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Research paper

Benthic foraminifera as biostratigraphical and paleoecological indicators: An example from Oligo-Miocene deposits in the SW of Zagros basin, Iran

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ABSTRACT

The Asmari Formation is a predominantly carbonate lithostratigraphic unit that outcrops in the Zagros Basin. Micropaleontological studies of the Asmari Formation in the Dehdasht area led to the identification of 51 species of foraminifera taxa. Among the foraminifera, *Nummulites* cf. *vascus*, *Operculin* sp., *Operculina complanata*, *Eulepidina dilatata*, *Eulepidina elephantine*, *Ditrupa* sp., *Miogypsina* sp., *Elphidium* sp. 14, and *Borelis melo curdica* are the most important. The *Lepidocyclina-Operculina-Ditrupa* assemblage zone represents the Rupelian–Chattian age. The Aquitanian age is also defined by co-occurrence of *Miogypsina* sp. and *Elphidium* sp. 14, and finally, the first occurrence of *Borelis melo curdica* represents the Burdigalian. Based on faunal assemblages, the following paleoenvironmental settings are determined for the deposition of the study section: (1) the deep, offshore settings in the aphotic zone dominated by pelagic and small benthic foraminifera; (2) the low energy, turbid and low light parts of the oligophotic zone characterized by large and flat lepidocyclinids (*Eulepidina*) and Nummulitidae; (3) the low turbidity, deeper part of the inner ramp dominated by *Miogypsinoides*, *Neorotalia*, *Lepidocyclina*, *Operculina* and *Archias*; (4) the shallow, marginal marine environment exposed to salinity fluctuations (short-term salinity fluctuations or fully marine conditions) dominated by small benthic Foraminifera (*Ammonia* and *Elphidium*); (5) highly translucent, shallowest part of the inner ramp dominated by representatives of *Borelis*, *Meandropsina* and *Peneroplis*. The biotic assemblages represent warm tropical waters with oligotrophic to slightly mesotrophic conditions.

1. Introduction

In most carbonate depositional environments, the bulk of sediment consists of skeletal fragments produced by different types of organisms with particular ecological requirements (Meteu-Vicens et al., 2008). Oligocene carbonate platforms are characterized by the re-establishment of shallow water marine benthic communities following major change at the Eocene/Oligocene boundary (e.g. Berggren and Prothero, 1992; Ivany et al., 2000; Prothero, 2003). During the Neogene, large benthic foraminifera (LBF) were still active carbonate producers, though not as prolific as during the Eocene. *Heterostegina*, *Amphistegina*, *Cycloclypeus*, and *Lepidocyclina* are common in packstones and grainstones of the late Oligocene through Miocene (e.g., Chapronière, 1984; Betzler, 1997; Hallock et al., 2006). Coralline red algae increased in diversity during the Oligocene (e.g., Manker and Carter, 1987; Buxton and Pedley, 1989; Pedley, 1998; Rasser and Piller, 2004), especially the shallow, warm-water lithophylloid and mastophoroid taxa, exhibiting their greatest species richness (Aguirre et al., 2000) and globally becoming dominant carbonate producers (Halfar and Mutti, 2005) during the early and middle Miocene. Larger foraminifera have arisen many times in the geological record from ordinary-sized ancestors (Lee et al., 1979). Their appearance is often related to periods of global warming, relative drought, raised sea levels, expansion of tropical and subtropical habitats, and reduced oceanic circulation (Hallock and Glenn, 1986).

The main factor limiting the latitudinal distribution of symbiont-bearing foraminifera is temperature (e.g. Hottinger, 1983; Langer and Hottinger, 2000) because persistent

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temperatures below 14 °C in the winter months seem to hinder their survival. Larger foraminifera are thus restricted to the tropics with the exception of a few species that can also survive in the warm temperate zone (e.g. Betzler et al., 1997; Hohenegger, 2000; Langer and Hottinger, 2000). Further factors influencing the distribution of larger foraminifera are light intensity, water energy and substrate conditions (Hottinger, 1983; Bassi et al., 2007). LBF and corallinacean are the most important biotic assemblages in the Asmari Formation. In the present work, we use the foraminiferal assemblages to determine the age of the Asmari Formation from the studied region and to interpret the paleoenvironmental settings and paleoecological conditions.

2. Geological setting

The Zagros mountains are a fold and the thrust belt that extends from southeastern Turkey through northern Syria and Iraq to western and southern Iran (Alavi, 2004). This orogenic belt is situated in the middle part of the Alpine Range. This belt is considered to be a passive eastern margin of the Arabian Shield (Stocklin, 1968; Farhoudi, 1978; Berberian and King, 1981). The Zagros Basin was a part of the stable supercontinent of Gondwana in the Paleozoic, became a passive margin during the Mesozoic, and then a convergent orogen in the Cenozoic (Barhroudi and Koyi, 2004). The Zagros mountains consist of three zones: (1) the simply folded Zagros; (2) the imbricate thrust zone; (3) the Khuzestan Plain (Motiei, 1993). Based on the sedimentary history and structural style, Falcon (1961) divided the simply folded Zagros into several zones: Fars, Lurestan, the Dezful Embayment, the Izeh Zone, the Abadan Plain, the thrust zone, the Bandar Abbas Hinterland and the complex structure with metamorphic rocks (Fig. 1A). The study area is located at the southwestern flank of the Kuh-e Siah Anticline, next to the Zargham Abad Village, about 80 km northeast of Behbahan and 15 km north of Dehdasht. The section was measured in detail at 30°52′ N and 50°38′ E (Fig. 1B). The study area is located in the folded thrust zone of the Zagros Basin (Izeh Zone).

3. Materials and methods

Field observations were complemented with the petrographic examination of 157 thin sections for the identification of large benthic foraminifera and other skeletal components. The suprageneric classification of foraminifera mainly follows Loeblich and Tappan (1988) criteria. Large benthic foraminifera are photosymbiontic organisms (Leutenegger, 1984; Reiss and Hottinger, 1984) that require light, which restricts these taxa to live in the photic zone. Changes in foraminiferal assemblages can indicate fluctuations in light level, providing information valuable for interpretation of palaeoenvironments (Hallock and Glenn, 1986; Hottinger, 1997; Hohenegger et al., 1999).

4. Results

The Asmari Formation outcrops with 318 m thickness in the study area, and consists of thin to thick bedded and massive

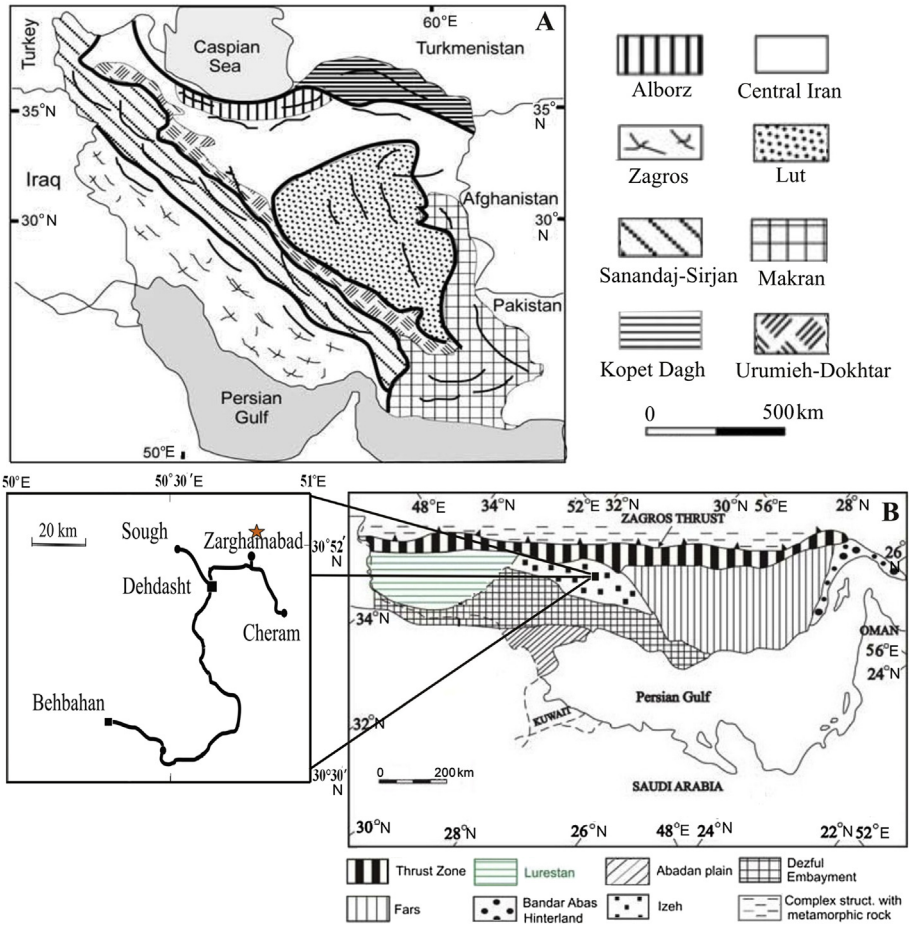

Figure 1. (A) General map of Iran showing eight geologic provinces. The study area is located in Zagros Province (adopted from Heydari et al., 2003). (B) Subdivisions of the simply folded Zagros belt (after Falcon, 1961).