Microbiostratigraphy Of The Early Cretaceous Sequence In Northeast Of Shiraz, Zagros Basin, Southwest Iran

Mahnaz Parvaneh Nejad Shirazi, Fatemeh Abedi

Department of Geology, Payame Noor University. PO BOX 19395-3697 Tehran, IRAN
mahnaz402002@yahoo.com

Abstract: Several stratigraphic units were analyzed in detail and a biostratigraphic zonation of the early Cretaceous rocks of the Fars basin (Sw. Iran) is proposed. All stratigraphic units were studied for the determination foraminifers accompanying with calcareous algae. Eighty samples from the early Cretaceous (Daryian Formation), Iran, were analyzed via light microscopy of thin sections, yielding 32 species. The following taxa are the most abundant: *Mesorbitolina texana, Mesorbitolina parva, Pseudocyclammina lituus, Pseudochrysalidina conica, Pseudochrysalidina* cf. *arabica, Pseudocyclammina hedbergi, Praechrysalidina infracretacea, Cuneolina pavonia, Dictyocunus arabicus, Iraqia simplex, Vercosella laurentii, Protomarssonella trochus, Nautiloculina oolithica,* and calcareous algae such as *Salpingoporella dinarica, Trinocladus tripolitanus*, *Terquemella* sp. and *Lithocodium aggregatum–Bacinella irregularis.* These assemblages can be assigned to the *Mesorbitolina texana–Pseudocyclamina lituus* Assemblage Zone indicative of an Aptian–early Albian age. The Daryian Formation is overlain by the Kazhdumi Formation and is underlain by the Gadvan Formation.

[Mahnaz Parvaneh Nejad Shirazi, Fatemeh Abedi. **Microbiostratigraphy of The Early Cretaceous Sequence in Northeast of Shiraz, Zagros Basin, Southwest Iran.** Journal of American Science 2012;8(3):54-57]. (ISSN: 1545-1003). http://www.americanscience.org. 8

Keywords: Microbiostratigraphy; early Cretaceous; Shiraz; Zagros; Iran

1. Introduction

Geographically the Zagros mountains belong to the Alpine-Himalayan chain, but clearly do not fit into models for the Alps or Himalayas (Takin, 1972). Some of these difficulties were discussed by Stocklin (1968), who concluded that Iran had a peculiar type of Alpine tectonics.

The Zagros mountain ranges dominate southwestern Iran. The sediments exposed here are generally of Mesozoic age. The intensity of folding gradually decreases towards the Persian Gulf where younger rocks are seen in outcrop.

The Daryian Formation is regionally significant as a petroleum reservoir and a source rock in the Zagros Basin (Afsharharb, 2001). The Daryian Formation is equivalent to the Shoabia Formation in neighboring Saudi Arabia, Iraq and Qwit (Motiei, 1993). James and Wynd (1965) studied the stratigraphic relationships of the Daryian Formation at Gadun Mountain in the Zagros Foldbelt, but the age of the unit remains poorly resolved. This study aims to document the foraminiferal fauna and calcareous algal flora in the formation in order to resolve the age of the unit and to clarify its depositional environment.

2. Material and Methods

The study area lies in the Zagros Basin, which developed on the northeastern continental margin of Africa during the Paleozoic Era. During the Permian Period, detachment of the Iran plate (comprising Alborz, the east-central Iran microcontinent and Sanandaj-Sirjan) from the Arabian plate caused the formation of the Neotethyan Ocean. Individual microcontinents later detached from this assemblage and followed a northward path, before suturing to Eurasia before and during the Miocene Epoch, when Africa collided with Eurasia. The Alpidic-Himalayan Orogeny caused major deformation of all Iranian terranes and generated their present configuration (Berberian et al., 1981; Alavi, 1994; Alavi, 2004; Golonka, 2000).

The study area (N 29°53′1″, E 52°56′4″; Figure 1) is approximately 50 km north-northwest of Shiraz city. The paved road from Shiraz to Marvdasht is the main access road to Rahmat Mountain. The studied section is 285.5 m thick and is within the Rahmat Anticline. The lower boundary of the Daryian Formation with the Gadvan Formation is gradational, and its upper boundary with the Kazhdumi Formation is disconformable. The Daryian Formation is composed of medium- to thick-bedded limestone containing *Orbitolina*.

More than 80 oriented surface samples from the early Cretaceous (Aptian- early Albian, Daryian Formation) were collected. About 80 oriented thin sections were prepared for petrographical studies. The identification of foraminiferal fossils is based on Loeblich and Tapan (1988), the algal study is based on Delloffre (1988) and Bassoullet et al. (1978), and the microfacies study is based on Dunham (1962) and Wilson (1975). Field and laboratory descriptions of the samples were plotted on a stratigraphic section (Figure 2). All slides used in this study are on file at the Payame-Noor University Branch in Shiraz.

Field work was concentrated at the southwestern flank of the Rahmat Anticline, in the vicinity of Rostamabad village. A section was measured in detail along a slope crossing the southwestern trend of the anticline.

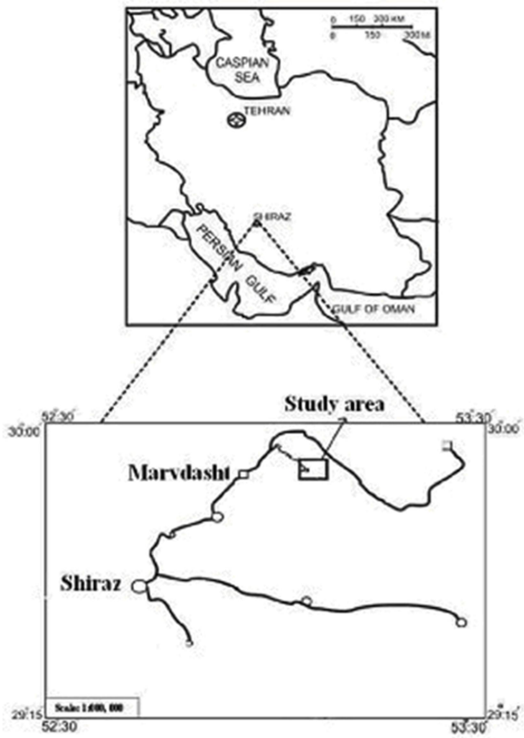

Figure 1. Location map of the studied area

3. Results

A biostratigraphic zonation for the Cretaceous System in southwest Iran was established by James & Wynd (1965), Gollestaneh (1966), Sampo (1969) and Kheradpir (1975).

In dating the middle Cretaceous rocks, the biostratigraphy of all the foraminifers and calcareous algae were taken into account, and three biozones were recognized in the study area.

This study aims to summarize the stratigraphic range of the assemblage zones and the species that occur in the early Aptian- early Albian (Daryian Formation) and to compare these data with zonations that have been recorded for the Zagros Basin. Three zones were established. We discuss them below in ascending stratigraphic order (Figure 2).

***Mesorbitolina texana–Pseudocyclammina lituus* Assemblage Zone**

This assemblage zone occurs throughout the Daryian Formation. This zone is characterized by foraminifers such as *Paleorbitolina lenticularis, Mesorbitolina texana, Mesorbitolina parva, Orbitolina* sp., *Pseudocyclammina lituus, Pseudochrysalidina conica, Pseudochrysalidina* cf. *arabica, Everticyclammina hedbergi, Praechrysalidina infracretacea, Choffatella decipiens, Debarina haurensis, Cuneolina pavonia, Dictyocunus arabicus, Dictyocunus* sp., *Iraqia simplex, Vercosella laurentii, Protomarssonella trochus, Quinqueloculina* sp., *Nautiloculina oolithica, Ammobaculites* sp. and *Haplofragmoiedes* sp. On the basis of index fossils, this foraminiferal assemblage zone is considered to belong to the Aptian–early Albian. Calcareous algae include *Salpingoporella dinarica, Trinocladus tripolitanus*, *Terquemella* sp., *Lithocodium aggregatum–Bacinella irregularis* and *Permocalcaleus* cf. *Inopinatu*s.

***Choffatella decipiens* Total Range Zone**

This zone is 115 m thick and is in the lower part of the Daryian Formation. It is characterized by *Choffatella decipiens*, *Paleorbitolina lenticularis*, *Mesorbitolina texana, Pseudocyclammina lituus, Everticyclammina hedbergi, Praechrysalidina infracretacea, Vercosella laurentii*, *Haplofragmoiedes* sp., *Debarina haurensis*, *Ammobaculites* sp., *Dictyocunus* sp., *Iraqia simplex*, *Dictyocunus arabicus* and *Pseudochrysalidina* cf. *arabica.* Some calcareous algae are present in this zone including *Lithocodium aggregatum–Bacinella irregularis*, *Terquemella* sp. and *Permocalcaleus* cf. *inopinatus.* The age of this zone, based on the above microfossils, is early Aptian. The upper part of this subzone (as seen in thin section no. 75) can be considered a key bed because of the frequency and accumulation of *Salpingoporella dinarica*.

***Mesorbitolina parva T*otal Range Zone**

This zone begins at the middle part of Daryian Formation and extends through a thickness of 50 m. This zone is characterized by the presence of *Mesorbitolina parva, Mesorbitolina texana, Pseudochrysalidina conica, Everticyclammina hedbergi, Praechrysalidina infracretace* and calcareous algae including *Lithocodium aggregatum* (syn *Bacinella irregularis*) and *Trinocladus tripolitanus*. This zone is considered to belong to the late Aptian on the basis of foraminifers.

The first zone is equivalent to zones 16 and 18 James & Wynd (1965), and the second and third zones are equivalent to zone 16 James & Wynd (1965). Kheradpir (1975) presented two kinds of biozones for the Zagros Basin. These biozones are based on algae and benthic foraminifers. The second and third zones are equivalent to *Orbitolina/Choffatella/Salpingoporella dinarica* ass. zone Kheradpir (Figure 3).

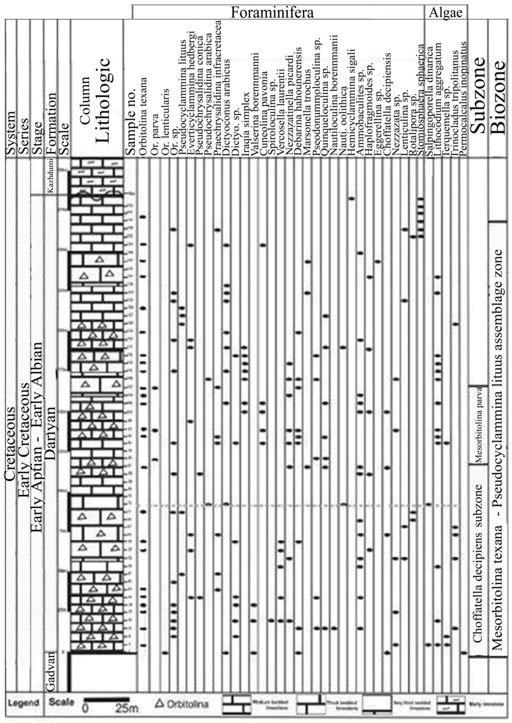

Figure 2. Stratigraphic column and biozones of Daryian Formation (Early Cretaceous)

Golestaneh 1965 Southern Iran	Barremian Aptian: Orbitolina / Choffatella / Salpingoporella dinarica ass. zone		Albian
James & Wynd 1965 South west Iran	Aptian: Hensonella / Orbitolina- Choffatella ass. zone 16		Albian: Conical Orbitolina ass.zone 18
Sampo 1969 South west Iran	Aptian: Choffatella decipiens zone		Albian
Kalantari 1969 South west Iran	Aptian: Choffatella decipiens + Pseudocyclammina rugosa		Albian
A.Kheradpir 1975 South west Iran	Barremian Aptian: Orbitolina / Choffatella / Salpingoporella dinarica ass. zone		Albian: Conical Orbitolina ass.zone 18
Velic 1988 Karst Dinarides in Croatia	Lower Aptian	Upper Aptian: Mesorbitolina parva zone	Lower Albian: Mesorbitolina texana zone
Biozones Proposed Here	Lower Aptian: Choffatella decipiens subzone	Upper Aptian: Mesorbitolina parva subzone	Lower Albian
Biozones Proposed Here	Mesorbitolina texana + Pseudocyclammina lituus ass. Zone		

Figure 3. Comparision of biostratigraphic schemes of the studied area with previous studies

4. Discussions

Studies of foraminiferal ecology have provided at least five distinct criteria for the reconstruction of marine paleoenvironments (Naish et al., 1997): (1) both the number of species and specimen abundance increase away from shore and with increasing depth of water to maximum values on the outer shelf and in the upper and middle bathyal zone; (2) diverse porcelaneous species are abundant in shoal near-shore marine environments; (3) arenaceous foraminifers with simple interiors may be abundant in shallow waters, whereas more complex types with labyrinthic interiors are more characteristic of bathyal depths; (4) deposition of planktic species occurs most abundantly on the outer shelf and in the upper bathyal zone, with even greater abundances in deeper waters under the right conditions; and (5) similar environmental adaptations of modern species and fossil homomorphs (and isomorphs) may be assumed, especially for groups of species.

The paleoecology of foraminifers in the Daryian Formation at Rahmat Mountain has been determined on the basis of the biozones studied. The *Mesorbitolina texana–Pseudocyclammina lituus* assemblage zone is characterized by large and agglutinated foraminifers such as *Mesorbitolina* and *Pseudocyclammina*. The *Mesorbitolina* has a high variety, which suggests a shallow-marine environment and indicates the beginning of the Daryian Formation. Among the dominant benthic foraminifers, *Orbitolina, Dictyoconus, Iraqia*, *Pseudochrysalidina* and *Pseudocyclammina* are the main genera recorded in the present work, reaching to 50% of the skeletal components and mainly represented by the oncoidal and concoidal orbitolinids. A miliolid-dominant facies is also recorded. In the Aptian-Albian beds (mainly limestone), benthic foraminifers are dominant.

The biotic distribution was controlled largely by paleoenvironmental changes, such as trophic level, water energy and clay influx, as well as sedimentary factors controlled by variations in accommodation space. In particular, in the Albian the biotic components and their ecological requirements indicate shallow-water carbonate facies characterized by shallow, warm and saline water conditions with different degrees of water energy that change to relatively deeper water in some parts of the area.

The association of orbitolinids with calcareous algae and echinoderms in slightly argillaceous limestones, as indicated from the present work, are interpreted to have been deposited in relatively high trophic conditions (mesotrophic).

Changes in trophic level might be related to variable humidity conditions during sea-level rise and fall. The increased weathering rates during early transgression, induced by stronger rainfall and clay reworking during flooding of exposed platforms, may have contributed to the onset of mesotrophic conditions favorable for the development of orbitolinids. Orbitolinid-rich facies occur generally contemporaneously from inner to outer platforms and in intrashelf basins. The overall pattern of the Albian sequence seems to indicate a regressive shallow-marine setting for the deposition of the upper Daryian succession. This succession represents shallow shelf sequences composed generally of limestones rich in benthic foraminifers.

Carbonate rocks of the Daryian Formation were deposited in tidal-flat, lagoon, bar and open-marine facies belts.

5. Conclusions

1. The age of the Daryian Formation is early Aptian–early Albian. This formation is represented by medium- to thick-bedded limestone containing *Orbitolina* in the Zagros Basin. The Daryian Formation overlies the Gadvan Formation and is overlain by the Kazhdumi Formation.

2. The Daryian Formation comprises three zones. The first zone is Aptian–early Albian, and the second and third zones are Aptian in age.

3. In general, these zones are equivalent to biozones, which were delineated by previous studies. Thus they can serve as complementary biozones in conjunction with those studies.

4. Orbitolinids in association with calcareous algae and echinoderms in slightly argillaceous limestones, as indicated in the present work, are interpreted to have been deposited in relatively high trophic conditions (mesotrophic).

Acknowledgements:

This research formed parts of a Master of Science thesis at Payam-E-Noor University. We are grateful to the students of Payam-Noor University for physical support during our field work. We also wish to express our gratitude to Dr. M. Bahrami (Shiraz Payame Noor University) for his helpful suggestions.

Corresponding Author:

Dr. Mahnaz Parvaneh Nejad Shirazi
Department of Geology
Science Campus, Payame Noor University
PO BOX 19395-3697 Tehran, IRAN
E-mail: mahnaz402002@yahoo.com

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