

## New Investigations of the Tarbur Formation Lithostratigraphy in The Review of Type Section and its Correlation with Kuh-e Tir Section

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### Abstract

**Introduction:** Tarbur Formation (Campanian-Maastrichtian) is acarbonate lithostratigraphic unit which is distributed in Fars and Lurestan. Really the Tarbur Formation is a rudistic limestone. This formation is sandwiched between Gurpi (Santonian) and Sachun (Paleocene) Formations. Two Tarbur Formation stratigraphic sections in east of Shiraz are chosen which name Kuh-e Gadvan (type section) and Kuh-e Tir.

**Aim:** In this research, biostratigraphic limits and identification of the benthic foraminifers have been studied. Also, study of the evolution of the reefs in these stratigraphic sections are the main objects of this study.

**Material and Methods:** In order to study of introduced objects, field and lab study have been done. 430 samples of two stratigraphic sections have been sampled and prepared thin sections. With using of different sections, index foraminifers have been identified. Also based on the Danhum's classification (1962) qualitative and quantitative microscopic study have been done.

**Results:** Biostratigraphic limits of the Tarbur Formation in Kuh-e Gadvan section is differ from that in Kuh-e Tir section. According to the identified foraminifers, the age of the Tarbur Formation in Kuh-e Gadvan is Campanian to Maastrichtian and in Kuh-e Tir section is Late Maastrichtian to Early Paleocene. New taxa of foraminifers are identified which are include: *Gouppillaudina iranica*, *G. shirazensis*, *Gavelinella pertusa*. Tarbur Formation of the both studied sections is divided into two lithostratigraphic member which are lower part (Well-bedded rudist limestone) and upper part (massive rudist limestone).

**Conclusion:** Although reef is an ecological unit, deposition of lowermost of reef facies in the studied sections are heterochronous. Lower biostratigraphic limit between Gurpi and Tarbur Formations in Kuh-e Tir section is disconformable. Microfacies studies indicate that stabilization, colonization and diversification stages have been detected in both stratigraphic sections.

**Key words:** Tarbur Formation, lithostratigraphy, Type section

### Introduction

In this study, type section of the Tarbur Formation and another section of this formation in Kuh-e Tir (south of Kharameh city) were investigated (figure 1). The distance of these two sections from each other is 45 km. and both studied sections have been located in high Zagros which are dependent to structural peculiarities of this region. In this research, the

studies have been made based on a lithostratigraphy review, identification of rock units and qualitative and quantitative study of microfacies.

#### History of previous studies

The type section of the Tarbur Formation was firstly studied by James & Wynd(1965)<sup>[1]</sup> in Kuh-e -Gadvan. In this lithostratigraphic studies, limestone with rudist was found in Tarbur formation that based on identified organic constituents, the age of the Tarbur formation was determined to be up to Maestrichtian. Kalantari(1975)<sup>[2]</sup> studied the stratigraphic components of the Tarbur Formation in Kuh-e Ahmadi (south east of Shiraz), he identified organodetrital limestone and dolomite and determined its age as Maestrichtian.

Afghah and Khosrow Tehrani (2004)<sup>[3]</sup> studied the Tarbur Formation in different stratigraphic sections and in this study, they identified two lithostratigraphic sections including well-bedded limestone in the lower part which overlies with massive limestone in the upper part. Based on their studies, the age of the Tarbur Formation has been determined Campanian to Early Paleocene.

#### Method of Research

In this study, 500 samples were selected from two stratigraphic sections and then a microfacies was provided from each type. Microfacies studies were done based on Fluegel (2004)<sup>[4]</sup> and the identification of foraminifera were based on Rahaghi, (1976)<sup>[5]</sup>, Kalantari, (1975)<sup>[2]</sup> and Loeblich & Tappan (1988).<sup>[6]</sup> The investigations of Khosrow Tehrani & Afghah (2004)<sup>[3]</sup> and Afghah (2005)<sup>[7]</sup> were also used in the identification of foraminifera. Microfacies studies were based on Danhum's classification (1962).<sup>[8]</sup>

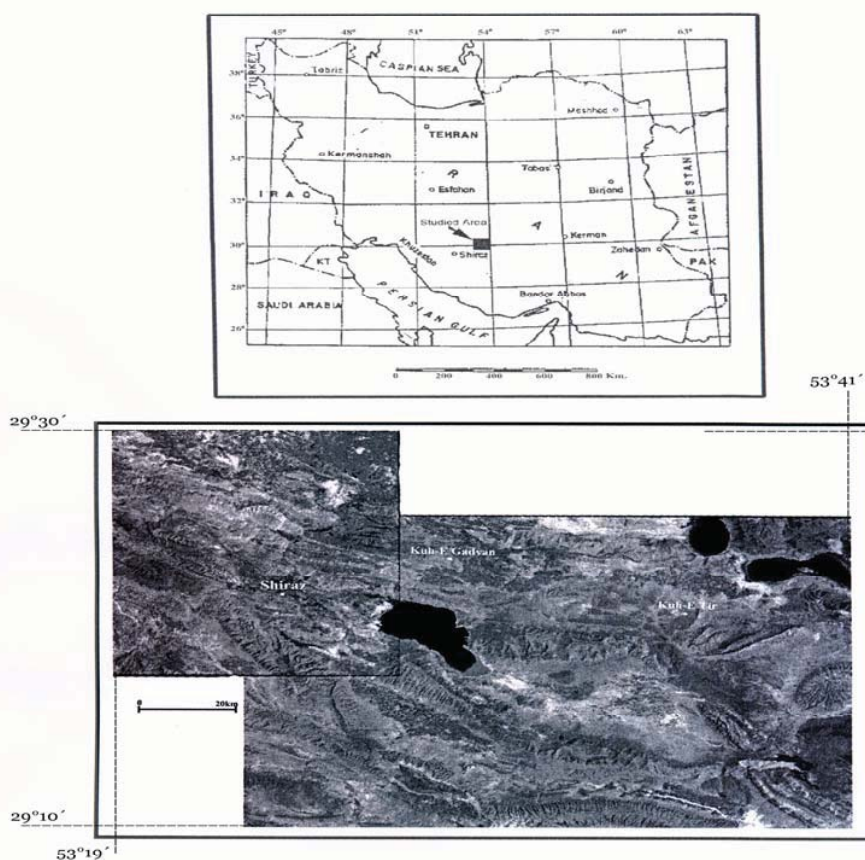


Figure 1: Geographical situation of the studied stratigraphic sections including type section in Kuh-e Gadvan and Kuh-e Tir sections

### Stratigraphy of Studied Sections

The type section of the Tarbur Formation in Kuh-e-Gadvan has been situated in eastern longitude of  $52^{\circ} 45' 5''$  and northern latitude of  $29^{\circ} 28' 1''$  (Figure 1). In this stratigraphic section the lower and upper lithostratigraphic limit of the Tarbur Formation are synchronized with the Gurpi and Sachun Formations. In this section, Tarbur Formation includes two parts (Figure 2) which are accordingly from down to up as follow: (Figure 3)

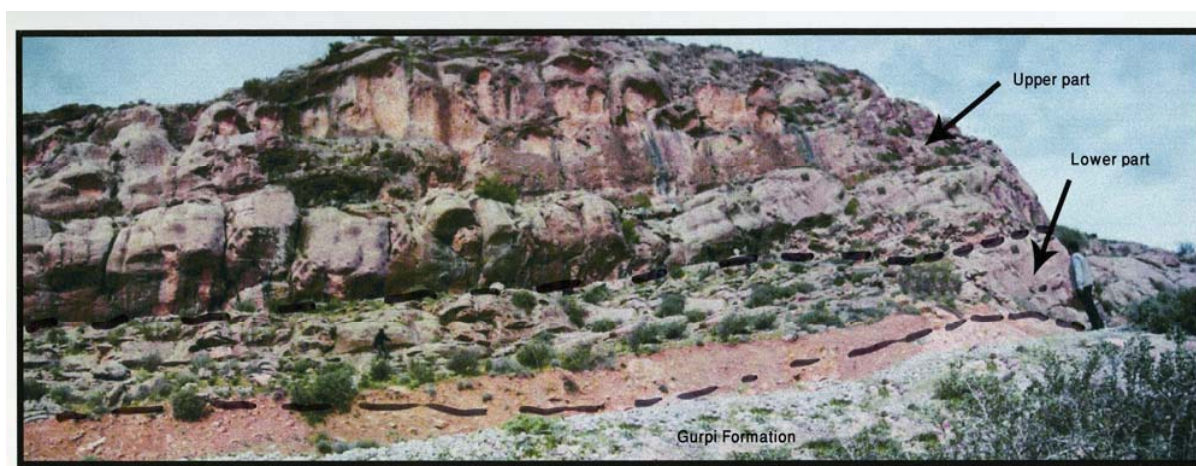


Fig.2 - Gadvan Stratigraphic Section

#### Lower part

This part includes 80 m. of milky to light gray well-bedded limestone, 95 m. of milky & gray to dark gray well-bedded limestone with rudist fragments and 57 m. of light gray well-bedded limestone with coral fossil (*Cyclolites* sp.) and rudist fragments. Thickness of this part is totally 232 meters and in view of porous bearing, it includes *Orbitoides media* d'Orbigny, *O. concavatus* Rahaghi and based on paleontology findings, the age of this section was considered to be of Campanian.

#### Upper part

This part encompasses 21 m. of gray and brown gray to light gray massive limestone, 30 m. of milky to gray massive limestone, 220 m. of light gray to dark gray massive limestone and 24 m. of milky massive limestone with rudist fragments. In general the thickness of the upper part is totally 341 meters. The foraminifera of this part encompass: *Lepidorbitoides sociali* Schlumberger, *Orbitoides apiculata* Schlumberger, *O. triangularis* Rahaghi, *Loftusia minor* Cox, *Antalya korayi* Fariracci, *Omphalocyclus macroporus* Lamark, *Goupillaudina iranica* Rahaghi, *G. shirazensis* Rahaghi, *Goupillaudina* sp. and the age of this part is Maestrichtian. In general, the age of upper and lower parts of Tarbur Formation in this section of Kuh-e-Gadvan is determined to be from Campanian to Maestrichtian.

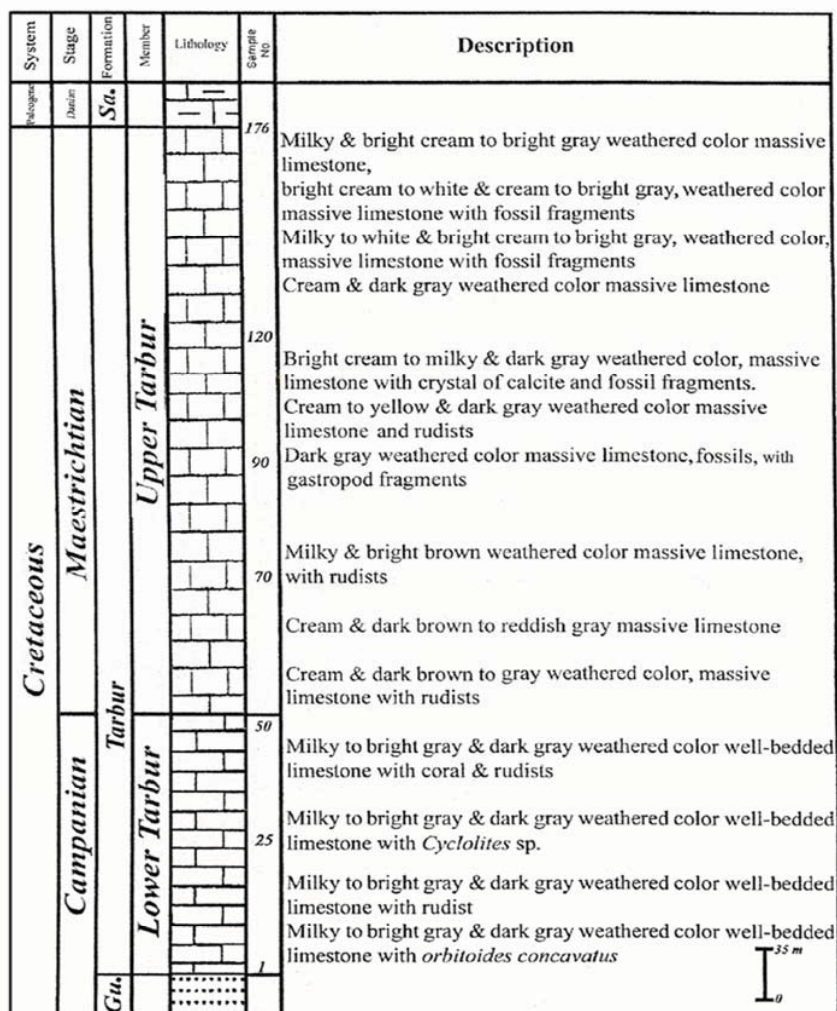


Fig.3 Lithology of the Tarbur Formation in Kuh-e Gadvan; Gu: Gurpi Formation, Sa: Sachun Formation .

### Tarbur Formation in Kuh-e- Tir

This section in Kuh-e-Tir has been situated in the following coordinates: eastern longitude of 53° 31' and northern latitude of 29° 23' 01" (Figure 1). The lower and upper limits of the Tarbur Formation are synchronized with Gurpi and Sachun Formations accordingly. In this section, Tarbur Formation includes two parts(Figure 4) which are accordingly from down to up as follow: (Figure 5)



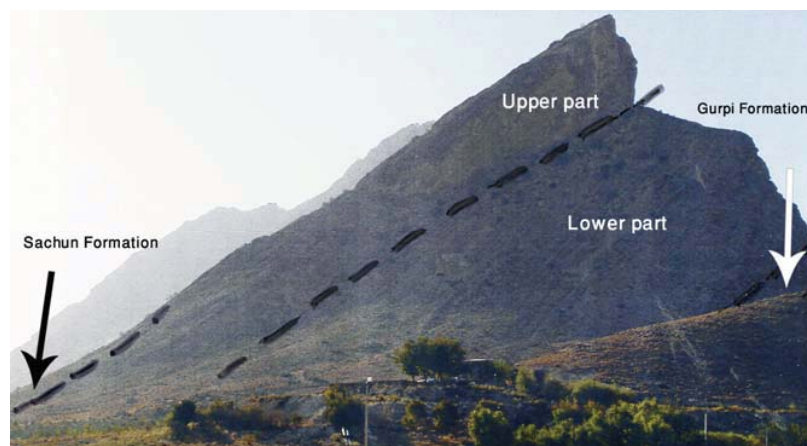


Fig4- Kuh-E Tir Stratigraphic Section

### Lower part

This part from down to up includes 38m. of cream to red organodetrital medium-bedded limestone with iron nodules, 137.5m. covered by debris, 43m. of dark cream to cream and white medium-bedded limestone, 70m. of gray medium-bedded limestone with rudist fragments, 25m. of yellow medium-bedded limestone with rudist and 62m. of alternatively gray and yellow medium-bedded limestone with rudist and *Cyclolites*. Thickness of this part is totally 365m and mainly includes *Lepidorbitoides socialis* Schlumberger, *Orbitoides media* d'Orbigny, *O. triangularis* Rahaghi, *Broeckinella* sp., *Nezzazantinella* sp., *Omphalocyclus macroporus* Lamark, and the age of this section is Middle part of Early Maestrichtian.

### Upper part

This parts comprises of 3 m. gray massive limestone with rudist, 101 m., cream massive limestone, 15m., gray massive limestone with rudist, 32 m., cream massive limestone with residues of and rudist and gastropod, 15m., light gray to dark gray limestone and finally 60 m., cream to yellow massive limestone with rudist and gastropod fragment. The thickness of this parts is totally 162m. which bears foraminiferal species such as *Antalya korayi* Fariracci, *Orbitoides media* d Orbiny, *Vania anatolica* Sirel, *O. apiculata* Schlumberger, *Loftusia minor* Cox, and *Dictyoconella complanata* Henson. The age of this part is related to late Maestrichtian to Early Paleocene. The thickness of Tarbur Formation in this section is 585 meter

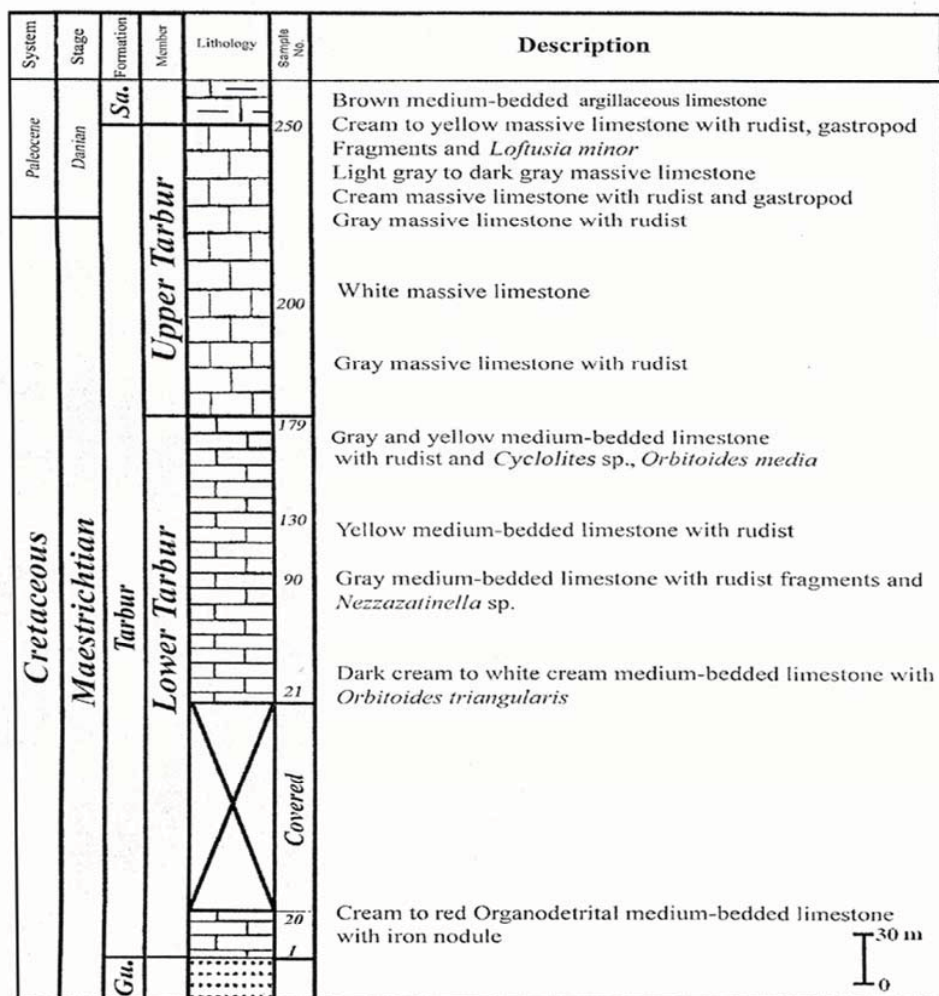


Fig.5: Stratigraphic Columnar Section of Tarbur Formation in Kuh-e Tir, Gu: Gurpi Formation, Sa: Sachn Formation

**Microfacies in Tarbur Formation of Kuh-e Gadvan section****Lower Part**

The beginning of this part is initiated with 5 meters wackestone (Figure 6) and then it contains the alternating of packstone and grainstone and in the middle to terminate parts, wackestone and very few mudstone. The greatest amount of microfacies elements includes bioclast that its quantity in the middle part of this section is maximum 50%.

**Upper Part**

This part is indeed initiated with alternating packstone and grainstone. The thickness of this part is about 60m. and the remaining of the upper part includes alternating of packstone and wackestone. The amount of Extraclast in comparison with lower part has been significantly decreased, its maximum is in some grainstone with the rate of 6% and its minimum is in wackestone with the rate of 2%. At the beginning of this part, bioclasts is in its maximum percentage that is 32% and its minimum quantity is in the middle part that is 10%.

**Microfacies in Tarbur Formation of Kuh-e Tir****Lower Part**

This part is initiated with 13 m. of packstone. (Figure 7) As mentioned before, 100 m. of the sediments in the lower part of Kuh-e Tir have been covered with debris (refer to figure 3) and after that an alternation of packstone with interfaces of boundstone and at the end of this part grainstone are observed. The maximum percentage of bioclast in this part is 55% which is related to boundstone and its minimum percentage is up to 5% in the end part of wackestone. The maximum rate of Extraclast is related to grainstone in the middle part.

**Upper Part**

This part also includes an alternation of packstone and wackestone with interfaces of boundstone, however the extension of wackestone in this part is more than other. In this part, the bioclasts shifts vary that changes from 5% to 50%. The rate of extraclasts in this part is less than lower part and its maximum amount does not exceeds 5%. In general, the changing process of intraclasts in both parts is convergent with bioclasts and extraclasts changes.

**discussion**

In the investigation of the facies of Tarbur Formation in type section and in Kuh-e Tir, five main carbonate facies groups were identified which encompasses wackestone, packstone, grainstone, boundstone and mudstone. In these two sections, the amount of extraclasts is ever greater in the lower part than the upper part and it means that lower part of the Tarbur Formation was ever formed in a higher energetic environment than the upper part. It is to be noted that in both mentioned sections, the first of the lower part includes an alternation of packstone and grainstone that considering the formation environment of these facies, high energy facies are placed at the beginning reef of Tarbur Formation. Also the appearance of extraclasts from more ancient formations in the a fore mentioned facies is very rare among the conditions of reef formation in the environment and in the limit of waves base influence. The studies on the investigated sections indicate that the age of Tarbur Formation is from Campanian to Early Paleocene. The facies studies also represents that the extension of bioclasts in facies expresses the growth and development of various organisms among them rudist is more significant Khosrow Tehrani & Afghah( 2005).<sup>[9]</sup> It is necessary to note that different lower and upper lithostratigraphic contact of the Tarbur Formation is a cause which confirms tectonic activity during sedimentation of the Tarbur Formation in the Kuh-e tir stratigraphic section. Also micropaleontological data and continue lithostratigraphic characteristic in Maestrichtian- Paleocene boundary indicate intraformational boundary of C/T.

Generally, microfacies which is detected in the upper part of the Tarbur formation in the Kuh-e Tir is wackestone. That is another cause that proofs lithostratigraphic facies continuity during Late Maestrichtian through Early Paleocene.

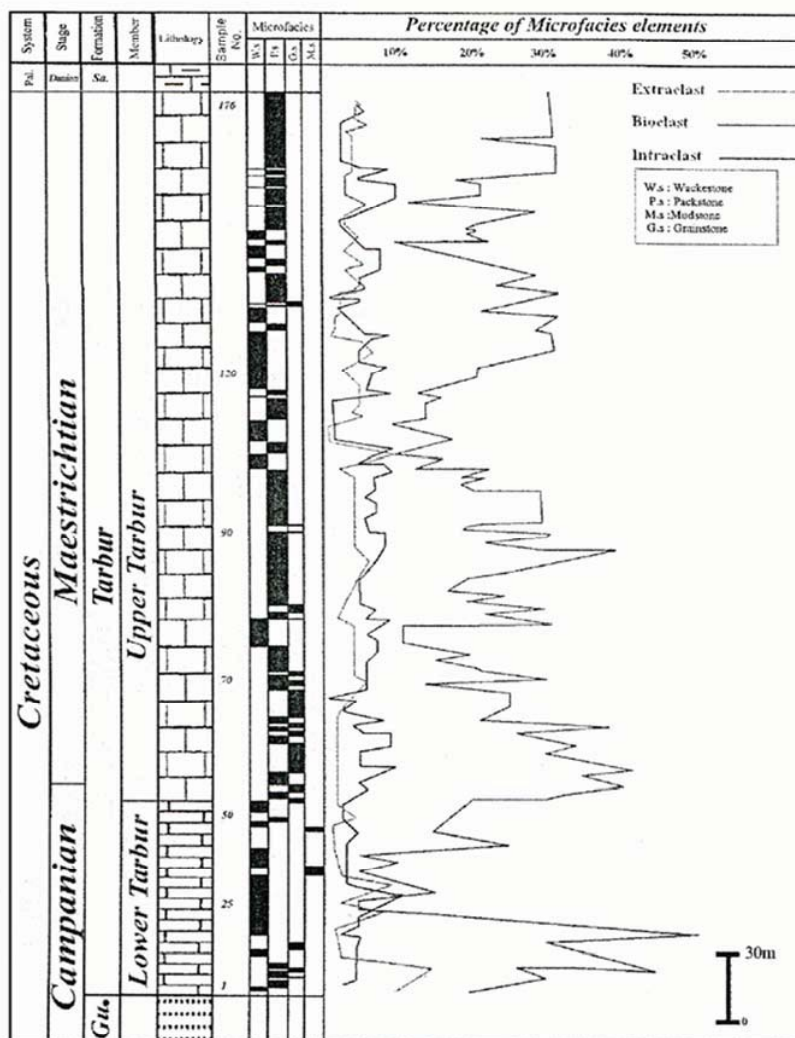
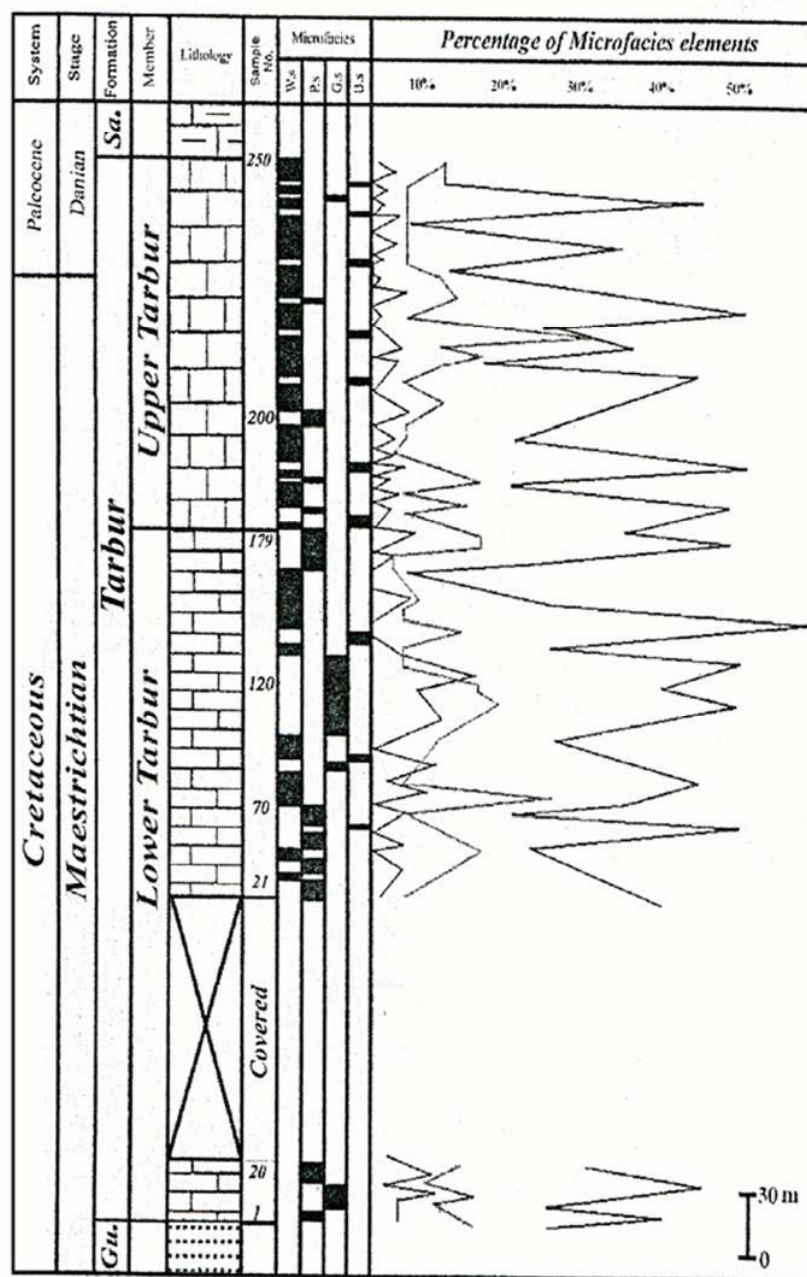


Fig.6: Distribution of Microfacies elements and Microfacies of Tarbur Formation in Kuh-e Gadvan  
Cu: Gurpi Formation , Sa: Sachn Formation , Pal.:paleogene





Extraclast

Bioclast

Intraclast

W.s : Wackestone

P.s : Packstone

G.s : Grainstone

B.s : Boundstone

Gu.: Grpi Formation

Sa. : Sachun Formation

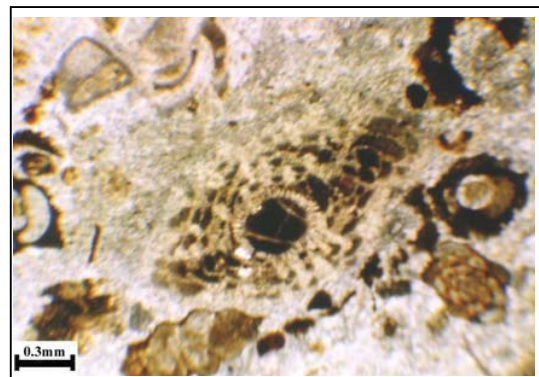
Fig.7: Distribution of Microfacies elements and Microfacies of the Tarbur Formation in Kuh-e Tir.



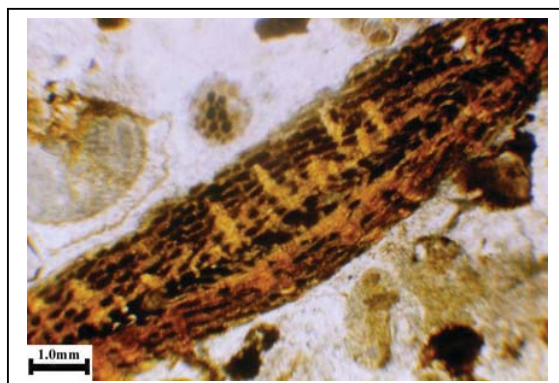
## Plate 1:

- 1- Subsagittal section of *Antalyna korayi* in lower part of Kuh-e Tir
- 2- Subaxial section of *Lepidorbitoides minor* in lower part of Kuh-e Tir
- 3- Logitudinal section of *Dictyoconella* sp. in upper part of Kuh-e Gadvan
- 4- Half of the axis section of *Vania anatolica* in the lower part of Kuh-e Tir section
- 5- Axial section of *Orbitoides media* in the lower part of Kuh-e Tir
- 6- Axial section of *Broeckinella* sp. In the lower part of Kuh-e Tir
- 7- Subaxial section of *Goupillaudina shirazensis* in the upper part of Kuh-e Gadvan
- 8- Axial section of *G.iranica* in the upper part of Kuh-e Gadvan.

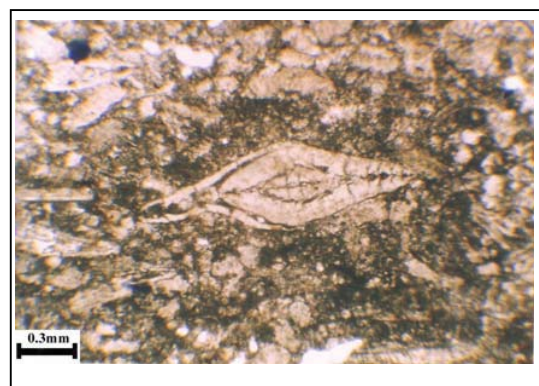
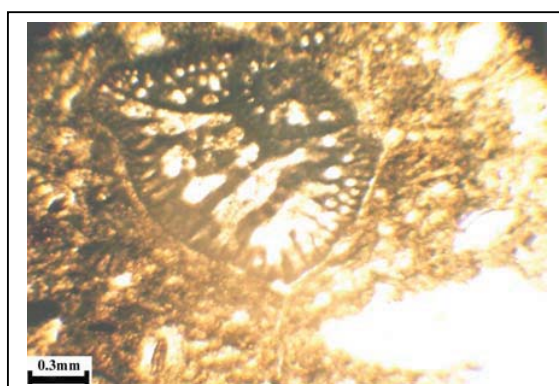




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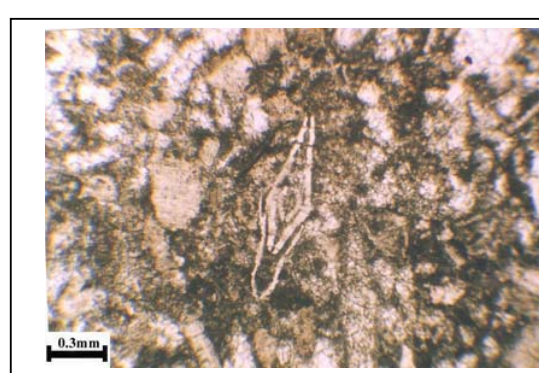
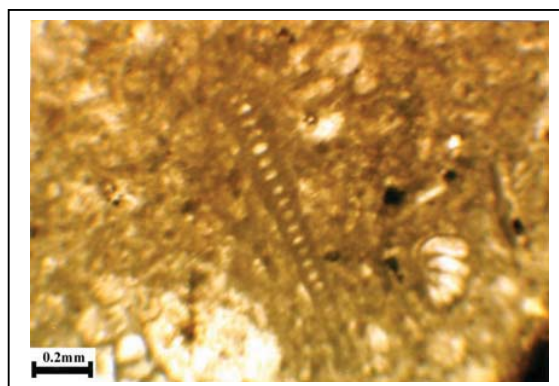
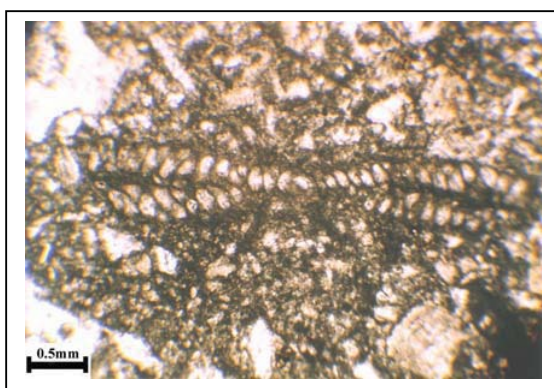


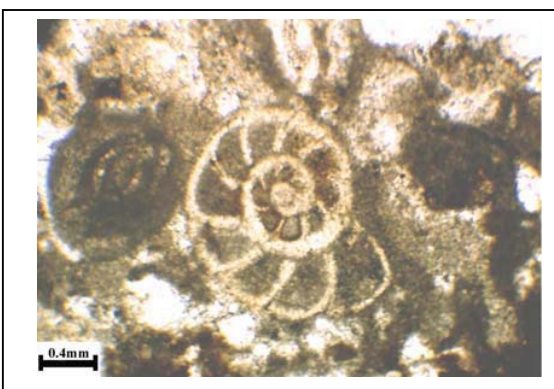
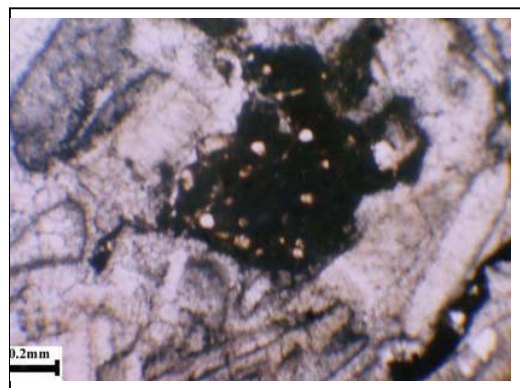


Plate 2:

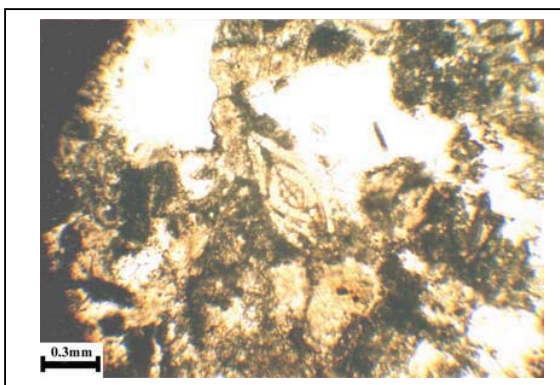
- 1- Subaxial section of *Omphalocyclus macroporus* in the upper part of Kuh-e Tir
- 2- Sagittal section of *Gavelinella pertusa* in the upper part of Kuh-e Tir
- 3- Subaxial section of *Goupillaudina* sp. In the upper part of Kuh-e Gadvan
- 4- Axial section of *Orbitoides concavatus* in the lower part of Kuh-e Gadvan
- 5- Extraclast fragments of Gurpi Formation in the lower section of the lower part of Kuh-e Tir, microfacies are mainly related to Gurpi Formation.
- 6- Cross section of a Gastropod probably *Konus* type in the upper part of Kuh-e Tir
- 7- Subaxial section probably of *Antalya* sp. In the upper part of Kuh-e Gadvan
- 8- Axial section of a Rotaliid in the upper part of Kuh-e Gadvan



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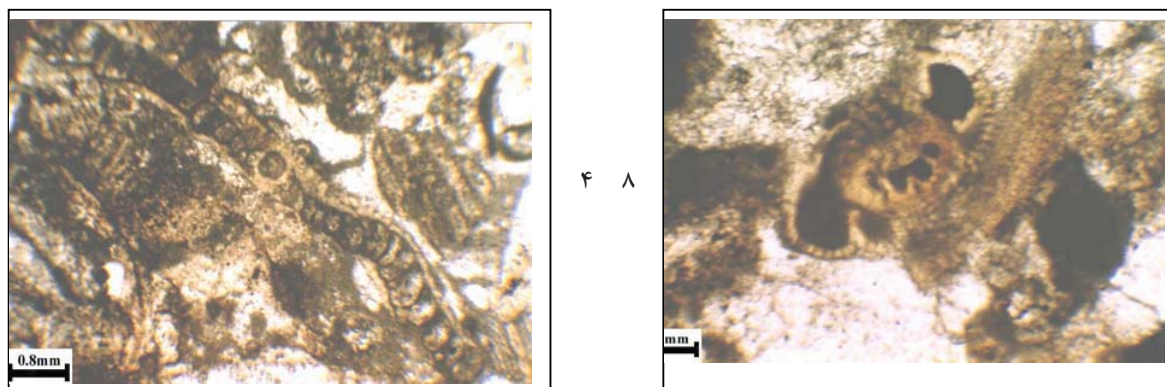
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### Conclusion

Considering the stratigraphic demarcation of the Tarbur Formation in both sections, this investigation shows that the synchronic line is in Maestrichtian-Paleocene boundary (figure 8). In this case, the lower part of the Tarbur Formation in Kuh-e-Tir section and a part of its upper part are equal to upper part of Tarbur Formation in type section. Actually the boundary between Maestrichtian and Early Paleocene is intraformational in Kuh-e-Tir stratigraphic section which is different from the type section. Therefore, there will be no rock-synchronous relation in the upper and lower part, but the upper and lower parts are the process of genesis and formation of organodetrital facies of Tarbur Formation.

The extension of rudists in Kuh-e-Gadvan (type section) is generally in packstone and grainstone while wackestone generally has residues of foraminifers, weeds and gastropods. In general, the present facies of Kuh-e-Gadvan in correlation with the section of Tarbur Formation in Zarghan have more similarities that is they are similar and comparable both in view of their age and the distribution of facies. The section of Kuh-e-Tir is similar with the section of the Tarbur Formation in Sarvestan in view of the distribution of facies and age category which have been studied by Afghah and Khosrow Tehrani (2004)<sup>(3)</sup>. Furthermore, considering the faunal assemblage constituents, the age of the Tarbur Formation is from Campanian to Early Paleocene, but the biostratigraphic limits in different sectors are different.

In view of investigating development processes of reef based on James (1984)<sup>[10]</sup> standard, the processes of grainstone and packstone alternations in the lower part of both studied stratigraphic sections are related to stabilization and based on the mentioned standard, colonization in Kuh-e-Gadvan section has been from the middle of lower part to the end of upper part while this process in Kuh-e-Tir section has been from upper part of derbis and extended to the beginning of upper part and a diversification is observed in continuation.

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