FORAMINIFERA AND AGE OF THE ARAEJ FORMATION IN THE DUKHAN OIL FIELD, WESTERN QATAR
ARABIAN GULF

By

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Mحتوى الفورامينيفرا ومناقشة عمر تكوين العريج في حقل بترول دخان - غرب قطر

عبد الجليل عبد الحميد هويدي و حمد عبد الرحمن آل سعد

The detailed examination of the three members of the Araej Formation (lower Araej, Uwainat and upper Araej) in four wells, in the Dukhan Field, led to the identification of 36 foraminiferal species. Of these, 29 species belong to the arenaceous Suborder Textularina. This fauna enable to subdivide the Araej Formation into five zones. The lower three zones are: the Ammodiscus orbis Zone in the lower half of the lower Araej member, the Pfenderina trochoidea Zone in the upper half of the lower Araej Member and the lower part of the Uwainat Member and the Trocholina intermedia Zone in the upper part of the Uwainat Member. These zones are of Bathonian age. The upper Araej Member includes a lower barren interval and an upper Kurnubia jurassica Zone. The upper Araej Member is considered to be of Callovian age. The distribution of the genus Pfenderina is largely controlled by sedimentary facies. It seems that members of the Suborder Lagenerina never occur with Pfenderina in Middle Jurassic sediments of the Middle East. A correlation between the established zones and their equivalents in the surrounding regions is attempted.

INTRODUCTION

The Dukhan field is the only major oil field in onshore Qatar which is located on the western side of the Qatar Peninsula (Fig. 1). The Middle Jurassic, in Dukhan Field, is represented by the Izhara and Araej formations. The Araej formation comprises one of the main oil producing horizons in the Dukhan Field. The middle carbonate part, the Uwainat Member, includes the major hydrocarbon accumulations within the Araej Formation.

Publications on the Araej Formation especially on its faunal content are scarce. (Smout & Sugden, 1961) used mainly the foraminifera collected from the boreholes of the Araej Formation of Qatar to introduce their new Family Pfenderinidae and identify the new species Pfenderina trochoidea. (Sugden &
Standing, 1975) mentioned a list of fossils of which only nine species of foraminifera were recorded, in addition to a number of simple arenaceous foraminifera, in the Uwainat Member, which had not been determined specifically. They correlated the Araej Formation in Qatar with the middle and upper Dhruma Formation and assigned the Araej Formation to the Bathonian/Callovian. Based on the studies of (Imlay, 1970), they put the boundary between the Bathonian and Callovian at the boundary between the lower Araej and the Uwainat members. The faunal content and age of the Dhruma Formation of Saudi Arabia, which is partly equivalent to the Araej Formation of Qatar, were studied by Redmond, (1964, 1965), Powers et al (1966); and Powers, (1968).

The Araej Formation is characterized by cyclic shallow carbonate deposits which include three members: lower Araej, Uwainat and upper Araej. The lithofacies and depositional setting of these members were studied in detail by Al-Saad et al. (in prep).

This paper is the first detailed study of the foraminiferal faunas of the Araej Formation and their biostratigraphic importance. 95 core samples from 4 wells in the Dukhan oil field were selected as representatives of the different lithofacies of the Araej Formation (Fig. 1). A representative of each sample, in addition to thin sections, was prepared for the micropaleontological study.

Fig. 1: Location map of Dukhan Oil Field, West Qatar.

**Faunal content:**

In the study area, thirty-six species of foraminifera were identified in the Araej Formation. These microfaunas are restricted to some horizons of the formation and are always rare except in some samples of the Uwainat Member.

According to the classification of Loeblich and Tappan (1988), 28 species of the identified fauna belong to the Suborder Textulariina (Delage & Herouard, 1896), 4 species to the Suborder Involutinina (Hohenegger & Piller, 1977), 3 species to the Suborder Milolinia (Delage & Herouard, 1896) and one species to the Suborder Robertinina (Loeblich & Tappan, 1984) (Table 1).

The thirty-seven species identified in the Araej Formation are placed into 16 genera (Table 1). A brief description of the more diverse and the stratigraphically important genera is given below:

**Genus Riyadhella Redmond, 1965**

The genus *Riyadhella* was introduced by Redmond, (1965) from the Bathonian/Callovian middle and upper Dhruma Formation in Saudi Arabia. He identified 8 new species of this genus. These species were distinguished mainly by the size of the test, the number of the chambers per whorl and the general shape of the chamber. The genus *Riyadhella* is recorded out side of Saudi Arabia only in West India (in Loeblich & Tappan, 1988). In Qatar, six species of this genus are recorded in the Uwainat Member (pl. 1) whereas rare occurrences are recorded in the upper and lower Araej members (Fig. 2).

![Fig. 2: Distribution chart of the identified foraminifera in the Araej Formation. (Not to scale).](image-url)

**Genus Pseudomarssonella Redmond, 1965**

The *Pseudomarssonella* was first recorded by Redmond (1965) from the Bathonian/Callovian middle and upper Dhruma Formation in Saudi Arabia. The *Pseudomarssonella* Redmond
Foraminifera and age of Araej formation

(1965) differs from the very similar genus Marssonalla Cushman, 1933 in having a cribrate aperture in place of a simple opening along the inner margin of the apertural face. This genus is recorded, in this study, for the first time in Qatar. Sugden & Standring, (1975) list a number of simple arenaceous fossils, in the Uwainat Member, which may include representatives of this genus. The elements of this genus in the Araej Formation are generally poorly preserved, but it was possible to distinguish 10 species of which 9 species were previously named by (Redmond, 1965), whereas one species is different from any described Pseudomarssonella species (pl. 3).

The main occurrence of the representatives of this genus is in the Uwainat Member, but it is rarely recorded in the lower and upper members (Fig. 2). In this study, a Bathonian/Callovian age is suggested for the representatives of this genus.

Genus Pfenderina Henson, 1948:

The genus Pfenderina was first named by Henson, (1948) with Eoropertia neocomiensis Pfender as its genotype. This genus is distinguished from any other genus of the subfamily Pfenderininae Smout & Sugden, (1962) by the absence of the subepidermal partitions.

In the beginning, it was classified in the family Trochammini dae. In 1961, Smout and Sugden studied in detail the genus Pfenderina and redescribed it based on isolated specimens for the first time. They also added their new species Pfenderina trochoidea. They erected the family Pfenderinidae Smout & Sugden, (1961) which includes Pfenderina and Kurnubia. They denoted that Pfenderina is recorded from the Berriasian/Valanginian in Europe, while it is recorded from older horizons, Bathonian, in the Middle East. Loeblich & Tappan, (1964)

Table 1

The foraminiferal species of the Araej Formation arranged according to their systematic position in the classification of the Loeblich & Tappan, (1988).

<table>
<thead>
<tr>
<th>Suborder</th>
<th>Superfamily</th>
<th>Family</th>
<th>Subfamily</th>
<th>Genus</th>
<th>Species</th>
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(Terquen, 1877)
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Contd. Table 1
The foraminiferal species of the Araej Formation arranged according to their systematic position in the classification of the Loeblich & Tappan, (1988)

<table>
<thead>
<tr>
<th>Suborder</th>
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<th>Species</th>
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considered them as a subfamily, Penderinidae Smout & Sugden, (1961), belonging to the family Pavoniniidae Loeblich & Tappan, (1961). Redmond, (1964) investigated a well-preserved material from Saudi Arabia and concluded that interior labyrinthic passages in the family Penderinidae Smout & Sugden, (1961), are outside rather than inside of the chamber cavities. He identified two new species of which P. inflata Redmond is the oldest known occurrence of this genus as it is recorded in Bajocian, lower Dhruma, sediments.

The distribution of the genus Penderina is largely restricted to clean, shallow marine limestone (Smout & Sugden, 1961). A relationship is also observed between Penderina and the occurrence of representatives of the Suborder Lagennina (Delage & Herouard, 1896). These relations can be illustrated with a comparison between East Arabia and North Egypt. In East Arabia, the Bathonian fauna are rich in Penderina while representatives of the Suborder Lagennina are completely absent. In contrast to North Egypt, where the Bathonian faunas are rich in representatives of the Suborder Lagennina as Nodosaria, Dentalina and Lenticulina while Penderina is completely absent. The other elements of the faunal assemblages are generally similar in both areas.

Genus Kurnubia Henson, 1948:

The genus Kurnubia was first identified by Henson, (1947) from the Jurassic limestone in the core of the Kurnub anticline in Palestine from where he also introduced Kurnubia palastiniensis at its genotype. Valvulinella jurassica Henson, (1948) was included in this genus by Smout & Sugden, (1961; Loeblich and Tappan, (1964). The genus Kurnubia ranges from the Oxfordian to the Valanginian (Smout & Sugden, 1961). Redmond, (1964) recorded Kurnubia variabilis in Callovian sediments in Arabia which is the oldest known representative of the genus Kurnubia.

In Egypt, the Kurnubia in general and Kurnubia jurassica in particular are recorded in Callovian sediments (Osman & Hassanein, 1961; Hassan et al., 1978; Abd El Shafy, 1981; Abd El Shafy, 1984). According to these authors, Ammodiscus orbis is a guide form for the lower part of the Egyptian Bathonian. Furthermore, this zone is equivalent to the Pseudomarssonella mcclurei and Dhrumella evoluta zones of early Bathonian age in Saudi Arabia (Powers, 1968).

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Table: Correlation between the Bathonian/Callovian foraminiferal zones in the Dukhan Field and its equivalents in Saudi Arabia.

Fig. 3: Correlation between the Bathonian/Callovian foraminiferal zones in the Dukhan Field and its equivalents in Saudi Arabia.

Biological stratigraphy

The identified foraminiferan faunas are used to subdivide the Araej Formation in the study area into five biostratigraphic zones. The lower three zones belong to the Bathonian while the uppermost one and the underlying barren interval belong to the Callovian. A brief description of these zones, from base to top, is given below:

1. *Ammodiscus orbis* Zone

In the studied sections, this zone is represented by nearly the lower half of the lower Araej Member, (Fig. 2). It includes the part of the Araej Formation below the first appearance of the genus *Penderina* and is composed of grey to dark pritic wackestone/packstone facies with foraminifera in some horizons. Thirteen foraminiferal species were recorded in this zone, of which 10 species belong to the Textulariina, 2 species belong to the Involutinina and one species belongs to the Robertinina.

*Ammodiscus orbis* (Lalicker, 1950) is selected as index for this zone since it is also used by many authors in the northern Egypt as a zonal marker (Hassan *et al*., 1978; Hassanein, 1970; Abd El Shafy, 1981; Abd El Shafy, 1984). According to these authors, *Ammodiscus orbis* is a guide form for the lower part of the Egyptian Bathonian. Furthermore, this zone is equivalent to the *Pseudomarssonella mcclurei* and *Dhrumella evoluta* zones of early Bathonian age in Saudi Arabia (Powers, 1968, Fig. 3). In the studied area, the *Ammodiscus orbis* Zone is considered to be of early Bathonian age.

2. *Penderina trochoidea* Zone

This zone represents the upper half of the lower Araej Member and the basal part of the Uwainat Member (Fig. 2). It corresponds to the total range of the genus *Penderina*. It is composed in its lower part by grey laminated shale with increased faunal content. Twenty foraminiferal species were recorded, of which 18 species belong to the Textulariina, one species belongs to the Involutinina and one species belongs to the Mioloilia. The *Penderina* Zone is a very characteristic horizon in the Middle East region from where many records of species of the genus *Penderina* were reported (Hudson, 1954; Smout & Sugden, 1961; James & Wynd, 1965; Powers *et al*., 1966; Powers, 1968 & Sampo, 1969).

Smout & Sugden, (1961) and Powers, (1968) considered the *Penderina trochoidea* Zone to be of Bathonian age. The genus...
Fig. 1: *Haplophragmoides barthouxi* Said & Barakat, Lower part of the Lower Araej Member, × 50. Fig. 2: *Nautiloculina circularis* (Said & Barakat), Lower Uwainat Member, × 50. Fig. 3: *Riyadhella inflata* Redmond, Lower Uwainat Member, × 75. Fig. 4: *Riyadhella intermedia* Redmond, Lower Uwainat Member, × 100. Fig. 5: *Riyadhella arabica* Redmond, Upper part of the Lower Araej Member, × 100. Fig. 6: *Riyadhella hemeri* Redmond, Upper part of the Lower Araej Member, × 100. Fig. 7: *Riyadhella sp.*, Middle Uwainat Member, × 100. Fig. 8: *Riyadhella rotundata* Redmond. Upper part of the Upper Araej Member, × 100. Fig. 9: *Verneuilinoides minuta* Said & Barakat, Lower part of the Lower Araej Member, × 100. Fig. 10: *Trocholina intermedia* Henson, Upper Uwainat Member, × 50. Fig. 11: *Trocholina conica* (Schlumberger), Middle part of the Upper Araej Member, × 50.
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PLATE 2

Fig. 1 & 2: Pfenderina trochoidea Smount & Sugden, Lower Uwainat Member, × 40. Fig. 3, 4 & 5: Pfenderina neocomiensis (Pfender), Upper part of the Lower Araej Member, 3 × 40; 4 & 5. × 25. Fig. 6: Pfenderina sp., Middle part of the Lower Araej Member, × 40. Fig. 7: Pseudopfenderina butterlini Brun, Middle part of the Lower Araej Member, × 40. Fig. 8: Kurnubia jurassica (Henson), Upper part of the Upper Araej Member, × 50. Fig. 9: Migros magharaensis (Said & Barakat), Upper Uwainat Member, × 75. Fig. 10: Valvulina sp., Middle Uwainat Member, × 75. Fig. 11. Riyadhella rotundata Redmond. Upper Uwainat Member, × 40.
PLATE 3

Fig. 1 & 2: Pseudomarssonella maxima Redmond, Middle Uwainat Member, × 75. Fig. 3: Pseudomarssonella inflata Redmond, Upper part of the Lower Araej Member, × 75. Fig. 4: Pseudomarssonella bipartita Redmond, Middle Uwainat Member, × 75. Fig. 5: Pseudomarssonella sp. Upper part of the Upper Araej Member, × 75. Fig. 6: Pseudomarssonella primitiva Redmond, Middle Uwainat Member, × 75. Fig. 7: Pseudomarssonella cf. mcleurei Redmond, Upper part of the Lower Araej Member, × 75. Fig. 8: Pseudomarssonella reflexa Redmond, Upper part of the Upper Araej Member, × 100. Fig. 9: Pseudomarssonella biangulata Redmond. Lower Uwainat Member, × 75. Fig. 10: Pseudomarssonella plicata Redmond, Middle Uwainat Member, × 75. Fig. 11: Pseudomarssonella media Redmond. Lower part of the Lower Araej Member, × 40.
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FIG. 1: Nautiloculina oolithica Mohler, Q1, Upper Araej Member, × 25. Fig. 4: Riyadhella sp. Q4, Uwainat Member, × 25. Fig. 5 & 6: Valvulinae, Q4, Uwainat Member, × 25.
Fig. 1: *Pseudopfenderina butterlini* Brun., Q1, Upper part of the Lower Araej Member, × 25. Fig. 2 & 3: *Pfenderina trochoidea* Smout & Sugden, Fig.: 2, Q4, Lower part of the Uwainat, × 25; Fig. 3: Q1, Middle part of the Lower Araej Member, × 100. Fig. 4: *Pfenderina neocomiensis* (Pfender), Q3, Lower part of the Uwainat Member, × 25. Fig. 5 & 6: *Pseudomarssonella sp.* Q4, Middle part of the Uwainat Member, × 25.
Foraminifera and age of Araej formation

PLATE 6

Fig. 1: Agathammina sp. Q4, Uwainat Member, × 25. Fig. 2: Trocholina conica (Schlumberger), Q4, Upper Araej Member, × 100. Fig. 3: Trocholina minuta Derin & Reiss, Q1, Lower Araej Member, × 25. Fig. 4: Trocholina palastiniensis Hensen, Q1, Upper Araej Member, × 25.
interval including the lower part of the upper Araej Member which is probably equivalent to the Callovian (Fig. 3).

Textularina, 2 to the Involutinina and 2 to the Miliolina. In the Invol)ltinina
Powers, (1968). However, it is attributed here to the early Member, and is associated with a dark grey, pyritic, argillaceous Bathonian
Zone is of early Callovian age. The
Zone of Powers, (1968) in Saudi Arabia. The Arabia (Fig. 3).

wackestone/packstone facies. In the study area, it is represented poor in foraminifera as only 9 species were recorded of which 7
study area, the of late Bathonian age. This zone is equivalent to the late Jurassic of the

This zone coincides with the upper part of the upper Araej Member, and is associated with a dark grey, pyritic, argillaceous wackestone/packstone facies. In the study area, it is represented by the total range of the zonal marker. This interval is generally poor in foraminifera as only 9 species were recorded of which 7 belong to the Suborder Textulariina and 2 to the Suborder Involuitinina (Fig. 2; Table 1).

This zone coincides with the upper part of the upper Araej Member, and is associated with a dark grey, pyritic, argillaceous wackestone/packstone facies. In the study area, it is represented by the total range of the zonal marker. This interval is generally poor in foraminifera as only 9 species were recorded of which 7 belong to the Suborder Textulariina and 2 to the Suborder Involuitinina (Fig. 2; Table 1).

In the study area, Kurnubia jurassica Henson, (1948) is the only and rather rare species of the genus Kurnubia which is rarely recorded. Kurnubia jurassica Henson, (1948) is widely distributed in the Callovian of the Middle East, (Henson, 1948; Powers et al 1966; Powers, 1968; Sampo, 1969; Abd El Shafy, 1984 & Abd El Shafy et al 1990). It is chosen here as a zonal marker. This zone is equivalent to the Kurnubia bran­kampi Zone of Powers, (1968) in Saudi Arabia. The Kurnubia jurassica Zone is of early Callovian age. It is underlain by a barren interval including the lower part of the upper Araej Member which is probably equivalent to the Praekurnubia crusi Zone of Powers, (1968). However, it is attributed here to the early Callovian (Fig. 3).

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