Islamic Azad University
Mashhad Branch

Microbiostratigraphy of the Oligo-Miocene Asmari Formation, Kuh Siah Anticline (Izeh Basin), SW Iran

Iraj Maghfouri Moghaddam*[1], Zahra Khanjai [1]

1. Department of Geology, Faculty of Sciences, Lurestan University, Khorram Abad, Iran
Received 24 January 2014; accepted 17 August 2014

Abstract

This research focusses on the biostratigraphy and paleoecological implications of the carbonatesof the Asmari Formation. The Asmari Formation is located in the Siah Kuhanticline of Izeh, Zagros Basin, SW Iran. It is of Late Oligocene (Chattian) - Early Miocene (Burdigalian) age. In this stratigraphic section, the Asmari Formation overlies the Pabdeh Formation and underlies the Gachsaran Formation. It consists of cream-colored limestone intercalated with marl. 182 thin sections were prepared and the benthic foraminifera distribution analyzed. Examination of large benthic foraminifera from the 228 m-thick Asmari Formation led to the identification of 3 biozones: the Lepidocyclina- Operculina- Ditrupa Assemblage Zone, Miogypsina-Elphidium sp. Assemblage Zone and the Borelis melocurdica- Meandropsina iranica Assemblage Zone.

Keywords: *Asmari Formation, microbiostratigraphy, Zagros Basin, Oligo- Miocene, SW Iran.*

1. Introduction

This study discusses the biostratigraphic framework of the Asmari Formation based on large benthic foraminifera. The study area is located in the north-western flank of the Siah Kuh anticline of Izeh in the Zagros Basin, 18 km northeast of Dehdasht in SW Iran, at 50° 33́ 15″ longitude and 30° 56́ 14″ latitude (Fig. 2). The Asmari Formation is one of the largest and most important oil reservoirs in the world and has been in use since 1908 [1, 2, and 3]. Recent studies show that interest is increasing in enhanced oil recovery methods that optimize production. One of the initial stages of this process is to obtain an improved understanding of a reservoir’s heterogeneities [4].

Lithologically, the Asmari Formation consists of limestone and marly limestone, anhydrite (Kalhur Member, Lurestan), lithic and limy sandstone (Ahwaz Member, southwestern Dezful Embayment) [5]. Its thickness and age vary within the Zagros Basin (Fig.1). According to Thomas [6, 7], it is chrono-stratigraphically divided into three units: the Lower Asmari of Oligocene age, the Middle Asmari of Aquitanian age and the Upper Asmari of Burdigalian age.

2. Methods

This research focusses on the micro biostratigraphy of the Asmari Formation based on the larger benthic foraminifera of the Siah Kuh anticline.

One hundred eighty two samples from the Asmari Formation in the selected stratigraphic section were studied. All rock samples and thin sections are housed in the Lurestan University Department of Geology. The foraminiferal biostratigraphy was based on the examination of thin sections. Classification was done according to the concepts of Loeblich and Tappan [9] while species determination was done using various sources [10, 11, 12, and 13]. The biostratigraphic framework of the Asmari Formation was introduced by Wynd [14] and revised by Adams & Bourgeois [15]. Recently, age determination using Sr dating was used to study the biozonation of the Asmari Formation throughout the Dezful Embayment (Fig.3). This determination is largely based on Laursen et al., [16].

3. Geological Setting

The Asmari Formation lies conformably on the deep facies of the Pabdeh Formation (Paleocene-Oligocene). Upper contact of the Asmari Formation with the Gachsaran Formation is marked by an unconformity (Fig.5). The Zagros foreland basin extends approximately 1,800 km from eastern Turkey, through Kurdestan and SW Iran, to the Oman Sea (Stocklin 1968). The Zagros Mountain Belt is divided into several zones (Fig.4) that differ according to their structural style and sedimentary history. They include the Thrust Zone, Lurestan, Izeh, Abadan Plain, Dezful Embayment, Fars and Bandar Abbas Hinterland [17].

----

*Corresponding author.
E-mail address (es): irajmmms@yahoo.co.uk

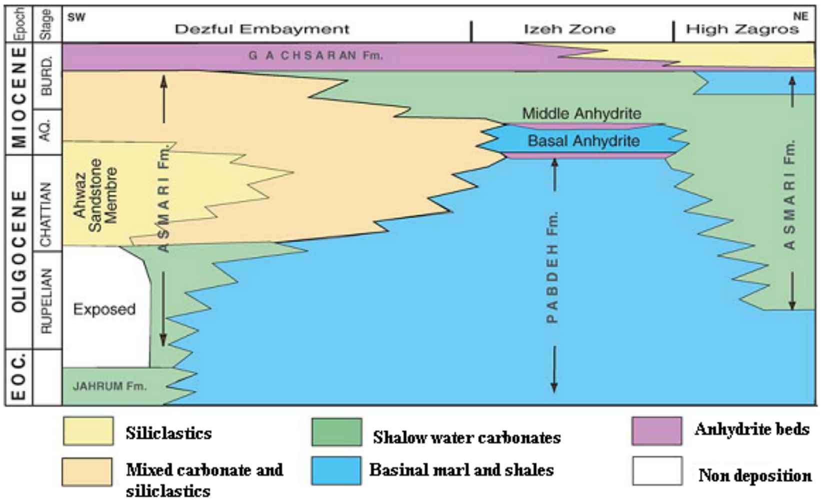


Fig. 1: Schematic section showing the stratigraphic position of the Asmari Formation within the Cenozoic rocks of the Zagros Basin [8].

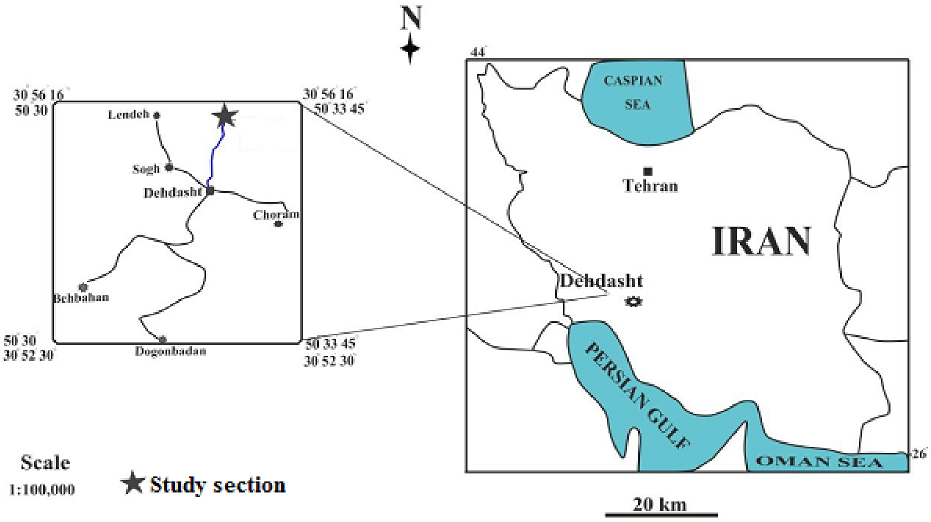


Fig. 2: Location of study in northeastern Dehdasht, SW Iran.

Epoch	Stage	Wynd(1965) Non	Wynd(1965) Biozone	Adams & Bourgeois(1967) Non	Adams & Bourgeois(1967) Assemblage Zone	Laursen et al., (2009) Non	Laursen et al., (2009) Biozone
Miocene	Bordigalian	61	Borelis melo curdica	1	Borelis melo group Meandropsina iranica	1	Borelis melo curdica - Borelis melo melo
	Aquitanian	59	Austrotrilina howchini - Peneroplis evolutus	2	Miogypsinoides - Archaias - Valvulinid sp.1	2	Elphidium sp. 14 - Miogypsina - Peneroplis farsensis; Indeterminate
				2a	Elphidium sp. 14 - Miogypsina		
				2b	Archaias asmaricus - Archaias hensoni		
Oligocene	Chattian	58	Archaias operculiniformis	3	Eulepidina - Nephrolepidina - Nummlites	3	Archaias asmaricus - Archaias hensoni - Miogypsinoides complanatus; Lepidocyclina - Operculina - Ditrupa
		57	Nummulites intermedius - Nummulites vascus				
	Rupelian	56	Lepidocyclina - Operculina - Ditrupa	4	Globigerina spp.	4	Nummulites vascus - Nummlites fichteli; Globigerina - Turborotlia cerroazulensis Hantkenina
		55	Globigerina spp.				

Fig. 3: Comparison of Asmari biozones according to Wynd[14], Adams and Bourgeous [15] and Laursen [16].

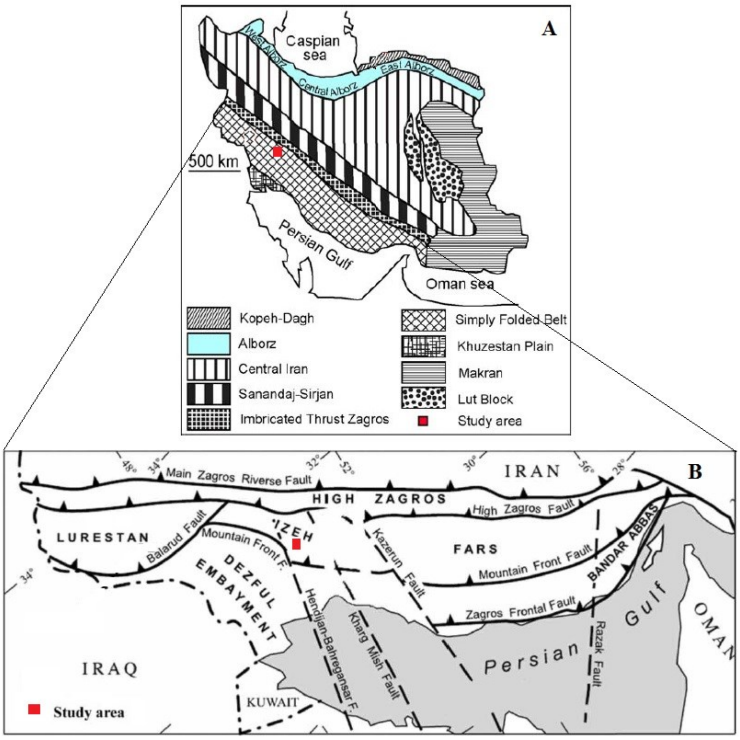


Fig. 4: (A) General tectonic map of Iran showing the subdivision of tecto-sedimentary deposits after [17] shows folded Zagros basin and area under study (B) Structural subdivision of Zagros Basin [18].

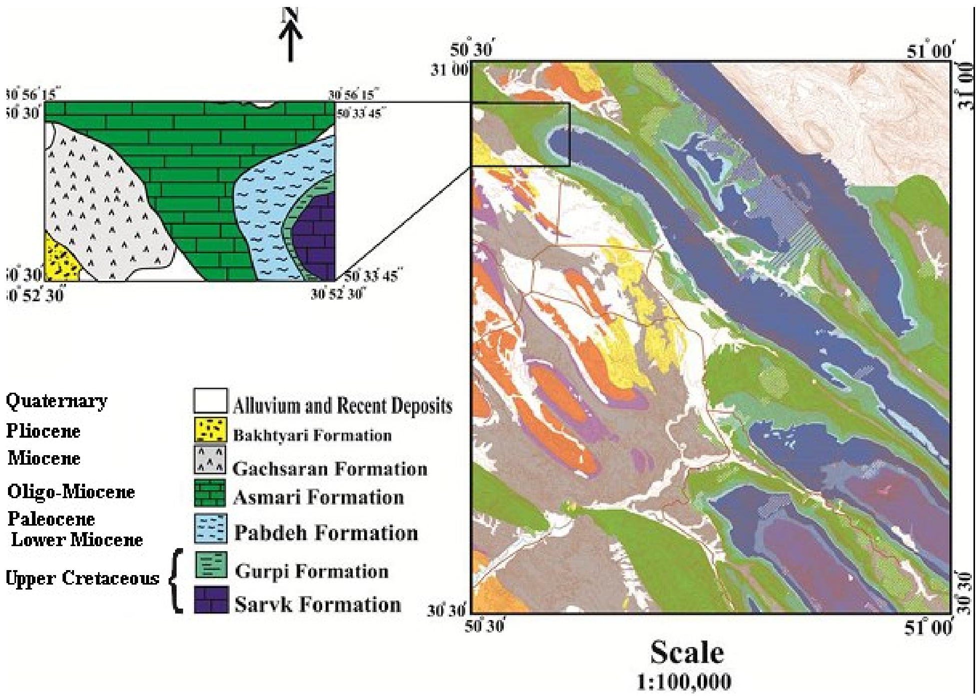


Fig. 5: Simplified geologic map of the studied area adopted from NIOC 1/100,000 scale geologic map, modified after [19].

4. Biostratigraphy

Larger benthic foraminifera are widely distributed in the Tertiary carbonate platform of the Asmari Formation. They developed complicated internal structures that are identifiable when sliced into thin sections [20]. These organisms can provide detailed information for the biostratigraphic analysis of the shelf limestone because of their rapid diversification, abrupt extinction and abundance [20]. Three assemblages of foraminifera were documented in the studied area and are discussed in ascending stratigraphic order as follows (Fig.6):

Assemblage 1: This assemblage occurs at the base of the Asmari Formation upward to 37.5m. The most frequent foraminifera are: Globigerina sp., Bigerina sp., Haplophragmium sp., Uvigerina sp., Polymorphina sp., Spiroclypeus sp., Spherogypsina sp., Lenticulina sp., Operculina sp., Textularia sp., Praerhapydionina sp. and Nepherolepidina sp.. They are frequently associated with the microfossils: Ditrupa sp. (annelid tube), Kufuas sp. (bivalve mollusk siphon), Onychocella sp., Tubucellaria sp. (bryozoan), Lithophyllum sp., Lithothamnium sp. (red algae), ostracoda, Bivalve mollusks(mollusca), gastropods and echinoderm fragments. Assemblage 1 correlates to the Oligo-Miocene biozones of the Zagros and the Lepidocyclina-Operculina–Ditrupa Assemblage Zone of Laursen et al., [16] and is of Chattian age.

Assemblage 2: This assemblage occurs in the middle portion of the Asmari Formation from 37.5 to 128m. The foraminifera and microfossils include: Miogypsina sp., Polymorphina sp., Elphidium sp., .Dendritina sp., Peneroplis thomasi, Meandropsins sp., Austrotrillina asmaricus, Discorbis sp., Tubucellaria sp. Lithophyllum sp., Lithothamnium sp., Favreina sp, (coprolith), ostracoda, bivalves, gastropods and coral fragments. This assemblage corresponds to the Miogypsina- Elphidium sp.14 Assemblage Zone, Laursen et al. [16] and is Aquitanian in age.

Assemblage 3: This assemblage is present in the upper part of the Asmari Formation from 128 to 228m and consists of Borels melo curdica, Borelis melo group, Meandropsins iranica, Ammonia beccarii, Neorotalia sp., polymorphina sp, Tubucellaria sp. Lithophyllum sp., Lithothamnium sp., ostracods, bivalves, gastropods, echinoderms and coral fragments. Assemblage 3 is an example of a Sr Assemblage Zone. It is of Burdigalian age [16] from the Zagros Mountains and central Iran [17].

5. Discussion

Prior to the use of strontium isotope stratigraphy, separation of Lower Oligocene (Rupelian) and Upper Oligocene (Chattian) strata in the Zagros Basin was impossible. Isotopic data indicates that the last occurrence of nummulites (in the Zagros) was located at the top of the Lower Oligocene [16]. Therefore, the Archeas asmariensis- A.hensoni- Miogypsinoides complanatus Assemblage Zone corresponds to the Upper Oligocene (Fig.3). The Globigerina-Turborotalia cerroazulensis- Hantkenina Assemblage Zone is comparable to the upper part of the Pabdeh Formation and the Nummulites vascus- N.intermedius Assemblage Zone in the deeper parts of the Zagros Basin (Fig.1).

At the early stage of the late Oligocene and the end stage of the Zagros Basin formation, benthic foraminifera (Lepidocyclina- Operculina – Ditrupa Assemblage Zone) replaced Pelagic foraminifera. Red algae such as Lithophylium sp., and Lithothamnium sp. as well as some hyaline benthic foraminifera such as Heterostegina, Operculina and Lepidocyclina, identified in the Asmari Formation samples, are indicators of a dysphotic zone. Bassi et al. [20] divided the photic zone into upper and lower parts. According to their classification, Neorotalia lived in the upper portion of the upper photic zone, while Operculina and Lepidocyclina were dominant in the lower portion of the upper photic zone with Lepidocyclina inhabiting the lower photic zone. The morphology of Operculina is a clue to the paleobathymetry; Hottinger [11] observed that modern day Operculina in the Gulf of Aqaba, Red Sea, showed increasing signs of compression at increasing water depths (Fig. 7 e-g). The strongly compressed forms illustrated in Figure 7 a-d indicate water depths of 50-100 meters below sea level. This flattening at increasing depths is seen in a number of both modern and fossilized foraminifera. It is presumed that as light penetration in seawater decreases with depth, a larger surface area is needed for photosynthetic symbionts to exit [23].

Because of the lack of equatorial sections, it was not possible to identify all Operculina in the studied section to a species level. However, their morphology suggests water depths of 50-100m (Fig.7i). Neorotalia sp. is abundant in the Miogypsina- Elphidium sp.14 Assemblage Zone. The presence of large Neorotalia is typical of an open marine platform condition with water depths of approximately 20-50 meters below sea level [24]. As the reduction in depth of the Miogypsina- Elphidium sp.14 Assemblage Zone and Borelis melo curdica Assemblage Zone continues, they spread across the Zagros Basin unlike those confined to the center.

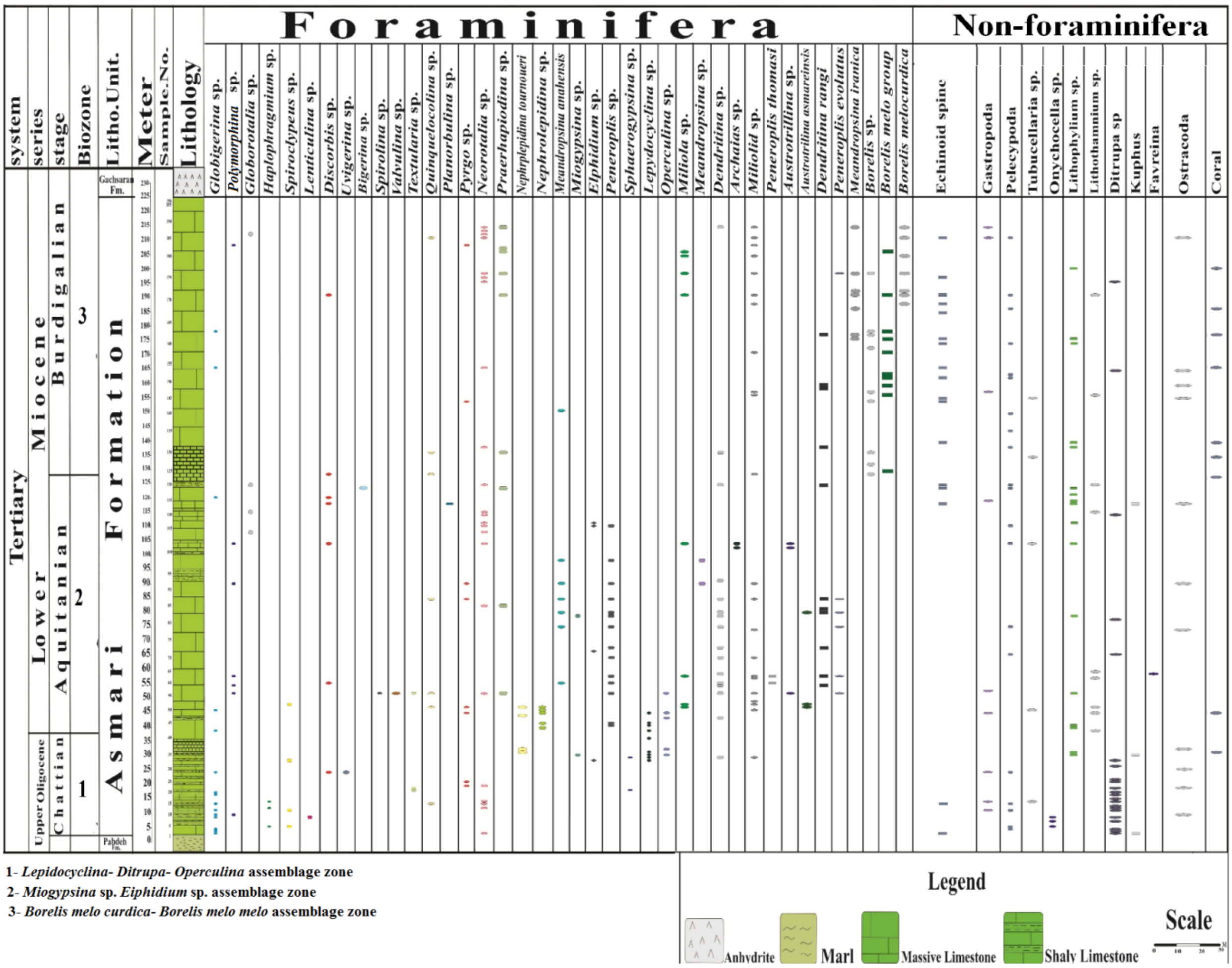


Fig. 6: Lithostratigraphic columns and vertical distribution of benthic foraminifera in studied stratigraphic section.

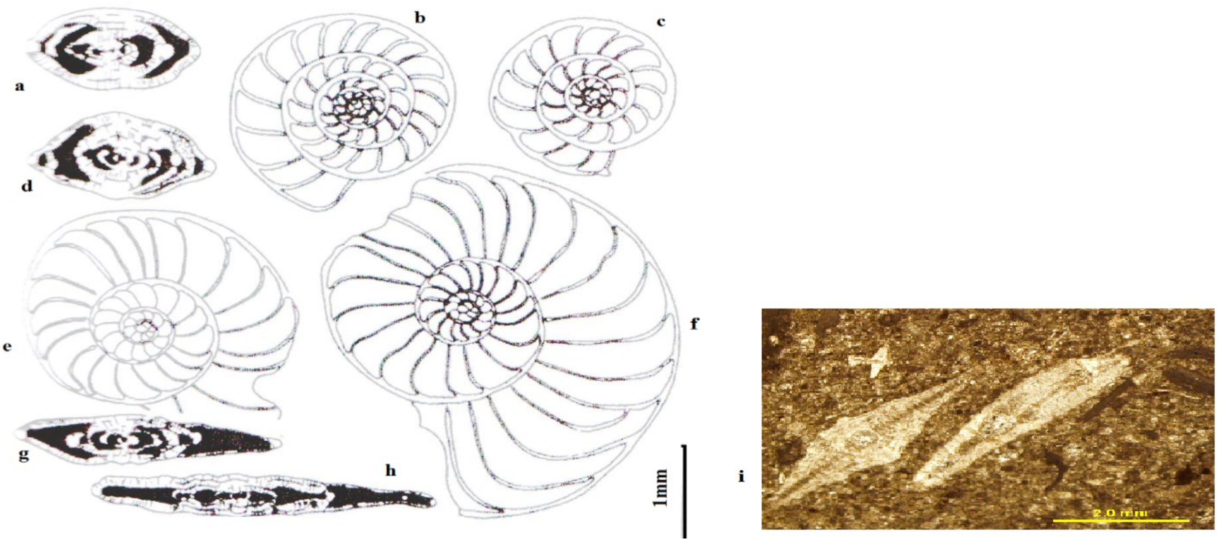
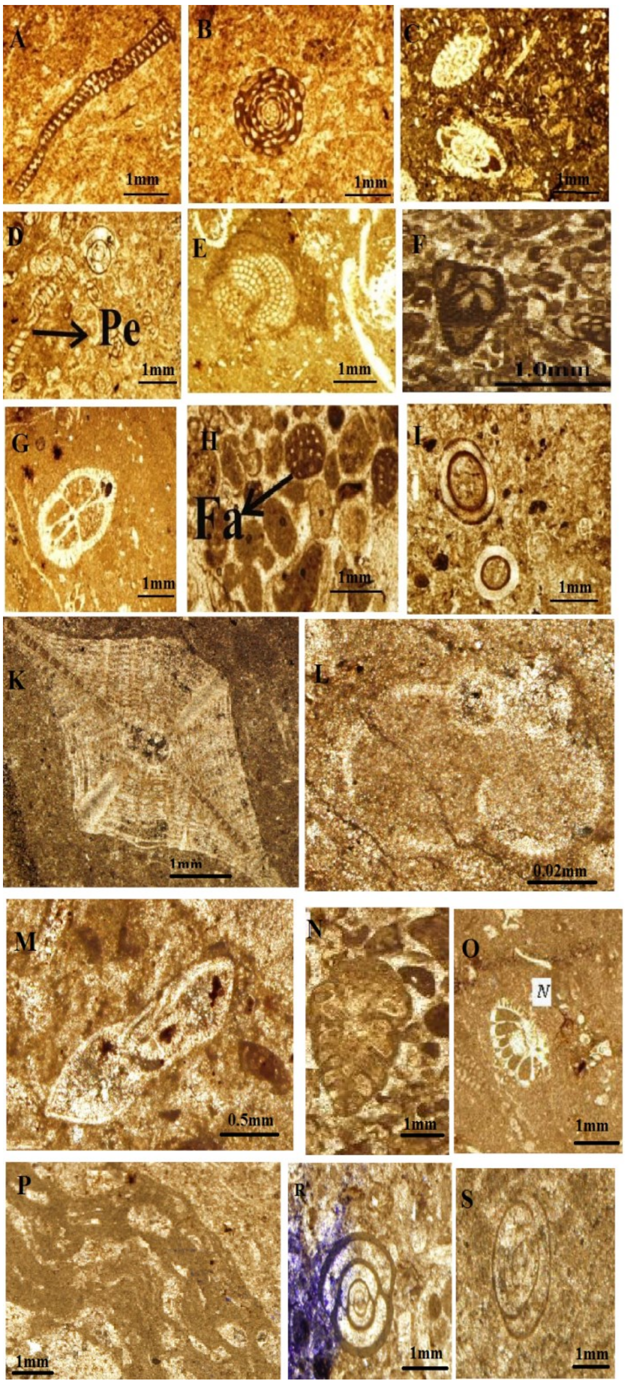


Fig.7: Variations in the morphology of *Operculina* with changes in water depth (after Reiss & Hottinger, 1984). Specimens a-d are from an average depth of 20-50m in the modern Gulf of Aqaba. Secimens e-g are from water depth of 50-100m. Sample 43, i (left): *Nephrolepidina* sp. i (right): *Operculina* sp..The quality of figures are acceptable for publishing .Figure should improved .

6. Conclusion

The stratigraphic section of the Asmari Formation in the Siah Kuh anticline of Izeh, Zagros Basin, SW Iran was studied in order to determine an accurate age. The Asmari Formation gradually overlies the Paleocene to Lower Oligocene Pabdeh Formation. Its upper boundary with the Gachsaran Formation is marked by a disconformity. Microfossil deposits from the studied sections of the Asmari Formation indicate a Late Oligocene (Chattian) to Early Miocene (Burdigalian) age. On the basis of the foraminifera recognized in the studied section, the Asmari Formation (upper portion of the lower depths) is comparable with the Lepidocyclina-Operculina-Ditrupa Assemblage Zone, Miogypsina- Elphidium sp.14 and Borealis melo curdica- Borelis melo melo Assemblage Zone. The paleoecological characteristics of the microfauna of the Asmari Formation in the Siah Kuh anticline show a shallowing of the water depth from the Late Oligocene (Chattian) to Early Miocene (Burdigalian).



Plate

A: Meandropsina iranica, sample No 188; B: Borelis melo curdica, sample No 124; C: Elphidium sp., sample No 34, D: Peneroplis evolutus , sample No 67; E: Archaias sp., sample No 102; F: Austrotrillina asmerinsis, sample No 51; G: Tubucellaria sp., sample No 102; H: Favreina sp., sample No 64; I: Ditrupa sp., sample No 2; K: Nepherolepidina sp. sample No 23; L: Globigerina sp. sample No 25; M: Uvigerina sp. sample No 26; N: Valvulina sp. sample No 25; O: Neorotalia sp., sample No 85; P: Lithothamnium sp., sample No 36; R: Pyrgo sp. sample No 51; O: Polymorphina sp., sample No 86.

References

[1] Beydoun, Z. R., 1991. Arabian plate hydrocarbon geology and potential a plate tectonic approach, A. A. A. P. G. NO 33.

[2] Edgell, H. S., 1996. Salt tectonics in Persian Gulf Basin, Geological Society of London, special publication, 100: 139- 15.

[3] Motiei, H., 1993. Stratigraphy of Zagros, In: Treatise of Geology of Iran, 1. Iran Geol. Surv., 559p.

[4] Van Buchem, F., Allen,T., 2006. The evolution of the Oligocene-Early Miocene mixed sedimentary system in the Dezful Embayment (SW Iran). GeoArabia Conference, Abstract, Geoarabia, 12(2), 202.

[5] Vaziri Moghaddam, H. Kimiagari, M., and Taheri, A., 2006. Depositional Environment and sequence stratigraphy of the Oligo-Miocene Asmari Formation in SW Iran, Springer Verlag,52, 41-51.

[6] Thomas, A.N., 1948. The Asmari Limestone of Southwest Iran. - AIOC Report No.705, Teheran, (Unpublished).

[7] Thomas, A.N., 1949. Tentative isopach map of the Upper Asmari Limestone of the Oligocene and Lower Miocene in Southwest Iran. - AIOC Report No.731, Teheran (Unpublished).

[8] Van Buchem, F.S.P., Allan, T.L., Laursen, G.V., Lotfpour, M., Moallemi, A., Monibi, S., Motiei, H., Pickard, N.A.H., Tahmasbi, A.R., Vedrenne, V., and Vincent, B., 2010. Regional stratigraphic architecture and reservoir types of the Oligo-Miocene deposits in the Dezful Embayment (Asmari and Pabdeh

Formations) SW Iran. In: van Buchem, F.S.P, Gerdes, K.D., and Esteban, M., (Eds.), Mesozoic and Cenozoic carbonate Systems of the Mediterranian and the Middle East: Sequence and Diagenetic Reference Models. Geological Society, London, Special Publication, 329, 219-263.

[9] Loeblich, A.R., and Tappan, J.H.,1988. Foraminiferal Genera and their Classification. Van Nostrand Reinhold. 2 vols. pls. 847. New York, 869 p.

[10] Rahaghi, A. 1983. Stratigraphy and faunal assemblage of Paleocene-Eocene in Iran ,N.I.O.C. pub., No.7, 161p.

[11] Hottinger, l., (1983). Processes determining the distribution of larger foraminifera in space and time, in Meulenkamp, J.E. (ed.), Reconstruction of marine paleoenvironments: Utrecht Micropaleontological Bulletin, 30, 239-253.

[12] Hottinger, l., (1997). Shallow benthic foraminifera assemblages as signals for depth of their deposition and their limitation, Bulletin de la Societe Geologique de France, 168(4), 491-505.

[13] Hottinger, l., (2000): Cenozoic of larger foraminifera, Micropaleontology, 46, 127–151.

[14] Wynd, J., 1965. Biofacies of the Iranian Consortium agreement Area, Iranian Oil Corporation Companies, Geological and Exploration Division, unpublished.

[15] Adams, T. D., and Bourgeois,F., 1967. Asmari biostratigraphy, Geological and Exploration", IOOC, Report no. 1074, (Unpublished).

[16] Laursen, G. V. Monibi, S. Allan, T. L. Pickard, N. A. Hosseiney, A. Vincent, B. Hamon, Y. Van-Buchem, F. S. P. Moallemi, A. Druillion, G. 2009. The Asmari Formation Revisited: Changed Stratigraphic Allocation and New Biozonation", First International Petroleum Conference & Exhibition, Shiraz, EAGE.

[17 Daneshian, J., and Ramezani Dana, L. 2007. Early Miocene Bentic Foraminifera and biostratigraphy of the Qom Formation, DehNamak,Central Iran ,Journal of Asian Earth sciences 29:844-858.

[18] Stocklin, J., 1968. Structural history and tectonics of Iran: a review. Am. Assoc. Pet. Geol. Bull, 52: 1229–1258.

[19] Sherkaty, S., and Letouzey, J., 2004. Variation of structural style and basin evolution in the central Zagros (Izeh zone and Dezful Beltl Iran): Marine and petroleum Geology, 21(5): 35-554.

[20] Liewellen, P. G. (972. Geological map of Ddehdasht, Scale 1:100 000. N. I. O. C.

[21] Beavington-Penney, S. J., and Racey, A., 2004. Ecology of extant nummulitids and other larger benthic foraminifera application in paleoenvironmental analysis, Earth Science Review,67 (3-4), 219-265.

[22] Bassi, D., Hottinger, L. and Nebelsick, H., 2007. Larger Foraminifera from the Upper Oligocene of the Venetian area, northeast Italy: Palaeontology, 5(4), 845-868.

[23] Simmons, M.,2002. Biostratigraphy & Sequence stratigraphy of the Oligocene- Miocene Asmari Formation, Bibi Hakimeh Field, Zagros Folded Belt,Iran. Caspian Report, 74p.

[24] Murray, J.W., 1991. Ecology and distribution of benthic foraminifera, In: Lee, J.J., Anderson, O.R. (Eds), Biology of Foraminifera. Academic Press, New York, 221–224.