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Bio-Sequence Stratigraphy of the Rupelian – Burdigalian Deposits in the SW Zagros Basin, Iran

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ABSTRACT

In this research, 3 stratigraphy sections were selected from the Asmari Formation in the interior fars from Zagros foreland basin in Southwest of Iran. The Asmari Formation is included foure rock units in stratigraphic sections. Twenty-eight Foraminifera genera and species are discovered in the study areas and have been scattered in five biozone. Based on biozones study, the age of the aforementioned sediments is from Oligocene - Miocene totally which are as follow: Biozone no. 1 : *Nummulites fichteli, Nummulites vascus* assemblage zone. Biozone no. 2 : *Archaias asmaricus, Archaias hensoni, Miogypsinoides complanatus* assemblage zone. Biozone no. 3: *Austrotrillina howchini, Peneroplis evolutus* assemblage zone. Biozone no. 4 : *Miogypsina, Elphidium, Peneroplis* assemblage zone. Biozone no. 5: *Borelis melocurdica* zone. Also lower and upper bouandery lithostratigraphy of Asmari Formation has been in the study areas. Actually, based on the sequence stratigraphic studies, the sediments of studied sections include a two 3rd order sediment sequence (sequence no.: 1 and sequence no. :2). Sequence no. : 1 in Ahmadi anticline section with sequence lithostratigraphy limit of SBI type is placed on Jahrom Formation Kuh-e Charm sections with sequence lithostratigraphy limit of SB2 type is placed on Pabdeh Formation and upper limit of the aforementioned sequence is of SB2 type which is placed under sequence no. : 2, this age sequence Ruplian – Chattian. Sequence no. :2 in Ahmadi anticline and Kuh-e Charm sections with sequence lithostratigraphy limit of SB2 type is placed on sequence no : 1 and upper limit of the aforementioned sequence is of SB2 type which is placed under Razak Formation in Ahmadi anticline section and Gachsaran Formation in the Kuh-e Charm sections, this age sequence Aqitanian — Burdigalian.

Keywords Zagros, Asmari Formation, Oligocene, Miocene, Biozone.

INTRODUCTION

This paper deals with the Asmari Formation, a thick carbonate which deposited in Zagros foreland basin during the Oligocene-Miocene, is well known as a major prolific oil SSSSproducing sequence Southwestern of Iran.

The first published reference to the Asmari For-

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mation, was originally defined by Busk and Mayo (1918), have named the Cretaceous-Eocene in this area Asmari Formation, after the Kuh-e- Asmari occurrence in Khuzestan province. The type section of Asmari Formation has been studied earlier. Considered the age of Asmari Formation as Oligocene-Miocene. He chose the type section in Tangegoletorsh, located in Southeast Masjedsoleiman (SW Iran) and based on lithology features divided it into the following three members from base to top: The lower Asmari, middle Asmari and upper Asmari. Many authors restricted the Asmari, Limestone to Miocene proper, excluding the Oligocene Brissopsis from the true Limestone Formation to be found at Asmari Mountain. The age of Asmari Formation has been said Oligocene to Burdigalian by Thomas (1948). Later, carried out the first study of the biostratigraphic properties of this Formation by James and Wynd (1965) and reviewed by Adams and Bourgeois (1967).

James and Wynd (1965), Kalantary (1986), and Jalali (1987) introduced the microfaunal characteristics and assemblage zones for the Asmari Formation. The carbonate rock of Asmari Formation has been studied by Seyrafian et al. (2011), Vaziri-Moghaddam et al. (2006). The lithology of the Asmari Formation consists of limestone, dolomitic limestone, dolomite and marly limestone. Somean hydrite (Kalhur Member) and lithic and limy sand stones (Ahwaz Member) also occur within the Asmari Formation. This study is based on one stratigraphy section of Asmari Formation in the High Zagros.

MATERIALS AND METHODS

The main objective of this article reports on lithostratigraphy, biostratigraphic and sequence stratigraphy study to the determination of the Oligocene-Miocene benthic Foraminifera and distributions them in the 3 stratigraphic sections and introduction of biozone and the age detection. This results could contribute to the better understanding outcrop of the Asmari Formation in the study areas and discuss about paleo environment.

RESULTS AND DISCUSSION

Geological and geographical settings

The Zagros region is located to the Southwest of Iran and divided into six major tectono stratigraphic domains: The interior Fars, Coastal Fars provinces, Dezful embayment, The lzeh zone, The Lurestan province and The High Zagros zone (Fig. 1). The Zagros basin was associated to the Gondwana supercontinent during the Paleozoic. It was a site of passive margin and convergent orogeny in the Mesozoic and Cenozoic eras, respectively (Heydari 2008).

In the most places of the Zagros basin, included Lurestan, Khuzestan and some parts of the Coastal Fars and Interior Fars provinces the Asmari Formation lies conformably on the deeper facies of the

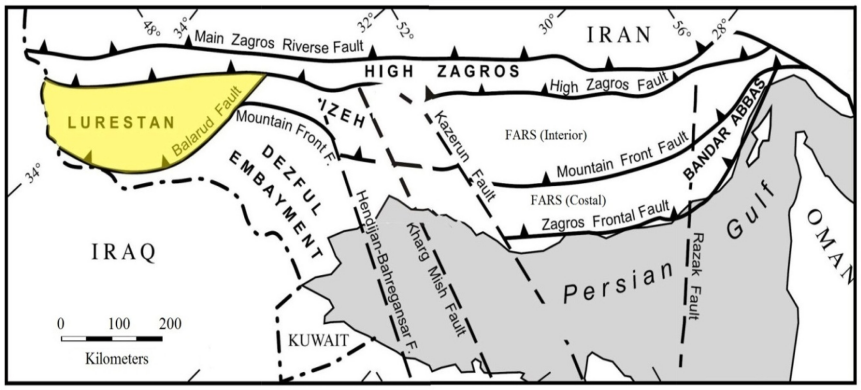

Fig. 1. Six major tectonostratigraphic domains of the Zagros basin (Motiei 1993). Tectonic subdivision of Zagros with the main structural trend (Sherkati and Letouzey 2004). The study areas are located in Interior fars.

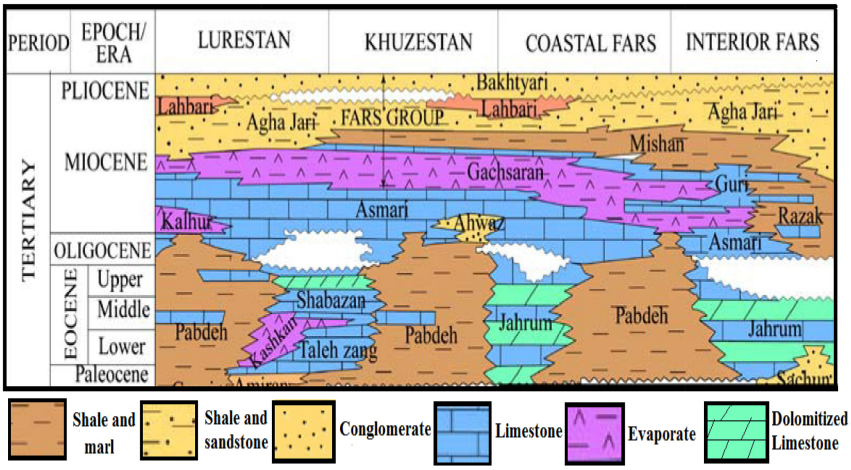

Fig. 2. Cenozoic stratigraphic correlation chart of the Iranian Sector of the Zagros basin, adopted from James and Wynd (1965).

Pabdeh Formation (Paleocene-Oligocene). The upper contact of the Asmari Formation with the Gachsaran Formation is marked by an unconformity in most places James and Wynd (1965), (Fig. 2). The Ahmadi anticline section is located (±~65 km) Southwest of Shiraz city from folded Zagros belt of international Fars. Geographic coordination of Ahmadi anticline section is described 29^0 17′ N, 53^0 15′ E (Figs.3 and 2). The Kuh-e Charm section is located (±~45 km) Northwest of Yasuj city from folded Zagros belt of international Fars. Geographic coordination of Kuh-e Charm section is described 31^0 45′ N, 52^0 14′ E (Figs. 3 and 2).

Biostratigraphy

Biostratigraphic of the Asmari Formation was established by James and Wynd (1965) and the following biozone were introduced : *Globigerina* spp. (zone 55), *Lepido cyclina, Operculina, Ditrupa* (zone 56), *Nummulites intermedius, Nummulites vascus* (zone 57) and *Archaias operculiniformis* (zone 58) assemblage zones for the Oligocene : *Austrotrillina howchini, Peneroplis evolutus* (zone 59) assemblage zones for Aquitanian and *Borelis melocurdica* assemblage zone for the Burdigalian times.

Adams and Bourgeois (1967) reviewed the previous biostratigraphic studies and suggested the following biozones for the Asmari Formation : *Eulepidina, Nephrolepidina, Nummulites assemblage* zone for the Oligocene; *Miogypsinoides, Archaias, Valvulinid* assemblage zone for the Aquitanian; *Archaias Asmaricus, Archaias hensoni* and *Elphidium* sp. 14-*Miogypsina* assemblage sub-zones for the early to middle and middle to late Aquitanian ages respectively and *Borelismelo* group –*Meandropsina iraniaca* assemblage zone for the Burdigalian. The biozones introduced by James and Wynd (1965), Adams and Bourgeois (1967) were widely used throughout the Zagros and Central Iranian basins for the Asmari Formation and its age equivalent Qom Formations, respectively (Daneshian and Ramezani 2007).

Many authors defined the following assemblage zones: *Nummulites vascus-Nummulites fichteli* and *Eulepidina formosoides* assemblage zones for the Rupelian; *Nummulites vascus, Nummulites fichteli* and *Eulepidina* and *Miogypsinoides, Eulepidina* assemblage zones for the early and late Chattian respectively; *Austotrillina howchini, Miogypsina, Miogypsinoides deharti* for the Aquitanian and *Borelismelo* group *Miogypsina* for the Burdigalian age. These biozones could be compared to the European basin.

Ehrenberg et al. (2007) applied the method of strontium isotope stratigraphy to date the Asmari For-

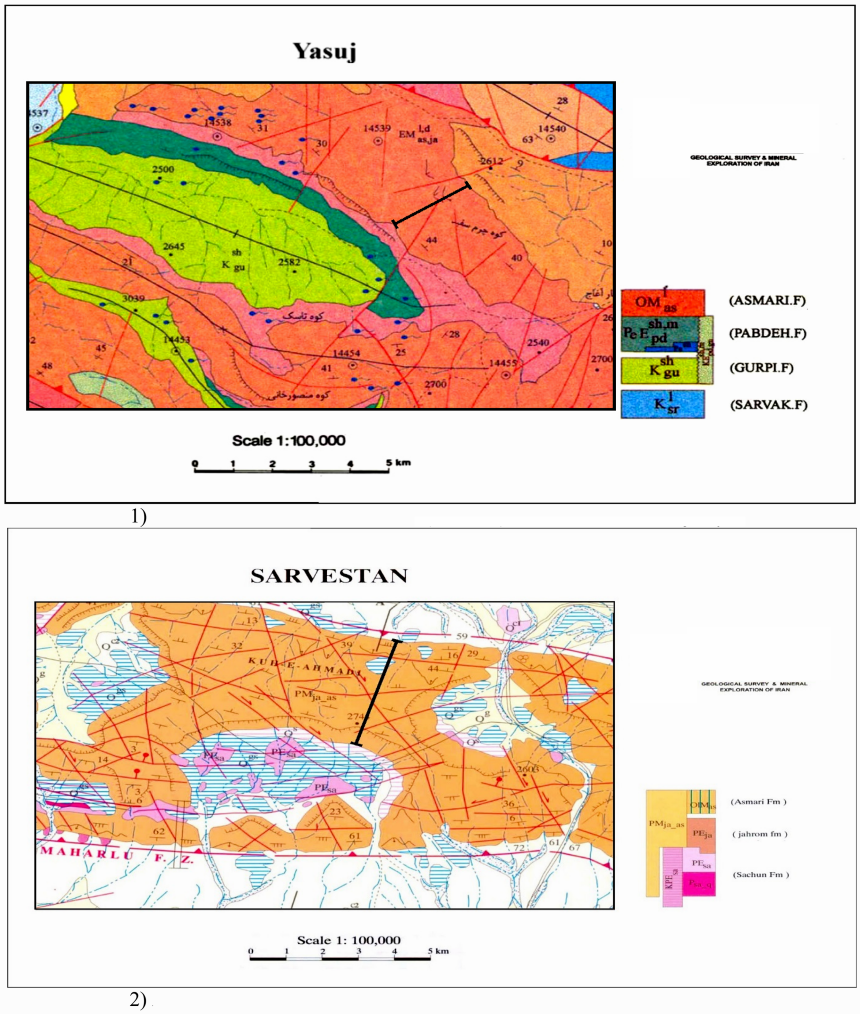

Fig. 3. Location of the study area : 1) Kuh-e Charm section, 2) Ahmadi anticline section.

mation in some localities in the Southwest of Iran. He introduced five biostratigraphic events based on index fossils, species of *Nummulites* and *Spiroclypeus blankenhorni,* the genus of *Miogypsina* and *Archaias* and species of *Borelis melocurdica*. Based on this study, last *Nummulites* occurrences is about 1 Ma before the end of Rupelian time. Extinction of *Nummulites* near end of the Rupelian was also stated earlier.

Biozonation and age determinations are based on strontium isotope stratigraphy recently established for the Asmari Formation by Laursen et al. (2009). Based on this new biozonation, the sediments that had been previously assigned to the Miocene (Aquitanian) are currently considered as late Oligocene (Chattian) in age (Figs. 4—8).

Many authors applied Srisotope dating for the Asmari Formation and proposed revised time intervals based on new biozones : *Nummulites vascus, Nummulites fichteli* assemblage zone for the Rupelian, Lepidocyclina, *Operculina, Ditrupa* assemblage zone for the Rupelian Chattian, *Archaias asmaricus, A. hensoni, Miogypsinoides complanatus* assemblage zone for the Aquitanian and *Borelis melocurdica, Borelis melomelo* assemblage zone for the Burdigalian. As

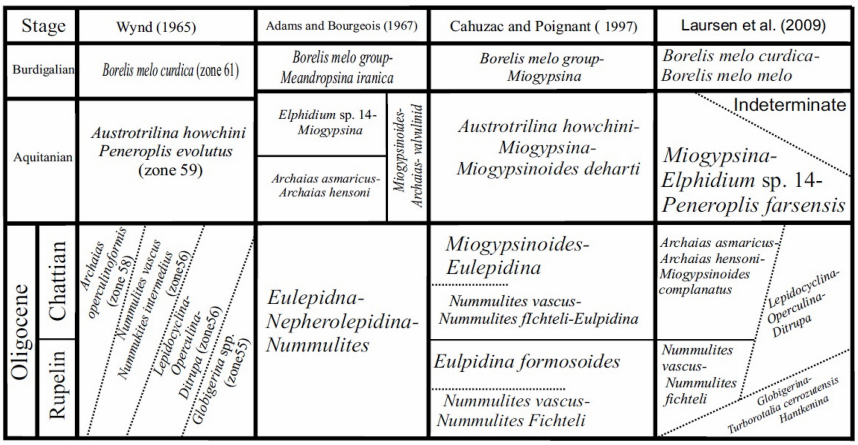

Fig. 4. Biozonation of the Oligocene-Miocene carbonates of the Zagros basin after (James and Wynd 1965, Adams and Bourgeois 1967) and for the European basin after (Cahuzac and Poignant 1997) Biozonation of the Upper Oligocene-lower Miocene sediments by the distribution of larger benthic Foraminifera (Laursen et al. 2009).

previously mentioned, we have identified four Foraminifera assemblages within the Asmari Formation in the study area. More recent biostratigraphic studies of the Asmari Formation were made (Seyrafian et al. 2011, Laursen et al. 2009, Maghfouri-Moghadam and Samiei 2015, Amirshahkarami et al.(2010) in microfacies and depositional environments Seyrafian et al. (2011), Dehghanian et al. (2012), Monjezi et al. (2015) and depositional environment and sequence stratigraphy (Vaziri-Moghaddam et al. (2006), Amirshahkarami et al. (2010), Ehrenberg et al. (2007), Vaziri-Moghaddam et al. (2010).

Assemblage biozone description

The biostratigraphic of the Asmari Formation has been studied by paleontological analysis in Ahmadi anticline, Kuh-e Charm and Deh-Now sections from Zagros basin (Figs. 9—13). In this research, five assemblage zones have been determined by distribution of the bentic Foraminifera in the studied area and discussed in ascending stratigraphic order as follows : Biozone no. 1 : *Nummulites fichteli, Nummulites vascus* assemblage zone. Biozone no. 2 : *Archaias asmaricus, Archaias hensoni, Miogypsinoides complanatus* assemblage zone. Biozone no. 3 : *Austrotrillina howchini, Peneroplise volutus* assemblage zone. Biozone no. 4 : *Miogypsina, Elphidium, Peneroplis* assemblage zone. Biozone no. 5 : *Borelis melocurdica* zone.

Biozone no. 1 : *Nummulites fichteli, Nummulites vascus* assemblage zone

This assemblage zone of Laursen et al. (2009). The most important Foraminifera are *Heterostegina* sp., *Operculina complanata, Amphistegina lessoni, Globigerina* sp., *Elphidium* sp., *Discorbis* sp., *Rotalia viennoti, Lepido cyclina* sp., *Ditrupa* sp. the assemblage is attributed to the Rupelian based on the content of Foraminifera (Ahmadi anticline, Kuh-e Charm and Deh-Now sections).

Biozone no. 2 : *Archaias asmaricus, Archaias hensoni, Miogypsinoides complanatus* assemblage zone

This assemblage zone of Laursen et al. (2009). The most important Foraminifera are *Spiroclypeus* sp., *Archaias operculiniformis, Archaias* sp., *Elphidium* sp. 1- *Ammonia beccarii, Rotalia* sp., *Spirolina, Miogypsinoides complanatus, Pyrgo* sp., *Quinqueloculina* sp., *Discorbis* sp., *Lithophyllum* sp., *Lithothamium* sp., *Subterrani phylum thomasi, Rupertia* sp., *Tubucellaria* sp., *Pyrgo* sp., *Quinqueloculina* sp., *Elphidium* sp., the assemblage is attributed to the Chattian based on the content of Foraminifera.

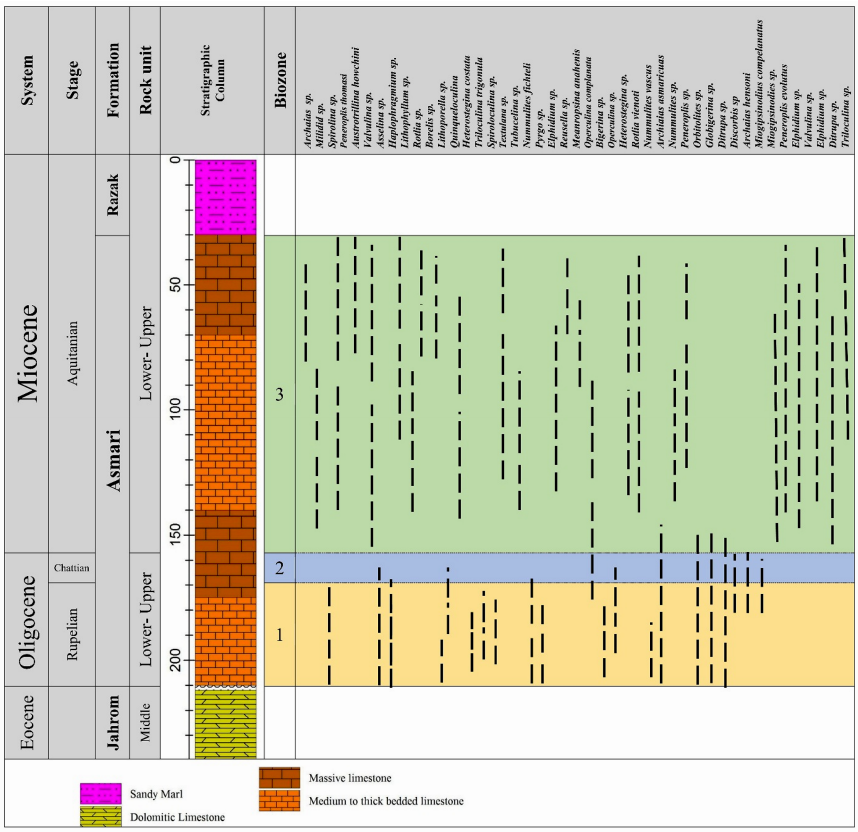

Fig. 5. Biostratigraphy range chart of Asmari Formation in Ahmadi anticline section.

Biozone no. 3 : ***Austrotrillina howchini, Peneroplis evolutus*** **assemblage zone.**

This assemblage zone of James and Wynd (1965). The most important Foraminifera *Valviulina* sp., *Peneropelis thomasi, Miliolida* sp. 10, *Elphidium* sp., *Eulepidina dialata. Quinqueloculina* sp., *Pyrgo* sp., *Praerhapydionina delicate, Asterocyclina* sp., *Peneroplis* sp. the assemblage is attributed to the Aquitanian based on the content of Foraminifera (Ahmadi anticline and Deh-Now sections).

Biozone no. 4 : ***Miogypsina, Elphidium, Peneroplis*** **assemblage zone**

This assemblage zone of Adams and Bourgeois (1976). The most important Foraminifera are *Haplophragmiums lingeri, Miogypsinoides* sp., *M. complanatus, Pyrgo* sp., *Miliolid, Milola* sp., *Quinqueloculina* sp., *Schlumbergerina* sp., *Lithophyllum* sp., *Lithothamnium* sp., *Subterraniphyllum thomasi* the assemblage is attributed to the Aquitanian based on the content of Foraminifera (Kuh-e Charm section).

Biozone no. 5 : ***Borelis melocurdica*** **zone**

This assemblage zone of Laursen et al. (2009). The most important Foraminifera are, *Spiroclypeus* sp., *S. blankenhorni, Peneroplis* sp., *P. thomasi, Archaias hensoni, Spirolina* sp., *Triloculina trigonula, Borelispygmaea, Borelismelo, Meandropsinairanica, Miogypsinoides complanatus, Miliolidpyrgo* sp., *Miliola* sp., *Quinqueloculina* sp., *Schlumbergerina* sp., *Lithophyllum* sp., *Lithothamnium* sp., *Subterraniphyllum thomasi, Rupertia* sp., *Onychocella* sp., *Tubucellaria* sp. the assemblage is attributed to the

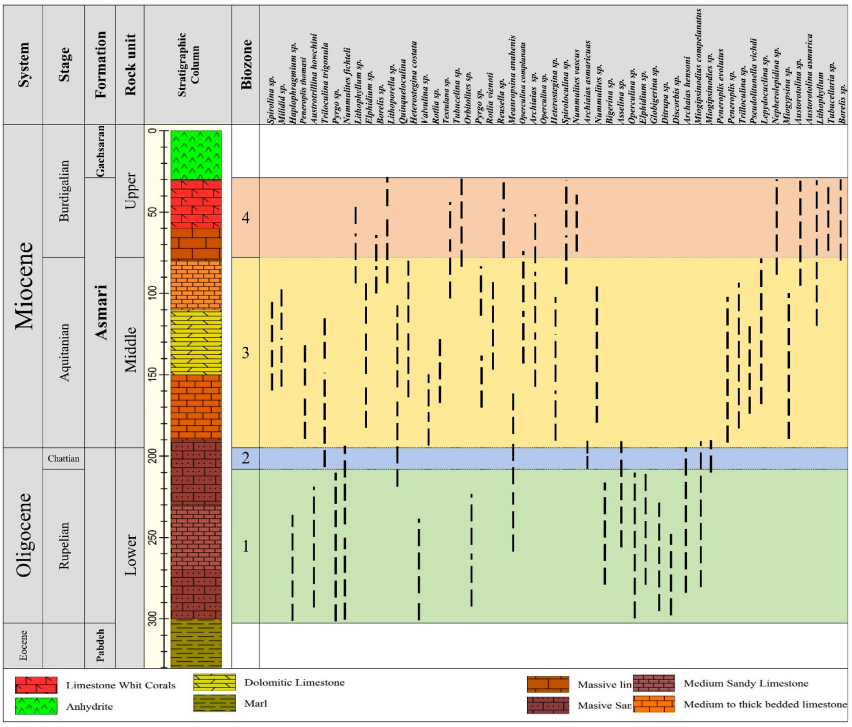

Fig. 6. Biostratigraphy range chart of Asmari Formation in Kuh-e Charm section.

Burdigalian based on the content of Foraminifera (Kuh-e Charm section).

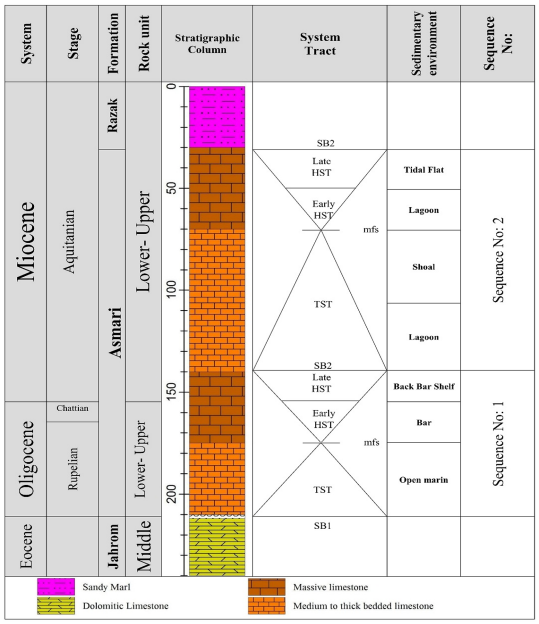

Fig. 7. Sequence stratigraphy diagram of Asmari Formation in Ahmadi anticline section.

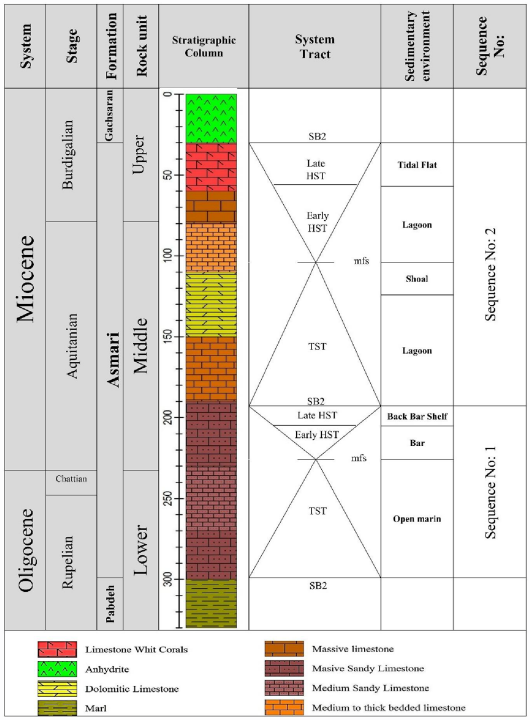

Fig. 8. Sequence stratigraphy diagram of Asmari Formation in Kuh-e Charm section.

Fig. 9. Boundary image down of the Asmari Formation with Pabdeh Formation in the Charm-Sefid Mountain stratigraphic cut (visible to the North).

Sequence stratigraphy

Sequence stratigraphy includes the study and research on sedimentary facies, their time and place changes and diagnosing sedimentary environments relevant to relative changes in sea level and introduces the sediments of a basin in the form of sequences which have been placed among conformities and disconformities. The considerable point is that the facies of Asmari Formation in the studied zone are different from that of Khuzestan and Larestan zones. Besides being different in view of paleogeography of the basin in the aforementioned zones, local tectonic has also played significant role in the studied zone. Diagnosing disconformity levels has been done based on field observations, microfacies and lithology analyses. In general, based on sequence stratigraphy studies, two 3rd class sedimentary sequences (3rd class cycle) have been identified for sediments of Asmari Formation in the studied stratigraphy sections (Figs.4 and 5).

Sedimentary sequence no. 1

This sequence belongs to the age between Ruplian Chattian and is related to Asmari Formation. The lower lithostratigraphic limit in the studied Ahmadi anticline section of this sequence that is SBI type has been rested on Jahrom Formation and in the studied Deh-Non and Kuh-e Charm sections of this sequence that is SB2 type has been rested on Pabdeh Formation and its upper limit is of SB2 type. The thickness of this sequence in the Kuh-e Charm section is 110 m, Deh-Now section is 100 m and Ahmadi anticline section

Fig. 10. The image of cream color limestone, medium to thick layers of Asmari Formation, in Ahmadi anticline stratigraphy (visible to the West).

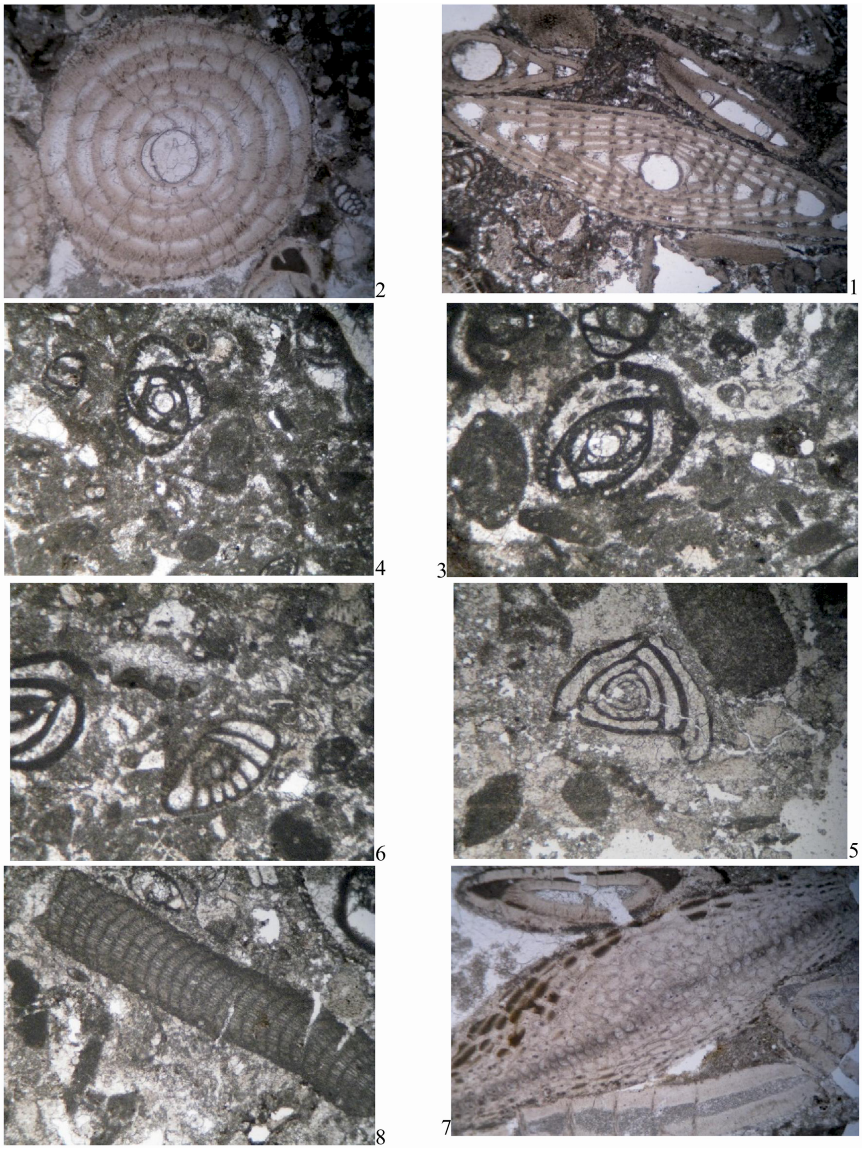

Fig. 11. 1. *Nummulites fichteli,* 2. *Nummulites intermedius*, 3 & 4. *Austeratrillina asmaricus*, 5. *Triloculina trigonula*, 6. *Elphidium* sp., 7. *Lepydocyclina* sp., 8. *Lithophyllum* sp.

is 70 m. The maximum flooding surface (mfs) in the zone is in wackstone limes section including *Nummulites vascus, Nummulites fichteli* and *Eulepidina* Foraminifera. The aforementioned sequence includes HST, TST facies. TST facies group includes limes of open marine facies and HST facies group includes Barfacies. Parasequence stacking pattern in TST with form Progradational and Aggradational in HST.

Sedimentary sequence no. 2

This sequence belongs to the age between *Aqitanian* to *Burdigalian*. The lower lithostratigraphic limit is of SB2 type, which has been rested on the upper section of Formation and upper limit of the aforementioned sequence is of SB2 type which is placed under Razak Formation in Ahmadi anticline section

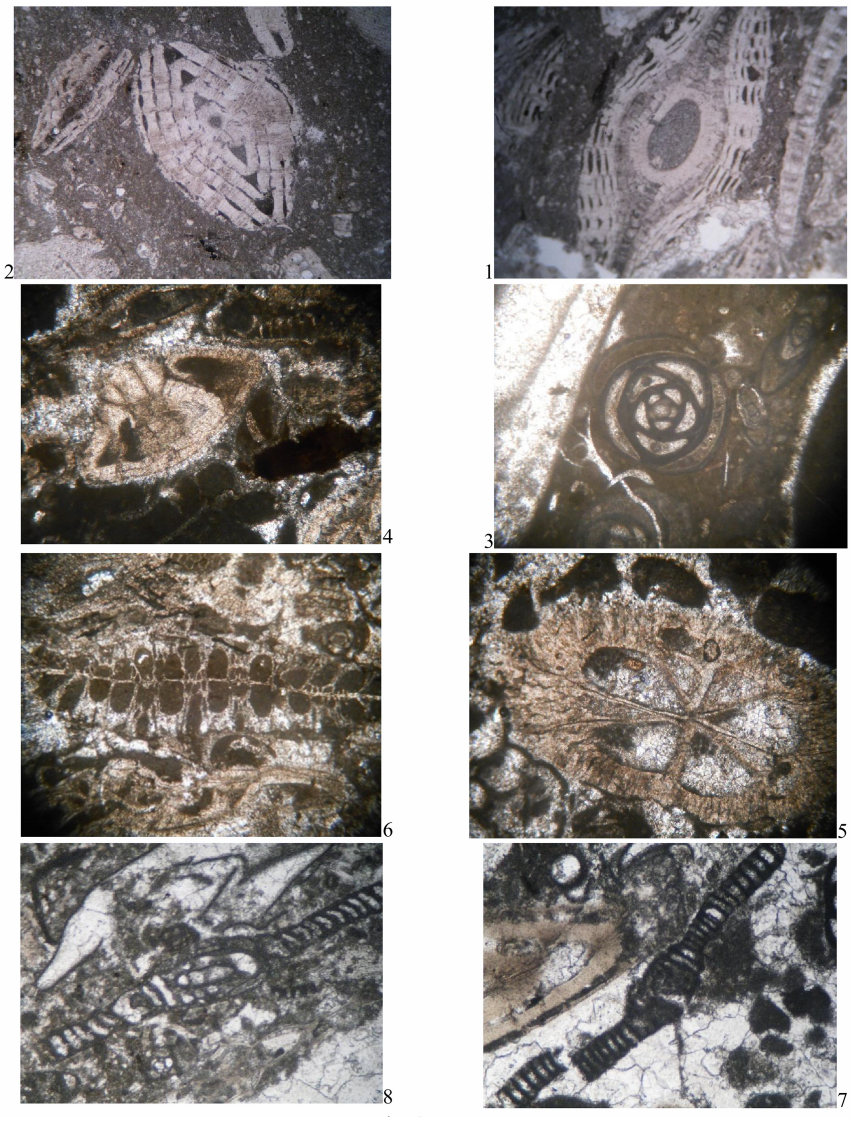

Fig. 12. 1. *Eulepidina cf. elephantina*, 2. *Nummulites vascus*, 3. *Quinqueloculina* sp., 4. *Rotalia viennoti,* 5 & 6. *Tubucellaria* sp., 7 & 8. *Peneroplis tomasi.*

and Gachsaran Formation in the Deh-Now and Kuh-e Charm sections. The thickness of this sequence in the Kuh-e Charm section is 160 m, Deh-Now section is 70 m and Ahmadi anticline section is 110 m. The maximum flooding surface (mfs) in the studied sections is packstonefacies including gloconite and bentic Foraminifera and algal such as *Miliolid, Quinqueloculina* sp., *Schlumbergerina* sp., *Lithophyllum* sp., *Lithothamnium* sp., *Subterraniphyllum thomasi.* The aforementioned sequence includes TST facies group including open lagoon and shoal and HST facies group including laggon and tidal flat facies. Parasequence stacking pattern in HST with form Retrogradational and Aggradational in TST.

Conclusion

In this research, 3 stratigraphy sections were se-

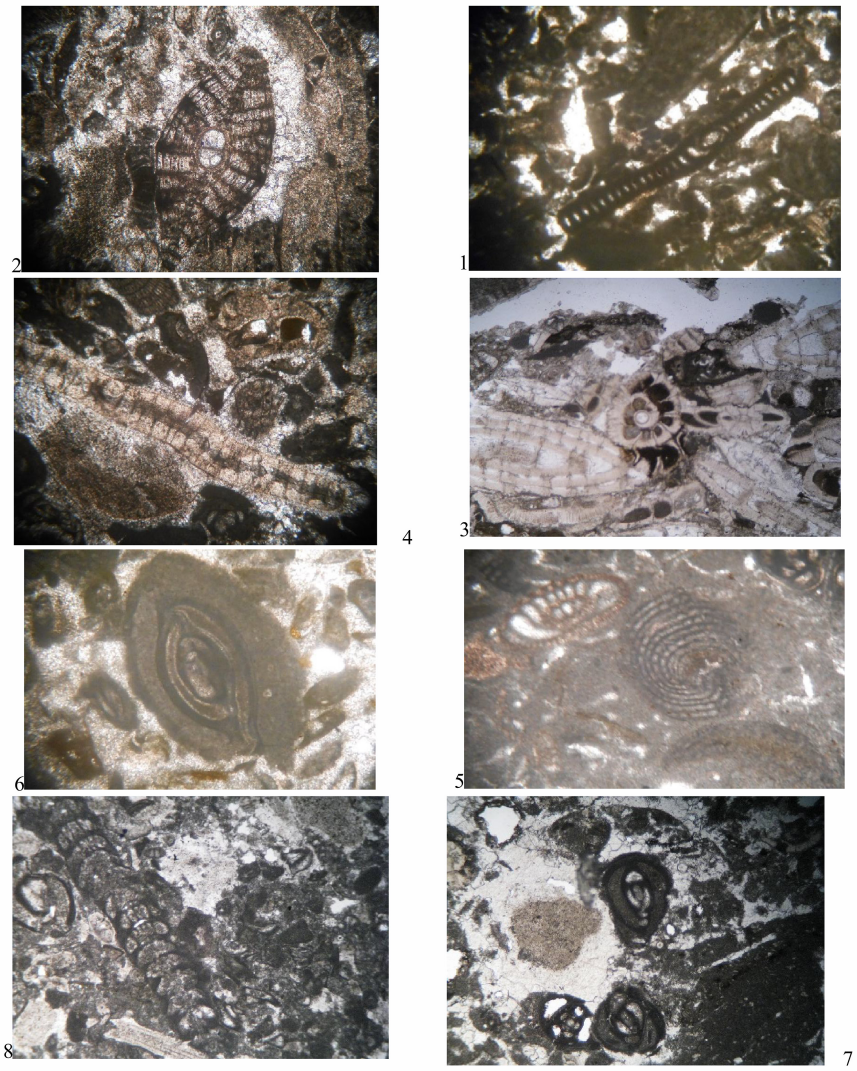

Fig. 13. 1. *Meandropsina arahensis,* 2. *Nephrolopidina* sp., 3. *Rotalia vinote*, 4. *Hetrostegina* sp. 5. *Archaias kirkukensis*, 6. *Pyrgo* sp., 7. *Nilliolides* sp., 8. *Haplophrogmum. cf. slingery.*

lected from the Asmari Formation, based on the investigation of foraminifers of the studied sections, there are these biozones that have been identified which includes: Biozone no. 1: *Nummulites fichteli, Nummulites vascus* assemblage zone. Biozone no. 2 : *Archaias asmaricus, Archaias hensoni, Miogypsinoides complanatus* assemblage zone. Biozone no. 3 : *Austrotrillina howchini, Peneroplis evolutus* assemblage zone. Biozone no. 4 : *Miogypsina, Elphidium, Peneroplis* assemblage zone. Biozone no. 5 : *Borelis melocurdica* zone.

In view of age, TST facies in sequence no. 1 : Are synchronic with biozones no. 1 and HST facies is synchronic with biozone no. 2 and 3. In view of age, TST facies in sequence no. 2 : Are synchronic with biozones no. 3 and 4 and HST facies is synchronic with biozone no. 4 and 5. The lower lithos Strati-

graphic limitin the studied Ahmadi anticline section of this sequence no. 1 : Type SBI has been distinctive with an erosion-made disconformity as the result of an Peirnean Orogenic phase operation, between Jahrom and Asmari Formations (middle) Eocene –lower Oligocene). According to the biostratigraphic limites of the studied sections, datum line is determined in lower Oligocene.

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