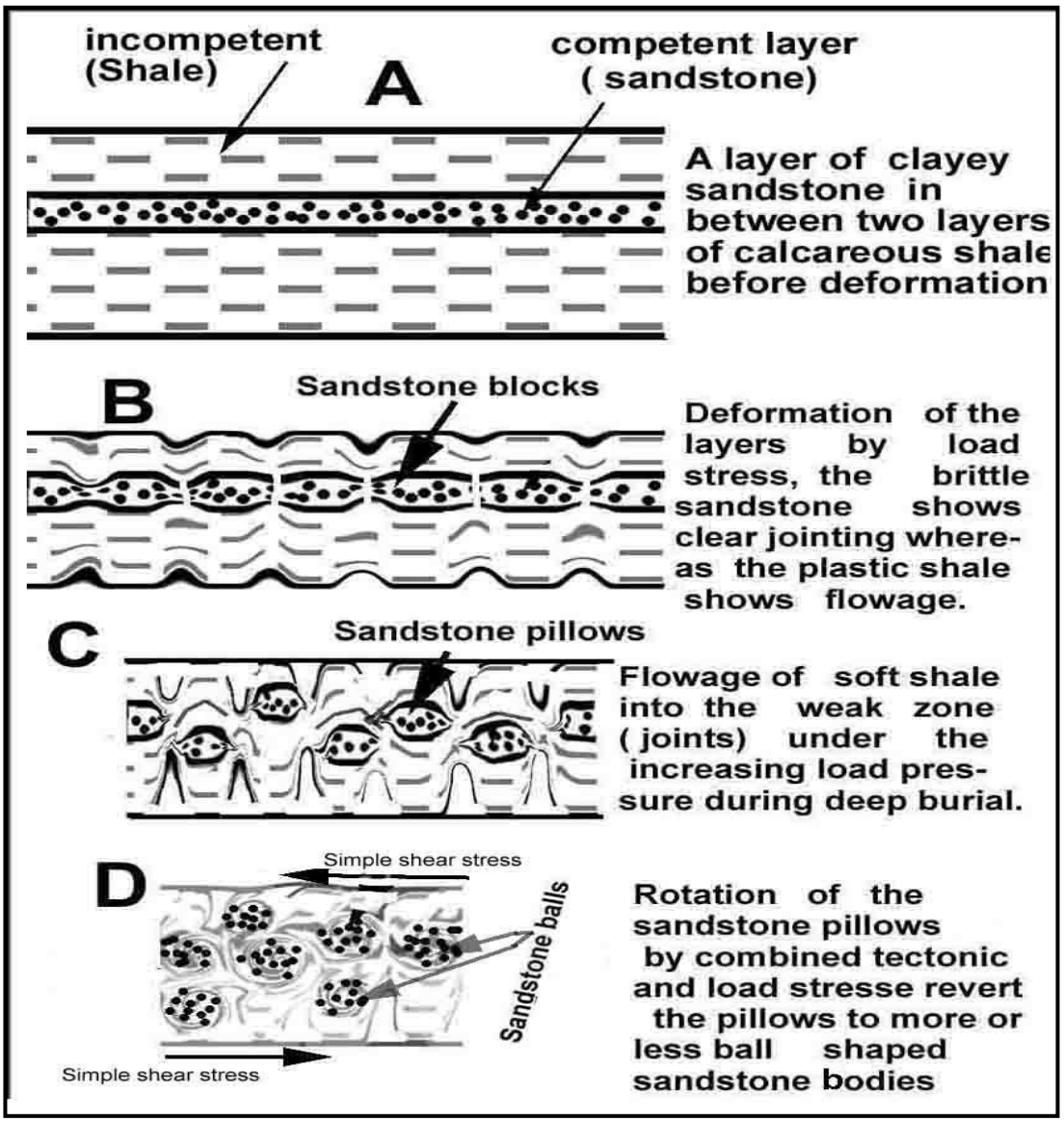

Fig.6: Four stages of development of ball and pillow structure by tectonic stresses when competent and incompetent beds are associated (Karim, 2006).

Bellen et al. (1959) have mentioned variable character and thickness of the conglomerate even over very small exposed area of the gorge section. They added that the conglomerate change laterally to marl and in other place, it is 3 meters thick and laterally changes to massive bed of about 20m thick. These conglomerate-like masses, in the present study, are found (as beds) in three localities of the inlet and outlet of the Bekhme Gorge. At these localities, the white and rounded ball and pillows are concentrated in marly matrix as beds of limestone about (0.2 -1)m thick (Figs. 4 and 7). These balls and pillows are very similar to the sedimentary conglomerate in appearance but in close looks and under microscope they are all consisting of same lithologies (fine grain limestone with same type of planktonic forams). Tucker (1990, p.163) described deep water limestones (pelagic limestones) and mentioned that they contain nodular limestone which are surrounded by clay seems due to pressure solution.

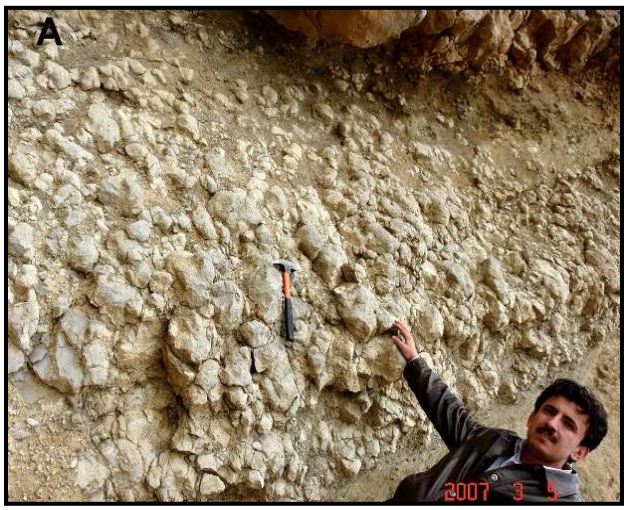

Fig.7: Conglomeritic-like ball and pillow formed in marly limestone bed near the boundary of the two formations.

The third point is that the claimed or assumed conglomerate (present ball and pillow) is located inside the bluish green marl, which contains planktonic forams. Moreover, it is not associated with sandstone or sand size clasts, this give an other evidence of non-sedimentary origin of the conglomerate that mentioned by Bellen et al (1959) and other authors. The matrix of the previously supposed conglomerate is marl. The deposition of marl and conglomerate (gravels and boulders without sand) is abnormal in the view of hydrodynamic (hydraulics grain equivalent) and sedimentologic principles, if not associated with more or less sand size grains Blatt et al. (1980).

The fourth point is that, in the 10m thick lower division of Aqra–Bekhme formations, Bellen et al. (1959) mentioned the occurrence of marl and Globigerina forams. It is clear that, the environment, across the boundary, is deepened instead of shallowing. Most possibly the environment changed from reef to fore reef environment at the boundary. In sequence stratigraphy literatures by Vail et al. (1977), Loutit *et al.* (1988), Haq (1991), Emery and Myers (1996), the conglomerate is deposited during regression (lowstand systems tract). However, the coexistence of marl and planktonic formas in the boundary is evidence of transgression (high stand system tract) and deepening. But the submarine erosions must not be excluded which occur in many formations.

The fifth point is that at the Zanta gorge 35km to the west of Bekhme gorge, the contact contains neither erosional surface nor breccias (or ball and pillows). At these localities, the massive Aqra–Bekhme Formation changes, across the boundary, to well-bedded limestone and marly limestone then changes downwards to massive Qamchuqa Formation. Therefore it seems that the contact is gradational in this locality (Fig.8).

The sixth point is that no previous studies have shown any clear photos for the occurrence of conglomerates between the two formations. Omer (2006) showed two color photos (Fig.9) for the unconformity nature of the contact between the two formations. However, none of them shows clear conglomerate, as the first one which more likely appears to be solution cavity that is covered internally by white coating (Fig.9A). The second photo (Fig.9B) shows saccaroidal dolomite. This type of dolomite could be generated by groundwater erosion. Karim, et al (2000) found same type of dolomite (they called it friable dolomite) in the Qamchuqa Formation in the southwestern limb of Piramagroon anticline. They attributed the generation of these friable dolomites to be due to the percolation of groundwater.

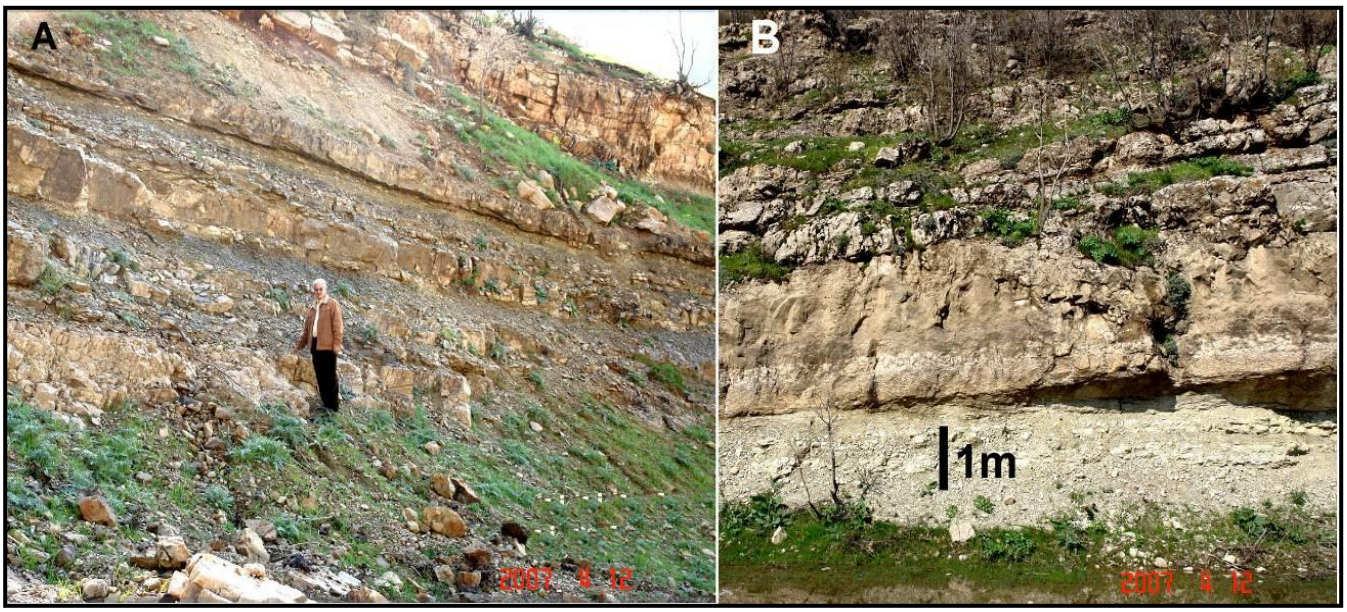

Fig.8: Boundary between Qamchuqa and Bekhme Formations at southwestern and northeastern upper limb of Perse anticline at northeast of Dinarta town. The boundary consists of intercalation of marl and bioturbated dolomitic limestone, which is possibly gradational.

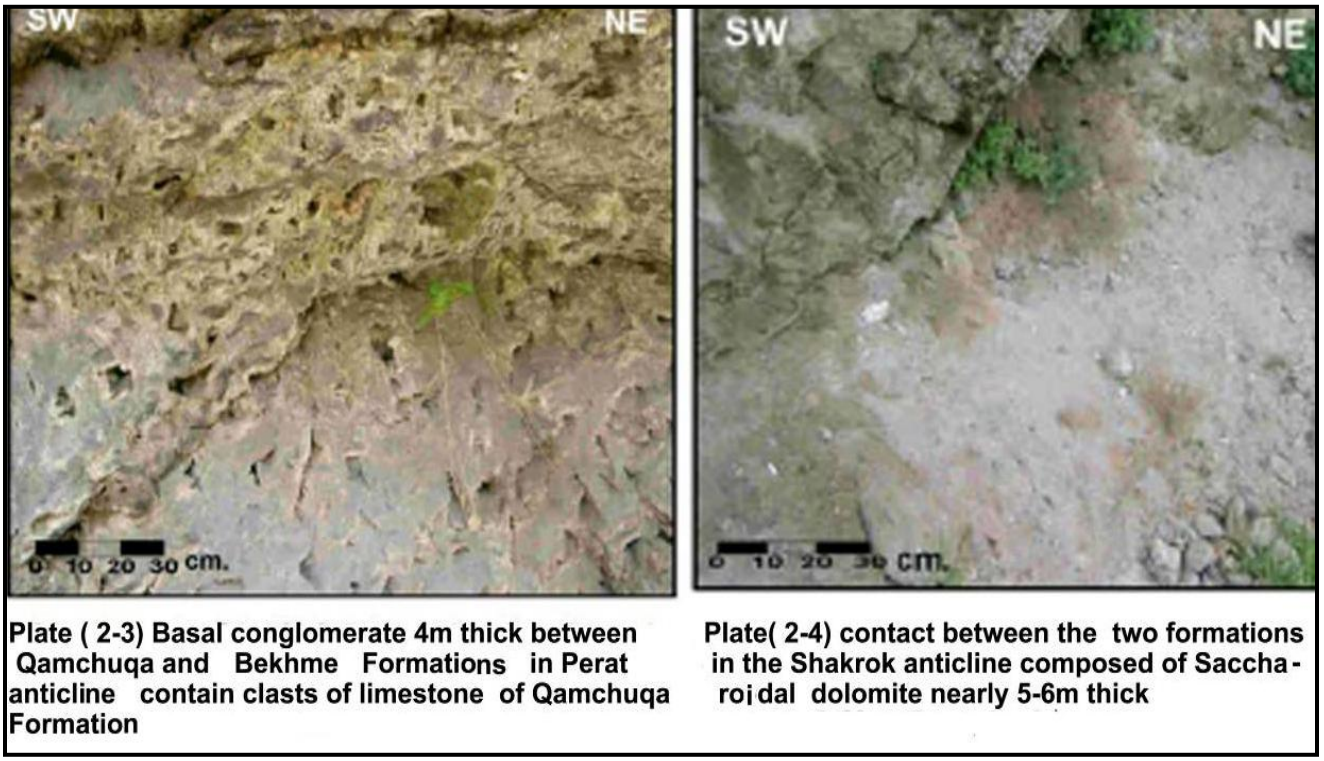

Fig.9: Two photos with their title and plate numbers as prepared by Omer (2006) for unconformity between Qamchuqa and Bekhme Formations.

The seventh point is that Sissakian and Youkhana (1984) have surveyed and mapped the area around Shaqlawa town including Safeen, Harir and Shakrook anticlines. In their survey, they are found neither conglomerate nor erosional surface between the two formations. Moreover, they have found a succession of 65 m of soft rock (green marl and marly limestone) that is located at the top Qamchuqa Formation. They claimed Albian age to this succession depending on the recorder following fossils: *Orbitulina* spp. *Valvulammina* sp., *Pseudolituonella* sp., *pseudocrysalidea* sp. *Orbitolina* cf. *discoidea*(GRAS) *Guneolina* sp., *Iraqia* sp., *Orbitolina* cf. *concava* (LMARK).Moreover, they claimed unconformable contact between the two formations. But, the authors believe that some of the identified fossils indicate Cenomanian age and the soft rock successions could be correlated with Kometan Formation, age wise

The eighth point is that Al-Jassim *et al.*(1989) studied biostratigraphy of Kometan Formation in the Qarachuq well No.1, Kirkuk and Well No. 166. In these wells they concluded and mentioned the following:

- The age of Kometan Formation Late Turonian–Early Campanian
- In two of the three wells, the Kometan Formation consists of shale and marly limestone.
- In the two wells, they did not observe any unconformity or missed ages from Turonian till Middle Campanian.

The result of the above study supports the result of the present study according to the following points:

- Kometan Formation was continuous in deposition in all northeastern Iraq, but as different facies. The well bedded limestone of type section is changed, in some place, to shale, marl and marly limestone as in the wells studied by Al-Jassim *et al.* (1989) and in the Qamchuqa Gorge as mentioned in the present study.
- If there are no unconformities, in Kirkuk–Qara Chuq vicinity areas (as mentioned by Al-Jassim, *et al*. (1989) respectively, why must be unconformity in the Bekhme Gorge and extend from Late Albian to Early Campanian as suggested by Bellen *et al.*(1959)?. This gorge is only about 50 and 100kms far from Safeen and Qarachuq anticlines respectively.

CORRELATION OF THE STRATIGRAPHIC POSITION

In the present study, samples are taken from marl, marly limestone and white limestone in the boundary zone between the two formations, but none of them yielded identifiable planktonic forams. This is true for the study of Bellen et al.(1959), Buday, (1980), Al-Qayim and Shaibani (1995), and Jassim and Golf (2006). They did not mention any index forams that were related to the boundary Zones between Qamchuqa and Bekhme formations. As the authors are aware, the study of the Al-Qaradaghy (1989) did not record any index planktonic forams for age determination across the contact. The absence of index forams either attributed to environmental constrain which was not suitable for surviving certain organisms or may be related to destruction by diagenesis. Therefore, the age determination and correlation of the stratigraphic position of the boundary zone with other sections (of same age) in the surrounding that are related claimed unconformity (or gap) are base on Bellen et al (1959).

As previously mentioned in the Bekhme gorge there is about 30m of soft lithologies between the two formations. In Kirkuk and Qarachuq areas, same lithologies are recorded by Al-Jassim *et al.* (1989) respectively. These lithologies nearly located in the same stratigraphic position and have same age of the claimed unconformity. These lithologies are well dated by planktonic zonation in the Kirkuk well No.166 and Qarachuq Well No.1. (Fig.10). The correlation is shown in Fig. (10) between these two wells with the soft lithologies of the Bekhme gore at the boundary between the two formations.

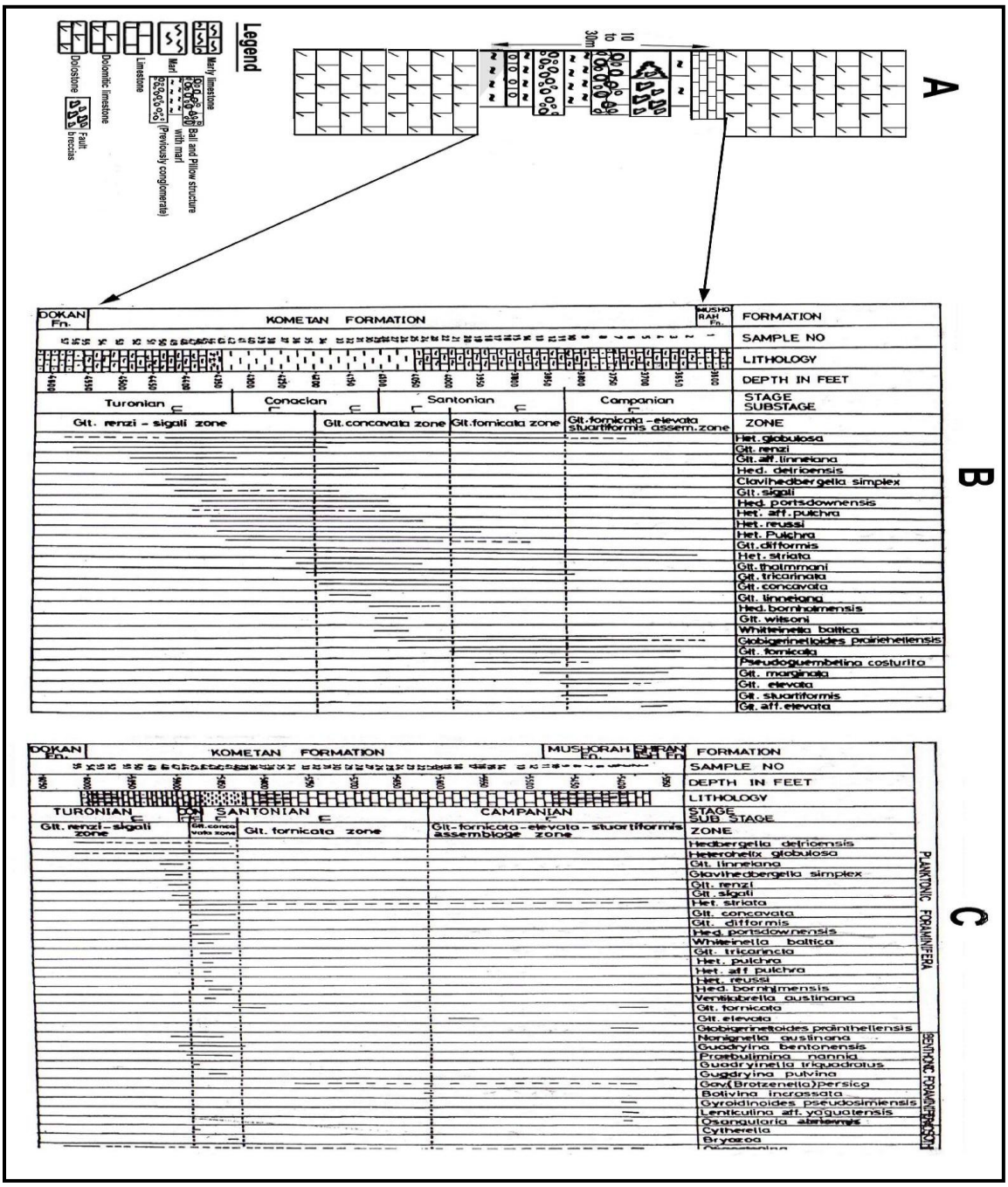

Fig.10: Correlation of the boundary zone between Bekhme and Qamchuqa Formation in the Bekhme gorge (A) with two biozonation charts of Kirkuk Well No. 166 (B) and Qarachuq Well No.1(C) by Al–Jassim et al. (1989). These authors recorded neither unconformity nor gaps in sedimentation during Turonian until Middle Campanian.

It is possible that this gap is coinciding with deposition of the relatively soft interval (marl, limestone and white limestone) that exist between the two formations in the four studied sections. In the Shaqlawa vicinity, Sissakian and Youkhana (1984) have found soft facies (marl and marly limestone) in the most upper of part of Qamchuqa Formation which may be equivalents to the soft lithologies that

are recorded in the present study in the Bekhme gorge at the boundary zone between the two formations.

DISCUSSION

The possible results of the seemingly of the conformable boundary are manifesrtted by the following points:

- The first is, it may deny the long and huge gap that exists between Late and Early Cretaceous rocks in the studied area. This gap extends from Upper Albian to Lower Campanian (Fig.11) and persisted for about 18 million years. The authors tried to prove that sediment of this gap do exist, therefore we cooked samples from the marls but the existed forams were not identifiable. This is also true for thin sections of the white limestone beds, which gave no evidences that contradict our suggestions. The clasts of breccias contain planktonic forams that younger than Cenomanian (according to K. M. Ismail, personal communication). This is aid this work, because according to our inference the age of boundary zone must be younger than Cenomanian. When removing of this gap is accepted, then whole stratigraphy of the area may be changed and new age determination and correlation is necessary.
- The second point is that according to Bellen (1959), Buday (1980) and Jassim and Goff (2006) the Qulqula Conglomerate Formation has the age of Albian-Cenomanian and represent a tectonic movement during these ages. But Baziani (2006) and Karim and Baziani (2006) refused the occurrence of the Qulqula Conglomerate Formation and requested to cancel it from the stratigraphy of Iraq. Therefore, both, the present work and those of Karim and Baziani (op cit) are evidence for absence of the intense tectonic activity, which is able to uplift and deposit conglomerate or to make a large gap that is persisted for 18 million years (Fig.11)

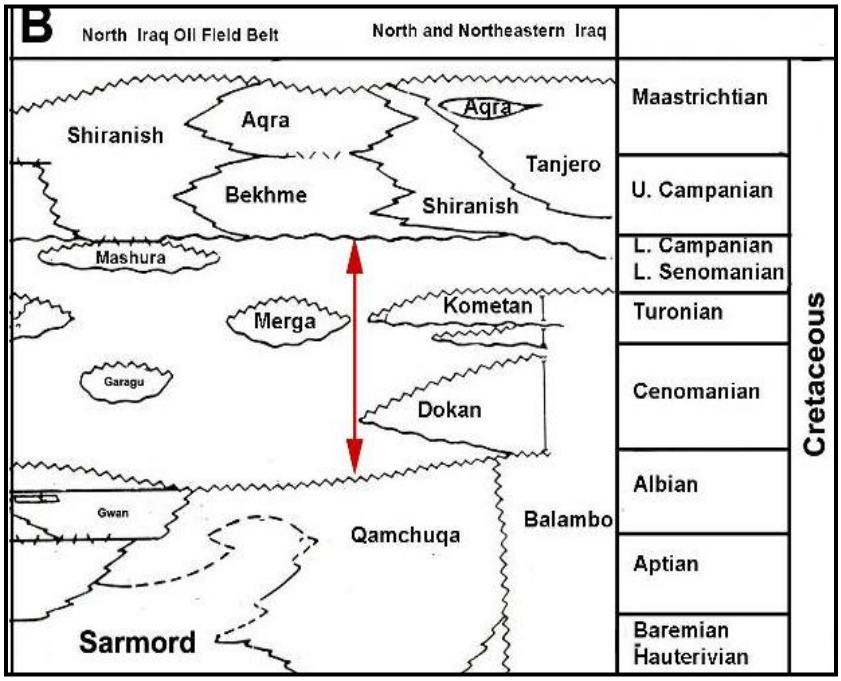

Fig. (11) The time expanded stratigraphic column of Northern and Northeastern Iraq shows the position and extent of the gap of the unconformity (Bellen et al., 1959).

- The third is, this gap, possibly coincideswith deposition of the relatively soft interval (marl, limestone and white limestone) that exist between the two formations in the four studied sections. In the Shaqlawa vicinity, Sissakian and Youkhana (1984). Moreover, this succession may be equivalent of the lowermost part of Kometan Formation, since part of the mentioned fossils by Sissakian and Youkhana (1984) indicated Cenomanian age.

CONCLUSIONS

This study has the following conclusions:

- The previous unconformable contact between Qamchuqa and Aqra-Bekhme formations is re-studied in four sections. In all these sections no conglomerate or erosional surface are observed.
- This study inferred that the contact is most possibly conformable which shows no subaerial erosion. However, submarine erosion is not excluded. The breccias which is found in the present study is fault a breccia.
- The conglomerate−like structures that are found in the boundary zone is secondary (diagenetic) in origin as they formed during burial by stress of overburden or tectonics and their ball-like shape is enhanced by weathering. .
- The boundary zone across the previous unconformable contact is suffered from deepening (deposited during highstand systems tract) in contrast to previous studies, which claimed shallowing, which was assumed to be represented by conglomerate.
- A soft interval of the marl and marly limestone occur along the contact between Qamchuqa and Aqra-Bekhme formations which makes contact more clear and traceable in the field.

REFERENCES

Al–Jassim, J. A., Al–Sheikhly, S.S.J. and Al–Tememmey, F.M. 1989. Biostratigraphy of the Kometan Formation (Late Torunian–Early Campanian) in northern Iraq. Jour. Geol. Soci. Iraq.Vol.22, N.1`.pp.53–60.

Al-Karadaghy, A. I.,1989. Microfacies study of Bekhme Formation in selected section from north and northeast of Iraq. Unpubl. M Sc thesis, University of Salahaddin. 130pp.

Al-Qayim, B. and Al-Shaibani, S., 1995. Lithostratigraphy of Cretaceous-Tertiary transects Bekhme Gore, NE- Iraq. Iraqi Geological Journal, Vol. 28, No.2, p. 127-136.

Baziani, M. M. Q., 2006. Sedimentology and stratigraphy of Qulqula Conglomerate Formation, Kurdistan Region, NE-Iraq. Unpublished M. Sc. thesis, University of Sulaimani, 103p.

Bellen, R. C. Van, Dunnington, H. V., Wetzel, R. and Morton, D., 1959. Lexique Stratigraphique, Interntional. Asie, Iraq, vol. 3c. 10a, 333 pp.

Blatt, H., Middleton, G. and Murray, R. , 1980. Origin of Sedimentary Rocks. Second edition, Prentice Hall Pupl. Co., New Jersey, 782pp.

Buday, T. , 1980. Regional Geology of Iraq: Vol.1, Stratigraphy: I.I.M Kassab and S.Z.Jassim (Eds) GEOSRVY. Min. Invest. Publ. 445pp.

Emery, D. and Myers, K. 1996. Sequence Stratigraphy. Blackwell Scientific Limited. 297pp. Haq, B. U. 1 991. Sequence stratigraphy, sea level change and significance for deep sea. Special. Publs. int. Ass. Sediment. vol.12, No.1. 12-39 p.

Jassim, S.Z. and Goff, J. C., 2006. Geology of Iraq. Dolin, Prague and Moravian Museun, Berno. 341pp.

Sissakian, V. and Youkhana, R., 1984.The study of upper most part of Qamchuqa Formation at Shaqlawa vicinity, north Iraq.. Journal of Geological Society of Iraq, vol.17, p.1–7.

Karim, K.H. Hamasur, G.A. and Mohamad, S. T. 2000. Qara-Chattan rock slide in Piramagroon anticline, NE-Iraq. Journal of Zankoy Sulaimani, Vol.3, No.1. p.33–47.

Karim, K.H. 2006 a. Origin of ball and pillow like structures in Tanjero Formation and Kolosh Formations in Sulaimanyia area, NE-Iraq , Vo. 4 No.1., p.45-53.

Karim, K.H. and Baziani , M. M., 2007 (in press). Relationship between Qulqula Conglomerate Formation and Red Bed Series at Qulqula area, NE-Iraq. Accepted four publication by Iraqi journal of Earth Science (Mosul University).

Loutit, T. S., Hardenbol, J., Vail, P. R., and Baum, G.R., 1988. Condensed section: The key to the age dating and correlation of continental margin sequences. In: sea level change: An integrated approach (Eds Wilgus. C. K., Hastings, B.S., Kendall, C. G. Posamentier, H., Ross, C. and Van Wagner, J.) Soc. Econ. Paleo. Mineral., Spec. Publ. 42 , p.183-215 p.

Omar, A. A. 2006. An Integrated Structural and Tectonic Study of the Bina Bawi-Safin-Bradost Region. Unpublished Ph. D. Thesis, University of Salahaddin, 230p.

Tucker M.E.,1991. Sedimentary Petrology, an introduction to the origin of sedimentary rocks .2nd Ed. .260 pp.

Sissakian, V. K., 2000. Geological Map of Iraq. 3rd edi., Scale 1:1000000,GEOSURV, Baghdad, Iraq.

Vail, P.R., Mitchum, R.M., Todd, R. G., Widmier, J.M. and Hatleid, W.G., 1977. Seismic stratigraphy and global changes in sea level. In: seismic Stratigraphy –Application to Hyrocarbon Exploration (ed. by C. E. Payton). Memoir of the American Association of the Petroleum Geologists, Tulsa, 26, p.49-62.