Australian Journal of Basic and Applied Sciences, 6(13): 18-26, 2012
ISSN 1991-8178

Stratigraphy and Foraminiferal biozonation of upper cretaceous sediments in Southwest Sepid Dasht, Lurestan, Iran

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Abstract: In order to study lithostratigraphy and microbiostratigraphy of Tarbur and Amiran Formations in southwest Sepid Dasht (Lurestan), the stratigraphical section of Cham sangar was selected. Lithostratigraphical studies shows presence of limestone, dolomitic limestone, sandy limestone, shale and marl in this section. The existing index facies in this section include grainstone, packstone and wackstone. Microbiostratigraphical studies done on 67 thin sections from 77.3 m of Tarbur Formation sediments in Cham sangar section indicates the existence of 12 genera and 23 species of benthic foraminifers. Based on assessment of existing set of foraminifera, *Omphalocyclus - Loftusia* assemblage zone has been proposed for Cham sangar section. Micropaleontological studies suggest middle-Maastrichtian to late-Maastrichtian age for Tarbur Formation in southwest Sepid Dasht. The performed studies for the first time mention that in Lurestan province, Tarbur Formation with index lithology and fauna of Maastrichtian interbeds in clastic-conglomerate deposits of Amiran Formation base in a local tongue manner which indeed introduces age of Amiran Formation basal part as Maastrichtian.

Key words: Lurestan- Tarbur Formation- Maastrichtian- Cham sangar

INTRODUCTION

Considering having specific biostratigraphical characteristics in different stratigraphical sections, changes in fauna and finally relative age changes in different places, Tarbur Formation has a big significance amongst facies of Zagros Upper-Cretaceous. Timing interval of Tarbur Formation deposition in Interior Fars ranges from late-Campanian to Lower-Paleocene (Afghah, 2005; Khosro Tehrani, 2004) and in Lurestan from middle-Maastrichtian to late-Maastrichtian (Abyat, 2007, Abyat & Afghah, 2007; Abyat *et al*., 2007a, Abyat *et al*., 2007). Tarbur Formation type section (which is located in Gadvan Mount in 1.2 km distance of Tarbur village) studied for the first time bye (Alavi, 2004). Type section has an eastern longitude of 52° 54′ 05″ and northern latitude of 29° 38′ 01″. Its thickness is 527.3 m and consists of massive limestones with plenty of fossils, rocky limestones and sometimes anhydritic limestones. Sachun Formation is above Tarbur Formation and Gurpi Formation is laid below it (Khosro Tehrani, 2004). This formation was deposited in proforland basin in Zagros fold-thrust belt (Alavi, 2004). In this study, in order to assess lithostratigraphy and microbiostratigraphy of Tarbur Formation, the stratigraphical section of Cham sangar was chosen. Study area is located in Zagros folded zone. Cham sangar stratigraphical section is 21 km from southwest Sepid Dasht and 84 km far from southeast Khorramabad. This area can be accessed via Sepid Dasht-Cham sangar asphalt road or Khorramabad-Sepid Dasht (Fig. 1). Its altitude from sea level is 844 m and has an eastern latitude of 33˚10′ and northern longitude of 48˚46′.

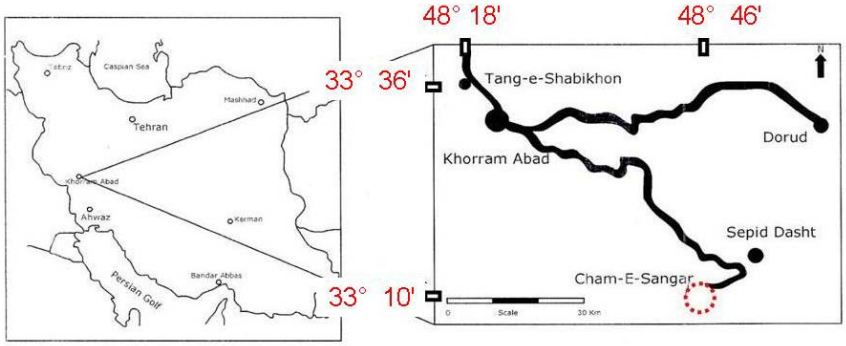

Fig. 1: Geographical position of the study section (shown by red circle)

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Research Method:

After choosing section and determining the upper and lower boundaries of Tarbur Formation in field visit, systematic sampling was done and 67 samples were taken. After preparing samples and making thin sections, lithostratigraphical and biostratigraphical studies were precisely performed. The existing foraminifera were evaluated based on these studies: Kalantari, 1976, Loeblich & Tappan, 1989, Meric & Gormuz, 2000, Meric & Gormuz, 2001, Abdelghany, 2003, Mehmat & Nazire, 2003, Zambetakis & Kemeridou ,2004, Abdelghany,2006, Zambetakis and Kemeridou, 2006, O¨zcan,2007, BouDagher-Fadel and Price, 2009, Çaglar and Önal, 2009. Additionally, microfacies were studied using method Dunham,1962.

Discussion:

Lithostratigraphy of Tarbur Formation in Cham sangar Section:

In this section, Amiran and Tarbur Formations are exposed on surface. Amiran Clastic Formation with lithology of sandstone, shale and olive conglomerate is placed below the limy tongue (Tarbur Formation) (Plate 1, Fig. 1). This formation has various Sedimentological structures like: symmetrical ripple mark, asymmetrical ripple mark, tongue ripple mark, mud crack, graded bedding and lamination. An alternation of red conglomerate and olive conglomerate of Amiran Formation upper part covers Tarbur Formation with an erosional unconformity (Fig. 2).

Evaluating observed olive conglomerates of Amiran Formation in lower and upper intervals of Tarbur Formation indicates the similarity between these two in lithological source and composition, therefore it can be mentioned from stratigraphical position point of view, Tarbur Formation is not above Amiran Formation but a part of Tarbur Formation is laterally interbedded into lower part layers of Amiran Formation (Abyat, 2007; Abyat & Afghah, 2007; Abyat *et al*., 2007). Studies of lithostratigraphy, microbiostratigraphy the section microfacies, confirm the past mentioned matters. The thickness of Tarbur Formation in Cham sangar section is 77.3 m which involves the following succession from down upward (Fig. 2):

1- 12 m, dark-gray *loftusia* limestone, thick-bedded with weathered gray to chickpea color.

2- 11.1 m, dark-gray dolomitic limestone, medium-bedded with weathered gray to cream color.

3- 18.7 m, glauconitic sandy limestone, gray to milky, thin-bedded with weathered white to light gray color, containing an olive marly interbedding with a thickness of 80 cm.

4- 7.6 m, gray limestone, medium-bedded with weathered white to cream color.

5- 27.9 m, alternation of limestone, sandy limestone with olive and purple marl and finally shale and sandy limestone.

Afghah & Khosro Tehrani, 2004, Khosro Tehrani & Afghah, 2004, Afghah 2005, in their researches in Interior Fars, have divided the Tarbur Formation by lithostratigraphical point of view into two intervals:

a- Lower interval: contains medium-bedded to thick-bedded limestone with rudist debris.

b- Upper interval: consists of massive limestone accompanying rudist, gastropods and green alga.

The existing lithology in this section is not similar to those in Interior Fars (Abyat, 2007; Abyat & Afghah, 2007; Abyat *et al*., 2007). As mentioned before, Tarbur Formation in this section is a composition of carbonate and clastic rocks. Carbonates of shallow sea environment (limestone and dolomitic limestone) construct the lower units of this section. In middle part, carbonate and clastic rocks (glauconitic sandy limestone) form the succession (Plate 1, Fig. 4) which shows an increase in energy level of environment. In the ending part, carbonates (limestone), medium-graded carbonate-clastic (sandy limestone) and fine-graded (marl and shale) alternately compose the depositional succession (Plate 1, Fig. 2). The sediments related to this interval indicate deposition in low-energy environment due to biological and sedimentological evidences. Field observations and thin section studies, led to recognize 6 carbonate microfacies and a clastic microfacies in Tarbur Formation which were deposited in Lagoon, Bar and open marine environments. Lagoon facies group (A) includes A1: Dasycladaceae Bioclast Wackstone, A2: Foraminifera Bioclast Packstone-Wackstone, A3: Coral Foraminifera Bioclast Wackstone-Packstone. Bar Facies group (B) involves B1: Rudist Foraminifera Bioclast Grainstone (Plate 2, Fig. 2). Open marine facies group (C) consists of C1: Rudist Foraminifera Bioclast Packstone, C2: Foraminifera Bioclast Wackstone (Plate 4, Fig. 4) and the clastic microfacies M1 which contains shale and marl. Studies of lithology, paleontology and succession of the mentioned microfacies, lead to confirm a regression from the beginning of middle-Maastrichtian to the ending of upper-Maastrichtian which coincides the global regression of the end of Cretaceous.

Discussing type of microfacies, percentage and type of composing elements, lower and upper layers of section beginning gray limestones consist of wackstone microfacies and the middle part is composed of packstone. The number of allochems in middle part is more than that in lower and upper intervals. Bioclast is the most abundant allochem of this unit (Plate 2, Fig. 3). Medium-bedded dolomitic limestone is above these layers. Down these layers contains wackstone and the upper interval involves packstone.

Number of allochems in beginning part is more than that in ending part. Above these deposits, glauconitic sandy limestone (inside which marly interbeds exist) can be observed. Microfacies in this unit consist of packstone and grainstone alternation in lower interval and grainstone in upper interval of marly interbeds.

Allochems are roughly more abundant than two previous units. Here also bioclast is the most plentiful allochem. In sandy limestones' interval, microorganisms' fragmentation is well observed such that most microfossils like *orbitoeides* and *omphalocyclus* are observed as debris (Plate 2, Fig. 2). Medium-bedded gray limestone continues the succession. Existence of grainstone microfacies in all intervals of this unit is an indicator to high energy of environment in the time of precipitation. Allochems are approximately numerous and their most frequent one is bioclast (Plate 2, Fig. 1). The ending layers consist of an alternation of limestone, sandy limestone with olive and purple marl and finally shale. Its limy units have grainstone microfacies in middle part and wackstone in the most superior unit. Allochems are so rare in this unit and has a poor content of fossils by which it seems the energy level in this interval reached the lowest value.

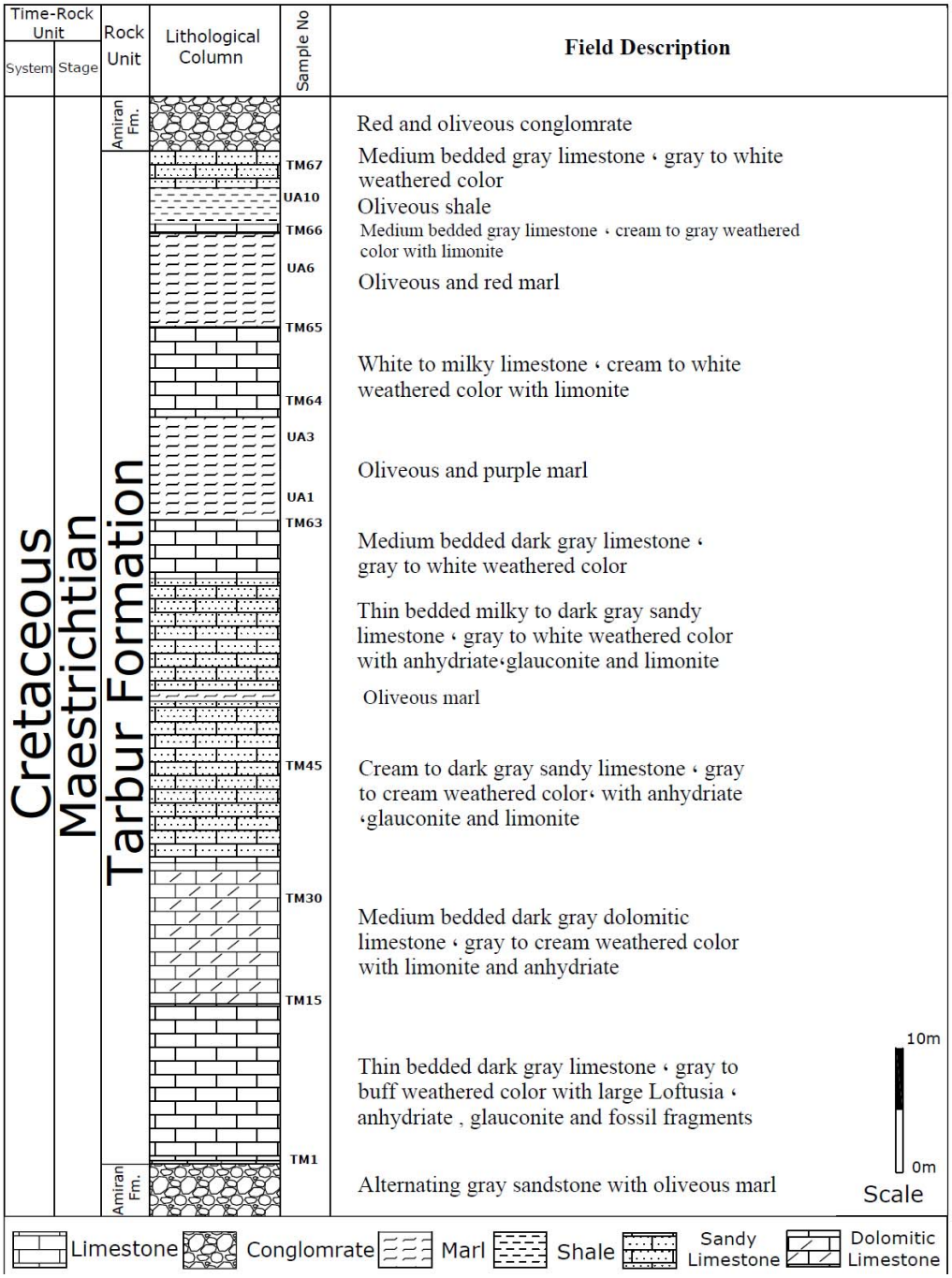

Fig. 2: Lithostratigraphy column of Tarbur Formation in Cham sangar section

Microbiostratigraphy of Tarbur Formation in Cham sangar Section:

According to Microbiostratigraphical studies done on Tarbur Formation in Cham sangar section, existence of 12 genera and 23 species of benthic foraminifera is proved which include (Fig. 3):

Loftusia minor, Loftusia harisoni, Loftusia coxi, Loftusia elongata, Loftusia morgani, Loftusia sp., *Minouxia lobata, Minouxia.sp., Lituonella nautiloides, Psuedolithounella* sp., *Broekinella* sp., *Omphalocyclus macroporus,Orbitoides media, Orbitoides cancavatus, Orbitoides apiculata, Orbitoides tissoti, Siderolites calcitrapoides, Siderolites* sp., *Nezzazatinella* sp., *Gavelinella* sp., *Goupillaudina* sp., *Miliolids* , *Rotalia trochidiformis, Rotalia* sp., *Murciella* sp.

In addition to mentioned foraminifera, by studying thin sections other elements were recognized and are as following:

Echinodermata, Pelecypoda fragment, Gastropoda fragment, Coral, Rudist, Algal debris, Salpingoporella sp., *S. dinarica, Ostracoda.*

Based on performed analysis and according to phonestic content, *Omphalocyclus-Loftusia* assemblage zone has been suggested for this section. Fossil collection of Cham sangar section can be compared to *Omphalocyclus- Loftusia* assemblage zone,Wynd,1965, which can be seen in Interior Fars in upper parts of Tarbur Formation and in silty layers of Sachun Formation base. Due to existing fossil collection, Tarbur Formation age in Cham sangar section was considered as middle-Maastrichtian to late-Maastrichtian.

Species; *Minouxia lobata, Psuedolithounella* sp., *O. apiculata, R. trochidiformis, Nezzazatinella* sp., *Murciella* sp., *Goupillaudina* sp. in previously done studies on this section were not introduced by Mirbeyk *et al*. (2006) and are reported for the first time in this area. Generally comparing index foraminifera of Tarbur Formation in studied sections of Fars province like works James & Wynd,1965,Afghah & Khosro Tehrani,2004, Khosro Tehrani & Afghah,2004, Afghah 2005,Afghah & yosef zadeh,2007,to performed studies on this section, below results can be deduced: extension of the study area, time and position changes of sedimentation regime cause variety in sections microfauna such that some genera and species are only found in a particular province, for instance species; *Goupillaudina shirazensi, Lepidorbitoides minor, Lepidorbitoides socialis, Orbitoides triangularis* can only be observed in Fars province and species; *Loftusia harisoni, Loftusia coxi, Loftusia elongata, Loftusia morgani* are only seen in southwest Sepid Dasht (Abyat,2007,Abyat *et al*.,2007).. Those foraminifera with hyaline shell and those with agglutinate shell in Cham sangar section have larger size and more extension. It seems clastic facies of Amiran Formation helped to build the larger agglutinate shell in Cham sangar section in Lurestan (Abyat,2007,Abyat *et al*.,2007). The Loftusia genus is observable in Lurestan with high variety of species, larger size and number while in Fars only two species; *Loftusia coxi* and *Loftusia minor* are detectable. The observed Loftusia in Cham sangar section are comparable to those in other regions of Tethys southern edge like Turkey,Greece,Iraq and Oman (Meric & Gormuz, 2000, Meric & Gormuz,2001, Abdelghany,2003Mehmat & Nazire, 2003, Zambetakis & Kemeridou, 2004; Mehmat & Nazire, 2003, Zambetakis & Kemeridou ,2004, Abdelghany,2006, Zambetakis and Kemeridou,2006, O¨zcan,2007, BouDagher-Fadel and Price, 2009, Çaglar and Önal, 2009). In Fars province, the *Orbitoides* genus can be seen in form of numerous species like *Orbitoides apiculata, Orbitoides triangularis, Orbitoides cancavatus, Orbitoides tissoti,* and *Orbitoides media* and are so various and abundant but this genus in Cham sangar section is seen with less species and abundance. Monolepidorbis fossil (which is index for biozone 36 ,Wynd,1965, exists in Tarbur Formation basal limestones and indicates the age of Campanian) cannot be seen in this section. Motiei,1993, counts on *Siderolites* as one of the most plentiful fossils present in biozone 37 ,Wynd,1965 and suggests its loss in Lurestan biozone 37. However, the high frequency of *Siderolites calcitrapoides* in Cham sangar section conflicts this expression.

Statistical Assessment of Number of Foraminifera's Genera and Species in Lithostratigraphical Units:

Distribution and number of foraminifers' genera and species in different units of Tarbur Formation in Cham sangar section vary due to existing discrepancy in lithology. Evaluating diversity and number of genera and species based on a lithology-arranged manner, results are statistically as following:

Species variety from down upward in Tarbur Formation in this section is obviously decreased such that in the beginning layers, species are 24 and they become 7 in the ending layers. Thus, by passing time biological conditions needed for diversity of species of a known genus get unpleasant.

Number of genera obeys this trend such that in beginning to middle layers it oscillates between 12 and 13 but after those middle layers, number of genera are decreased and then at the ending part reaches 6 which is the lowest (Graph 1). Generally speaking about diversity of genera and species, sandy limestone layers are first at the ranking and after those, beginning layers have a large number. The ending unit which is composed of an alternation of limestone, sandy limestone, marl and shale, has the lowest number of genera and species. This reduction in genera and species accompany a decrease in allochems and regression of depositional basin.

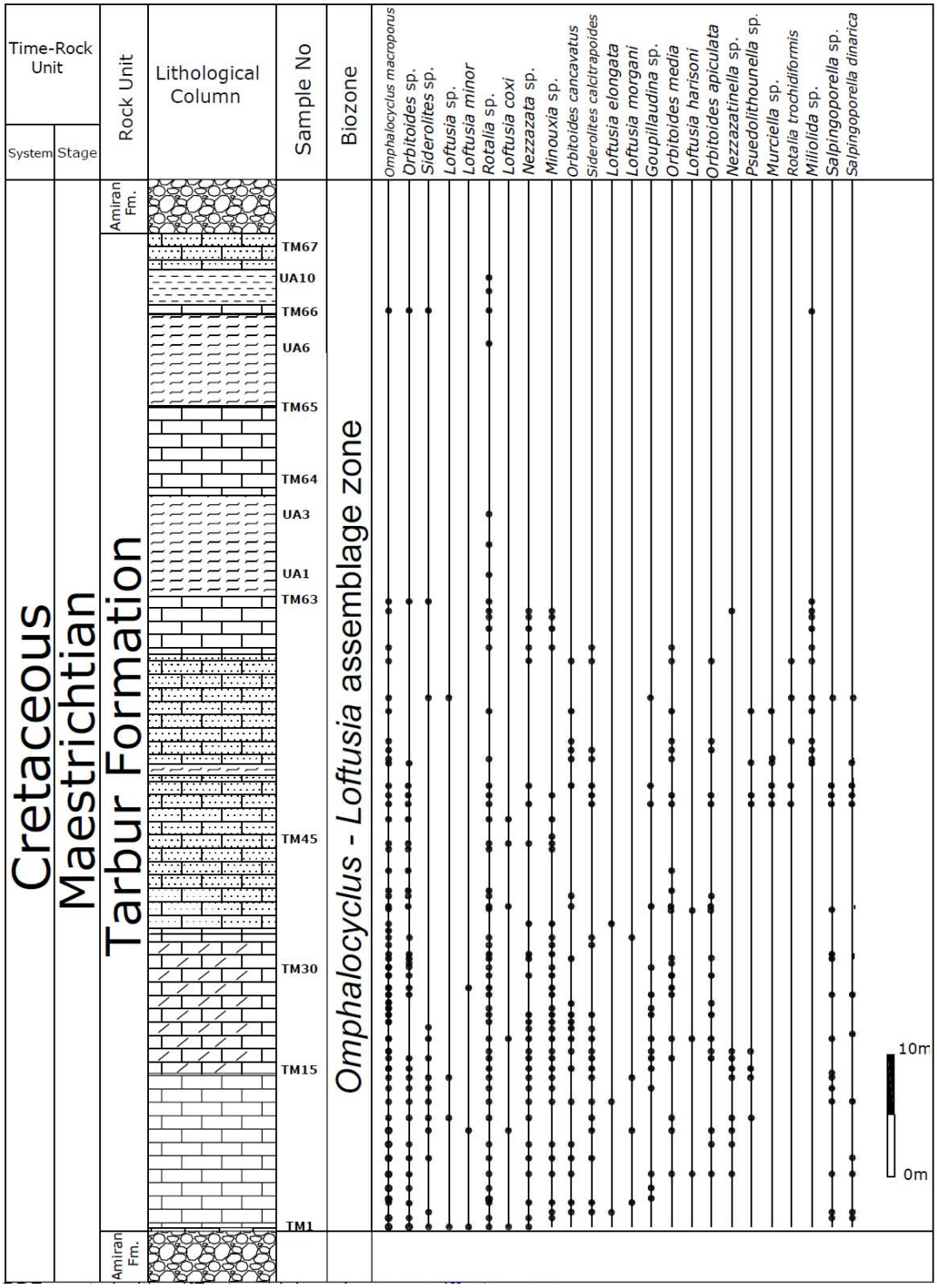

Fig. 3: Biostratigraphical distribution diagram of Tarbur Formation in Cham sangar section

Graph 1: Frequency diagram of species and genera in different parts of Cham sangar section

A: Thick-bedded dark-gray loftusia limestone

B: Medium-bedded dark-gray dolomitic limestone

C: Glauconitic sandy limestone, gray to milky, thin-bedded

D: Medium-bedded gray limestone

E: Alternation of limestone, sandy limestone with olive and purple marl and finally shale and sandy limestone

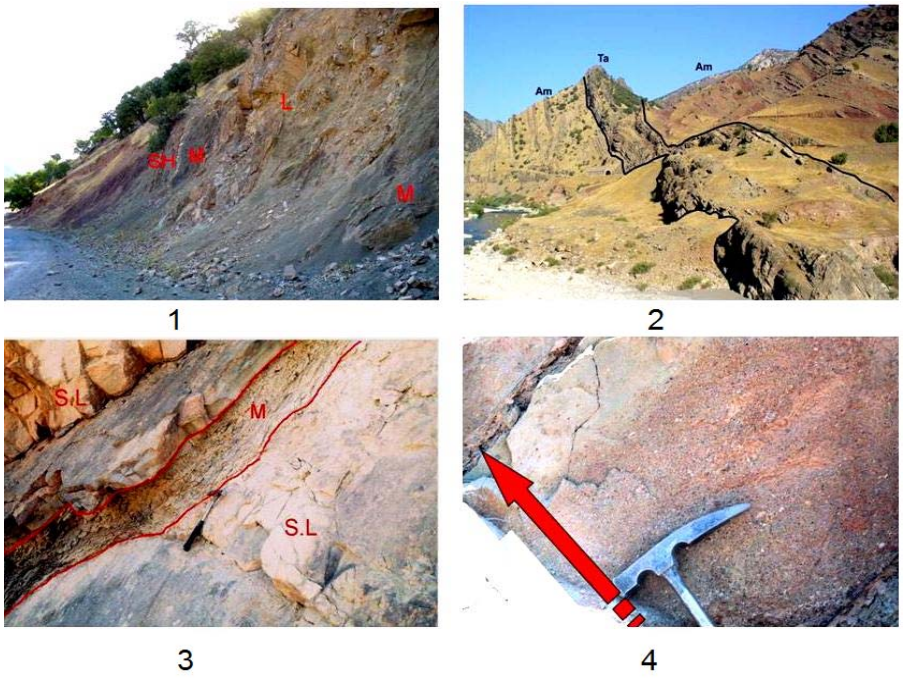

Plate 1:

Fig. 1: A view of limy tongue of Tarbur Formation in lower part of Amiran Formation, Cham sangar section, S.W Sepid Dasht, Lurestan

Fig. 2: Alternation of carbonate and clastic rocks of ending part of Tarbur Formation (L: limestone, SH: Shale, M: Marl)

Fig. 3: A view of graded bedding in clastic deposits of Amiran Formation lower part (arrow shows the trend of decrease in grains size)

Fig. 4: Glauconitic sandy limestone with a marly interbed (S.L: sandy limestone, M: Marl)

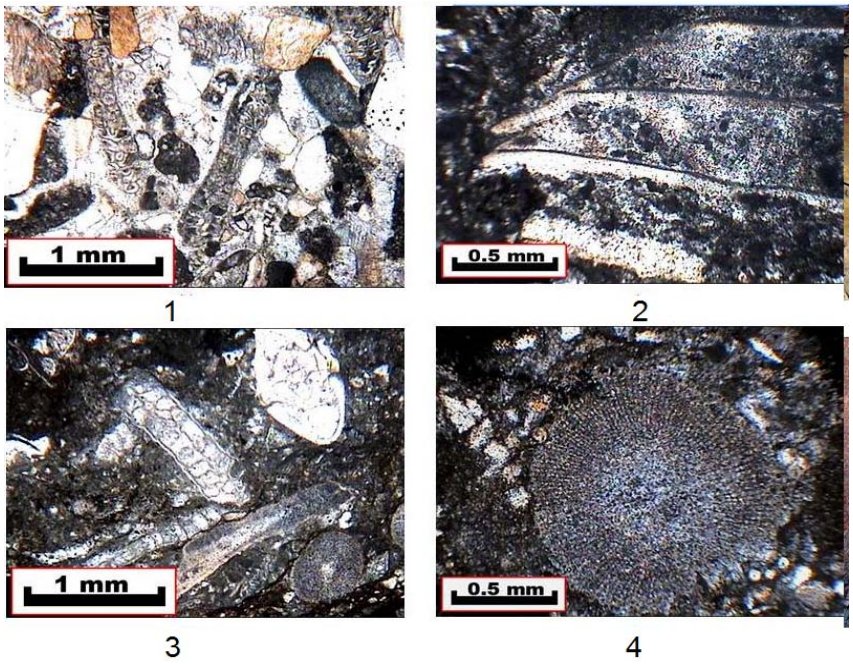

Plate 2:

Fig. 1: An example of identified bioclasts, a section of rudist shell (radiolites)
Fig. 2: Fragmentation of microorganisms (Omphalocyclus) in sandy limestones of Cham sangar section due to waves high energy, bar microfacies B1, Rudist Foraminifera Bioclast Grainstone
Fig. 3: Another example of identified bioclasts, transverse section of Echinoid spicule.
Fig. 4: Microfacies C2, Foraminifera Bioclast Wackstone, fossils like Orbitoides, Omphalocyclus, Rotalia and Echinoid spicule are seen in a micritic context in this thin section.

Conclusion:

1- In this section Tarbur Formation is positioned into Amiran Clastic Formation in a tongue form. Tarbur Formation lower boundary is identified by an erosional surface between conglomerate of Amiran Formation's ending and limestones of Tarbur Formation's beginning and its upper boundary with Amiran Formation is recognizable with an erosional unconformity.

2- In Cham sangar section based on biostratigraphical studies, 12 genera and 23 species of benthic foraminifera were detected which caused to propose *Omphalocyclus-Loftusia* assemblage zone for this section. This biozone introduces age interval of middle-Maastrichtian beginning to upper-Maastrichtian ending. Fossil collection of Cham sangar section is comparable *to Omphalocyclus-Loftusia* assemblage zone Wynd,1965.

3- *Loftusia* genus is seen in this section with high species diversity, larger size and more numerous, while in Fars *Loftusia coxi* and *Loftusia minor* were only observed. The detected *Loftusia* in Lurestan province can be compared to those in other regions of Tethys southern edge like Turkey,Greece,Iraq and Oman

4- Presence of species; *Loftusia harisoni, Loftusia coxi, Loftusia elongata, Loftusia morgani and* absence of *species; Goupillaudina shirazensi, Lepidorbitoides minor, Lepidorbitoides socialis, Orbitoides triangularis* are considered as biological variations between this section and Interior Fars sections.

5- According to existing lithological and paleontological evidences, energy level of depositional environment in a general view is gradually reduced from the beginning to the end of section. The highest energy is related to the sandy limestone of section middle units. Lithological succession, microfacies and paleontological evidences in this section show a regression from middle-Maastrichtian beginning to upper-Maastrichtian ending which is coincided with regression of end of Cretaceous.

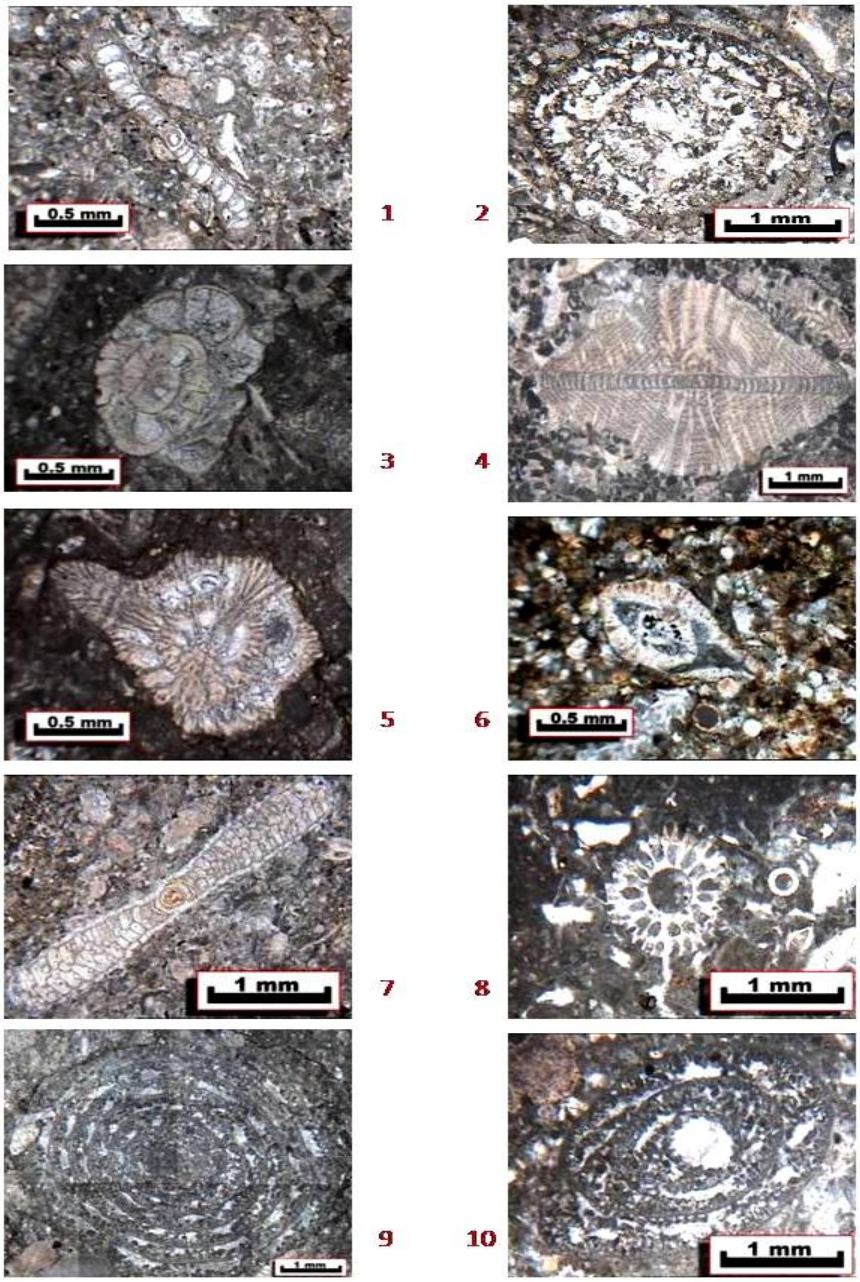

Plate 3:

1- *Orbitoides cancavatus,* Axial section, Cham sangar section (S.W Sepid Dasht)
2- *Loftusia cf. minor, Sub axial* section, Cham sangar section (S.W Sepid Dasht)
3- *Rotalia cf. trochidiformis,* Equatorial section, Cham sangar section (S.W Sepid Dasht)
4- *Orbitoides media,* Sub axial section, Cham sangar section (S.W Sepid Dasht)
5- *Siderolites calcitrapoides,* Axial section, Cham sangar section (S.W Sepid Dasht)
6- *Goupillaudina* sp., Axial section, Cham sangar section (S.W Sepid Dasht)
7- *Omphalocyclus macroporus* , Axial section, Cham sangar section (S.W Sepid Dasht)
8- *Salpingoporella* sp., Transverse section, Cham sangar section (S.W Sepid Dasht)
9- Loftusia cf. morgani, Equatorial section, Cham sangar section (S.W Sepid Dasht)
10- *Loftusia harisoni,* Equatorial section, Cham sangar section (S.W Sepid Dasht)

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