Islamic Azad University
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Mohammad Sadegh Dehghanian et al. / Iranian Journal of Earth Sciences 5 (2013) / 66 - 73

Oligocene-Miocene Microfacies Study of Asmari Formation (NW - SE of Shiraz, Iran)

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Received 25 August 2012; accepted 19 March 2013

Abstract

In this research, totally 610.4 meters of the Asmari Formation are studied in two stratigraphic sections on Bavan Mountain and Sarvestan section in Fars province, Iran. The indexed microfacies are carefully determined through studying of 230 thin sections. This research shows that the indexed microfacies are mudstone, wackestone, packstone, prainstone and the amount of microfacies elements such as bioclasts, pellets, extraclasts and intraclasts. They are varied in different parts of the studied sections and the total amount of bioclasts in the section is more than other elements. The abundance of benthic bioclasts represents the regression of the basin from the open sea into the sub tidal and intertidal zone.

Keywords: *Oligocene-Miocene, Microfacies Study, Asmari Formation, Bavan section, Sarvestan section.*

1. Introduction

Carbonate Asmari Formation (Oligocene-Miocene) is the most important reservoir rock of Iranian Southwest oil fields. It also has a worldwide reputation among the petroleum geologists. In this research the organic elements existing in the microfacies have been studied qualitatively and quantitatively. It is proven through the quantitative and qualitative research that the index microfacies of the Asmari Formation are mudstone, mackestone, packstone, grainstone. These microfacies have been studied on the basis of orthochemical and allochemicalical elements, their percentages, and their texture in the stratigraphy section (Danham, 1962). The first essay on the Asmari Formation has been written by Busk and May (1918). The above-mentioned researchers named their studied finding as 'Asmari' and determined its age. Richardson measured the type section of this formation in Tang-e Gel-e Torsh for the first time (Motiei, 2003). The Iran National Oil Company carried out a research on Zagros and issued its findings as 'Stratigraphic nomenclature of the Iranian oil consortium agreement. According to this research Farat and Jorib formations in Iraq and Khamir Limestone in Fars area have been considered as equivalent and introduced Kalhor sediments and Ahwaz sandstone as the 'Member' (Motiei, 2003). Wynd (1965) studied biostratigraphy specifications of the Asmari Formation and determined six zones of accumulation in it. Adams and Bougeois (1967) issued their integrated research on the Asmari Formation as 'Asmari biostratigraphy'.

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They achieved three important results:
1) Introduction of the triple division of Asmari stratigraphy time as the stratified rock division.
2) Reject the deltaic resource for Ahwaz sandstone.
3) Complement the research which has been done by James and Wynd (1965).

Some other research has been done on this matter, and finally Stocklin and Setudehnia (1991) issued their findings as 'Stratigraphic lexicon of Iran' in the second edition of their article. Also, Motiei (2003) edited and issued the second edition of his book. Because of the development of oil discoveries in Iran and the significant impact of the Asmari Formation as the most important oil reservoir rack of Iran, a lot of researches have been done on it, mostly in Dasht-e Khouzestan area as an oil field (southwestern Iran). Also Boeck (1929), Lces (1933), Bozorgnia and Kalantari (1965), Kalantari (1976), Rahaghi (1976), Rahaghi (1978), Kalantari (1978), Kalantari (1980), Amirshahkarami and Taheri (2010), Amirshahkarami (2010) Shafieeardestani (2010) studied and reviewed in micropaleontology of Zagros. So that, Kalantari (1986), Kalantari (1992), Maghsodi Gharebalagh (2005), Mohseni (2006), Vaziri-Moghaddam (2006), Ranjbaran (2007), Ehrenberg (2007), Amirshahkarami (2007a,b), Bahrami (2009), Taheri (2010), Vaziri-Moghaddam (2010), Dehghanian (2011) studies in sedimentary environment and microfacies of Zagros.

2. Methodology

In this research, Danham (1962) nomenclature method has been used to entitle of sedimentary facies, and the method of Afghan and Dehghanian (2007), Dehghanian et al. (2011), Flügel (2004), Adams,

Makenzi and Quilford (1984) has been used for qualitative and quantitative studies on microfacies.

Stratigraphic sections

Bavan and Sarvestan stratigraphic sections are located in Fars province, northwest and southeast of Shiraz (figure 1). Geologically they are located in the structural Zagros folded zone (James and Wynd 1965) (figure 2). Base of Bavan section, is located on the Pabdeh shales and covered by evaporates of Gachsaran formation. Also base of Sarvestan section is located on the Jahrum formation and is covered by Razak formation.

Bavan Section is located near Bavan village, far 97 km from northwest of Shiraz. The Gachsaran Formation is on and Pabdeh Formation is below of the Asmari Formation in this section. The thickness of Asmari Formation is 401.5 meters in this section. As it is shown in figure 2, the microfacies are mudstone, wackestone, packstone and grinstone.

Lithostratigraphic study

Base on field measurement, 26 lithostratigraphic parts were divided in Asmari Formation, Bavan section. The descriptions of them were as:

- Thickly bedded, Cream weathered color, microcrystalline limestone with 4.0m thickness and a vein of calcite.
- Thickly bedded, Cream to white weathered color, microcrystalline limestone with 2.1m thickness.
- Medium bedded, Cream weathered color, Microcrystalline and ferruginous limestone with 5.8m thickness and a vine of manganese and fossil fragments, bivalves and gastropods.
- Medium bedded, Cream weathered color, Ferruginous limestone with 7.4m thickness.
- Thickly bedded, Cream, blue to green weathered color, microcrystalline limestone with 16.9m thickness and layers of gypsum and weathered shale.
- Thickly bedded, Cream to pale yellow weathered color, Ferruginous limestone with 6.4m thickness and a vein of calcite.
- Medium bedded, Cream weathered color, Ferruginous limestone with 7.7m thickness and layers of green marl.
- Medium to thickly bedded, Cream weathered color, Limestone with 5.1m thickness, have microfossils, highly weathered.
- Medium bedded, Pale green weathered color, Limestone 6.6m thickness, highly weathered.
- Thinly bedded, Gray to cream weathered color, Ferruginous limestone with 3.6m thickness and a vine of Manganese and chert.
- Thickly bedded, Gray to cream weathered color, Karstic limestone with 7.1m thickness, high weathered and fractures.
- Thinly bedded, Cream to white weathered color, Limestone with 8.8m thickness, have microfossils.
- Thinly bedded, Cream to weathered color, Limestone and marl 6.1m thickness, highly weathered.
- Thinly bedded, Cream in gray weathered color, Ferruginous limestone and shale 8.5m thickness, highly weathered.
- Thin to medium bedded, Cream weathered color, Cherty Limestone with 21.4m thickness, highly weathered.
- Thinly bedded, Cream to gray weathered color, crashed karstic dolomitic limestone with 5.9m thickness, highly weathered.
- Medium bedded, Cream weathered color, Dolomitic microcrystalline limestone 11.1m thickness.
- Medium bedded, Cream to yellow weathered color, Dolomitic limestone 14.4 m thicknesses, has Lepidocyclina Sp.
- Medium bedded, Cream weathered color, crashed Limestone with 6.2m thickness, highly weathered.
- Thickly bedded, Gray to cream weathered color, Karstic microfossilliferous limestone with 10.4m thickness, highly weathered.
- Thickly bedded, Cream to yellow weathered color, Karstic limestone 9.3m thickness, highly weathered.
- Thinly bedded, Cream weathered color, Limestone with 10m thickness and a vine of Manganese highly weathered.
- Thinly bedded, Gray weathered color, Limestone with 26.9m thickness, highly weathered.
- Thickly bedded, Cream to yellow weathered color Limestone with 41m thickness, highly weathered.
- Thickly bedded, Gray to blue weathered color, Limestone with 78.2m thickness.
- Thickly to Massive bedded, Cream weathered color, microfossilliferous Limestone with 70.4m thickness.

The continuous changes of bioclasts abundant are more in the lower parts. The maximum abundance of bioclasts is 35% and the minimum amount of them is repeated in different parts of the section. The maximum amount of pellets exists in the Ba98 sample which is 25%. The maximum amount of intraclasts and extraclasts are observed in the Ba44, Ba47 samples which are 10% and 5%. Meanwhile, the changes curve of bioclasts and pellets is convergent in most cases. The changes curves of bioclasts and intraclasts are convergent. So, the changes curve of intraclasts and pellets is convergent in most cases.

Sarvestan stratigraphic section is located near Sarvestan city, far 88 km from the southeast of Shiraz. Upper and lower of Asmari formation is continuously with Jahrum and Razak formations with a 208.9 meters thickness. As it is shown in figures 3 and 5, the microfacies of this section are 23% mudstone, 45% bioclastic pelletiferous wackestone, 6% bioclastic packstone and 26% bioclastic pelletiferous grainstone. The end part of Jahrum Formation which is located in the upper part of Asmari section has Mudstone faces. The distribution curve of bioclasts is varied in the

lower part and this shows that the highly abundance of extraclasts and intraclasts.

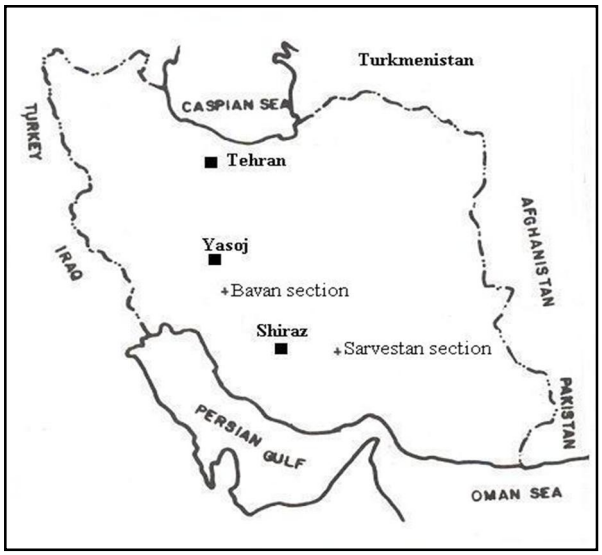

Fig. 1. The map showing location of the study areas in Northwest and Southeast of Shiraz, Iran.

Base on field measurement, 27 lithostratigraphic parts were divided in Asmari Formation Sarvestan section. The descriptions of them were as:

- Cream weathered color, Karstic and ferruginous limestone with 1m thickness.
- Thickly bedded, Cream to brown weathered color, ferruginous limestone with 8.8m thickness.
- Very thickly bedded, Cream to brown weathered color limestone with 3.8m thickness, low weathered color.
- Thickly bedded, Cream to brown weathered color, Sandy limestone with 11.8m thickness.
- hickly bedded, Cream in brown weathered color, Karstic Sandy limestone with 6.1m thickness, highly weathered.
- Medium bedded, Cream, gray to brown weathered color, Berrecia sandy limestone with 3.8m thickness.
- Thickly bedded, Cream, gray to brown weathered color, Ferruginous, Crashed breccias sandy limestone with 11m thickness, highly weathered.
- Thickly bedded, Cream to gray weathered color, Sandy limestone with 8.8m thickness, vein of calcite and fracture, highly weathered.
- Thickly bedded, Gray weathered color, Crashed ferruginous sandy limestone with 3.6m thickness and a vein of calcite, high weathered.
- Medium bedded, Dark gray, Milky to cream weathered color, Karstic and ferruginous sandy limestone with 5.1m thickness and veins of calcite, Silicified bivalves and gastropods fossil fragments, highly weathered.
- Medium bedded, Brown to red weathered color, karstic and ferruginous sandy limestone with 19.7m thickness, highly weathered.
- Medium bedded, Gray to brown weathered color, sandy limestone with 3.2m thickness and a vein of calcite.
- Medium bedded, Milky, pink to gray weathered color, karstic and ferruginous sandy limestone with 10.5m thickness and a vein of calcite, highly weathered.
- Medium bedded, dark gray, Milky to pink weathered color, karstic and ferruginous sandy limestone with 4.1m thickness and a vein of calcite, bivalves, gastropods and echinoderms fossil fragments, highly weathered.
- Medium bedded, Dark gray, pink to brown weathered color, karstic and ferruginous sandy limestone with 13.5m thickness and a vein of calcite, highly weathered.

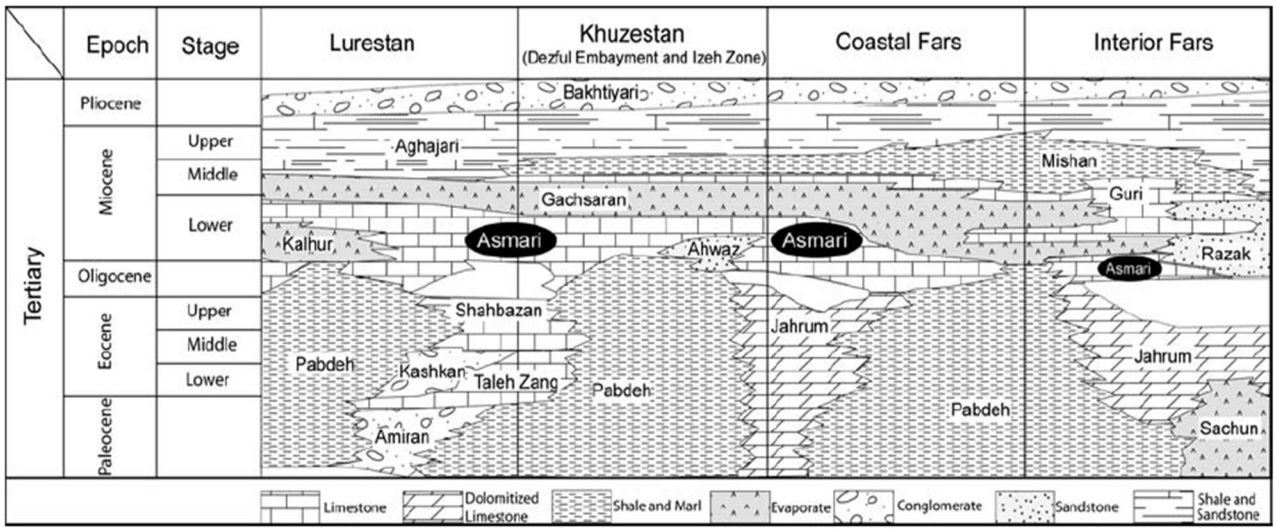

Fig. 2. Cenozoic stratigraphic correlation chart of the Iranian sector of the Zagros Basin, adopted from James and Wynd (1965). In Amirshahkaram andi.and et al. (2010).

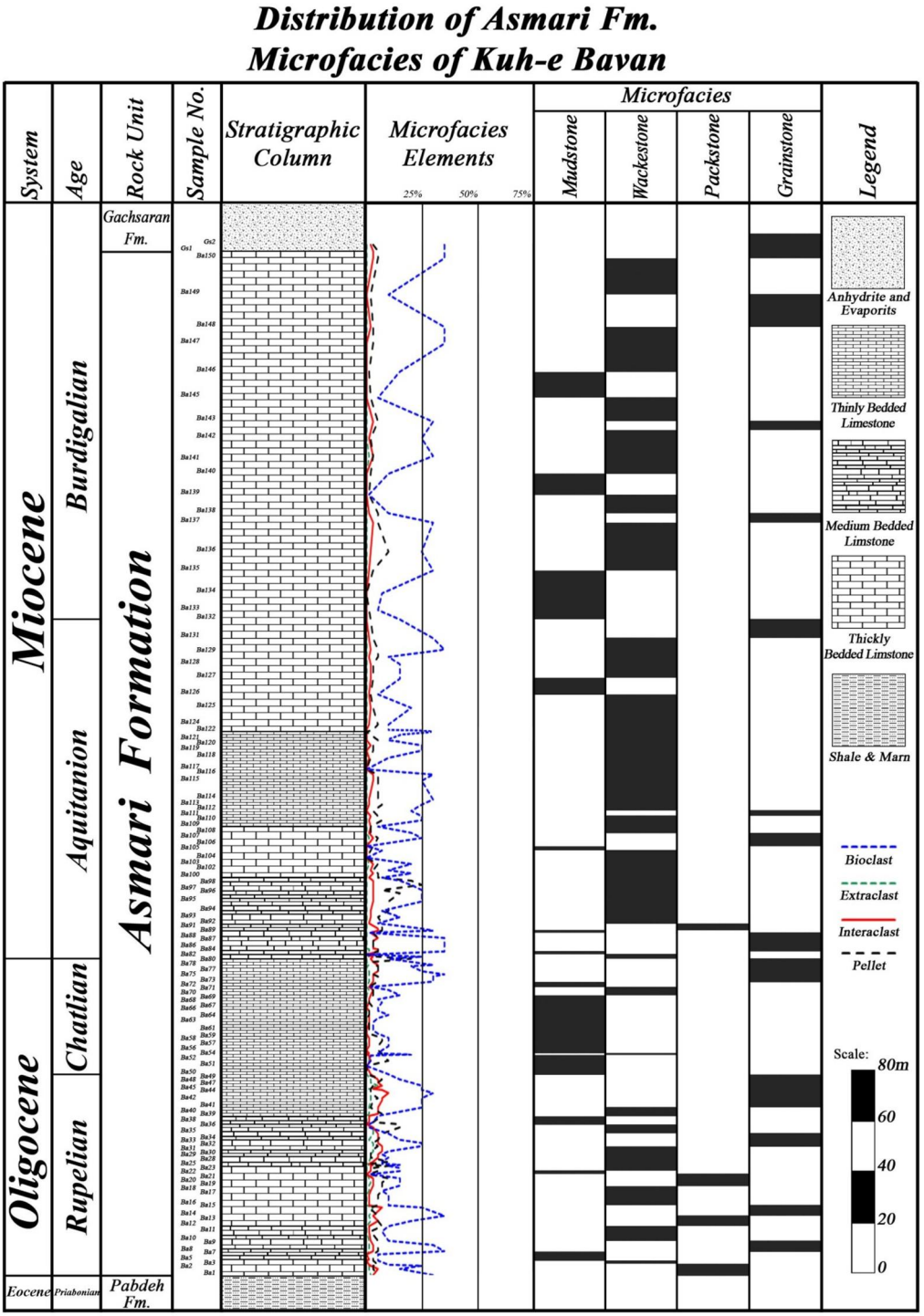

Fig. 3. The distribution of stratigraphy, carbonate microfacies and its elements in Bavan Section.

- Medium bedded, Gray, pink, green to brown weathered color, Ferruginous sandy limestone with 13.4m thickness and a vein of calcite and fossil fragments, Bivalve.
- Medium bedded, Gray to pink weathered color, Ferruginous sandy limestone with 2.9m thickness and a vein of calcite.
- Medium bedded Brown, red to yellow weathered color, Ferruginous, Microcrystalline sandy limestone with 8.1m thickness and veins of Iron.
- Medium bedded Gray, Brown, pink, yellow to brown weathered color, Microcrystalline sandy limestone with 14.3m thickness and veins of calcite and bivalves and chinoderms fossil fragments.

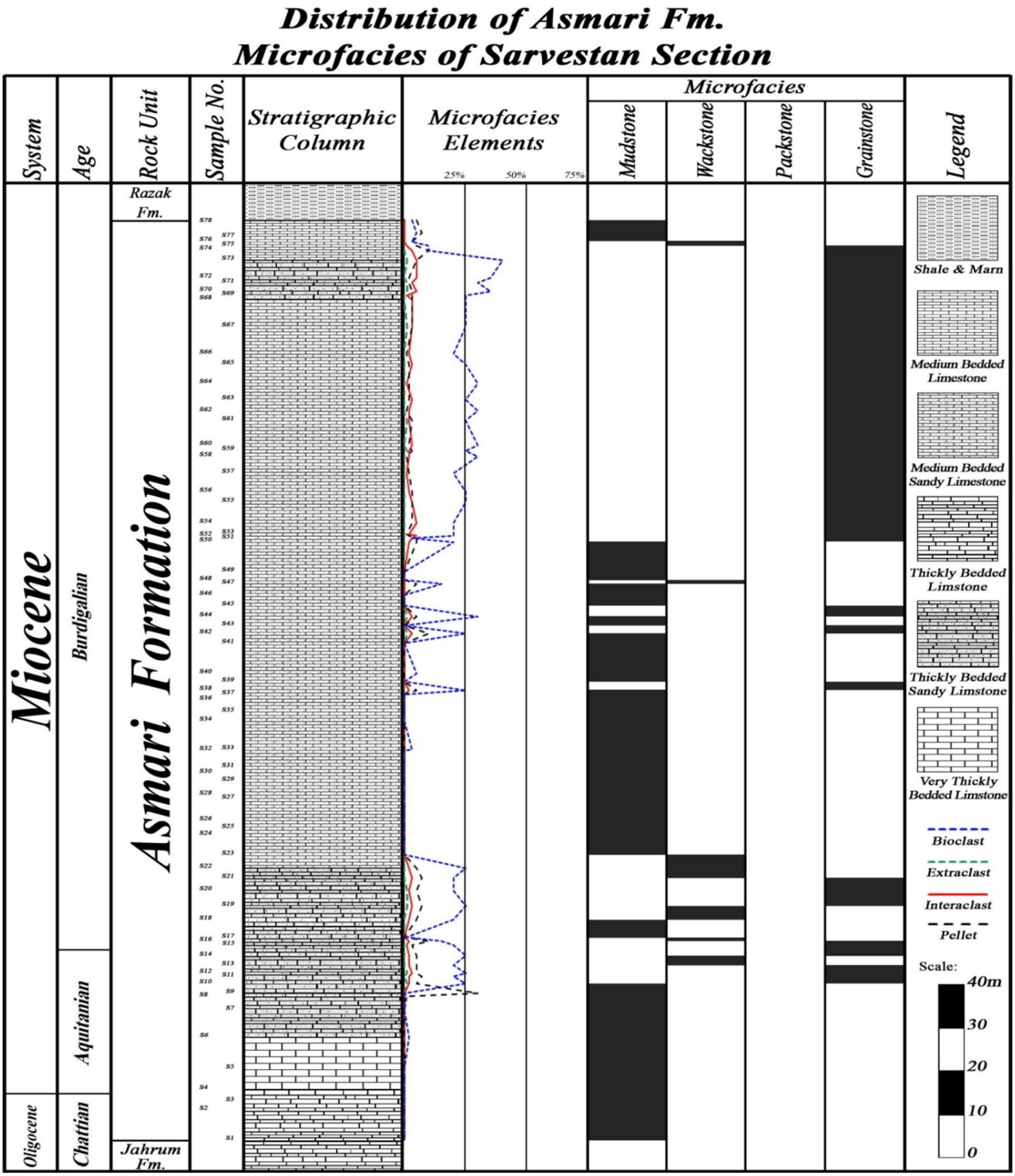

Figure 4: the distribution of stratigraphy, carbonate microfacies and its elements in Sarvestan Section

- Medium bedded, Dark gray to yellow weathered color, Sandy limestone with 6.3m thickness and veins of calcite, highly weathered.
- Medium bedded, Yellow to brown weathered color, Karstic sandy limestone with 10.4m thickness and veins of calcite, Bivalves and gastropods fossil fragments.
- 8.0m: Thickly bedded, Gray, brown to yellow weathered color, Microcrystalline sandy limestone with 8m thickness and a vein of calcite.
- Thickly bedded, Gray to brown weathered color, Karstic sandy limestone with 14.7m thickness, highly weathered.

- Thickly bedded, Brown to yellow weathered color, Ferruginous sandy limestone with 1.9m thickness and a vein of calcite, highly weathered.
- Medium bedded, Brown to yellow weathered color, Ferruginous limestone with 7.1m thickness and veins of calcite and bivalves and gastropods fossil fragments, highly weathered.
- Medium bedded, Brown to yellow weathered color, Ferruginous, Karstic Limestone with 3.2m thickness, highly weathered.
- Medium bedded, Milky to gray weathered color, Ferruginous limestone with 5.8m thickness and a vein of calcite.

The continuous changes of bioclasts abundance are more in middle parts. The maximum abundance of bioclasts is 40% and the minimum amount of them is repeated in different parts of the section. The maximum amount of pellets in S9 sample which is 30%. The maximum amount of intraclasts and extraclasts are observed in the S72, S73 and, S44 samples which are 5% and 2% in sequence. Meanwhile, in most cases the changes curve of bioclasts and pellets is convergent. The changes curves of bioclasts and intraclasts is convergent. So, the changes curve of intraclasts and the pellets is convergent in most cases.

Conclusion

Based on figure 5 have concluded that, bioclasts elements in Sarvestan section are higher than these elements in Bavan section. It suggests that the environmental conditions were better in Sarvestan area. Sequential changes of sedimental facies in Bavan section are higher than Sarvestan section. Therefore in may be suggested that sedimentary basin is unstable in Bavan.

Bioclasts enhancement at the end of Bavan section shows that proper has been prepared conditions for living organisms. The energetic facies in Sarvestan section are higher than Bavan section and it is leading to Asmari Formation has better conditions for oil reservoir rock transformation in Sarvestan section.

In Sarvestan section extraclasts has only about 1% of the total grains, while them has formed about 2% of the total clastic grains in Bavan section. This show, decrease the depth, and increase the energy in the sedimentary basin and appropriate conditions for transition of clastic elements to the basin. Also, reduce of the depth in the basin and increase of extraclasts in the base and top of Asmari Formation, which is showed suitable conditions for terrigenous entry into the sedimentary basin. In both sections, the abundance of bioclasts (especially benthic) represents the regression of basin from the open sea into the sub tidal and intertidal zone.

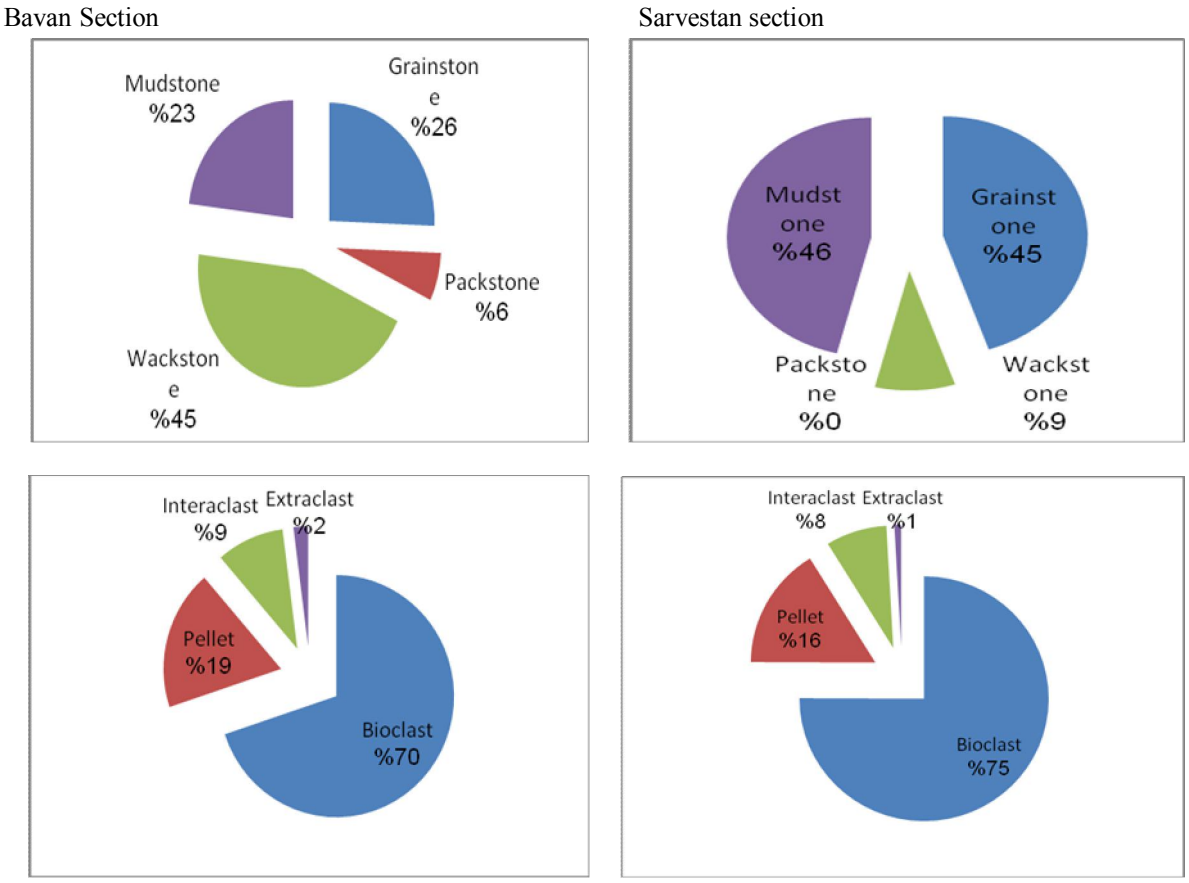

Fig. 5. Distribution charts of orthochemical and allochemical components in Bavan and Sarvestan Sections.

Based on sedimentary facies studies, determines that higher percentage of micritic facies in Bavan section. Therefore inferred were stable conditions that during the deposition of Asmari Formation basin in Bavan. It also proves that the deposition depth of Asmari Formation was more in Bavan than Sarvestan, So that 77% of the Bavan section sedimentary facies related to deep and calm zones.

Totally 15 lithostratigraphic units identified in two studied sections, including 9 units in Bavan and 6 units in Sarvestan. The differences of stratigraphic units number between two sections is due to Bavan closer than Sarvestan section to Zagros thrust. Continual changes in the sedimentary basin and development of lithostratigraphic units have causes that the alignment of Sarvestan section and Sarvestan fault and the activity of fault during deposition of Asmari Formation.

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