AGE DETERMINATION AND ORIGIN OF CRENULATED LIMESTONE IN THE EASTERN PART OF SULAIMANIYAH AREA, KURDISTAN REGION, NE IRAQ

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ABSTRACT

Many outcrops of crenulated limestones are observed in eastern part of Sulaimaniyah area. These limestones are deformed into tight and/ or open mesoscopic folds, which are superimposed on larger-scale synclines or anticlines. The outcrops are discussed and the biostratigraphically is analyzed. The identified planktonic foraminifera indicated that these limestones belong to Kometan Formation and its age extends from Turonian to Late Campanian. The age determination depends on the index planktonic foraminifera; such as *Marginotruncana sigali* and *Dicarinata imbricate* indicate Turonian age, whereas *Dicarinata primitivae* indicate Coniacian age, *Dicarinata asymmetrica*, indicates Santonian age and *Radotruncana calcarata* indicates early Late Campanian age.

تحديد عمر ودراسة أصل الحجر الجيري المتجعد في الجزء الشرقي من منطقة السليمانية، شمال شرق العراق

عماد محمود غفور، كمال حاجي كريم و مشير مصطفى البازياني

المستخلص

تم ملاحظة العديد من المكاشف المتجعدة للحجر الجيري في شرق منطقة السليمانية. إن هذه الصخور مشوهة إلى طيات ضيقة أو مفتوحة صغيرة الحجم والمتراكبة على طيات أكبر.

من خلال تحليل الطباقية الحياتية للصخور المتكشفة ظهر أن المكاشف تعود إلى تكوين كوميتان. إن المدى الجيولوجي للفورامنيفرا الطافية الموجودة يمتد من التورونيان إلى الكامبانيان المتأخر. واعتمد هذا العمر على الأنواع الدالة من الفورامنيفرا الطافية لعمر التورونيان والمتمثلة بالنوعين *Dicarinata imbricate* و *Marginotruncana sigali* وكذالك لعمر الكونياسيان والمتمثلة بنوع *Dicarinata primitivae* ولعمر السانتونيني والمتمثلة بنوع *Dicarinata asymmetrica* ولعمر الكامبانيان مبكّر المتأخر والمتمثلة بنوع *Radotruncana calcarata*.

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INTRODUCTION

The eastern part of Sulaimaniyah Area includes outcrops of crenulated limestone, which can be seen sporadically in the eastern and northeastern boundary of Sharazoor Plain in several places, especially near Said Sadiq town. In the present study, three localities are inspected and only one of them is sampled (Fig.1). The first place (X_1) (sample one) is located directly to the northwest of Said Sadiq town at the latitude and longitude of N: 35º 21' 26.25", E: 45º 51' 16.13" (Fig.2). At this locality, the crenulated limestone exists as a large hill, which is called Ashbolagh hill and it is 130 m high. The second outcrop (X_2) is located 2 Km to the northwest of Greza village, which forms the peak of the mountain with the same name. The third outcrop (X_3) is located on the Shinarwe Mountain; about 6 Km to the east of Halabja town (Fig.1).

The crenulations, in the aforementioned three areas, consist of tight or open mesoscopic folds, which are superimposed on larger-scale syncline (Fig.2). The folding occurred in the beds of well bedded white, fine crystalline limestone. In many places, the axes of the folds are very clear in 3D relief on the surface of the outcrops of the Ashbolagh hill (Fig.3). Thin section study showed that the lamination origin is not primary; as it is neither biogenic (stromatolitic) nor physically deposited. It has secondary origin, which is developed by pressure and flexure slip during folding.

The stratigraphic origin of these rocks are not known exactly as many authors (such as Ma'ala, 2007 and Ali, 2008) mapped the area and not differentiated the carbonate rocks of the Early and Late Cretaceous formations (Balambo, Dokan, Gulneri and Kometan formations). Bellen *et al*. (1959) cited that Kometan Formation does not exist in the Sirwan Valley. Lithologically, the crenulated limestone is very similar to Kometan Formation and upper part of the Balambo Formation. The type locality of the Balambo Formation is close to the studied area (about 25 Km) and its upper part (as seen by authors) consists of well bedded milky limestone (Fig.4).

The aim of this study is to differentiate and separate the crenulated limestone from the other units in the studied area. The methods of the study included field work and collection of 100 samples, which are regularly sampled and thin sectioned for each sample. The thin sections were inspected under polarized and stereoscopic microscopes.

According to Bates and Jackson (1980), crenulations are small scale folding (wave length up to a few millimeters) that is superimposed on large-scale folding. Crenulations may occur along the cleavage planes of deformed rocks. Richard (1961) mentioned that crenulation cleavage differs essentially from slaty and fracture cleavages, it is only developed in laminated rocks and consequently it is always similar to a secondary structure. Variety of planar features form in rocks, these can be conveniently divided into primary and secondary produced as the result of planes. Primary planes are formed when the rocks are deposited, extruded, and included bedding and flow banding. Secondary planes are produced as a result of tectonic processes and include joints, faults, mineral fabrics and metamorphic banding (Price and Cosgrov, 1990). Under polarized microscope very small scale folding can be seen which are developed along the secondary fractures (Fig.5). More than two sets of cross cutting fractures can be seen in some slides.

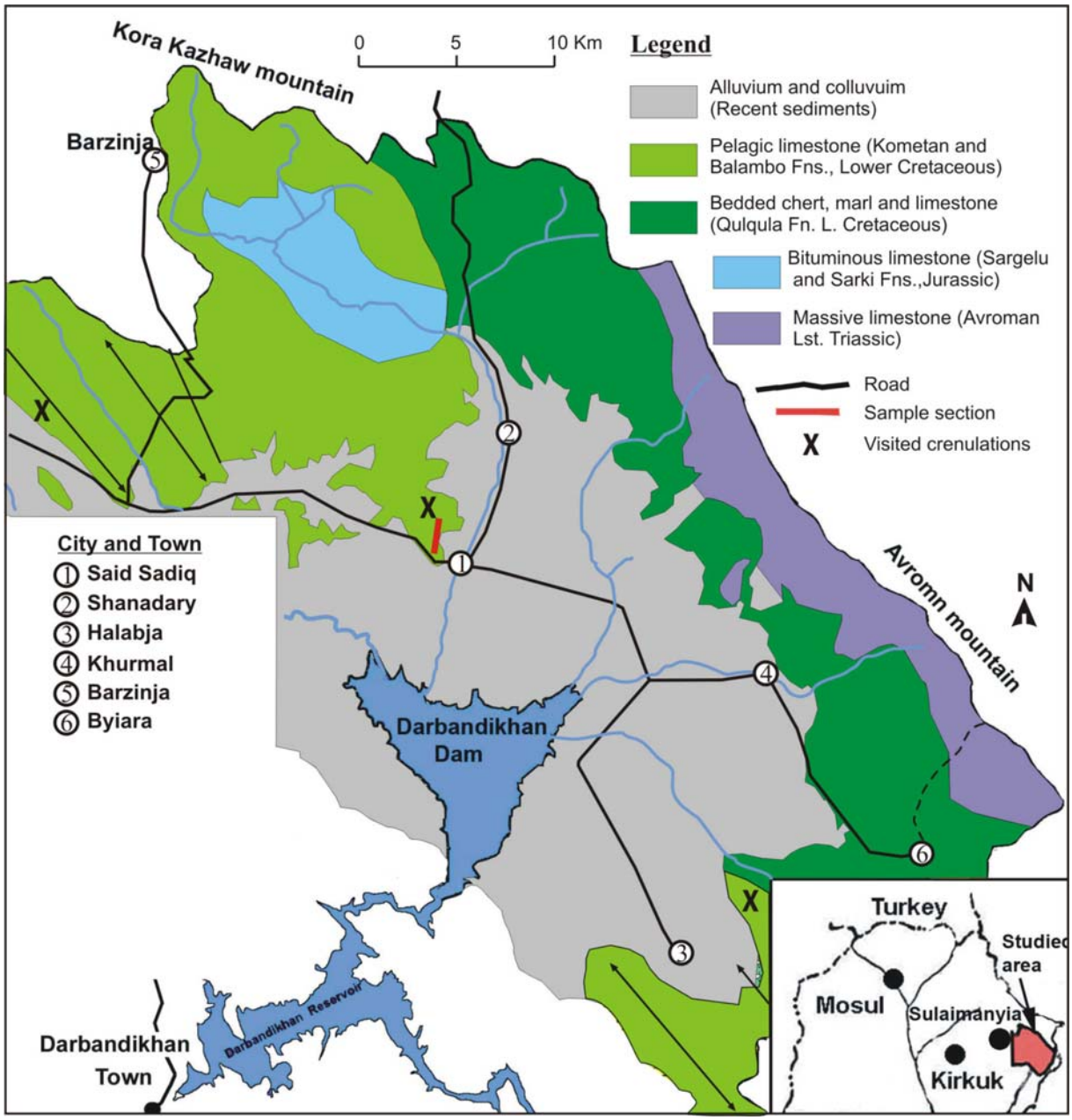

Fig.1: Geological map of the studied area
(modified from Ali, 2008)

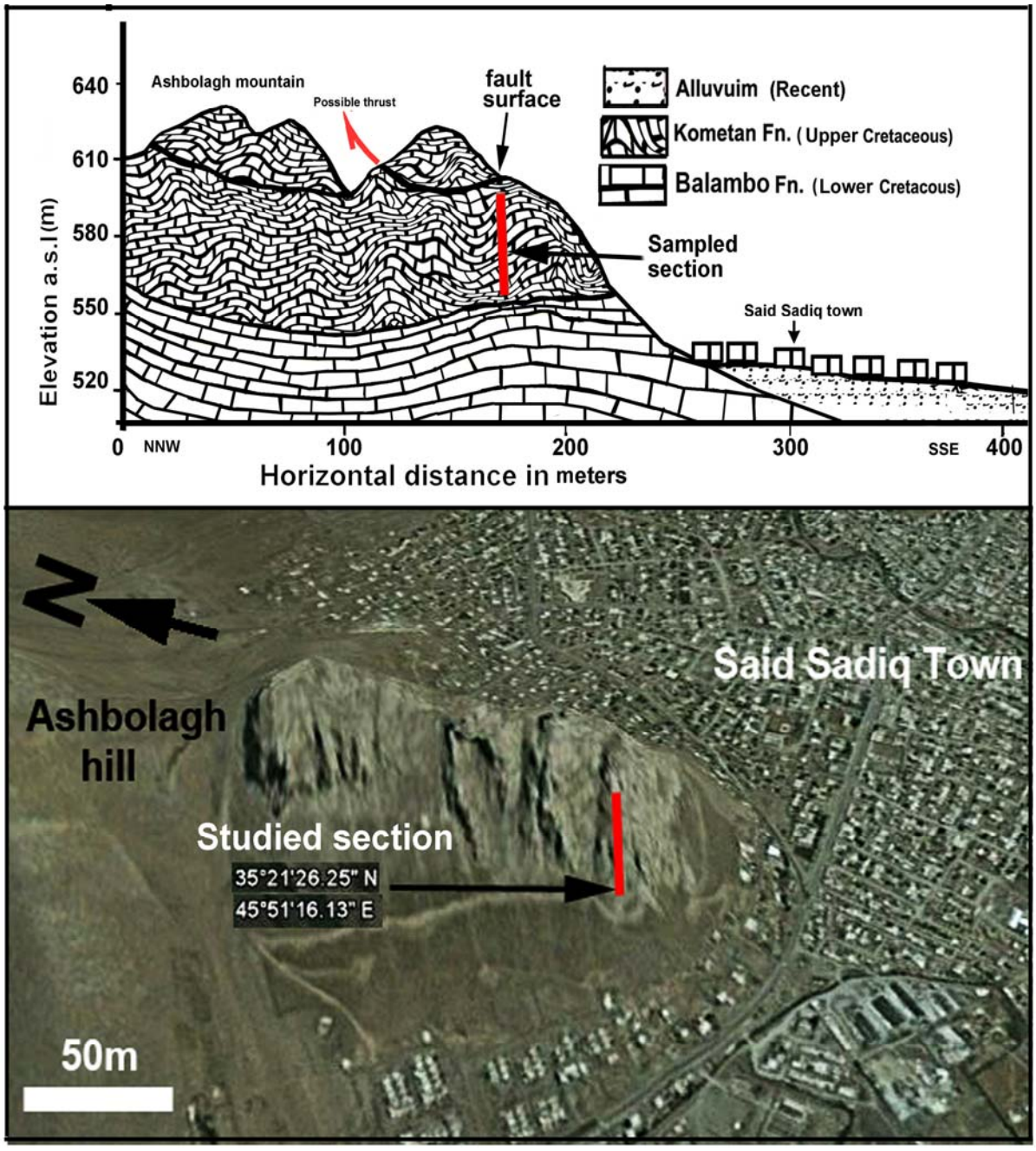

Fig.2: Geologic cross section and Google Earth image of Ashbolagh hill showing sampled section

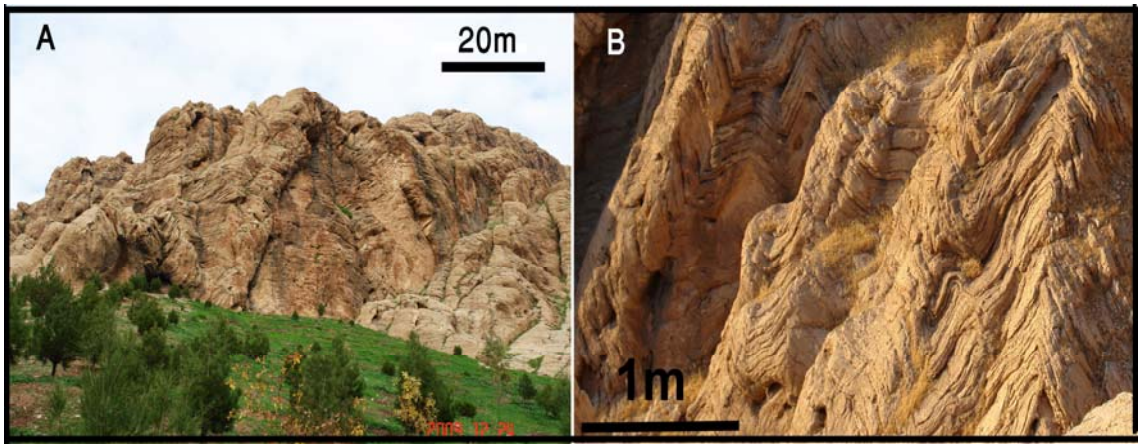

Fig.3: **A)** General view of Ashbolagh hill
B) Close up view showing crenulated limestone

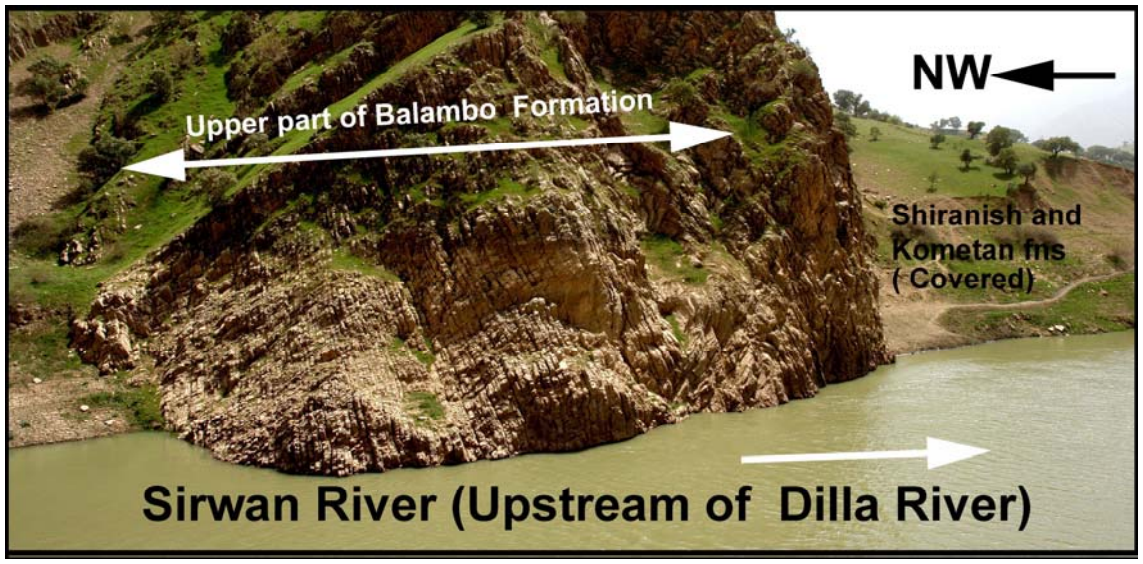

Fig.4: Upper part of the type section of the Balambo Formation in Sirwan valley, which is lithologically very similar to Kometan Formation

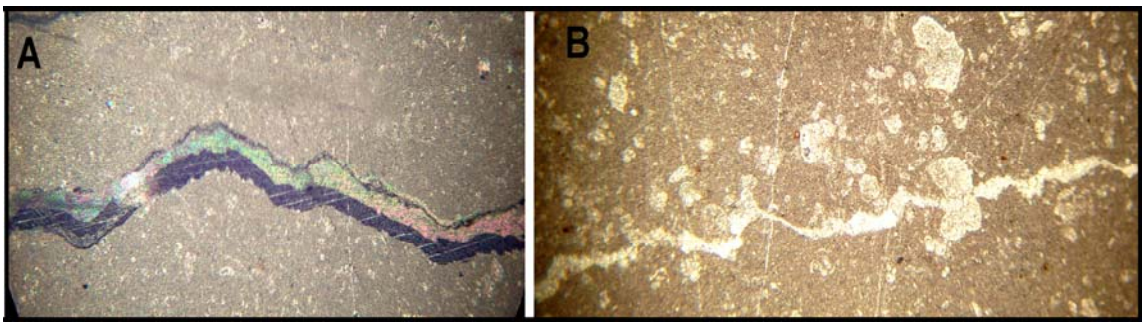

Fig.5: Crenulations under polarized microscope (40 X), showing microscopically folded fractures.
A) Under XP light shows two phases (dark and light) band of filling of fracture with secondary spary calcite.
B) Under normal light shows a folded fracture, which cut across a Globotruncana foram

LOCATION AND GEOMORPHOLOGY

The studied area is located in the northeastern part of Iraq in the eastern part of the Kurdistan Region, and comprises large area of the eastern part of the Sulaimaniyah area. It extends between the latitudes 35º 05' 00" and 35" 47' 00" to the north and longitudes 45º 12' 00" and 46º 12' 30" to the east. The studied area is mountain encircled basin and located in Iraqi side of Zagros mountain belt, which includes mainly the area located around Said Sadiq, Khurmal and Halabja vicinities. The area is surrounded from all sides by high mountains, while its central part consists of gently inclined flat and intermittently hilly plain. The area is a part of the Darbandi Khan Dam watershed and dissected by relatively three large streams of Zalim, Chaqan and Tanjero, which form, with their smaller branches, dendritic drainage pattern.

GEOLOGICAL SETTING OF THE AREA

The area is a part of the Western Zagros Fold – Thrust Belts. According to tectonic classification of Buday (1980) and Buday and Jassim (1987), the area is mainly located in the High Folded Zone and partly in the Imbricate Zone. The Thrust Zone, Qulqula Radiolarian Formation and Avroman Group are located directly to the north and northeast of the studied area.

According to Karim *et al*. (2009) the area consists of large graben, which is bounded by two normal faults from its eastern and western peripheries. The area is included in the Western Zagros Fold – Thrust Belt, which is deformed by Laramide and post Laramide Orogenies. During these orogenies, both Iran and Arabian Plates were collided; directly to the north of the studied area during Miocene (Buday, 1980 and Al-Qayim, 2000). In this area, the anticlines and synclines are relatively tight and have high amplitudes. Some of them are overturned toward southwest due to the stress of the overriding Iranian Plate. Mainly, all the rocks of the basin are sedimentary, which range in age from Lower Cretaceous (pelagic limestone) to Paleocene that include clastics rocks as Tanjero and Kolosh Formations (Upper Cretaceous and Paleocene, respectively), which are exposed in synclines, while the resistive limestones are exposed along anticlines.

PALEONTOLOGICAL STUDY

More than 50 thin sections were prepared from the collected limestone samples and for identification of the fauna; binocular microscope was used. The following species of planktonic foraminifera are identified in thin sections (Figs.6 and 7): *Radotruncana calcarata* (Cushman); *Globotruncanita conica* (White); *Globotruncanita stuarti* (de Lapparent); *Globotruncanita stuartiformis* (Dalbiez); *Contusotruncana patelliformis* (Gandolfi); *Globotruncanella minuta* Caron and Gonzales Donoso; *Gumbeletria cenomana* (Keller); *Globotruncana carina* Dalbiez; *Globotruncana carinata* Dalbiez; *Globotruncana linueuiana* (*D' Orbigny*); *Globotruncana bulloides* Vogler; *Globotruncana ventricosa* White; *Globotruncana hilli* Pessagno; *Globotruncana mariei* Banner and Blow; *Globotruncana fornicata* Plummer; *Whitenella paradubia* (Sigal); *Whitenella archaeocretacea* Pessagno; *Pseudotextularia* sp.; *Whitenella baltica* Dopuglas and Rankin; *Whitenella* sp.; *Dicarinella asymmetrica* (Sigal); *Dicarinata imbricate* (Mornod); *Dicarinata primitivae* (Dalbiez); *Marginotruncana schneegansi* (Sigal); *Marginotruncana coronata* (Bolli); *Marginotruncana undulate* (Lehmann); *Marginotruncana sigali* (Reichel); *Hedbergella montemonthensis* (Olsson); *Hedbergella holmdelensis* Olsson; *Rotalipora cushmani* (Morrow); *Rotalipora fornicate*; *Rosta fornicate*; *Globigerinelloides alvarienzi* (Eternod Olvera); *Globigerinelloides*

bolli Pessagno; *Globigerinelloides caseyi* (Bolli, Loeblich and Tappan); *Globigerinelloides bergreeni*; *Globigerinelloides maridalensis* (Bolli); *Globigerinelloides ultramicrus* (Subbotina); *Globigerinelloides prairiehillensis* Pesagno; *Rugoglobigerina rugosa* (Plummer); *Archaeoglobigerina rugosa*; *Archaeoglobigerina blowi* Pessagno; *Psudogumbelina costulata* (Cushman); *Ventilabrella eggeri* Cushman; *Ventelabrella multicartheta* (De Klasz); *Heterohelix reussi* (Cushman); *Heterohelix globulosa*; *Heterohelix ultimatumida*; *Heterohelix carinata*; *Heterohelix moremani* (Cushman); *Heterohelix punculata*; *Heterohelix planeta*; *Heterohelix striata* (Ehrenberg); *Lavihetrohelix glabrans*; *Laviheterohelix pulchra*; *Gansserina wiedenurciyeri*; *Whitinella baltica* Douglas and Rankin. *Marginotruncana sigali*, and *Dicarinata imbricate* indicate Turonian, *Dicarinata primitivae* indicate Coniacian, Dicarinata *asymmetrica* indicate Santonian, *Radotruncana calcarata* (Cushman) indicate Late Campanian.

- **Biostratigraphy**

Biostratigraphic study of thin sections is based on the geological range of the identified planktonic foraminifera. Relevantly, Kometan Formation is studied by different authors from 1959 to 2005. Bellen *et al*. (1959) studied the type section of the formation with Early Turonian – Santonian age, Youkhanna (1976) claimed Turonian – Santonian age, Al-Tameme (1986) studied the Kometan Formation and divided it into 4 biozones of Late Turonian – Early Campanian age. Al-Jassim *et al*. (1989) studied the Kometan Formation in Northern Iraq and four assemblage zones have been distinguished, which are Turonian – Early Campanian in age. Al-Zaef (1997) studied the formation in Jambour field and claimed Late Turonian – Early Campanian age, Abawi and Hammoudi (1997) studied the biostratigraphy of the Kometan Formation and divided the formation into 5 biozones based on the planktonic foraminifera and indicated Late Turonian – Early Campanian age. Al-Khafaf (2005) studied the Kometan Formation in Dokan area and divided it into 5 biozones based on the identified planktonic foraminifera and claimed Late Turonian – Early Campanian age.

CONCLUSIONS

- Many outcrops of crenulated limestones are observed in the eastern part of the Sulaimaniyah area and discussed petrographically and biostratigraphically.
- The crenulated limestones are rich in planktonic foraminifera and based on the range of these fauna, it is proved that they belong to the Kometan Formation.
- The identified planktonic foraminifers extend in age from Turonian to early Late Campanian.
- This study is the first to prove (biostratigraphically) the occurrence of the Kometan Formation in the eastern part of the Sulaimaniyah Governorate.

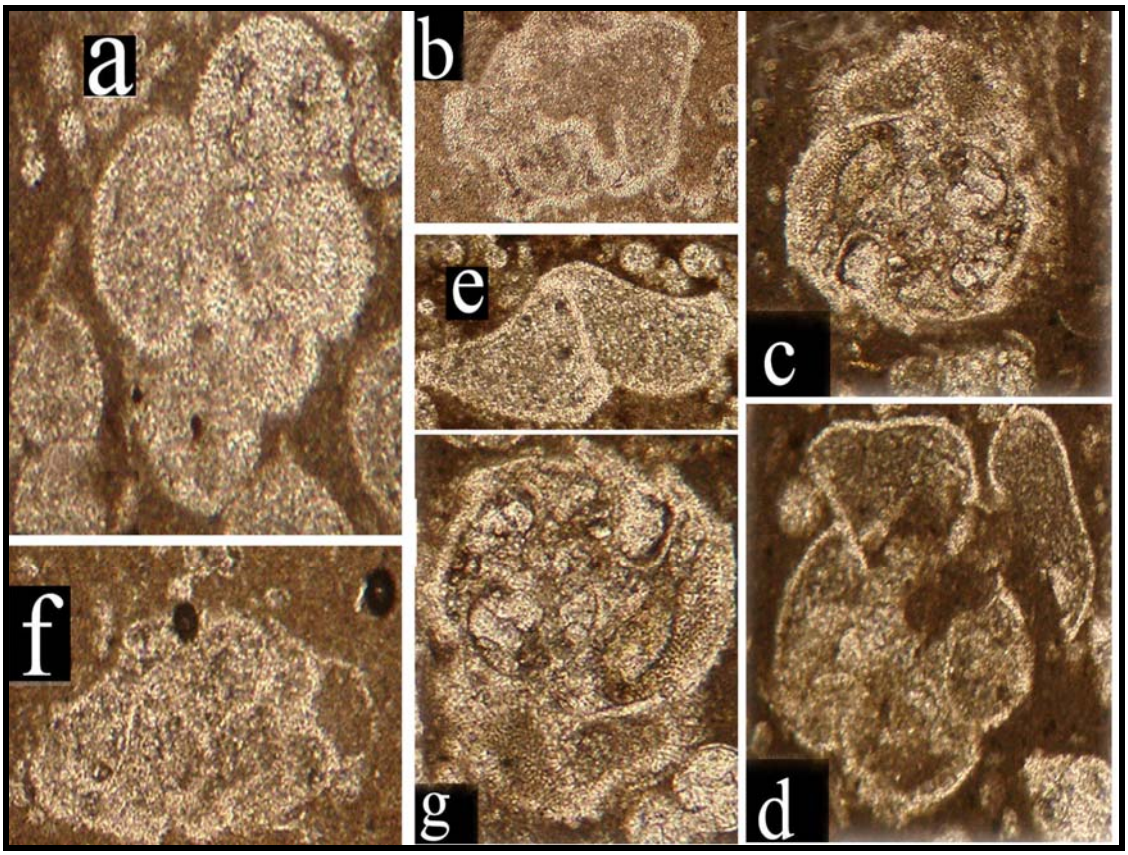

Fig.6:

a) *Globigerinelloides* sp.,
b) *Radotruncana calcarata* (Cushman), 100 X
c) *Radotruncana calcarata* (Cushman), 100 X
d) *Radotruncana calcarata* (Cushman), 100 X
e)*Radotruncana calcarata* (Cushman), 100 X
f) *Globotruncana linueuiana* (D'Orbigny), 100 X
g) *Radotruncana calcarata* (Cushman), 100 X

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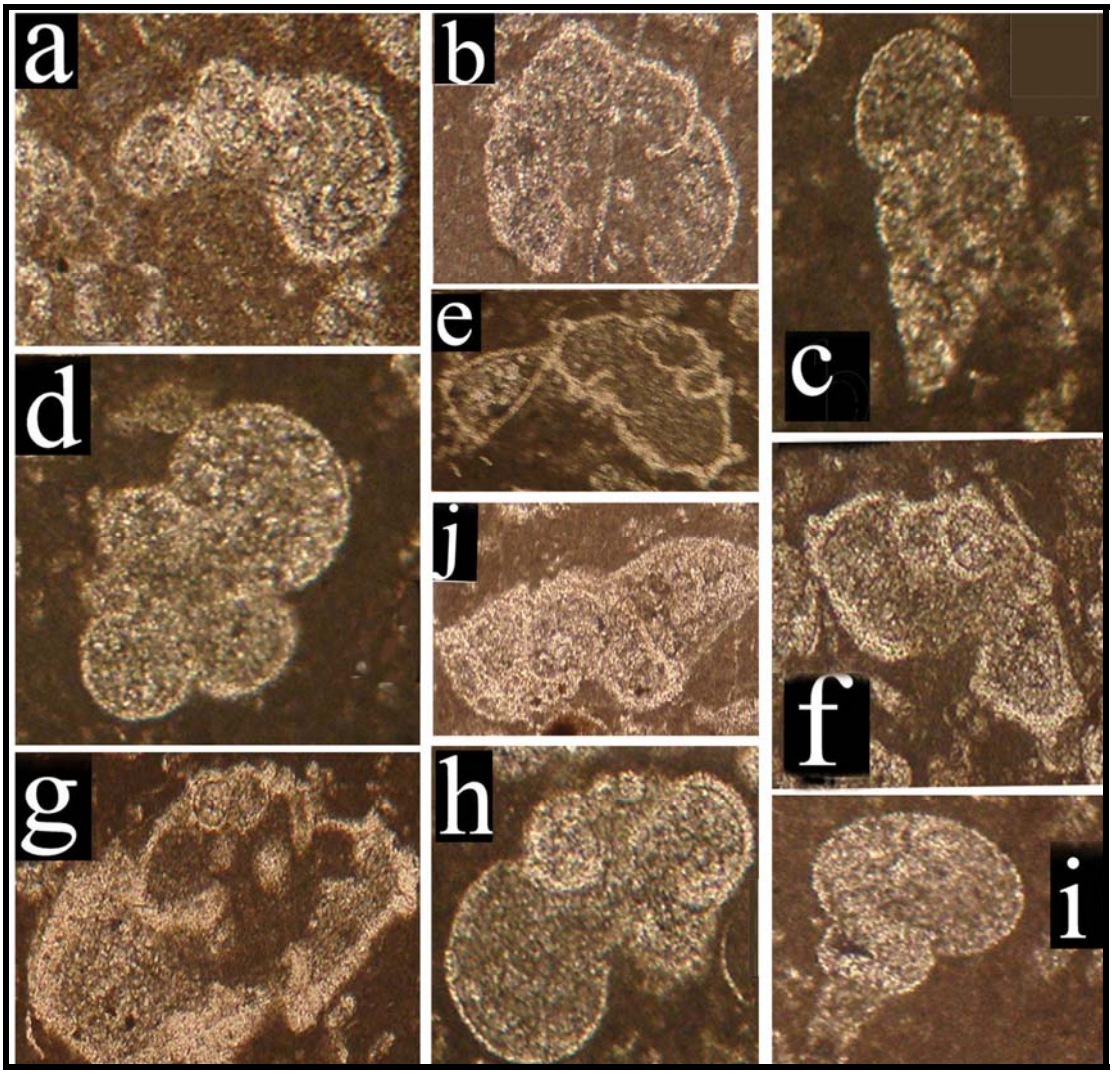

Fig.7:

a) *Hedbergella montemonthensis* (Olsson), 100 X
b) *Globotruncanita conica* (White), 100 X
c) *Heterohelix moremani* (Cushman), 100 X
d) *Whitinella baltica* Douglas and Rankin, 100 X
e) *Globotruncana ventricosa*, 100 X
f) *Globotruncana fornicate*, 100 X
g) *Marginotruncana coronate*, 100 X
h) *Rugoglobogerina rugosa*, 100 X
i) *Psudotextularia* sp., 100 X
j) *Marginotruncan scheenegensis*, 100 X

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