Planktonic foraminiferal biostratigraphy of the Upper Cretaceous Reddish to Pale brown transitional succession in Smaquli Area, Northeast Iraq (Kurdistan Region)

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Key word: Biostratigraphy, Planktonic foraminifera, Upper Cretaceous, Shiranish Formation, Kurdistan

ABSTRACT

The Upper Cretaceous reddish to pale brown transitional succession (Shiranish Tanjero transition unit) in the Smaquli area was studied to document the nature of reddish unit within the studied section, which comprise three lithostratigraphic units; Upper part of Shiranish Formation (Late Campanian), Reddish to pale brown unit (Early Maastrichtian) and lower part of Tanjero Formation (lower-middle Late Maastrichtian). Sixty seven planktonic foraminiferal species that belong to nineteen genera are recorded and six Planktonic Foraminiferal Biostratigraphic zones have been detected in the studied section. They represent *Globotruncana aegyptiaca* Interval Zone (CF8), *Gansserina gansseri* Interval Zone (CF7), *Contusotruncana contusa* Interval Zone (CF6), *Pseudotextularia intermedia* Interval Zone (CF5), Racemiguembelina *fructicosa* Interval Zone (CF4), *Pseudoguembelina hariaensis* Interval Zone (CF3). They display Late Campanian—Middle- Late Maastrichtian age. They are discussed and correlated with their equivalents in and outside of the studied area, particularly with the zonal scheme of Li and Keller, (1998a) and Abramovich *et al*., (2002). The age of this succession is estimated to be more than 2.150my. The planktonic foraminifera biozones of the studied section display continuous sedimentary succession they show incessant in sedimentary sequence without any interruption.

الطباقية الحياتيةللفورامنيفرا الطافية للتتابعات الصخرية الانتقالية البنية المائلة الى الاحمرار (الكريتاسى الاعلى) فى منطقة سماقولى ، شمال شرق العراق، اقليم كردستان

خالد محمود اسماعيل الشارباژيرى

المستخلص

اظهرت الدراسة الحالية تواجد تتابعات صخريةبنية مائلة الى الاحمرار لعصر الكريتاسى الاعلى فى منطقة سماقولى و التى تقع بين تكوينى شيرانش و تانجرو. و اجريت لها دراسة طباقية حياتية للفورامنيفيرا الطافية حيث تم تحديد الانطقة الحياتية التالية:

Globotruncana aegyptiaca Interval Zone (CF8), *Gansserina gansseri* Interval Zone (CF7), *Contusotruncana contusa* Interval Zone (CF6), *Pseudotextularia intermedia* Interval Zone (CF5), *Racemiguemblina fructicosa* Interval Zone (CF4), *Pseudoguembelina hariaensis* Interval Zone (CF3).

وقد قدر العمرالجيولوجى لهذه التتابعات الصخرية بفترة زمنية مقدارها 2،150 مليون سنة و من خلال هذه الدراسة تبين ان الترسيب مستمر بدون اى انقطاع و امكن التعرف على سبعة وستين نوعا من الفۆرامنيفيرا الطافيةالعائدة الى تسعة عشرة جنسا ، و تم اجراء عملية المقارنة و التعاقب مع الانطقة الحياتية الاخرى داخل و خارج العراق. ان المكشف الجيد لهذه التتابعات فى منطقة الدراسة و وضعها وصفاتها الصخرية المميزة و المختلفة تماما مع تكوينى شرانش و تانجرو الواقعة بينهما و امتدادها الجغرافى و العمودى يجعلها بان تكون وحدة صخرية مستقلة.

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INTRODUCTION

The Late Cretaceous (Late Campanian – Maastrichtian) Sequence in north and northeastern Iraq is well exposed and represented by six subsequences. Two diagnostic subsequences (facies) of them, in the studied area represent with outer shelf- basinal facies (Shiranish Formation) and isolated basin of the Balambo -Tanjero (Tanjero Formation) (Jassim and Goff, 2006) . his paper deals with the field observation and detailed planktonic biostratigraphic zonation of reddish to pale brown succession, which represents transitional facies change between Shiranish and Tanjero formations.

The Shiranish Formation was defined by Henson (1940 in Buday, 1980) from the High Folded Zone in north Iraq near Shiranish Islam village NE of Zakho.The Tanjero Formation was first defined and described under the name of Tanjero clastic Formation by Dunnington (1952 in Bellen *et al*.,1959) from the Sirwan Valley, southeast of Sulaimani, 2 km to the south of Kani Karweshkan village, near Halabja Town and located at the right bank of Sirwan River (upstream of Dialla River). Now, most of the type section is inundated by Darbandekhan Dam reservoir.The studied section is located in Sulaimani Governorate, Smaquli area, at latitude 36^0 10^- $51^=$ and longitude 44^0 36^- $40^=$ about 25 Km to the northeast of Koy Sinjaq town, and 5 Km southeast of Gali village. The studied area is located southwest of Zagros Thrust Belt, along the distal margin of the Tanjero Foreland Basin, which is developed from the basin fill of the Neo-tethys Sea and colliding of Iranian and Arabian Plates (Karim 2004). Structurally the studied area is located within High Folded Zone near the boundary of Low and High Folded Zones (Buday and Jassim 1987).

The main objective of this study is concerned with the age determination of the reddish to pale brown succession (Shiranish Tanjero transition unit), which represents transitional facial change from basinal sediments, of Shiranish Formation to flysch type foreland basin, of Tanjero Formation. Moreover to investigate in detail, the vertical distribution of Planktonic foraminifera in this unit at Awagird Mountain in the Smaquli area, based on the available and the inferred evidences of planktonic foraminiferal biostratigraphic study of the reddish succession (Shiranish Tanjero transition unit) in the studied area. Furthermore, the present study deals for the first time with the field observation of lithology, stratigraphic position and geographic distribution of reddish succession. There are no previous studies about reddish succession in the studied area; except the sedimentological study of (Karim 2004), which deals with the red sandstone beds within Tanjero Formation.

LITHOLOGY AND STRATIGRAPHY

The reddish to pale brown succession (Shiranish Tanjero transition unit) consists of 66 m alternation of thin bedded fossiliferous reddish to pale brown claystone, marl alternate with thin reddish shale intercalated by thin pale brown some time to pale grey marly limestone of (5-10) cm. thickness from the base to the top of this interval.(Figs.2 and4).Throughout the studied area the reddish to pale brown succession (Shiranish Tanjero transition unit) is underlain by Shiranish Formation. It is likely forming a normal stratigraphic boundary of conformable graditional contact, from bluish white marl and marly limestone of Shiranish Formation to the first appearance of reddish to pale brown claystone or marl beds of the transitional unit. The upper contact is marked by presence of olive green and dark grey lithology with the first appearance of 20cm hard well bedded sandstone, at the base of Tanjero Formation (Figs. 2 and 4).

It is important to mention that the general lithologic constituents of Shiranish - Tanjero transition unit resembles the same lithologic character of monotonous and similar repetition in all studied

sections of the studied area, with exception that there are few sandstone layers at the base of this interval at Hizop area, 20 km southeast of the studied section .

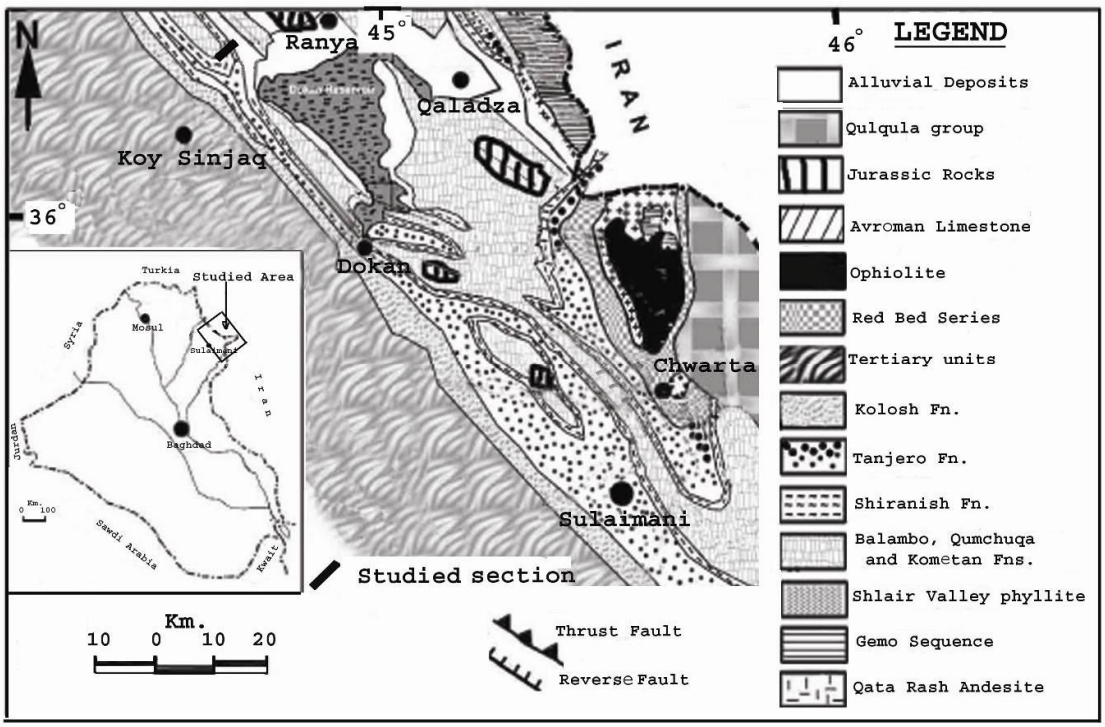


Fig. (1) Location and geological map of the studied area (modified from Sissakian, 2000)

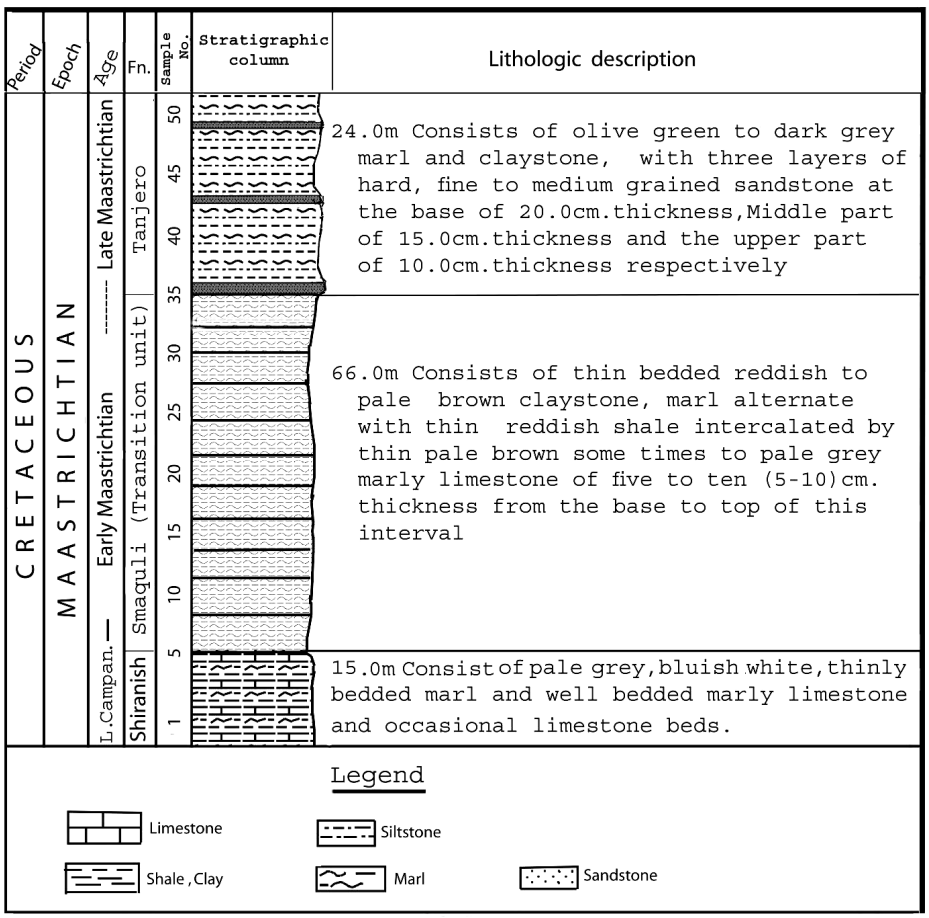


Fig (2) Stratigraphic column of Awagird section in Smaquli area, northeast of Koy Sinjaq City (not to scale)

The reddish succession geographically manifested excellent exposure extends for 75 Km in length, as a general southeast northwest trend from the Girda Sura village, southeast limb of Kosrat Mountain when it is plunging down under Dokan Lake (northwest side of the Dokan Dam). The name of Girda Sura village reveal the lithologic colour of this unit where it is exposed, to the south of Shaqlawa city which is vanishing there, it extends continuously from Girda Sura village (15m thick) throughout southwestern limb of Kosrat anticline at Merga Pasha , Girda Baru village and Khalakan city (20-25m thick), Badawan village (10m thick), Bestana (27m thick), Hizop (20m thick) and to Smaquli region along the northeastern limb of Safeen anticline, at the studied section (66m thick) , it reaches maximum thickness (72m thick) at Gorge of Gali village it also extended to Snawa, Nazanin and Heran villages of 25m thick, between Heran and Nazanin. Along the northwestern side of Safeen anticline the reddish unit extends from Smaqa Qali Gali, Smaqa Qali Karank to Smaqa Quli Barchau where it terminates.(Figs 3 and 5). The main structural unit in the studied area is Awgird Mountain, which represents the southeastern part of Safeen anticline. The general lithostratigraphic sequences in Smaquli area consist of the following formations (Fig. 5).

1- Gercus Formation (Eocene).
2- Kolosh Formation (Paleocene --Early Eocene).
3- Tanjero Formation (Late Maastrichtian).
4- Shiranish-Tanjero Transition unit (Early Maastrichtian)
5- Shiranish Formation (Campanian – Early Maastrichtian).
6- Kometan Formation (Turonian Santonian)
7- Qumchuqa Formation (Albian Cenomanian).

MATERIALS AND METHODS

Fifty samples were collected at (1 - 3) m interval for the studied section, including fife samples from the upper part of Shiranish Formation and fifteen samples from the lower part of Tanjero Formation (Fig.2).

Samples were treated (soaked) with the ethanoic acid solution (CH_3COOH) made up of 80% acetic acid and 20% H_2O for the duration time from (1 – 5) hours, the technique proposed here, based on cold-disaggregation with acetic acid. The acetic acid causes a very slow reaction that disaggregates the rocks without destroying and corroding fossil content. This method firstly was used by Lirer (2000).The disaggregated samples were washed with tap water through a 63-µm sieve until clean foraminiferal residues were recovered. The washed samples were oven-dried at 40 C^o and sieved through a 150-µm sieve (after drying). A laboratory procedure and scanning electron microscope photo processed in the Institute for Paleontology, University of Bonn, Germany.

PREVIOUS STUDIES

Bellen *et al.* (1959) have described briefly the distribution, age, lithology, fossil content, and stratigraphy of the Shiranish and Tanjero formations, in different localities.

Kassab (1972, 1974b, 1975c, 1975d, 1976b) and Kassab *et al* (1986) studied the biostratigraphy of the Shiranish and Tanjero formations at their type localities and in other six locations in north and northeast Iraq. They deducted the Late Campanian –Maastrichtian age for the both formations in Iraq and recognized two planktonic foraminiferal zones and five subzones; consequently, from base to the top as follows:

1- *Globotruncana fornicata –stuartiformis-elevata-roseta- ventricoza* Zone.

a- *Globotruncana calcarata-- elevata--aegyptiaca* Subzone (Late Campanian)

b- *Globotruncana arca – tricarinata - subcircumnodifer* Subzone (Early Maastrichtian)

2 - *Globotruncana contusa- esnehensis- duwi* Zone

a- *G. gansseri- bahijae- Gublerina cuvillieri* Subzone (Middle Maastrichtian)

b- *Abathomphalus mayaroensis* Subzone (Late Maastrichtian)

c- *Globotruncana falsocalcarata* Subzone (Late Maastrichtian)

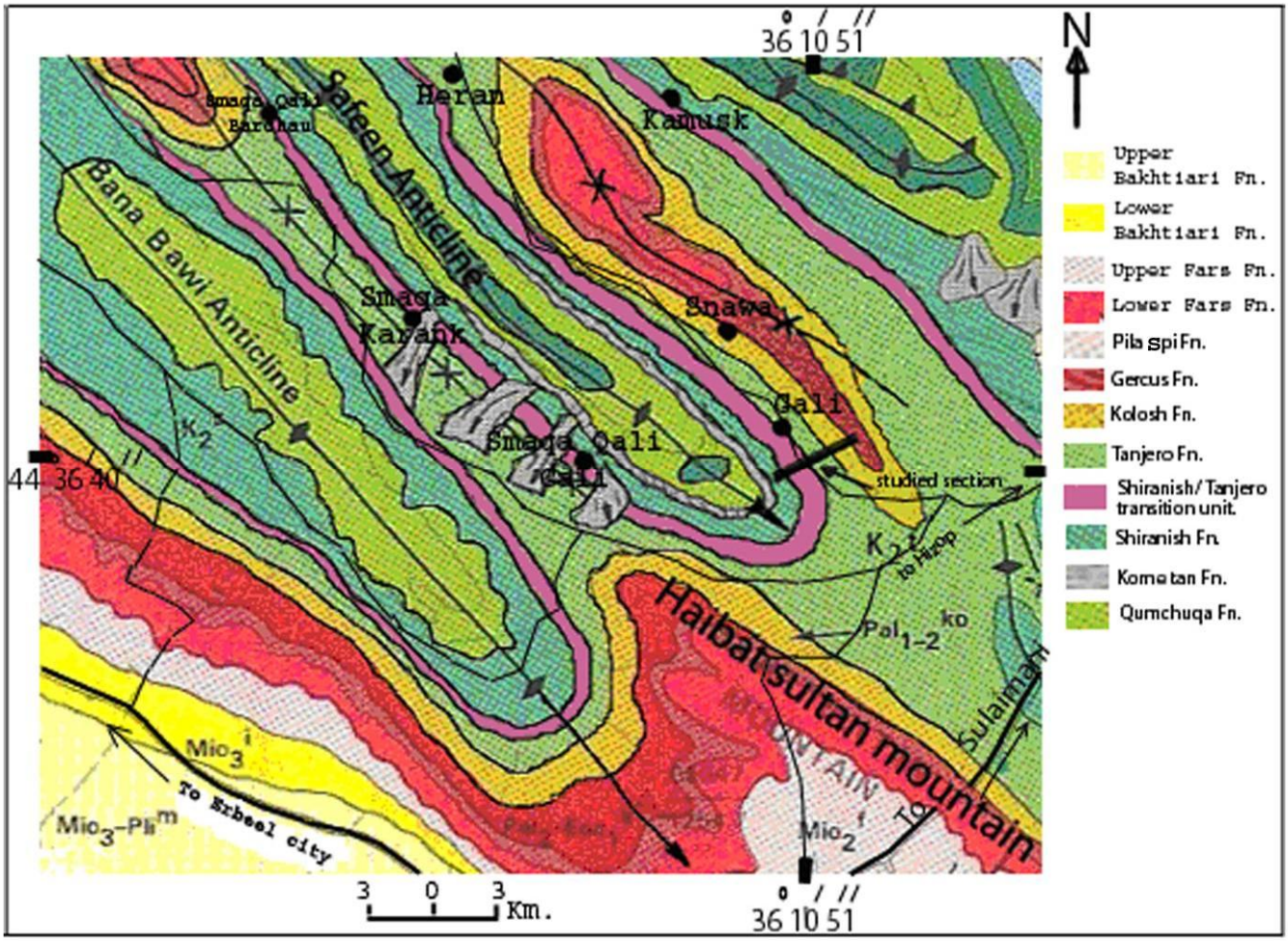


Fig (3) Geological map of the studied area showing the new formal stratigraphic unit (Reddish to pale brown succession) representing transitional facies between Shiranish and Tanjero Formations (modified from Sissakian, 1997

Abawi *et al.*, (1982) and Abdel-Kireem (1986a and b) included both formations within stratigraphy of Late Cretaceous of northeast Iraq. Also they recognized five planktonic foraminiferal subzones under two zones, as follows from the base to the top

a- *Globotruncana fornicate-arca-stuarti* Assemblage Zone

Globotruncana calcarata Subzone (Late Campanian)

b- *Globotruncana aegyptiaca –lapparenti-stuarti* Assemblage Zone.

1-*Rugotruncana subcircumnaodifer* Subzone (Early Maastrichtian)

2-*Globotruncana gansseri* Subzone (Middle Maastrichtian)
3-*Globotruncana contusa* Subzone (Middle Maastrichtian)
4-*Abathomphalus mayaroensis* Subzone (Late Maastrichtian)

Al-Mutwali and Al-Jubouri (2005) described the age of Shiranish Formation by Late Campanian—Late Maastrichtian based on the biostratigraphy of the following biozones**:**
1- *Globotruncana calcarata* (Late Campanian)
2- *Globotruncanella havanensis- Roseta fornicata* zone (Early Maastrichtian)
3- *Globotruncana aegyptiaca* Zone (Early Maastrichtian)
4- *Globotruncana gansseri* Zone (Late Maastrichtian)

Fig. (4) Gologic cross section of the reddish to pale brown succession (Shiranish -Tanjero transition unit) in Awagird anticline which is underlying by the Shiranish Formation and verlying by the Tanjero Formation.

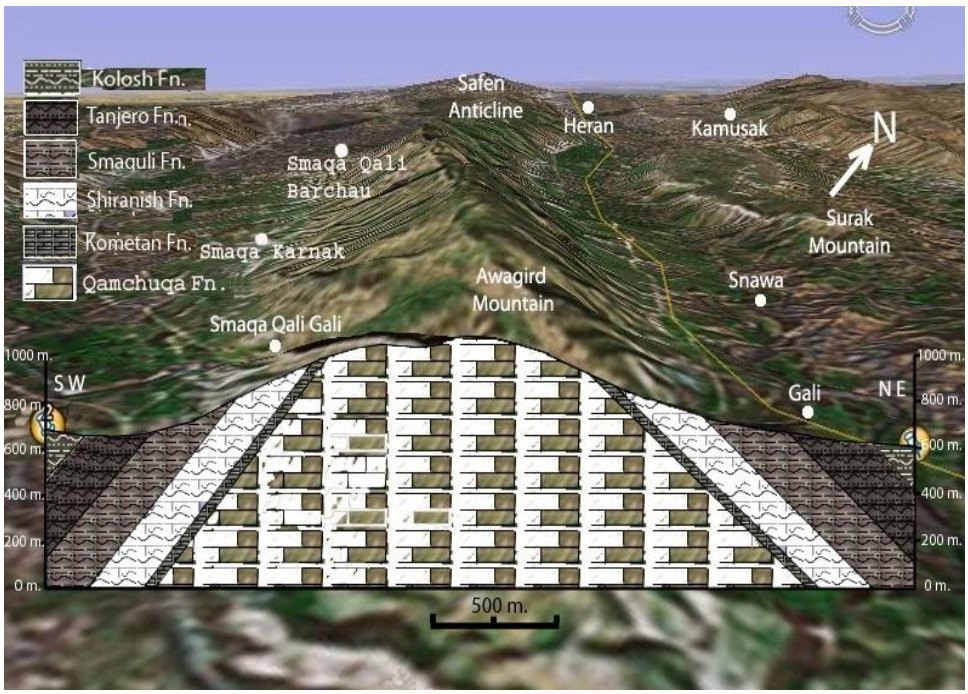


Fig. (5) Geological cross section along Awagird Mountain showing different lithologic units in the studied area from the core of anticline to both limbs (modified from Google Earth morphological feature of the studied area)

BIOSTRATIGRAPHY

The samples, which contain microfossils are collected from the studied section and provided predominant to extremely abundant well preserved forms, it is reveal as the radiation stage of biotic evolution and high diversity of Globotruncanids, Rugoglobigerinids, Globigerinids and Heterohelicids planktonic foraminifera with rare to moderate calcareous and agglutinated benthonic forams (Fig. 6). The foraminifera occurs continuously in the studied succession, generally shows incessant in sedimentary sequence without any interruptions

Sixty seven planktonic foraminiferal species belonging to nineteen genera were recorded (Fig.6). The planktonic foraminifera of Globotruncanids, Heterohelicids, Rugoglobigerinids, Globigerinelloidids and Globigerinids are the most prevalent planktonic forams and they show the best indication for typical Tethyan fauna type.

The planktonic foraminiferal zonation for the sediments in tropical/subtropical regions, like Li and Keller (1998a), Keller (2002 and 2004), Abramovich *et al.* (2002), Abramovich and Keller (2003), Samir (2002), Obaidalla (2005)and Sharbazheri (2007) are used exclusively as the biostratigraphic framework in this study.

Li and Keller (1998a) subdivided the Maastrichtian zonal scheme into nine Cretaceous Foraminiferal (CF) zones labeled CF9 to CF1, from the base to the top. They calibrated their ranges to the paleomagnatic time scale in the DSDP Site 525A, and on Tunisian sections (Li and Keller 1998b),

The recognizing and genetic classification used in this study follows that of Postuma (1971), Kassab (1974b), (1975d) and (1976), Masters (1977), Ramsay(1977), Jenkins and Murray (1981), Caron (1985), Loeblich and Tappan (1988),Georgescu (1996, 2002), and BouDagher-Fadel *et al* (1997),.The biostratigraphic correlation of the studied section is based on planktonic foraminiferal zonations (Figs.7, 8) shows a comparison between the biostratigraphic zones established in this study with other equivalent of the commonly used planktonic zonal scheme.

The biostratigraphic zones are described from the bottom to the top as follows:

Globotruncana aegyptiaca Interval Zone (CF8)

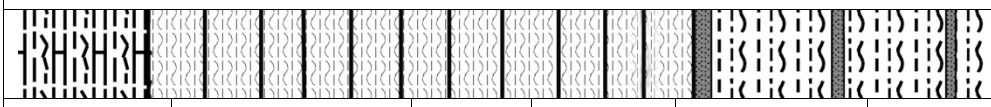
The *Globotruncana aegyptiaca* or (CF8) zone was originally established and described by Caron (1985) .It is marked by the interval from the First Appearance Datum (FAD) of the nominate species to the FAD of *Gansserina gansseri***.** In the studied section, it is defined by the first appearance (FA) of index taxon (*Globotruncana aegyptiaca* Nakkady) within the first sample taken from the upper part of Shiranish Formation at the base to the FAD of *Gansserina gansseri* (Bolli**)** Fig. 6, (Figs. 9, e-g) within reddish unit at the top. This zone is covered with frequent occurrence of the nominate species for 15 m. interval in the upper part of the Shiranish formation and (5m.) lower part of reddish unit. This zone indicates Early Maastrichtian and corresponds to that of Caron (1985), Shahin (1992), Li and Keller (1998a), Abramovich *et al* (2002), Al-Mutwali and Al-Jubouri, (2005), Sharbazheri (2007, 2008), (figs. 7, 8). This interval Zone is characterized by a well diversified planktonic foraminiferal species e.g. *Heterohelix navarroensis* Loeblich, *H. globulosa* (Ehrenberg), *H. striata* (Ehrenberg), *H. reussi* (Cushman), *H. nauttalli* (Voorwijk), H. *punctulats* (Cushman),*H. pulchra* (Brotzen), *Planoglobulina carseyae* (Plummer), *P. brazoensis* Martin *P. acervulinoides* (Egger), *Rugoglobigerinarugosa* (Plummer), *R. scotti* (Bronnimann), *R. hexcamerata* Bronnimann, *R. macrocephala* Bronnimann,

R. macrocephala Bronnimann, *R. rotundata* Bronnimann, *R. milamensis* Smith & Pessa, *Globotruncanita stuarti* (de Lapparent), *Globotruncanita stuartiforms* Dalbez, *Rugotruncana subcircumnodifer* (Gandolfi), *Globotruncana aegyptica* Nakkady, *Glt. orientalis* El Naggar, *Glt. rosetta* (Carsey), *Glt. falsostuarti* Sigal *Glt. mariei* Banner & Blow, *Glt. arca* (Cushman), *Glt. gagnebini* Tilev, ,*Glt. bulloides* Vohgler, *Glt. linneina* (d Orbigny),*Glt. ventricosa* White, *Glt. insignis* (Gandolfi), *Abathomphalus intermedius* (Bolli), *Globotruncanella petaloidea* (Gandolfi),*Globotruncanella havanensis* (Voorwuk), *Pseudotextularia elegans* (Rzehak), *Pseudoguembelina costulata* (Cushman), *Globigerinelloides voluta* (White), *Globigerinelloides multispiinata* (Lalicker), *Globigerinelloides prairiehilleinsis* Pessango, *Globigerinelloides douglasi* Kassab, *Globigerinelloides escheri* (Ehrenberg), *Archaeoglobigerina carteri* (Kassab), *Hedbergella monmothensis* (Olsson),.Beside these planktonic foraminiferal assemblages rare benthonic foraminiferal species were recorded

According to the all mentioned authors, and Faris (1984), Martines (1989), Abdel-Kareem & Samir (1995), Al-Mutwali (1996), Elnady and Shahin (2001) and Khalil & Mashaly (2004), the age estimation of this biozone indicates Early Maastrichtian, and Li and Keller (1998a) record the time span of this Biozone from (72.48 - 70.39) Ma estimated by absolute ages based on magnetochron ages, while Premoli Silva *et al*., 1998, in their study of bio-isotope stratigraphy on eastern Mediterranean, and Maestas *et al*., 2003, recorded the *Globotruncana aegyptiaca* Zone from the Late Campanian age. The Geologic Time Scale (GTS2004) by (Gradstein *et al*., 2004) (Fig.4) the accompanying International Stratigraphic Chart, issued under auspices of the International Commission on Stratigraphy (ICS) shows the current chronostratigraphic scale and ages with estimates of uncertainty for all stage boundaries, placed this span of time (72.48 - 70.39) Ma under the upper limit of Campanian. The chronostratigrapic duration age was estimated on different techniques and methods to construct a GTS (2004) placed the Maastrichtian stage between time intervals of (70.6 $-^{+}$ 0.6) Ma at the base, and to (65.5 $^{+}-$ 0.3) Ma at the top.

Gansserina gansseri Interval Zone (CF7)

The *Gansserina gansseri* or (CF7) zone was introduced by Bronnimann (1952) in Samir (2002) as *Globotruncana gansseri* Zone and placed into the Early Maastrichtian of Trinidad. In present study, this biozone is defined by the interval between the FAD of nominate species *Gansserina gansseri* (Bolli) and the FAD of *Contusotruncana contusa* (Cushman), (Figs.9, h-I). Most of the workers in the zonal scheme placed *Gansserina gansseri* zone informally at the middle- lower Maastrichtian Kassab (1974, 1975c, 1975d and 1976b), Abawi *et al*., (1982), Faris (1984), Kassab *et a l.*, (1986), Abdel-Kareem (1986a & b), Abdel-Kareem & Samir (1995), Al-Mutwali (1996), Li and Keller (1998a), Luning *et al*., (1998), Premoli Silva *et al*., (1998), Elnady and Shahin (2001), Abramovich et al (2002), Samir (2002) , Maestas *et al*., (2003), Al-Mutwali and Al-Jubouri (2005), Chacon and Martin (2005), Sharbazheri (2007, 2008) (Figs. 7, 8), while Obaidalla (2005) placed this zone on the base of Late Maastrichtian and Maestas *et al.,* (2003) placed this zone at Late Campanian- Early Maastrichtian. This zone cover abundant occurrence of the nominate species for 28m. In addition to the index species, the planktonic assemblages of this zone include:

C R E T A C E O U S	PERIOD
U. Campanian Lower Masstrichtian ---------- Upper Masstrichtian	EPOCH
Shiranish / Reddish succession (Shiranish-Tanjero transition unit) / T a n j e r o	FORMATION
1 5 10 15 20 25 30 35 40 45 50	SAMPLE No
	LITHOLOGY
CF 8 / CF 7 / CF 6 / CF 5 / CF 4 / CF 3	Planktonic foram. CF. zones (Li and Killer, 1998a)
Glt. aegyptiaca / G. gansseri / C.contusa / P.intermedia / R. fructicosa / P.hariaensis	SUBZONE

PLANKTONIC FORAMINIFERA

Heterohelix navarroensis Loeblich
= *globulosa* (Ehrenberg)
= *striata* (Ehrenberg)
= *reussi* (Cushman)
= *nauttalli* (Voorwijk).
= *punctulats* (Cushman)
= *pulchra* (Brotzen)
Planoglobulina carseyae (Plummer)
= *brazoensis Martin*
= *acervulinoides (Egger)*
Rogoglobigerina rugosa (Plummer)
= *scotti (Bronnimann)*
= *hexcamerata Bronnimann*
= *macrocephala Bronnimann*
= *macrocephala Bronnimann*
= *rotundata* Bronnimann
= *milamensis* Smith & Pessa
= *pennyi* Bronnimann
Gansserina gansseri (Reuss)
= *wiedenmayeri* (Gandolfi)
Globotruncanita stuarti (de Lapparent)
= *stuartiforms* Dalbez
= *conica* White
= *pettersi* Gandolfi
= *angulata* Tilev
= sp.
Rugotruncana circumnodifer (Gandolfi)
= *subcircumnodifer* (Gandolfi)
Globotruncana aegyptica Nakkady
= *orientalis* Elnaggar
= *rosetta* (Carsey).
= *falsostuarti* Sigal
= *mariei* Banner & Blow
= *arca* (Cushman)
= *gagnebini* Tilev
= *bulloides* Vohgler
= *linneina* (d Orbigny)
= *ventricosa* White
= *insignis* (Gandolfi)
= *dupeublei* Caron et al.
Contusotruncana fornicate (Plummer)
= *contusa* (Cushman)
= *plicata* White
Abathomphalus mayaroensis Bolli
= *intermedius (Boli)*
Globotruncanella petaloidea (Gandolfi)
= *havanensis (Voorwuk)*
= *pschadae (Keller)*
Pseudotextularia elegans (Rzehak)
= *deformis* (Kikoine)
= *intermedia* (De Klasz).
Rascemiguembelina fructicosa (Egger)
= *powelli* Smith&Pessango
Pseudoguembelina costulata (Cushman)
= *hariaensis* Nederbragt
Gublerina cuvillieri Kikoine
Guembelitria dammula (Voloshina).
Globigerinelloides voluta (White)
= *multispiinata* (Lalicker)
= *prairiehilleinsis* Pessango
= *douglasi* Kassab
= *subcarinata* Bronnimann
= *escheri* (Ehrenberg)
Archaeoglobigerina carteri (Kassab)
Hedbergella monmothensis (Olsson)
= *holmdelensis* Olsson
Gumbelitra cretacea Cushman

Heterohelix navarroensis Loeblich, *H. globulosa* (Ehrenberg), H. *striata* (Ehrenberg), *H reussi* (Cushman), *H. nauttalli* (Voorwijk), H. *punctulats* (Cushman),*H. pulchra* (Brotzen), *Planoglobulina carseyae* (Plummer), *P. brazoensis* Martin *P. acervulinoides* (Egger), *Rogoglobigerina rugosa* (Plummer), *R. scotti* (Bronnimann), *R. hexcamerata* Bronnimann, *R. macrocephala* Bronnimann, *R. rotundata* Bronnimann, *R. milamensis* Smith&Pessa, *Gansserina gansseri* (Reuss), *G. wiedenmayeri* (Gandolfi), *Globotruncanita stuarti* (de Lapparent),*Globotruncanita stuartiforms* Dalbez, *Globotruncanita conica* White, *Globotruncanita pettersi* Gandulfi, *Globotruncanita angulata* Tilev, *Rugotruncana subcircumnodifer* (Gandolfi),*Globotruncana aegyptica* Nakkady, *Glt. orientalis* Elnaggar, *Glt. rosetta* (Carsey), *Glt. falsostuarti* Siga,l *Glt. mariei* Banner & Blow, *Glt. arca* (Cushman), *Glt. gagnebini* Tilev, ,*Glt. bulloides* Vohgler, *Glt. linneina* (d Orbigny),*Glt. ventricosa* White, *Glt. insignis* (Gandolfi), *Glt. dupeublei* Caron et al., *Contusotruncana fornicate* (Plummer),*Abathomphalusmayaroensis*(Bolli),*Abathomphalus intermedius* (Bolli), *Globotruncanella petaloidea* (Gandolfi), *Globotruncanella havanensis* (Voorwuk), *Pseudotextularia elegans* (Rzehak),*Pseudotextularia deformis* (Kikoine), *Pseudoguembelina costulata* (Cushman), *Gublerina cuvillieri* Kikoine, *Globigerinelloides voluta* (White), *Globigerinelloides multispiinata* (Lalicker), *Globigerinelloides prairiehilleinsis* Pessango, *Globigerinelloides douglasi* Kassab, *Globigerinelloides escheri* (Ehrenberg),*Archaeoglobigerina carteri* (Kassab),*Hedbergella monmothensis* (Olsson),*Hedbergella holmdelensis* Olsson,

The age estimation of this biozone by Li and Keller (1998a) record the time span of (70.39 - 69.56) Ma (830 Ky) estimating absolute ages based on magnetochron ages with 30 ky/m moderate rate of deposition (Fig.7).

Contusotruncana contusa Interval Zone (CF6)

Dalbeiez (1955) in Samir (2002) proposed the *Globotruncana contusa* Zone for the Late Maastrichtian of Tunisia. Biostratigraphic interval from the FAD of *Contusotruncana contusa* (Cushman), at the base and last appearance (LAD) of *Globotruncana linneniana* (d Orbigny) at the top. (Figs. 9, c, d, u). In present study this Zone **(CF6)** covers an interval of 13m and provided an assemblage of planktonic foraminifera which totally resembles that of the underlying *Gansserina gansseri* Zone **(CF7)**, except for the first appearance of *Contusotruncana contusa* (Cushman), *Contusotruncana plicata* White, *Rugotruncana circumnodifer* (Gandolfi), *Globotruncanella* pschadae (Keller), *Guembelitria dammula* (Voloshina).

As defined herin, the present biozone (CF6) is correlatable with the zone recorded by Li and Keller (1998a & b), Abramovich *et al*., (2002), Samir (2002) and Sharbazheri (2008), to the lower part of *Rosita contusa* Zone recorded in the Northeast of Iraq Abawi *et al*., (1982) and Abdel-Kareem (1986a & b), in Italy Premoli Silva and Sliter (1995, 1999), Premoli Silva *et al*., (1998), Abdel-Kareem & Samir (1995) Egypt**,** and it is correlated with middle part of Gansserina gansseri Zone of Al-Mutwali (1996), Hammoudi (2000), Al-Mutwali and Al-Jubouri (2005), Chacon and Martin (2005) Iraq, and other different localities of the world Robaszynski *et a l.*, (1984), Caron (1985), D Hont & Keller (1991), Maestas *et al*., (2003), Obaidalla (2005), (Figs. 7, 8).

Magnetochron records of this biozone by (Li and Keller 1998a shows the age estimation of the time span from (69.56 - 69.06) Ma 500 Ky/13m estimating absolute ages based on magnetochron ages with 38 Ky/m moderate rate of deposition (Fig.7)
Age: Late early Maastrichtian.

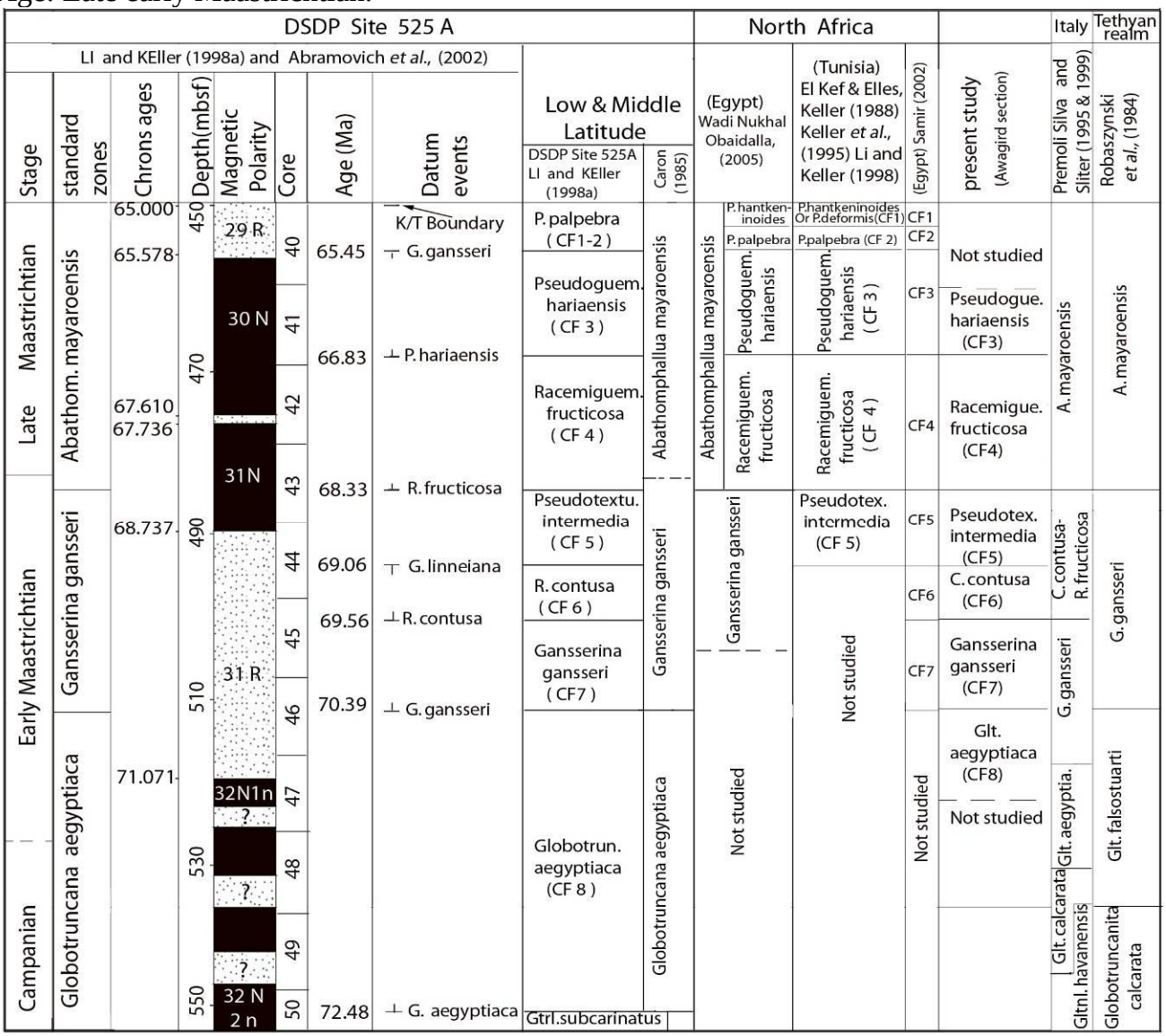


Fig :(7) Correlation chart showing the proposed biostratigraphic zones of Awagird section (Smaquli area) with the Planktonic foraminiferal zonation commonly used in low, middle and high latitudes, and new zonation proposed based on DSDP Site 525A, by Li and Keller (1998a) and Abramovich *et al*., (2002) in the new zonal scheme. The age of planktonic foraminiferal datum events is shown. (Modified from different authors)

Pseudotextularia intermedia Interval Zone (CF5)

In the present study *Pseudotextularia intermedia* Zone or (CF5) is defied by the LAD of the *Globotruncana linneiana* (d' Orbigny) at the base and the FAD of *Racemiguembelina fructicosa* (Egger) at the top (Fig 10, f). Nederbragt (1991) originally introduced this biozone as the interval from the FAD of *Planoglobulina acervulinoides* at the base and the FAD *Racemiguembelina fructicosa* at the top. In the present study, the definition is constrained according to Li and Keller (1998 a, b) .The interval of this zone is 18 m thick, besides the planktonic foraminiferal species enduring from the underlying biozones , some species shows their first appearance, e.g. *Pseudotextularia intermedia* (De Klasz),*Globigerinelloides subcarinata* Bronnimann, and *Gumbelitra cretacea* Cushman.

Due to high similarities of foraminiferal occurance, the present zone (CF5) is equivalent to that of Li and Keller (1998a,b), Abramovich *et al*., (2002), Samir (2002) , Sharbazheri (2008) it is mostly equivalent to the upper part of *Gansserina gansseri* Zone recorded in the North, Northeast of Iraq and different regions of the world Al-Mutwali and Al-Jubouri (2005), Al-Mutwali (1996), Hammoudi(2000), Caron (1985), Ubaidalla (2005), Robaszynski *et al*., (1984) and D' Hont & Keller (1991) and it is equivalent to the upper part of *Glt.contusa* Zone of Abawi *et al*., (19820 and Abdel-Kareem (1986), and *Glt .contusa-R . fructicosa* Zone of Premoli Silva and Sliter (1995, 1999), Abdel-Kareem & Samir (1995) (Figs 7, 8). The *Pseudotextularia intermedia* Zone spans about 0.73Myr (69.06--68.33)Ma 730Ky/18m estimating absolute ages based on magnetochron ages with 40.5 Ky/meter of moderate rate of deposition (Fig.7).
Age: Late Early Maastrichtian.

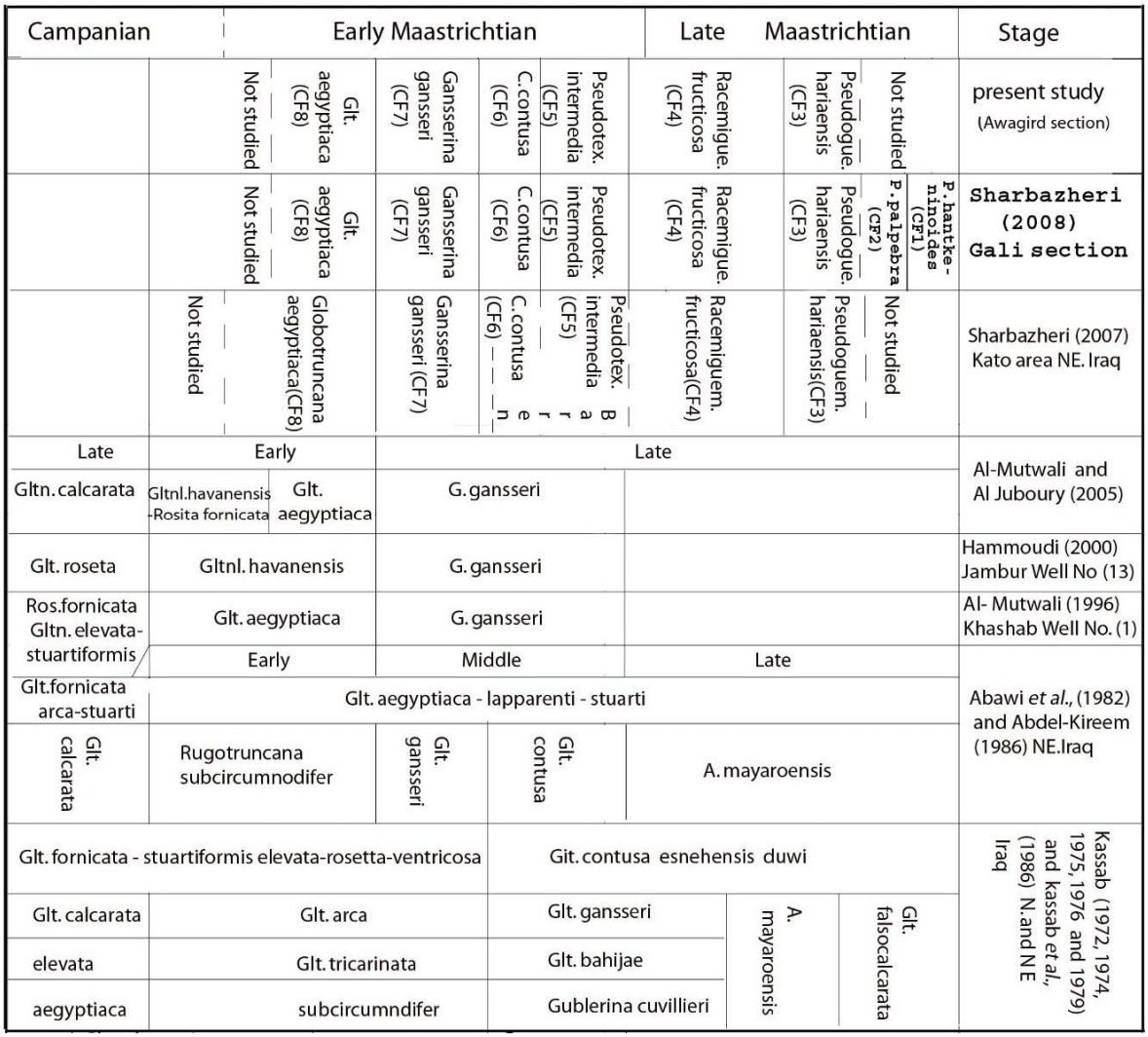


Fig :(8) Correlation chart showing the proposed biostratigraphic zones of Awagird section (Smaquli area) with the Planktonic foraminiferal zonation commonly used in Iraq.

Racemiguembelina fructicosa Interval Zone (CF4)

Racemiguemblina fructicosa Zone or (CF4) is introduced by Li and Keller (1998a ,b) as a biostratigraphic interval between FAD of *Racemiguembelina fructicosa* (Egger) at the base and the FAD of *Pseudoguembelina hariaensis* at the top. The FAD of *Racemiguembelina fructicosa* (Egger) in the studied section recorded from the upper most

part of reddish layers of Shiranish-Tanjero transition unit and covers the basal part of the Tanjero Formation (sample no.33) to the FAD of *Pseudoguembelina hariaensis* Nederbragt within Tanjero Formation (sample no.45). (Fig. 10, c). Attaining a thickness of 18 m.

It is important to mention that the zonal scheme of Cretaceous foraminifera (CF) proposed by Li and Keller (1998a & b) replaces the *Abathomphalus mayaroensis* Zone with four zones *(R. fructicosa* Zone, *P. hariaensis* Zone, *P. palpebra* Zone, *P. hantkeninoides* Zone), for a much improved age estimate at the late Maastrichtian (Fig. 7). The total range zone of *A. mayaroensis* Zone characterizes the Late Maastrichtian in low latitude regions as well as the Tethyan paleogeographic realm. However, it has been found that *A. mayaroensis* is very rare or absent in high latitude regions (Blow, 1979) and in the studied section also, consequently it is more accurate to use the new zonal scheme.

Most of the workers in the zonal scheme placed *Racemiguemblina fructicosa* Zone at the Early Late Maastrichtian, Keller *et al*., (1995), Li and Keller, (1998a&b), Premoli Silva (1999), Abramovich *et al*., (2002), Samir (2002) and Obaidalla (2005 Sharbazheri (2007 and 2008)) . As defined above, the present biozone (CF4) is correlatable with the lower part of *A. mayaroensis* of Abawi *et al*., (1982), Robaszynski *et al*., (1984), Caron (1985), Abdel-Kareem (1986) and Premoli Silva and Sliter (1995, 1999). (Fig. 7).

This zone covers abundant occurrence of the nominate species along 18m thick In addition to the index species, *Racemiguemblina fructicosa* (Egger), the planktonic foraminiferal assemblages of this zone include well preservation of: *Heterohelix navarroensis* Loeblich, *H. globulosa* (Ehrenberg), *H. striata* (Ehrenberg), *H. reussi* (Cushman), *H. nauttalli* (Voorwijk), H. *punctulats* (Cushman),*H. pulchra* (Brotzen), *Planoglobulina carseyae* (Plummer), *P. brazoensis* Martin *P. acervulinoides* (Egger), *Rogoglobigerina rugosa* (Plummer), *R. scotti* (Bronnimann), *R. hexcamerata* Bronnimann, *R. macrocephala* Bronnimann, *R. rotundata* Bronnimann, *R. milamensis* Smith&Pessa, *Gansserina gansseri* (Reuss), *G. wiedenmayeri* (Gandolfi), *Globotruncanita stuartiforms* Dalbez, *Globotruncanita conica* White, *Globotruncanita pettersi* Gandolfi, *Globotruncanita angulata* Tilev, *Rugotruncana subcircumnodifer* (Gandolfi), *Globotruncana aegyptica* Nakkady, *Glt. falsostuarti* Sigal, *Glt. dupeublei* Caron et al., and *Glt. mariei* Banner & Blow, in lower part., *Contusotruncana contusa*(Cushman), *C. plicata* White, ,*Abathomphalus mayaroensis* (Bolli) *Globotruncanella petaloidea* (Gandolfi), *Globotruncanella havanensis* (Voorwuk), *Globotruncanella pschadae* (Keller), *Pseudotextularia elegans* (Rzehak),*Pseudotextularia deformis* (Kikoine), *Pseudotextularia intermidia(De Klasz), Rascemiguembelina powelli* Smith&Pessango, *Pseudoguembelina costulata* (Cushman), *Gublerina cuvillieri* kikoine, *Guembelitria dammula* (Voloshina), *Globigerinelloides voluta* (White), *Globigerinelloides prairiehilleinsis* Pessango, *Globigerinelloides douglasi* Kassab, *Globigerinelloides subcarinata* Bronnimann, *Globigerinelloides escheri* (Ehrenberg), *Archaeoglobigerina carteri* (Kassab), *Hedbergella monmothensis* (Olsson), *Hedbergellaholmdelensis* olsson, *Gumbelitra cretacea* Cushman

The age estimation of this biozone by Li and Keller (1998a), records the time span of (68.33 - 68.83) Ma (500 Ky) estimating absolute ages based on magnetochron ages with 26.3 ky/m moderate rate of deposition (Fig.7).

Pseudoguembelina hariaensis Interval Zone (CF3)

The *Pseudoguembelina hariaensis* Zone is defined by Li and Killer (1998a) as a partial range of the nominate species between the FAD of *Pseudoguembelina hariaensis* Nederbragt and the last appearance LAD of *Gansserina gansseri* (Bolli). In the studied section, this zone also is marked by the FAD of the nominate species, but the last occurrence of *Gansserina gansseri* (Bolli), was not figured out, therefore the top of (CF3) was not recorded herein the studied section. This zone shows reliable abundancy of *Pseudoguembelina hariaensis* Nederbragt and other assemblages' of planktonic foraminifera which totally resembles that of the underlying *Racemiguemblina fructicosa* zone (CF4), except for the termination of *Globosotruncana falsostuarti* Sigal, *Globotruncanella havanensis* (Voorwuk) and *Globigerinelloides prairiehilleinsis* Pessango.

As defined herin, the present biozone (CF3) is correlatable with the zone recorded by Li and Keller (1998a,b), Keller (2002 and 2004), Abramovich *et al*., (2002), Samir (2002), Abramovich and Keller (2003), Obaidalla (2005)and Sharbazheri (2008) and it is correlated with the middle part of *Abathomphalus mayaroensis* zone recorded in the Northeast of Iraq Abawi *et al*., (1982) and Abdel-Kareem (1986), in Italy Premoli Silva and Sliter (1995, 1999) Premoli Silva *et al*., (1998), Abdel-Kareem & Samir (1995) Egypt, and Robaszynski *et al*., (1984) and Caron, (1985), (Fig 7).

The age estimation of this biozone by Li and Keller (1998a), is recorded as Middle Late Maastrichtian, with the time span of (66.8 - 65.45) Ma estimating absolute ages based on magnetochron ages (Fig.7).

CONCLUSIONS AND RECOMMENDATION

- The duration of the reddish to pale brown succession (Shiranish-Tanjero transition unit) of the studied section in the Smaquli area is estimated to be more than 2.150my.
- Sixty seven planktonic foraminiferal species belonging to nineteen genera have been recorded.
- Six Planktonic Foraminiferal biostratigraphic zones have been detected in the studied section represent *Globotruncana aegyptiaca* Interval Zone (CF8), *Gansserina gansseri* Interval Zone (CF7), *Contusotruncana contusa* Interval Zone (CF6), *Pseudotextularia intermedia* Interval Zone (CF5), *Racemiguemblina fructicosa* Interval Zone (CF4), *Pseudoguembelina hariaensis* Interval Zone (CF3), and they display Late Campanian—Middle Late Maastrichtian age.
- The planktonic foraminifera occur continuously in the sedimentary succession of the studied section shows incessant in sedimentary sequence without any interruptions.
- The lateral and vertical relations of reddish to pale brown succession is quite conformable with both underlying Shiranish and overlying Tanjero formations.
- The well exposed reddish to pale brown succession (Shiranish-Tanjero transition unit) has special monotonous, conventional lithologic character differs from both underlying Shiranish Formation and overlying Tanjero Formation, geographically extends for more than 75Km and it has mapable thickness which reaches 72ms. in Smaquli Gali Gorge. With relevant feasible geologic age of Early Maastrichtian about 2My duration.
- Consequently the author recommend the name of Smaquli Formation as a new formal lithologic unit to display an incipient effort of Formation rank according to international stratigraphic nomenclature code.

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EXPLANATION OF THE FIGURES

All planktonic foraminifera are from the reddish to pal brown succession of Upper Cretaceous (Maastrichtian) of Awagird section Smaquli area

Scale bar represents magnification on the specimens

Fig -9

a- b *Globotruncanita stuartiformis.* (Dalbiez). a- spiral view, b- umbilical view. Sample from *G, gansseri* Zone

C, d, u *Contusotrancana contusa (Cushman)*. c- spiral view, d- umbilical view, u- side view. Sample from *C. contoza* Zone

e- g *Globotruncana aegyptiaca* Nakkady. E- side view, f- spiral view, g- umbilical view, Sample from *R. fructicusa* Zone

h- i *Gansserina gansseri* (Bolli). h - umbilical view, i- spiral view, Sample from *G., gansseri* Zone

j- k *Gansserina wiedenmayeri* (Gandolfi). J- side view, k- umbilical view .

Sample from *G. gansseri* Zone

l- m *Contusotrancana plicata* White. L- spiral view. M- umbilical view. Sample from *G. gansseri* Zone

n-o *Globotruncana ventricosa* White. n- spiral view, o - umbilical view. Sample from *G. gansseri* Zone

p- r *Contusotruncana fornicate* (Plummer). p- umbilical view, q- side view, r- spiral view. Sample from *G. gansseri* Zone

s-t *Globotruncanita pettersi* Gandolfi. s- Umbilical view , t- side view. Sample from *G. gansseri* Zone

v *Globotruncana dupeublei* Caron, Gonzalez, Donoso, Robaszynski & wonders. spiral view. Sample from *G.gansseri* Zone

w-x *Rugoglobigerina rugosa*. (Plummer), 22- umbilical view, 23- side view. Sample from *R. fructicusa* Zone

Fig-10

a- b Globotruncanita conica (White). a- spiral view, b- umbilical view. Sample from *C. contoza* Zone

c *Racemiguembelina fructicusa* (Egger) Sample from *R. fructicusa* Zone

d *Racemiguembelina powelli* Smith & Passango Sample from *R. fructicusa* Zone

e *Pseudotextularia elegans* (Rzehak**)** Sample from *R. fructicusa* Zone

F *Pseudotextularia intermedia* (De Klasz). Sample from *P. intermedia* Zone

g- h *Globotruncanita stuarti*. (De Lapparent). G - spiral view, h- umbilical view. Sample from *R. fructicusa* Zone

i- j *Globotruncana orientalis* Elnaggar. i- umbilical view. j- spiral view. Sample from *P. hariaensis* Zone

k *Globotruncana arca*. (Cushman). 4- side view. Sample from *R. fructicusa* Zone

l *Globotruncanita angulata* Tilev. umbilical view. Sample from *G. gansseri* Zone

m *Globigerinelloides volutes* (White). umbilical view. Sample from *G. gansseri* Zone

n- o *Rugoglobigerina rugosas* (Plummer), n- umbilical view, o-spiral view. Sample from *R. fructicusa* Zone

p *Rugoglobigerina milamensis* Smith & Pessango. umbilical view. Sample from *R. fructicusa* Zone

q *Globotruncana mariei* Banner & Blow, umbilical view, Sample from *G. gansseri* Zone

r *Rugoglobigerina macrocephala Bronnimann*. umbilical view, Sample from *R. fructicusa* Zone

s *Globotruncana falsostuarti* Sigal, side view, Sample from *R. fructicusa* Zone

t *Globotruncanella havanensis* (Voorwuk), umbilical view, Sample from *R. fructicusa* Zone

u *Globotruncanella pateloidia* (Gandolfi), spiral view. Sample from *R. fructicusa* Zone

v *Pseudotextularia deformis* (Kekoine). Sample from *G. gansseri* Zone

w *Rugoglobigerina pennyi* (Gandolfi), 6- side view. Sample from *R. fructicusa* Zone

x *Rugotruncana circumnodifer* (Gandolfi), spiral view, Sample from *R. fructicusa* Zone

Fig -9

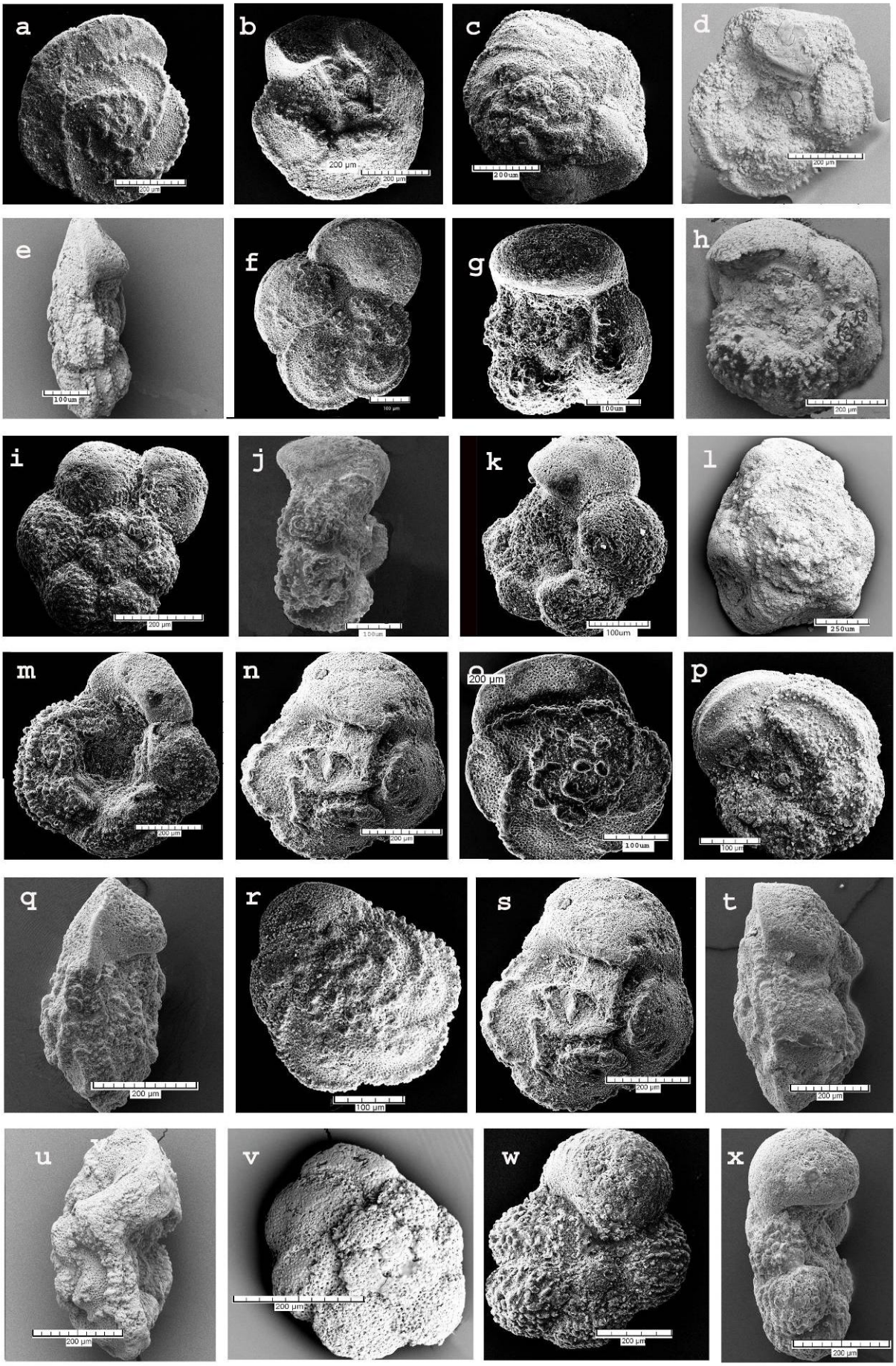

Fig-10