Microbiostratigraphy of the Lower Cretaceous strata from the Bararig Mountain, SE Iran

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ABSTRACT

The Barremian-Aptian sediments in the Bararig section (Southwest of Kuhbanan) consist of an alternation of marl and limestone. The palaeontological analysis led to identification of twenty seven taxa of benthic foraminifera and algae in the section studied. Diverse assemblages of benthic foraminifera and also the low planktonic/benthic (P/B) ratio show that the sedimentary environment in the study area was oxygenated and shallow.

Key words: microbiostratigraphy, palaeoecology, Lower Cretaceous, Bararig section, Kerman Province, Iran.

RESUMEN

Los sedimentos del Barremiano-Aptiano en la sección Bararig section (al suroeste de Kuhbanan) consisten en una alternancia de margas y calizas. El análisis paleontológico permitió la identificación de 27 taxa de foraminíferos bentónicos y algas en la sección estudiada. Diversas asociaciones de foraminíferos bentónicos y la baja relación de planctónico/bentónico (P/B) indican que el ambiente sedimentario en el área de estudio fue oxigenado y somero.

Palabras clave: microbiostratigráfia, paleoecología, Cretácico Inferior, sección Bararig, Provincia Kerman, Irán.
INTRODUCTION AND GEOLOGICAL SETTING

Lower Cretaceous sediments in some areas of the Kerman region, Iran, such as Baghin, Ekhtiyar-Abad and Kuhbanan, are marlstones and limestones with intercalations of marl. The first studies in the Kerman region were done by Pilgrim (1924). Huckreide et al. (1962) comprehensively studied the geology of the Kerman region and delineated the Cretaceous palaeogeography of this region. Cretaceous foraminifera of the Kerman region have been studied by Mahanipoor (2003), and Arab (2003, 2004, 2005). Vaziri (2003) studied the distribution of foraminifera and the paleoecology of the Cenomanian deposits. Hosseinipour et al. (2003), Arab et al. (2004, 2005) and Vaziri et al. (2006) studied the Albien-Cenomanian deposits in two stratigraphic sections (Henouj and Chenaroieh) in the western part of the Kerman region, and, eventually, biostratigraphic and paleoecologic studies were done by Ahmadi et al. (2010).

Cretaceous outcrops in the Kerman Province are shown in the Figure 1.

This paper presents the results of a palaeoecological study based on the microfossil content of samples collected in the Lower Cretaceous Bararig section, along the Zaran-Kuhbanan-Deh Ali road, Karman province (Figure 2).

Structural units of Iran

Fundamental differences in the crustal character and age of basement consolidation allow three major structural units to be recognized in the studied area, separated by ophiolite-bearing sutures. Other criteria such as structural style, the age and intensity of deformation, and the age and nature of magmatism are used to subdivide these major zones into smaller elements. The three major units and their main constituents are as follows: 1) the southern unit, with a crystalline basement consolidated in Precambrian time, platform-type Paleozoic sediments and younger deposits. This unit comprises the Zagros fold belt; 2) the central unit, interpreted as an assemblage of marginal Gondwana fragments, originally united with the main continent and separated from the North (Eurasian) continent during the Mesozoic. In Mesozoic times, these fragments were detached from Gondwana and attached to Eurasia. During the Late Cretaceous they rejoined the Gondwanic Afro-Arabia. This unit comprises Central Iran and the Alborz; 3) the northern unit, markedly separated from the central unit by ophiolites of the North Iran suture. The continental crust includes remnants of more or less cratonized, former (Paleozoic) oceanic crust possibly that of the Paleotheiths. The northern unit represents a marginal strip of the Hercynian realm of Central Asia, broadly overlapped by the Alpine realm. It was deformed and largely consolidated by strong Early Cimmerian and Late Alpine folding (Stocklin, 1968). The Northern Unit comprises the South Caspian Depression and the Kopet-Dagh Range (Figure 3).

![Figure 1. Cretaceous outcrops in the Kerman province (Bakhtiari, 2007, 2007, with minor changes). AFG: Afghanistan, PAK: Pakistan, IRQ: Iraq, TR: Turkey.](image1)

![Figure 2. Location of the studied section in the Bararig Mountain, SE Iran (Bakhtiari, 2007, with minor changes). AFG: Afghanistan, PAK: Pakistan, IRQ: Iraq, TR: Turkey, TM: Turkmenistan, ARM: Armenia, AZ: Azerbaijan.](image2)
A brief comparison of Cretaceous deposits in different parts of Iran

The most complete Cretaceous sections in North Iran are found in the Kopet-Dagh range on the border of Iran and Turkmenistan. The rocks consist of marine shales, marls, limestones and sandstones. The sequence reaches a thickness of more than 3000 m and seems to represent all major parts of the Lower Cretaceous strata (Afshar-Harb, 1994). In the Alborz mountains and farther south, Cretaceous limestones and marls are widely distributed but the sections are less complete. Elsewhere, unfossiliferous red clastic basal beds, which in the Ravar-Darband area, northern Kerman province, contain considerable amounts of gypsum, frequently initiate the Cretaceous sequence and are followed by limestones and marls of different ages. The oldest marine beds are Orbitolina-bearing limestones (Tiz-Kuh Formation of the Alborz, “Orbitolina limestone” in general), which are conventionally regarded as Aptian-Albian but may include stages as old as Barremian and as young as Cenomanian. An unusual shale facies reaching great thickness and containing very rare cephalopods represents the Barremian-Albian in the Biabanak area of Central Iran (Stocklin and Setudehnia, 1991).

With the exception of the Kopet Dagh area mentioned above, detailed stratigraphic studies of the Upper Cretaceous deposits have been carried out only in a few limited areas such as the central Alborz, Tehran, Jandaq, Esfahan and Kerman areas. Detrital limestones, reef limestones, marls and shales prevail. However, the marine sequences are frequently interrupted by conglomerates, red beds, sedimentary gaps and unconformities and the sections vary in detail over short distances, reflecting the unstable conditions of the sedimentary environment during the initial phases of the Alpine orogeny. This and considerable disagreement between interpretations of different authors regarding the stratigraphic significance of the faunas has so far made reliable correlation over any greater distance difficult and a consistent stratigraphic subdivision of the Upper Cretaceous has yet to be established. The Stratigraphic Terminological Committee (STC) of Iran has recommended not introducing any formal stratigraphic names for the Upper Cretaceous strata of the Alborz and of central and eastern Iran until more regional information becomes available to clarify the situation, in compliance with this recommendation (Stocklin and Setudehnia, 1991).
Stratigraphy of the Bararig section

The Bararig section is situated in the NW-SE striking Bararig mountains, at approximately 60 km southwest of Kuhbanan city (Kerman Province), and is accessible by the Zarand-Kuhbanan-Deh Ali road (Figure 2). The section is 190 m thick and is composed of two lithological associations, marls and limestones, which were deposited alternatively (Figure 4). The section from the lower to the upper part is as follows: green marls (90 m), gray limestones with intercalation of marls (40 m), light green marls (25 m) and gray, thick-bedded limestones (35 m). The mentioned units contain ostracods, benthic foraminifera and macrofossils. In order to conduct palaeontological studies, samples

<table>
<thead>
<tr>
<th>STAGE</th>
<th>SERIES</th>
<th>SAMPLE NO.</th>
<th>LITHOLOGY</th>
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<tbody>
<tr>
<td>CRETACEOUS</td>
<td>Barremian - Aptian</td>
<td>871, 872, 873</td>
<td>Orbitolina (Mesorbitolina) texana - Nezzazatinella picardi Assemblage Zone</td>
</tr>
</tbody>
</table>
| | | 874, 875, 876 |]
| | | | Nezzazatinella picardi Assemblage Zone |

Figure 5. Stratigraphic column and the range chart of the benthic foraminifera in the Bararig section.
from marls and limestones were collected. Due to lack of foraminifera in the marly layers, thin-sections of limestones have been made. The stratigraphic column and the range chart of benthic foraminifers are shown in Figure 5.

MATERIALS AND METHODS

This paper is based on the study of the Bararig section along the Zarand-Kuhbanan-Deh Ali road. The Barremian-Aptian succession was measured and sampled. Microfossil content of the samples was studied in 37 thin sections with an optical microscope. These allowed the identification of the vertical foraminiferal distribution and establishment of two regional biozones. The palaeoecological study determined three benthic foraminiferal groups. All rock samples and thin sections are housed in the Department of Geology, Shahid Bahonar University of Kerman.

The taxonomic determination of the foraminifers is based on the latest changes in the foraminiferal classifications: Loeblich and Tappan (1988, 1992) and Kaminski (2004), and takes into account the following works: Jones and Charnock (1985), Koutsoukos et al. (1990), Baud et al. (1994), Cherchi and Schroeder (1999), Yilmaz (1999), Granier et al. (2003), Masse et al. (2004, 2009).

SYSTEMATIC PALEONTOLOGY

*Cylindroporella* sp. cf. *Cylindroporella sugdeni*  
Elliott, 1957  
Figure 6-1

**Description.** Oblique-transversal section shows a cylindri-

**Total range.** Hauterivian – Aptian.

**Occurrence.** S45, S47 (see sample position in Figure 5).

**Stratigraphic distribution.** Hauterivian–Aptian of Switzerland, Portugal, France, and Aptian of Iran.

*Nautiloculina oolithica* Mohler, 1938  
Figure 6-4

**Description.** Longitudinal section shows a lenticular shape and planispiral coil, which is involute. Proloculus is globular and followed by three small chambers. Chambers increase gradually in size. Wall agglutinated, microgranular and single layered.

**Total range.** Oxfordian-Aptian.

**Occurrence.** S46, S47, S57, S59.

*Marssonella turris* d’Orbigny, 1840  
Figure 6-5

**Description.** Subaxial section shows biserial stage of a trochosorial. Diameter of chambers increases rapidly and the terminal chamber becomes flattened. Wall agglutinated with organic lining in calcareous particles.

**Total range.** Early to Late Cretaceous.

**Occurrence.** S31, S37, S39, S41, S49, S53, S56, S57, S59.

**Stratigraphic distribution.** Cosmopolitan in the Early to Late Cretaceous. Aptian of Iran.

*Novalesia angulosa* Magniez, 1974  
Figure 6-6

**Description.** Axial section represents biserial stage of coiling with seven rows of chambers. Radial beams are not clear, wall agglutinated with relict of interio-marginal slit aperture.

**Total range.** Late Aptian to Albian.

**Occurrence.** S31, S37, S39, S41, S44, S55, S56, S57, S59, S72, S73, S74.

**Stratigraphic distribution.** Late Aptian–early Albian of Spain and France. Albian of Croatia. Aptian of Iran.

*Charentia cuvillieri* Neumann, 1965  
Figure 6-7

**Description.** Transversal section shows planispirally en-

**Total range.** Hauterivian-Cenomanian.

**Occurrence.** S39, S41, S43, S44, S46, S47, S49, S51, S53, S55, S57, S59, S70, S72, S73, S74.

**Stratigraphic distribution.** Upper Barremian-Cenomanian of France, Spain, Crimea, Texas and Egypt. Aptian of Iran.

*Pseudolitiunella recheli* Marie, 1955  
Figure 6-8

**Description.** Test conical elongate. Early portion with a short trochosorial stage in the type species but more elongate in geologically younger species, later stage with broad and low uniserial chambers. The wall is calcareous, microgranular, imperforate and single layered.

**Range.** In this study, the late Aptian is considered as the age of this taxon in the studied section.

**Occurrence.** S31, S37, S39, S46, S49, S51, S55, S57, S59, S70, S72, S73, S74.

**Stratigraphic distribution.** Cenomanian-Campanian
of France, Spain, Turkey. Aptian of Iran. Lutetian of Libya.

*Rheocolpina* sp. cf. *Rheocolpina scarnellai*
*De Castro, 1963*

**Description.** Axial section reveals a small, elongate and conical test. Apical angle about 20°. Initial trochospiral stage consists of a rounded protoconch, a small deuteroconch, and one chamber, followed by a biserial stage with up to eight chambers, slightly compressed parallel to the plane.

**Total range.** Barremian to Albian.

**Occurrence.** S31, S33, S37, S39, S41, S43, S46, S47, S49, S51, S53, S55, S56, S57, S59, S70, S72, S73, S74.

**Stratigraphic distribution.** Early Hauterivian-Bedoulian of France and Italy. Aptian of Iran.

*Orbitolina* (Mesorbitolina) cf. *Orbitolina (Mesorbitolina) texana* *Roemer, 1849*

**Description.** The embryonic apparatus of macrospheric forms, which is very important for an exact determination, is preserved as well and is composed of protoconch, deuteroconch, and sub embryonic zone. It is located on the top of the specimen. The thickness of protoconch is about 0.11 mm and embryonic apparatus is about 0.25 mm.

**Total range.** Late Aptian-Early Albian.


**Stratigraphic distribution.** Barremian-Early Cenomanian of USA, Italy, Spain, China, Tibet and India. Aptian of Iran.

*cf. Mayncina bulgarica* *Laug, Peybernès and Rey, 1980*

**Description.** Equatorial section shows numerous chambers, about ten chambers per whorl, in a planispiral coiling. Chambers arrangement reveals height increase and a tendency to uncoil of the last two or three chambers. The wall is finely agglutinated.

**Total range.** Late Hauterivian-Aptian.

**Occurrence.** S37, S39, S70.

**Stratigraphic distribution.** Late Hauterivian-Aptian. Occurrence. S37, S39, S70.

**Stratigraphic distribution.** Late Cenomanian of France. Aptian of Iran. Tithonian-Barremian of Ukraine.

*Pseudocyyclammina* cf. *Pseudocyyclammina lituus* *Yokoyama, 1890*

**Description.** Sub-equatorial section shows planispirally enrolled, the early stage may be streptospiral and repre-
IDENTIFIED BIOZONES IN THE BARARIG STRATIGRAPHIC SECTION

According to the studies of thin-sections and identified taxa, two regional biozones are determined and described as follow:

Montseciella arabica Range Zone

Biostratigraphic interval represented by the total range of Montseciella arabica. This biozone is located in the middle part of the section and suggests a Barremian-Aptian age.

Orbitolina (Mesorbitolina) texana-Nezzazatinella picardi Assemblage Zone

This assemblage zone contains Praechrysalidina sp., Marxsonella turris, Minouxia sp., Novalesia angulosa, Rumanoloculina pseudominima, Haplophragmoides sp., Vercorsella cf. Vercorsella scarsellai, cf. Mayncina bulgarica, and Charentia cuvillieri. The mentioned biozone is defined by the first appearance of Orbitolina (Mesorbitolina) texana taxon and the overthwart of Nezzazatinella picardi taxon; it is found in the lower - upper limestones of the studied section and shows the Aptian age for these deposits.

PALAEOECOLOGY

The most abundant foraminifera in the studied section are orbitolinids represented by Pseudotextulariella, Orbitolina (Mesorbitolina), Pseudolituonella, miliolids and Pseudocyclammina. Paleocological studies show that, there are three groups of benthic foraminifera associations in the Bararig section, whereas pelagic foraminifera are missing: 1) Epifaunal genera: Charentia, Rzahkina, Lenticulina, Glomospira, Nezzazata Glomospirella, Nezzazatinella, Nutiloculina, Haplophragmoides, Trochaminoides, Rumanoloculina, Istriloculina, Ophthalimidium, Pseudocyclammina. 2) semi-infaunal genera: Orbitolina (Mesorbitolina) and Orbitolina. 3) Infaunal genus: Pseudolituonella, Pseudotextulariella, Praechrysalidina, Minouxia, Marxsonella, Bolivinopsis, Novalesia (Vaziri, 2003).

Epifaunal/infaunal ratio of benthic foraminifera is shown in the Figure 8. According to the thin-sections, epifaunal and semi-infaunal foraminifera make 94.58% of the total percentage of foraminifers in the Bararig section and only 5.42% of foraminifers in this section belong to infaunal forms. It is clear that epifaunal foraminifers are unstable in environments with low amount of oxygen but the infaunal foraminifers are stable in such conditions (Lamolda, 1982; Hart, 1985) therefore, the abundance of epifaunal foraminifers indicates an environment rich in oxygen. Meanwhile, the association of larger benthic foraminifera (such as orbitolinids) with algae shows that the environment is shallow and situated within the photic zone. The available palaeoecological data on miliolids indicates a preference for warm, shallow-water and tolerance between 18 to 36% fluctuations in salinity.

DISCUSSION AND CONCLUSIONS

Barremian-Aptian sediments of the Bararig mountain have all the characteristics of shallow-water deposits. The Urgonian succession consists of two depositional sequences characterized by marls and limestones. According to the foraminiferal assemblages found in the Bararig stratigraphic section and their comparison with stratigraphical sections in other parts of the world (specifically Europe) (Luperto-Sinni and Masse, 1986; Mancinelli et al., 2003; Luperto-Sinni, 1979), a Barremian-
Aptian age is suggested for this stratigraphic section.

Also, according to the studies of thin-sections and identified taxa two regional biozones are described: 1) Montseciella arabica Range Zone, and 2) Orbitolina (Mesorbitolina) texana-Nezzazatinella picardi Assemblage Zone. The abundance of larger foraminifera indicates good oxygenation of the environment (Kaiho and Hasegawa, 1994). Furthermore, because of the high amount of benthic foraminifera and the low P/B (planktonic/benthic) ratio in the studied section, a low water depth for the environment also is suggested. This is confirmed by the presence of epifaunal and infaunal foraminifers, which are found together in shallow environments (Corliss and Chen, 1988) and also by the presence of algae, also living in shallow, high light, and well aerated environments (Flugel, 1982).
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