Sedimentary facies and sequence stratigraphy of the Asmari Formation at Tange – Arabi,Zagros Basin, Iran

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Abstract

The Oligocene – Miocene ASMARI formation of the Zagros Basin is a thick sequence of shallow water carbonate. In the study area, it is subdivided into 9 microfacies that are distinguished on the basin of their depositional texture and fauna. Based on the paleoecology and lithology ,four distinct depositional settings can be recognized: tidal flat, lagoon, barrier, and open marine. The Asmari Formation represents sedimentation on a carbonate Shelf. two third-order depositional sequences are recognized from deepening and shallowing trends in the depositional facies. Changes in cycle stacking patterns, and sequence boundary features.

Keywords: *Asmari Formation ; Sequence stratigraphy; Larger benthic foraminifers; Shelf; Iran; Oligocene*

1. Introduction

The Asmari Formation is part of the Tertiary deposits(Oligo–Miocene) of southwest Iran. Lithologically, the Asmari Formation at the type section consists of 180m of mainly limestones, dolomitic limestones, and argillaceouslimestones (Motiei, 1993). It was deposited on a carbonate platform developed across the Zagros Basin (Fig. 1). Little work has been done on the effects of relative sea level changes during deposition of the Oligo–Miocene carbonate sediments in the Zagros Basin. The main objectives of this paper are to (1) describe and interpret the depositional environments represented by the Asmari Formation and(2) describe and interpret the origin of sequences that developed in the study area mainly based on the distribution of the foraminifera.

2. Methods and study area

This study involves one stratigraphic section from the Asmari Formation that was measured bed by bed andinvestigated sedimentologically. The rocks were classified in the field using a hand lens and their depositional fabricdescribed (Dunham, 1962), followed by sampling for thin section analysis. More than 97 thin sections were examined.Some samples from the underlying Pabdeh Formation were also analysed for comparison. The study area is located at Tange- Arabi about 13km northwest to Khormouj in southwest Iran . The section was meseared in detail at 28˚44́_N, 51°21_E.

3. Facies description and depositional environment

The primary depositional features discernible in thin sections,including textures, icrofossils, and sedimentary structures, have allowed the recognition of 9 facies. Systematic sampling and field observation at the study areashow that the lowermost outcrops of the Asmari Formation interfinger with the uppermost exposed layers of thePabdeh Formation (Oligocene). For comparison, some samples from the uppermost Pabdeh Formation have been studied as well.

3.1. Microfacies A1—plagic mudstone- wackstone (Pl. 1/1)

This facies is characterized by an association of pelagicforaminifera and fragments of molluscan shells. The texture is characterized a mudstone- packstone.The dominance of fine grained sediments, abundance of planktonic foraminifera and the lack of abraded detritus indicate a very low energy depositional environment, probably an outer slope environment.The low energy hydrodynamic character indicates deposition below the normal wave base (Wilson, 1975)

3.2. Microfacies A2—plagic, bioclast wackestone- packstone (Pl. 1/2)

These sediments contain sparse non-diagnostic fauna of ostracoda, pelagic foraminifera, and shell fragments. No sedimentary features indicative of shallow water or highenergy sedimentation were observed. The lime-mud dominated lithology, presence of pelagic foraminifera, and stratigraphic position indicate that deposition took place in a low energy deep water environment below storm wave base (Corda and Brandano, 2003).

3.3. Microfacies B1–bioclast grainstone (Pl. 1/3)

This facies is characterized by abundant corallinacean and coral. Other bioclasts are rare but include bryozoa and mollusca.The textures are grainstone.The depositional environment is interpreted as the upper part of a carbonate slope.

3.4. Microfacies B2–foraminifera, bioclast packstone–grainstone (Pl. 1/4)

The main bioclastic components are echinoidea, mollusca,bryozoa, and small benthic foraminifera. This facies has apackstone–grainstone texture. The features of these facies indicate moderate to high-energy shallow water conditionswith significant movement and reworking of bioclasts. Inaccordance with the standard microfacies types described by Wilson (1975) and Flugel (1982), microfacies B2 is interpretedas a shoal environment that was located at the platformmargin, separating the open-marine from the more restrictedmarine environment.

3.5. Microfacies C1—nummulitidae, pelagic foraminifera,bioclast wackestone-packstone (Pl. 1/5) This microfacies is composed of wackestone with pelagic foraminifera (globigerinids and globorotalids) and nummulitidae. This facies is characterized by the simultaneous occurrence of planktonic foraminifera and larger benthic foraminifera. The matrix is fine-grained micrite. This facies is distinguished from facies A by the presence of larger benthic foraminifera. The abundance of normal marine biota (larger benthic foraminifera with perforate walls) accompanied by pelagic foraminifera suggests a platform slope depositional setting between the normal wave base and the storm wave base for this microfacies. (Corda and Brandano, 2003; Romero et al., 2002). Similar sediments were reported from the deeper shelf by Geel (2000).

3.6. Microfacies C2—bioclast, nummulitidae wackestone–packstone (Pl. 1/6)

The predominate fauna are larger benthic foraminifera with perforate walls.the larger foraminifera, the nummulitidae are represented by Operculina, Heterostegina and Spiroclypeous. This microfacies has a fine grained matrix. This facies was deposited in a low-medium energy, open marine environment. This interpretation is supported by the abundance of typical open marine skeletal fauna including fiat and large nummulitidae, lepidocyclinidae, bryozoa, and echinoidea (Romero et al., 2002).The presence of large and flat foraminifera such aslepidocyclinidae and nummlitidae in comparison with analogues in the modern platform allowed us to interpret this facies as having been deposited in the lower photic zone.

3.7. Microfacies C3–bioclast, miliolids grainstone (Pl. 1/7)

This facies is composed of wackestone–packstone with micritic bioclastics. Skeletal grains include echinoid, nummulitidae(Operculina, Heterostegina and Spiroclypeus) and miliolids. The minor taxa are Austrotrillina, lepidocyclinidae. The occurrence of perforate benthic foraminifera and imperforate benthic foraminifera indicate that sedimentation took place in a shelf lagoon (Romero et al.,2002).

3.8. Microfacies C4–intraclast, miliolids, bioclast packstone–grainstone (Pl. 1/8)

The main biotic components consist of miliolids and echinoidea. Intraclasts are also present. Corallinacean and Miogypsinoides, and small benthic foraminifera are the minor elements.Textures refiect poorly sorted packstone–grainstone.Some of the grains have been partially micritized. Co-occurrence of normal marine bioclasts and lagoonal biota within traclasts suggest deposition at the lagoonal end of the platform margin (Hallock and Glenn, 1986).

3.9. Microfacies D–fenestrate mudstone (Pl. 1/9)

This microfacies consists of fine grained microcrystalline limestone. Bioclasts are lacking, fenestrate structures are well developed, and evaporate psuedomorphs are rare. fenestral structures are typical products of shrinkage and expansion, gas bubble formation, and airescape during flooding, or may even result from burrowing activity of worms or insects (Shinn, 1983). These vuggystructures are typical of a tidal flat zone .

4. Sedimentary model

The gradual transitions between lithofacies and biofacies types, and the depositional profile of the shelf transectin vestigated, indicate a very low gradient (Fig. 1). Owing to the generally similar morphology and hydrodynamic settingof shelf systems, the most appropriate model appears to be that of a very low-gradient, homoclinal carbonate shelf.

5. Sequence stratigraphy

The general vertical facies succession through the Asmari Formation and the stacking atterns and upward changes in the parasequences permit the identification of sequences andtheir component systems tracts within the succession.Sequence boundaries are the key to determine third-order depositional sequences and these boundaries are dependenton the evidence from vertical facies changes (Fig. 2).

5.1. Sequence 1

This sequence is 105.5 m thick and its facies associationscan be grouped into Transgressive and ighstandSystems Tracts. The basal part of a basinal facies is inter- preted as the Transgressive Systems Tract (TST) of the sequence 1 (Fig. 5).These sediments consist of marl with planktonic foraminiferaand, larger benthic foraminifera with perforated walls. Above this package, the strata show an increase indeeper water fauna and this bed is equivalent to the mfs.Wackestone and packstone with perforated larger benthic foraminifera overlie the mfs. The boundarybetween sequence 1 and sequence 2 is a type 2 of sequenceboundary (SB2), because the sequence boundary shows noclear evidence of subaerial exposure.

5.2. Sequence 2

The thickness of sequence 2 is nearly 75.5m. The lower part of sequence 2 (TST) consists of open shelf lagoon depositsthat are mostly characterized by the simultaneous occurrenceof both perforated and imperforated foraminifera.The upper part of sequence 2 (HST) is

composed oflimestone with imperforate foraminifera. This sequence is overlain by theGachsaran Formation of Middle Miocene age.

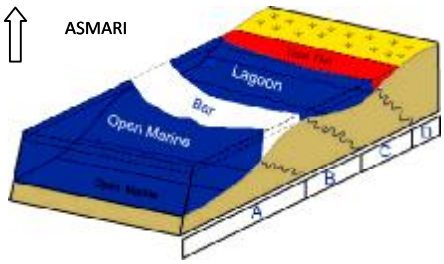

Fig. 1. Depositional model for the shelf carbonates of the Asmari Formation at Tange–Arabi area, Zagros

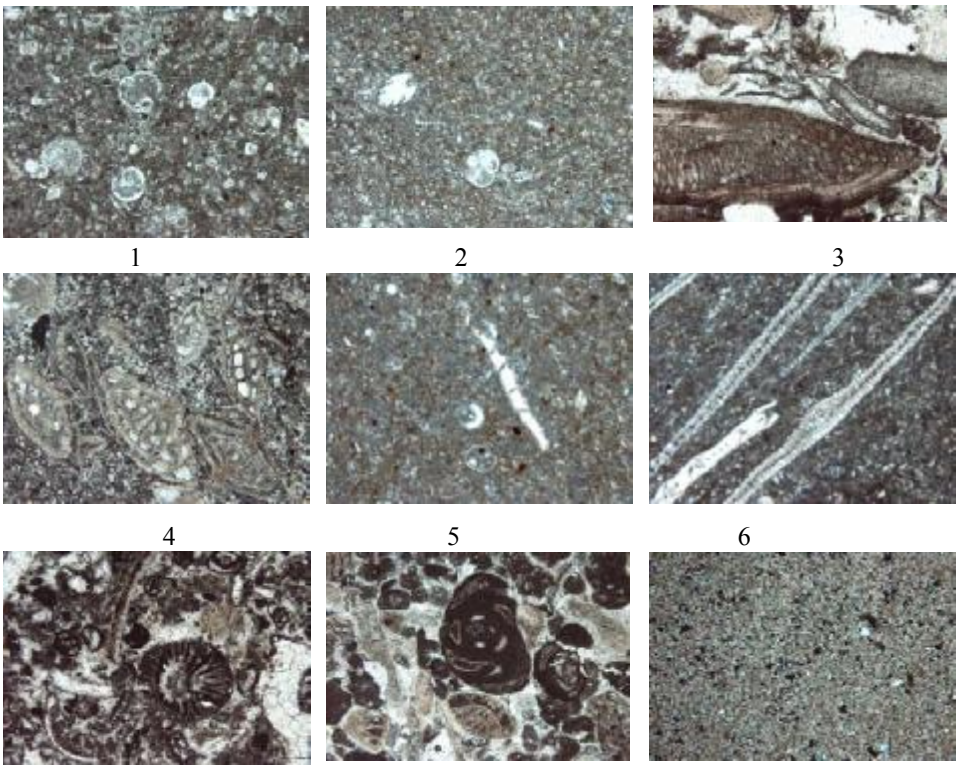

Plate 1.
Microfacies A1—plagic mudstone- wackstone (Pl. 1/1)
Microfacies A2—plagic, bioclast wackestone- packstone (Pl. 1/2)
Microfacies B1–bioclast grainstone (Pl. 1/3)
Microfacies B2–foraminifera, bioclast packstone–grainstone (Pl. 1/4)
Microfacies C1—nummulitidae, pelagic foraminifera,bioclast wackestone- packstone (Pl. 1/5)
Microfacies C2—bioclast, nummulitidae wackestone–packstone (Pl. 1/6)
Microfacies C3–bioclast, miliolids grainstone (Pl. 1/7)
Microfacies C4–intraclast, miliolids, bioclast packstone–grainstone (Pl. 1/8)
Microfacies D–fenestrate mudstone (Pl. 1/9)

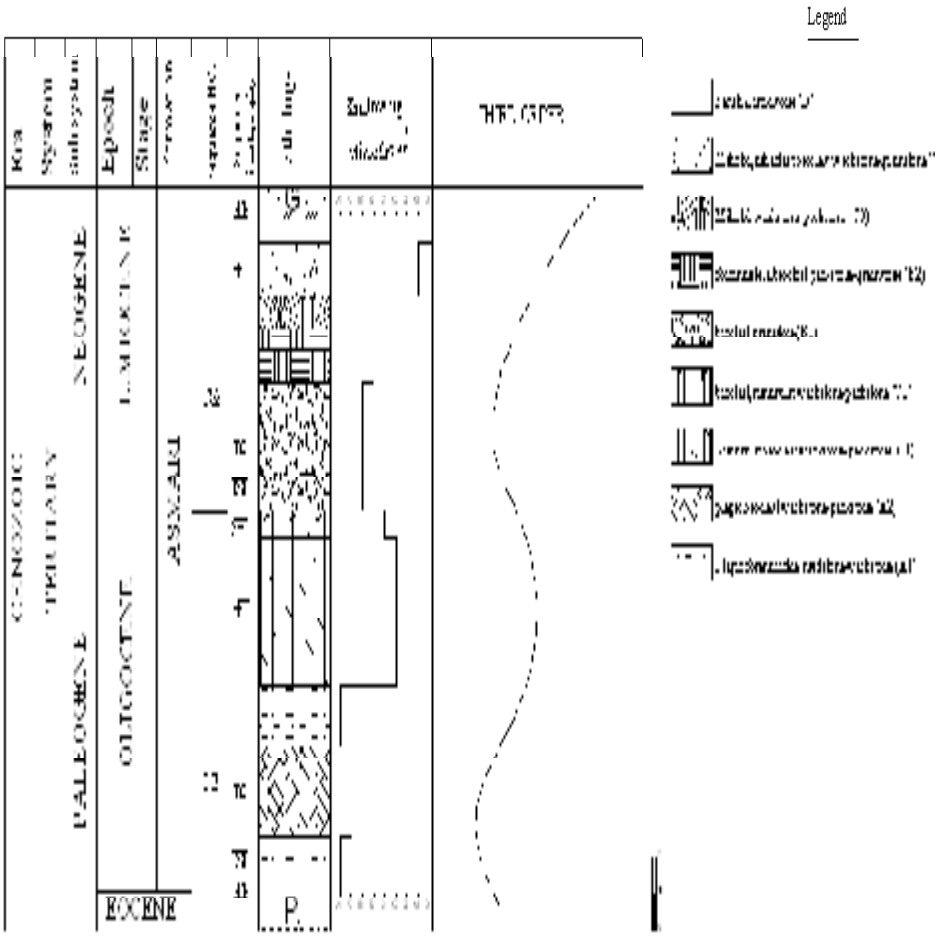

Fig2. Vertical facies distribution and sequences of the Asmari Formation at Tange–Arabi section, Zagros.