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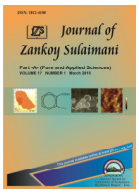

Origin of Fossiliferous Limestone Beds inside the Upper Part of Tanjero Formation at the Northwest of Sulaimani Area, Kurdistan Region, NE-Iraq

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Abstract

The present study is focused on origin of fossiliferous limestone beds that are exposed in the Chaqchaq Valley at 10 kms to northwest of Sulaimani city. These beds are exposed inside upper part of the Tanjero Formation (Upper part of Gurpi Formation in Iran) and, in this study, they are call Chaqchaq limestone. The petrography and age determination proved that they aged Late Maastrichtian and belongs to Aqra Formation (Seymare or Tarbur Formation in Iran). These beds represent the extreme distal facies of the formation. The fossil contents of these beds include large foraminiferas *(Omphalocyclus*, *Orbitoids* and *Loftusia*), fragments of Rudists in addition to solitary corals, echinoderm and gastropods. These fossils are all allochthous and reworked by submarine mass wasting from their original life position in Chwatra–Mawat area.

As the discovered outcrops are located, stratigraphically, near the boundary of Cretaceous and Tertiary ages, it has important contribution on changing paleo-geography and tectonism of northeastern Iraq during Maastrichtian and Paleocene. The paleogeography of the area was consisted of large foreland basin that was covered all north eastern Iraq without any compartmentation. Previously Aqra Formation is recorded in the Imbricated and Thrust Zones while the present study records it in the High Folded Zone for the first time in the Northeastern Iraq. This record will remove the uncertainty that associated with the relations of the stratigraphic units in the Imbricated and Thrust Zones with those of High Folded Zones. In these zones, Tanjero Formation (with Aqra Formation) and Red Bed Series are deposited during Maastrichtian and Paleocene. The occurrence of these beds inside hemiplelagite (upper part of Tanjero Formation), make the age determination of the beds and their equivalent (Aqra Formation) in the Chwarta Mawat area are possible by planktonic forms. The planktonic foraminiferas show that the age of these beds (Chachaq Limestone) is late Maastrichtian.

Introduction

In the studied area, previously, outcrops of this fossilliferous and detrital limestone are not recorded. Far to the north and northeast in the Chwarta-Mawat area outcrops of fossiliferous Aqra and Walash-Naoperdan Formations are recorded by Bellen, *et al.* (1959) [1], Buday (1980) [2] and Al- Mehadi (1975) [3]. In the latter area, Aqra Formation consists of reefal limestone with massive rudist beds, shoal facies and detrital forereef limestone (Buday, 1980[2] and Jassim and Goff, 2006) [4]. These authors cited that the age of the Aqra Formation is Maastrichtian. The overlying Formation in the type area is Kolosh-Khurmala Formations;

the contact is unconformable since there is conglomeratic bed at the top of Aqra Limestone (Buday, 1980) [2]. According to the above authors, the Aqra Formation, in the type area, is located in the High Folded Zone while in Sulaimani Governorate it is located in the Imbricated Zone. In this Zone, Al-Mehadi (1975) [3], Karim (2004[5]), Al-Kubaisy (2008) [6] and Sadiq (2009) [7] studied the formation in term of petrography, sedimentology, biostratigraphy and facies. Among these studies only the last one is concerned with tectonic and paleogeography of the formation in Chwarta-Mawat area and assigned the ramp paleogeography for the formation. The present study is the first one to record the occurrence of Aqra Formation in the High Folded Zone in Sulaimani governorate.

Location and geologic setting

The studied area is located in a large and flat bottomed valley (syncline) which is called Chaqchaq valley. The area consists of part of the Zagros Mountain belt (Fig.1) and surrounded by Piramagroon and Daban-Azimr mountains (anticlines) from southwest and northeast respectively. The valley (syncline) is consist a large syncline and show local refolding in which Tanjero and Shiranish Formations are exposed while along the crest and limbs of the surrounding anticlines, Kometan and Qamchuqa (changes to Balambo toward east and north) Formations are exposed (Fig.2). The area is about 20km far (to the northwest) from Sulaimani city, at two kms to the northwest of Kani Goran village and can be visited via a paved road (Fig.2 and 3). Tectonically the area is included in that part of the High Folded Zone that is called Balambo-Tanjero Subzone by Jassim and Goff (2006) [4]. The outcrops are restricted to the latitude N: 35 ^{o} 41^{-} 44.61$^{=}$ and N: 35 ^{o} 41^{-} 56.33$^{=}$ and longitude E:45^{o} 23^{-} 15.87$^{=}$ and 45^{o} 22^{-} 54.50$^{=}$. The center of the fossiliferous limestone outcrops is located at the intersection of N: 35^{o}41^{-} 52.28$^{=}$ E: 45^{o} 23^{-} 07.11.

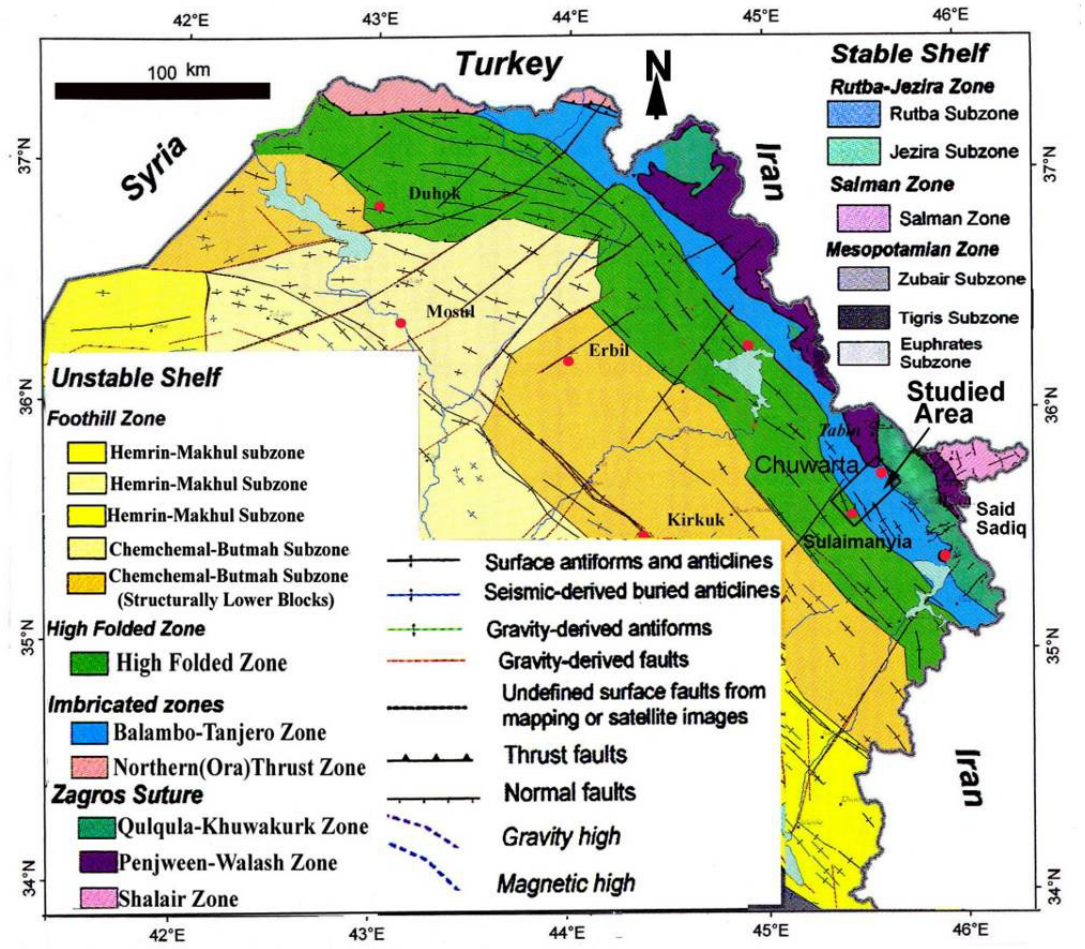

Fig.(1) Tectonic classification of the north Iraq (Jassim and Goff, 2006) [4] showing the studied area.

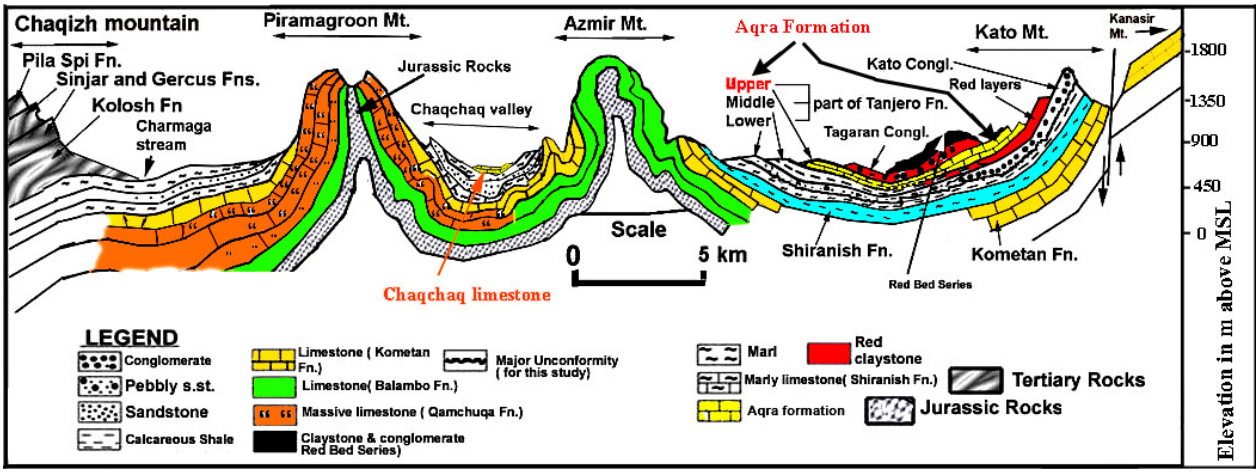

Fig. (2) Geologic cross section passing through Kato, Goizha and Baranan mountains (Karim, 2004) [5] on which the stratigraphic and geomorphologic position of the Aqra Formation is indicated in both Chwarta and Sulaimanyia areas.

Sampling and Field work

This study is achieved through field and laboratory works. During field survey the outcrop of the formation is found for the first time in the Chaqchaq valley. The extent of the outcrops are indicated and plotted on the map and google Earth images (Fig.3). Ten samples are taken from the beds for thin section preparation and many hand specimens of the fossils are collected which are numerous such as Coral, *Loftusia, Omphalocyclus, Orbitoids* and Echinoderms. Marlstones of the upper part of Tanjero Formation that are located directly below and above the fossiliferous limestone are sampled too. Four samples are taken from marlstone beds and subjected to washing method age determination by planktonic foraminiferas. To ascertaining that these beds are belonging to Aqra Formation, the collected fossils are compared with those in the Aqra formation in Chuwarta area.

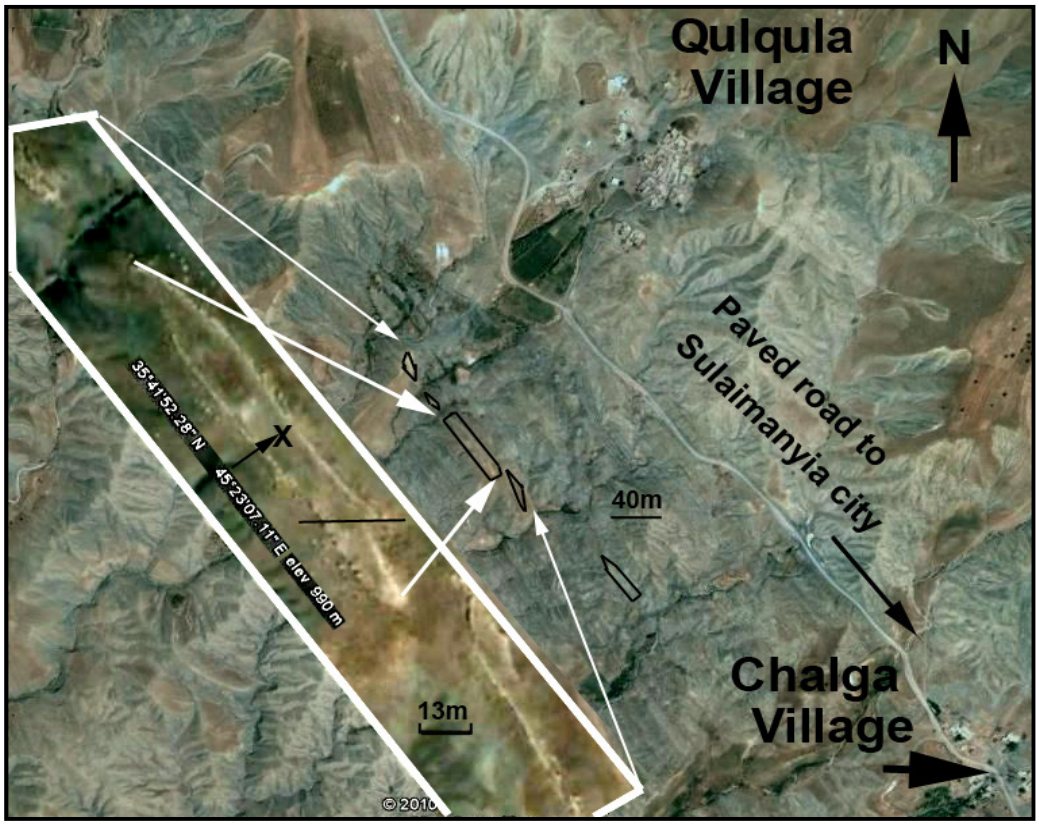

Fig (3): Location of the newly found Aqra Formation in the Chaqchaq valley, at the Northwest of the Sulaimanyiah city, Satellite Image (from Google, 2010).

Discussion

1. Lithology and stratigraphy of the beds

The outcropped beds are about 1.5 m thick and with width and lateral extend of 50m and 2000m respectively. They are either massive or crudely laminated with different type of texture such as fine grain, medium and coarse grain constituents. The limestone contains whole fossils and rudists and gastropods bioclasts and for this reason, it can be called, in place, detrital limestone. They show faint local normal graded bedding near the middle part of the outcrop to the south Qulqula village (Fig.3). The outcrops are located inside soft marl in the axis of the Chaqchaq syncline (Fig.4A). Due to these two facts the outcrops are strongly deformed by which they are separated into several blocks some of which is shaped to tight syncline. The outcrops have clear sharp and gradational boundaries with underlying and overlying marlstones respectively (Fig.4B). The lower boundary changes upward from bluish grey marl to hard fossilliferous, detrital milky limestone.

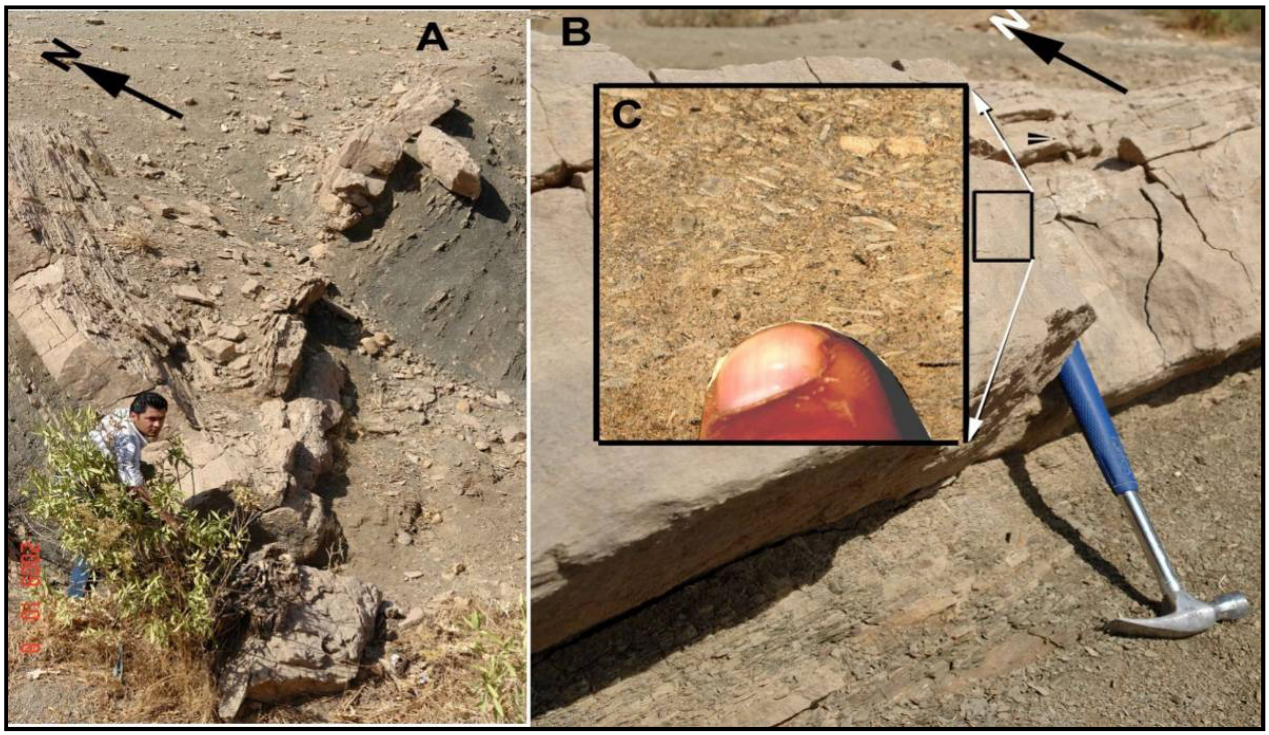

Fig. 4: Outcrop of Aqra Formation directly to the south of Qulqula Village A) highly deformed into tight syncline. B) The thickest outcrop of detrital limestone with Orbitoid forams about 1.5km to the northwest of Chalga village.

2. Comparison with Aqra Formation

The Chaqchaq Limestone can be compared and correlated with Aqra Formation at Chwarta-Mawat area lithologically, facially and paleontologically. By these, the age and basinal relations can be determined. The comparison achieved in fieldwork and by using previous studies of Mehadi (1975) [3] Sadiq (2009) [7] and Karim (2004) [5]. The best comparable properties are fossils and stratigraphic comparison. Both Aqra Formation and Chaqchaq limestone contain the below fossils and their bioclasts.

2.1. Loftusia

Al-Omari and Sadiq (1977) [8] studied *lofusia* from the Maastrichtian type locality of Aqra Formation Formation. Sadiq (2009) [7] found these fossils in three studied sections as the most abundant and easily identifiable fossils in Chwarta–Mawat area. The genus is abundant in Arabo Iranian platforms and rare in eastern Mediterranean and totally absent in western Mediterranean (Zambetakis et al, 2004) [9]. According to Meric and Mojob, (1977) [10], this genus has complex chamber wall that are represented by several

species confining mostly to Maastrichtian and are reported from Middle East, Eastern Turkey, Iran, Iraq, Qatar and Oman in the Tethys and no record further in the east. They noticed that during this period the genus exhibited a gradual increase in size (length and diameter).

According to Bracier (1980) [11], *loftusia* is benthic foraminifera of Maastrichtian age and has planispiral fusiform shape with the size of small oak (about 1cm in diameter and 2.5 cm in length). The test is non-lammilar agglutinated with calcareous cement, calcitic wall structure. The shell has labyrinthic wall with Irregular septa and chamberlets. Chaqchaq Limestone contains abundant *loftusia* (Fig.5A) which shows parallel arrangement of elongated axis which is shows southwest sediment transport during Late Maastrichtian.

2.2. Omphalocyclus

According to Ozcan (2007) [12], the occurrence of Omphalocyclus in different stratigraphic levels, ranging in age from Campanian to late Maastrichtian in Turkey is documented. The genus is quite rare in the (late) Campanian, becoming more frequent in late Campanian early Maastrichtian and late Maastrichtian beds. Enos et al (1995) [13] found this fauna in the Maastrichtian rocks of Marshall Islands and considered it as Maastrichtian index. *Omphalocyclus* is benthic foraminifera, known from the relatively shallow-water paleoenvironment located in the outer parts of the Late Cretaceous Tethyan platforms. The mineralogy of this type of the forams is calcitic by which the shell microstructure is well preserved which similar to *Orbitoid* but with larger and discoidal shape instead of fusiform. It is common in both Chaqchaq limestone and Aqra Formation at Chwarta-Mawat area (Fig.6A).

Fig. (5) Collected of *Loftusia* (A) and solitary Coral (B) from Chaqchaq limestone

2.3. Orbitoides

The test of *Orbitoides* is lenticular with a circular outline, and can reach a diameter of up to 5 cm (Loeblich and Tappan, 1988) [14]. The test is biconvex, often with one side more elevated. The surface is ornamented with small knobs. Its mineralogy is calcite by which the ornamentation of shell is well preserved and exist in detrital limestone (with litho- and bioclasts) (Fig.4 A and B). The genus *Orbitoides* displays some of the widest latitudinal and longitudinal extensions among the larger Upper Cretaceous foraminifera. The particularly wide distribution over the circumtropical warm water belt of the Cretaceous ocean is comparable to the distribution of modern Amphisteginids (Langer and Hottinger, 2000) [15] and thus particularly valuable tracer in indicating of circumglobal warm water surface currents and the heat transfer towards higher latitude.

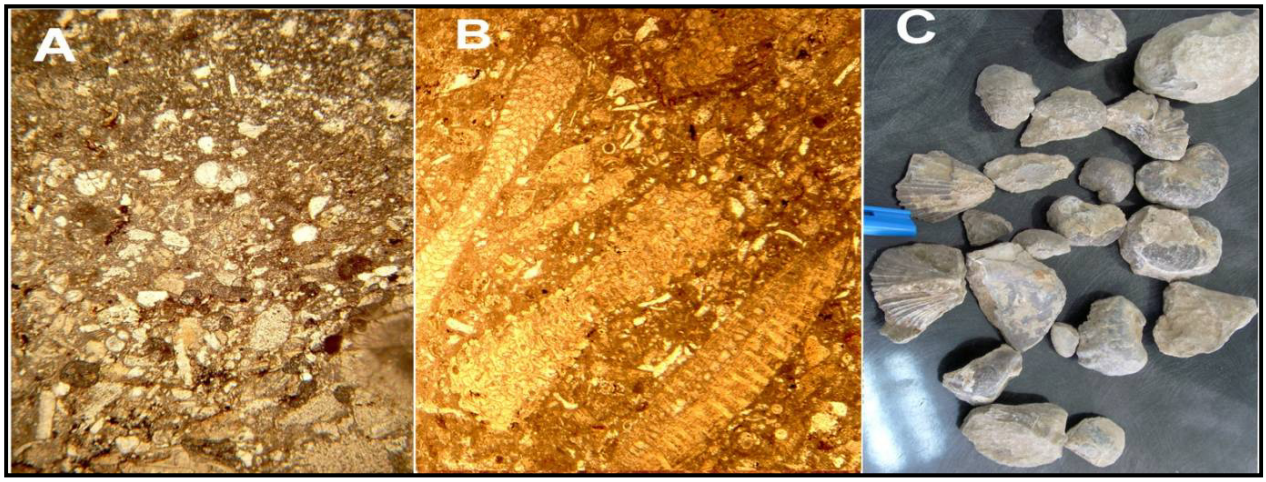

Fig. (6) A) normal graded bedding in the bioclastic packstone (X20). B) Longitudinal sections of *Omphalocyclus* (in the middle and Upper left) and Orbitoide (lower right (X30). C) Pelecypods in the Chaqchaq limestone.

3. Paleogeography

In the Sulaimani area, previously Aqra Formation is recorded only in the Imbricated and Thrust Zone at about 20km to the north of the Chachaq valley at Chwarta and Mawat area and Qandil Mountain. The record of the Aqra Formation in the High Folded Zone, directly to the northwest of Sulaimani city, has the following important result on the tectonic and paleogeography of the area. First, as Aqra Formation, in the studied area is deposited during Late Maastrichtian, it is a key for the paleogeography and tectonics of Late Cretaceous and Early Tertiary. The transport of the sediments of Chaqchaq Limestone by submarine turbidity and mass wasting is evidence from the lithology, fossils and sedimentary structure content of the limestone. Sadiq (2009) [7] found clear erosional surface in the middle part of Aqra Formation at 20km to the north of Chaqchaq valley near of Mawat Town (Fig.7). She added that the surface is overlain bioclastic grainstone.

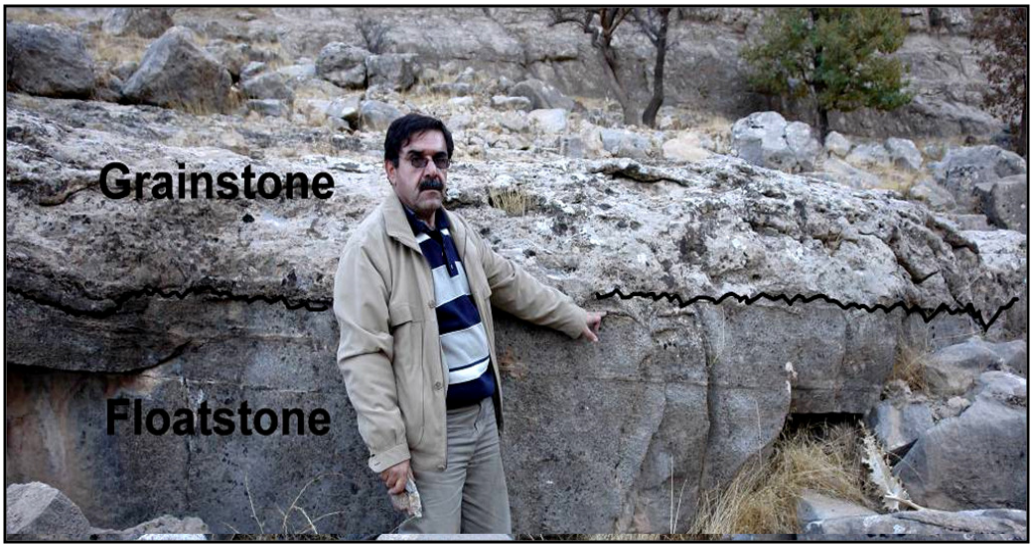

Fig. (7) The erosional surface between grainstone and underlying floatstone (Sadiq, 2009) [7] at 8km southwest of Mawat town. This surface can be correlated with that is located under Chaqchaq limestone.

It is possible that this erosion surface (Fig.8) may be correlated with the surface that is located below the Chaqchaq limestone. Secondly, the record of Chaqchaq limestone is a factor for removing of the uncertainty that is associated with the relation of the stratigraphic units in the Imbricated and High Folded Zones during Maastrichtian and Paleocene. The result shows that the Aqra and lower part of Red Bed Series (Paleocene),

in the Imbricated Zone, are laterally connected to the Tanjero and Kolosh Formations in the High Folded Zone and deposited in same foreland basin. This is shown in the conceptual model which is constracted according to field work and paleontological study (Fig.9). Previously, these relation between unit of High and Imbricate Zones are discussed and proved sedimentologicaly by Karim (2004) [4] and Al-Barzinjy (2005) [16] but without paleontological evidences that are shown in the present study.

Fig. (8) The Chaqchaq limestone has sharp contact inside blue marlstone of upper part of Tanjero Formation. The limestone is shaped into tight and asymmetrical syncline at 500m south of Qulqula village

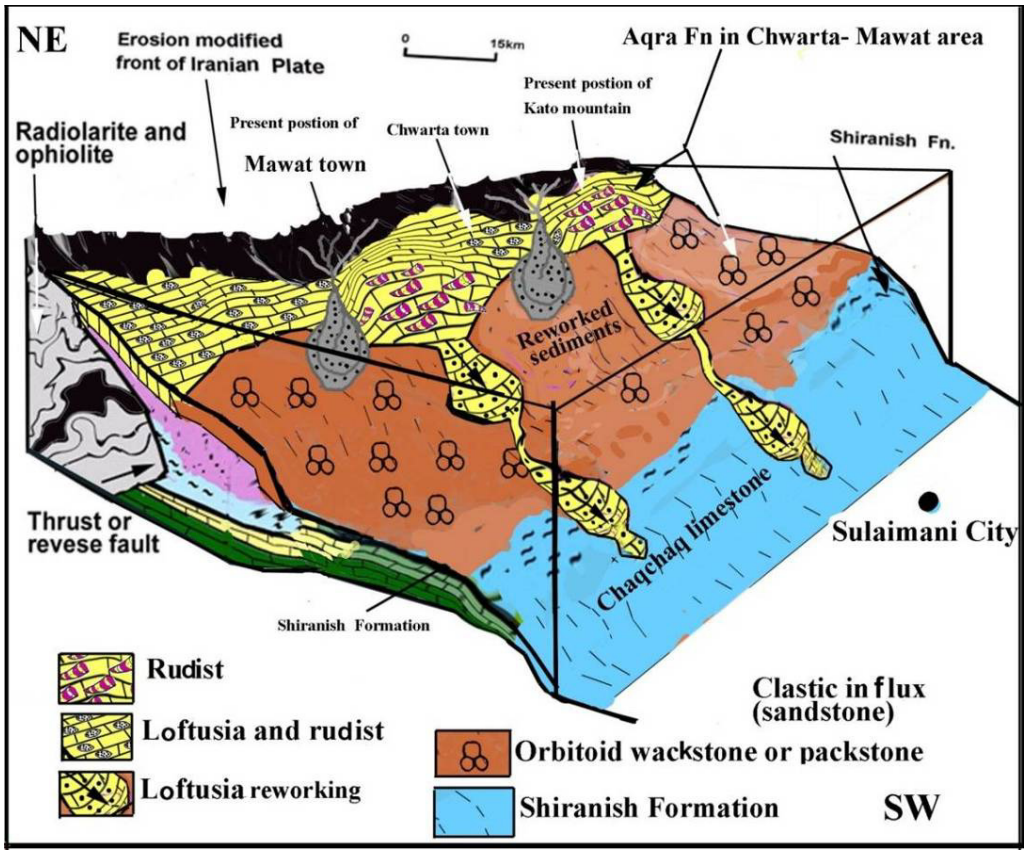

Fig. (9) Paleogeography of the studied area during late Cretaceous and Paleocene (Modified from Sadiq, 2009) [7].

4. Biostratigraphy

In this study six samples were collected for indicating the age of Chaqchaq limestone by microfossils. The samples are taken from the marlstone beds of Tanjero Formation that are overlying and underlying the limestone. Three samples are taken below the limestone in 1m intervals and three samples above it which provided abundant well preserved forms. The samples revealed high diversity of Globotruncanids, Rugoglobigerinids, Globigerinids and Heterohelicids planktonic foraminifera. In which Thirty five Planktonic Foraminiferal species belonging to thirteen genera were recorded in studied section along 10m thick (Plate 1, 2).among the identified planktonic foraminifera like *Heterohelix globulosa* (Ehrenberg), *Heterohelix nauttalli* (Voorwijk), *Heterohelix striata* (Ehrenberg), *Heterohelix punctulats* (Cushman), *Rogoglobigerina rugosa* (Plummer), *Rogoglobigerina hexcamerata* Bronnimann, *Rogoglobigerina macrocephala* Bronnimann, *Rogoglobigerina rotundata* Bronnimann, *Globotruncanita stuarti* (de Lapparent), *Globotruncanita stuartiforms* Dalbez, *Globotruncanita conica* White, *Globotruncanita angulata* Tilev, *Rugotruncana circumnodifer* (Finly), *Globotruncana aegyptica* Nakkady, *Globotruncana rosetta* (Carsey)., *Globotruncana falsostuarti* Sigal, *Globotruncana arca* (Cushman), *Globotruncana bulloides* Vogler, *Globotruncana ventricosa* White, *Globotruncana dupeublei* Caron et al. *Contusotruncana fornicata* (Plummer), *Contusotruncana contusa* (Cushman), *Contusotruncana plicata* White, *Contusotruncana walfischensis.* Todd, *Globotruncanella petaloidea (*Gandolfi), *Pseudotextularia elegans (*Rzehak), *Pseudotextularia intermedia (*De Klasz). *Rascemiguembelina fructicosa* (Egger), *Globigerinelloides bentonensis* Morrow, *Globigerinelloides subcarinata* Bronnimann, *Archaeoglobigerina blowi*. Pessango, *Archaeoglobigerina cretacea*. (dOrbigny), *Hedbergella monmothensis* (Olsson), *Hedbergella holmdelensis* Olsson, *Kuglerina rotondata.* (Bronnimann And three samples collected from detrital limestone ridge of Aqra lenses and shows high concentration of benthonic foraminiferal genera like *Luftosa, Orbitoides, Omphalocyclus, Lepidorbitoides, Pseudorbitoides, Siderolites, Rotalia, Textularia.*

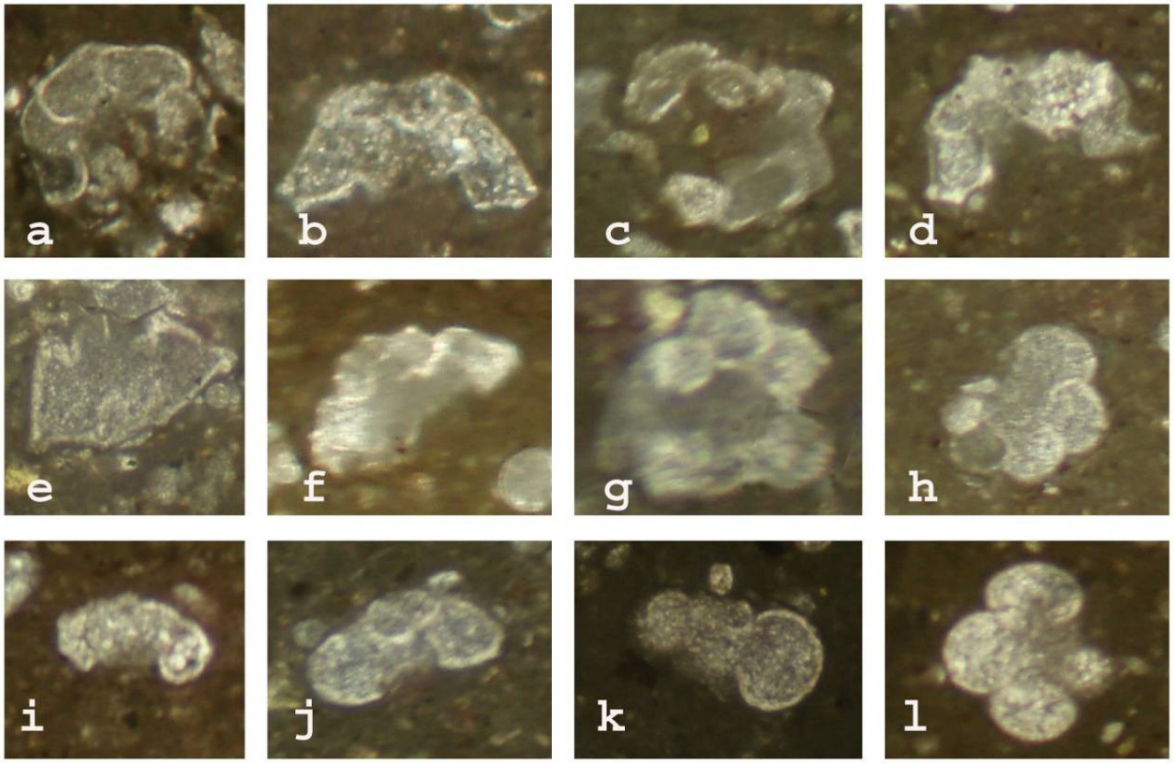

Plate:1 Figures from Aqra ridge, Chalga section, Late Maastrichtian, Specimen from *Racemiguembelina fructicosa* Zone. Figs: **a, b**:*Contusotruncana patolliforms.* (Gandolfi), X 100**; c, d:** *Contusotruncana walfischensis.* Todd, 100X **; e:** Globotruncana roseta (Garsey) X 100; **f:** *Globotruncana* dupeublei, caron, Gonzalez, Donsoso, Robaszynski and Wonders X 100; **g:** *Racemiguembelina fructicosa* (Egger) 100X; **h:** *Rugoglobigerina rugosa*. (Plummer), X 100**; i:** *Archaeoglobigerina cretacea*. (d Orbigny), 100X; **j:** *Archaeoglobigerina blowi*. Pessango, X 100; **k, l:** *Hedbergella monmuthensis* (Olsson), 100X.

The Planktonic Foraminiferal zonation for the sediments in tropical/subtropical regions, like Li and Keller (1998a and b) [17] [18], Keller (2002[19] and 2004) [20], Abramovich *et al.* (2002) [21], Abramovich and Keller (2003) [22], Samir (2002) [23], Obaidalla (2005) [24]and Sharbazheri (2007[25], 2008[26] and 2010[27]) are used exclusively as the biostratigraphic framework in this study.

According to the above mentioned Planktonic foraminiferal recording this interval located within *Racemiguembelina fructicosa* Zone or (CF4) which is introduced by Li and Keller (1998 a ,b) [17] [18] as a biostratigraphic interval between FAD of *Racemiguembelina fructicosa* (Egger) at the base and the FAD of *Pseudoguembelina hariaensis* at the top. The occurrence of *Racemiguembelina fructicosa* (Egger) in the studied section at the lower part and upper part of this section recorded in this stratigraphic section of Tanjero Formation and the occurrence of *Pseudoguembelina hariaensis* not observed here in the studied section.

Most of the workers in the zonal scheme placed *Racemiguemblina fructicosa* Zone at the Early Late Maastrichtian, Keller *et al*., (1995) [28], Li and Keller, (1998a&b) [17] [18], Premoli Silva and Sliter (1999) [29], Abramovich *et al*., (2002) [21], Samir (2002) [23] and Obaidalla (2005) [24], Sharbazheri (2007[25], 2008[26] and 2010[27]). As defined above, the present biozone (CF4) is correlatable with the lower part of *Abathomphalus mayaroensis* of Abawi *et al*., (1982) [30], Robaszynski *et al*., (1984) [31], Caron (1985) [32], Abdel-Kareem (1986b) [33] and Premoli Silva and Sliter (1995[34], 1999[29]).

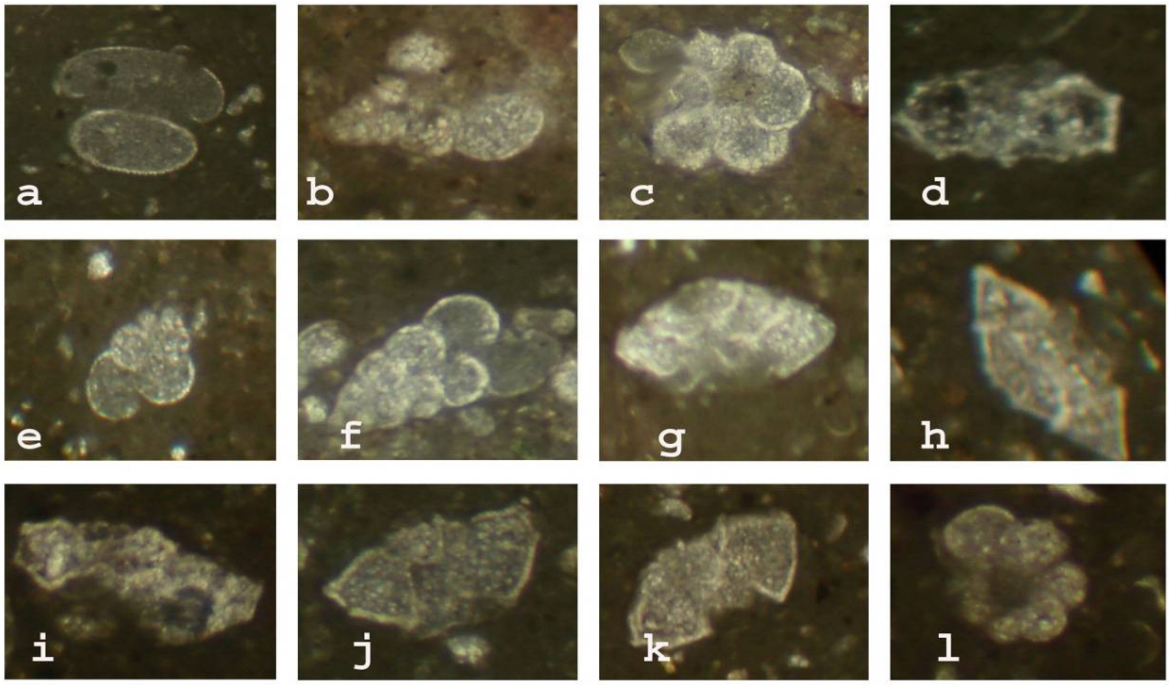

Plate:2 Chalga section, Late Maastrichtian, **Specimen from *Racemiguembelina fructicosa* Zone.**
Figs: **a** *Pseudotextularia elegans.* (Rzehak), X 100; b *Pseudotextularia intermedia.* De Klasz, X 100; **c** *Rugoglobigerina hexacamerata.* Bronnimann. X 100; d Rugotruncana subcircumnodifer (gandolfi) X 100; e *Heterohelix punctulata.* Cushman, X 100; **f** *Heterohelix globulosa.*(Ehrenberg), X 100; **g ,h** *Globotruncanita conica* White, X 100; **i** *Globotruncana aegyptica* Nakkady**; j, k** *Globotruncana arca* (Cushman) X 100; **l** *Rugoglobigerina rotundata*. Bronnimann. X 100.

Conclusions

This study has concluded the following:

1. The Aqra Formation at northwest boundary of Sulaimani city consist of fossiliferous and biogenic detrital limestone with *Omphalocyclus*, *Loftusia*, solitary coral and *Orbiroides* fossils.
2. The limestone is transported by submarine mass wasting from neritic environment in Chwart-Mawat area to deep environment at present position.

3. In the Thrust and High Folded Zones, Tanjero and Aqra Formations were sharing same basin and tectonic setting during late Cretaceous in large foreland basin without paleoridge between them.
4. The age of the Chaqchaq limestone is late Maastrichtian.

References

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

[2]Buday, T. 1980. Regional Geology of Iraq: Vol. I, Stratigraphy:I.IM Kassab and S.Z. Jassim (Eds) D.G. Geol. Surv. Min.Invest.Pub. 445p.

[3]Al-Mehaidi, H. M. 1975. Tertiary Nappe in Mawat Range, N.E Iraq, Jour. Geol. Soc. Iraq, vol. 8, p. 31-44.

[4]Jassim, S.Z. and Goff, J.C.2006. Geology of Iraq. Published by Dolin, Prague and Moravian Museum, Berno. 341p.

[5]Karim, K.H. 2004. Basin analysis of Tanjero Formation in Sulaimanyia area, NE-Iraq, Ph.D. thesis, University of Sulaimaniyai, 135 p.

[6]Al-Kubaysi, K. N. 2008. Biostratigraphy of Aqra, Tanjero and Shiranishs Formation in Chwarta Area, Sulaimanyah Governorate, NE-Iraq. Iraqi Bulletin of Geology and Mining, Vol.4, No. 5, p.1-23.

[7]Sadiq, D. M. 2009. Facies analysis of Aqra Formation in Chwarta-Mawat Area from Kurdistan Region, NE–Iraq.Unpublished MSc thesis, College of Science, University of Sulaimani.105p.

[8]Al-Omari, F. S. and Sadiq, A., 1977. Geology of North Iraq (in Arabic). Mosul University Press, pp.197.

[9] Zambetakis, L. and A. Kemeridou, 2004. Lofusia cf. anatolica horizon in upper maestrichtian limestone of the Eastern Greece platform., Bulletin of the Geological Society of Greece, XXXVI: 792-79.

[10]Meric. E., and Mojab, F., 1977. World-Wide Geographical distribution of the species of the foraminfieral genus Lofusia. Instabul. Univ. fen. Fak. Mec. Seri B. 42(1-4) p.143 - 155.

[11]Bracier M (1980) Microfossils. George Allen and Unwire, London.

[12]Özcan, E. (2007) Morphometric analysis of the genus Omphalocyclus from the Late Cretaceous of Turkey: new data on its stratigraphic distribution in Mediterranean Tethys and description of two new taxa Original Research Cretaceous Research, Volume 28, Issue 4, p.621-641.

[13]Enos, P, Camoin, G F. and Ebren,. P 1995.Sedimentary Sequence from Sites 875 and 876, outer Perimeter Ridge, Wodejebato Guyot (in Haggerty, J.A., Premoli Silva, L, Rack, F., and McNutt, M.K. (Eds.), Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 144.

[14]Loeblich, A. R. & Tappan, H.1988. Foraminiferal Genera and their Classification (2 vols). New York: Van Nostrant Reinhold; London: Chapman & Hall. 213 pp.

[15]Langer, M.R. & Hottinger, l., 2000.Biogeography of selected "larger" foraminifera, Micropaleontology, 46 (Suppl. 1): 105-126.

[16]Al-Barzinjy, S. T. M., 2005. Stratigraphy and basin analysis of Red Bed Series from northeastern Iraq-Kurdistan Region. Unpublished Ph.D. thesis, University of Sulaimani University, 159p.

[17]Li, L. and G. Keller., 1998a. Maastrichtian climate, productivity and faunal turnover in planctonic foraminifera in South Atlantic, DSDP sites 525A and 21. Marine Micropaleontology. Vol.33, p.55-86.

[18]Li, L. and G. Keller., 1998b. Diversification and extinction in Campanian -- Maastrichtian planktonic foraminifera of northwest Tunisia. Ecol. Geol. Helv.,91:p. 75-107.

[19]Keller, G., 2002. Guembelitria-dominated Late Maastrichtian planktonic foraminiferal assemblage mimic early Danian in central Egypt. Marine Micropaleontology.Vol. 47, pp.129-167.

[20]Keller, G., 2002. Guembelitria-dominated Late Maastrichtian planktonic foraminiferal assemblage mimic early Danian in central Egypt. Marine Micropaleontology.Vol. 47, pp.129-167. Keller, G., 2004. Low diversity, Late Maastrichtian and Early Danian planctonic foraminiferal assemblages of the eastern Tethys. Journal of Foraminiferal Research, vol.34, no, 1, p.49-73.

[21]Abramovich, S. Keller, G. Adatte, T. Stinnesbek, W. Hottinger, L. Stueben, D. Berner, Z. Ramanivosa, B. and Randriamanantenasoa, A., 2002. Age and paleoenvironment of Maastrichtian to Paleocene of the Mahajanga Basin, Madagascar: a multidisciplinary approach. Marine Micropaleontology.vol. 47, p.17-70.

[22]Abramovich, S. and Keller, G., 2003. Planktonic foraminiferal response to the Latest Maastrichtian abrupt warm event: a case study from South Atlantic DSDP Site 525A. Marine Micropaleontology. vol. 48, p.225-249.

[23]Samir, A. M., 2002. Biostratigraphy and paleoenvironmental changes in the Upper Cretaceous-Early Paleogene deposits of Gabal Samara section, Southwestern Sinai, Egypt. Egypt. Jour. Paleontol., Vol. 2, p. 1-40.

[24]Obaidalla, N. A., 2005. Complete Cretaceous/Paleogene (K/P) boundary section at Wadi Nukhul, southwestern Sinai, Egypt: inference from planktonic foraminiferal biostratigraphy. Revue de Paleobiologic, Geneve (2005) Vol. 24. (1):p. 201-224.

[25]Sharbazheri, K. M., 2007. Aging of Unconformity within Tanjero Formation in Chwarta Area Northeast of Iraq (Kurdistan Region). Iraqi Journal of Earth Science, Vol. 7, No.1, p.37-54.

[26] Sharbazheri, K. M., 2008. Biostratigraphy and paleoecology of the Cretaceous/tertiary boundary in the Sulaimani region, Kurdistan, NE-Iraq. Unpublished PhD. Thesis, University of Sulaimani, 200p.

[27]Sharbazheri, K. M., Khanaka, P. A., and Karim, K. H., 2010. Biostratigraphy of bluish marl succession (Maastrichtian) in Sulaimanyia area, Kurdistan Region NE- Iraq. in press, Accepted in International Symposium on Foraminifera September 5 – 10, 2010 , Bonn, Germany . p. 12,181.

[28]Keller, G. Li, L. and Maclleod, N., 1995. The Cretaceous/ Tertiary boundary stratotype section at El Kef, Tunisia: how catastrophic was the mass extinction? Paleogeography. Paleoclimatology. Paleoecology. 199, p. 221-254.

[29]Premoli Silva, I. and Sliter, W. V., 1999. Cretaceous Paloceanography: Evidence from planktonic foraminiferal evolution, in Barrera, Geological Society of America Special Paper 332, pp 301-328.

[30]Abawi, T.S., Abdel-Kireem, M. R. and Yousef G. M, 1982. Planktonic foraminiferal stratigraphy of the Shiranish Formation, Sulaimaniah- Dokan region, NE Iraq. Revista Espanola de Micropaleontologia , 14 (1).

[31]Robaszynski, F., Caron, M., Gonzalez, D. J. M. and Wonders, A. A.H., 1984. Atlas of Late Cretaceous Globotruncanids Revue de Microp., 26, 3-4, p.145- 305.

[32]Caron, M., 1985. Cretaceous planktic foraminifera. in Bolli, H.M., Saunders ,J.B. and Perch-Keller, G., 2002 Guembelitria-dominated Late Maastrichtian planktonic foraminiferal assemblage mimic early Danian in central Egypt. Marine Micropaleontology.Vol. 47, p.129-167.

[33]Abdel Kireem, M. R., 1986 b. Planktonic foraminifera and stratigraphy of the Tanjero Formation (Maastrichtian), northeastern Iraq. Micropaleontology, Vol.32, no.3, p.215-231.

[34]Premoli Silva, I. and Sliter,W. V., 1995. Cretaceous planktonic foraminiferal biostratigraphy and evolutionary trends from the Bottaccione section. Gubbio, Italy :Paleontographia Italica.v. 82. P. 1-89.