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ORIGINAL ARTICLE

Microfacies and paleoenvironmental analysis of lower to middle eocene sediments, west of Tafresh

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Lower to Middle Eocene outcrops of Naqusan section, located in the northwest of Tafresh, with a thickness of 110 meters chiefly encompasses sandy-marly limestone and tuff along with a low percentage of sedimentary rocks such as sandstone. Microfacies studies led to the identification of six carbonate microfacies related to three facies belts (shoal, lagoon and open marine). The general palaeogeographic context of this system was a marginal marine shelf setting with an inner platform that was very flat, ramp-like, with little topography but with local depressions. Regarding extensive presence of large benthic foraminifera and some algae, the studied section probably have been deposited in tropical waters.
Keywords: Paleoenvironment; eocene; naqusan; Tafresh

Introduction

Fifty-five million years ago, the earth was subjected to a sudden climate change, it was one of the most extreme and abrupt warming events recorded in the geological history (Youssef & Taha., 2013). Sea surface temperatures rose between 5 and 8°C over a period of a few thousand years. This called the Paleocene-Eocene Thermal Maximum (PETM; initially Late Paleocene Thermal Maximum, LPTM, Zachos et al., 1993). The climatic changes affected biota on a global scale, triggering abrupt turnover of the benthic and planktonic organisms in the ocean (e.g., Kennet and Stott., 1991; Kelly et al., 1996; Speijer and Morsi., 2002; Youssef., 2003a, b). In recent years, numerous studies have been done on the Paleocene-Eocene ramp (Rasser *et al*., 2005; Racey et al., 2001).

Larger foraminifera are the most common constituents of late Paleocene-early Eocene carbonate platforms, and this group shows a diversification at a specific level, i.e., adult dimorphism and large shell size within the P-E transition (Hottinger, 1998). The warmer paleoclimate of Middle Eocene in comparison with Upper Eocene and Oligocene is confirmed by the size of Middle Eocene Nummulites species, which are larger in Eocene period (Hallock and Gelenn 1986, Hottinger, 1998).

The main aim of this research is evaluating the microfacies and paleoenvironment characteristics of Lower to Middle Eocene sediments of Naqusan section located in the northwest of Tafresh region. The study area is a part of the Urumieh-Dokhtar zone (UDZ) which contains the Eocene to Miocene rock units.

Lithologycally, the deposited rock units in this region started with a basal conglomerate which turned with a variety of volcanic lava and then continued by tuff, sandstone, marl and limestone. This general lithology is also common in other parts of Central Iran (CI) (Haijian, 1996). The studied section is located in the northwestern Tafresh city (approximately 6 km of southeast Naqusan) (Figure 1).

The planned location of the appraisal section as follow:

- Easting: Longitudes: 49˚ 56' 32.82"
- Northing: Latitudes: 34˚ 43' 4.48"

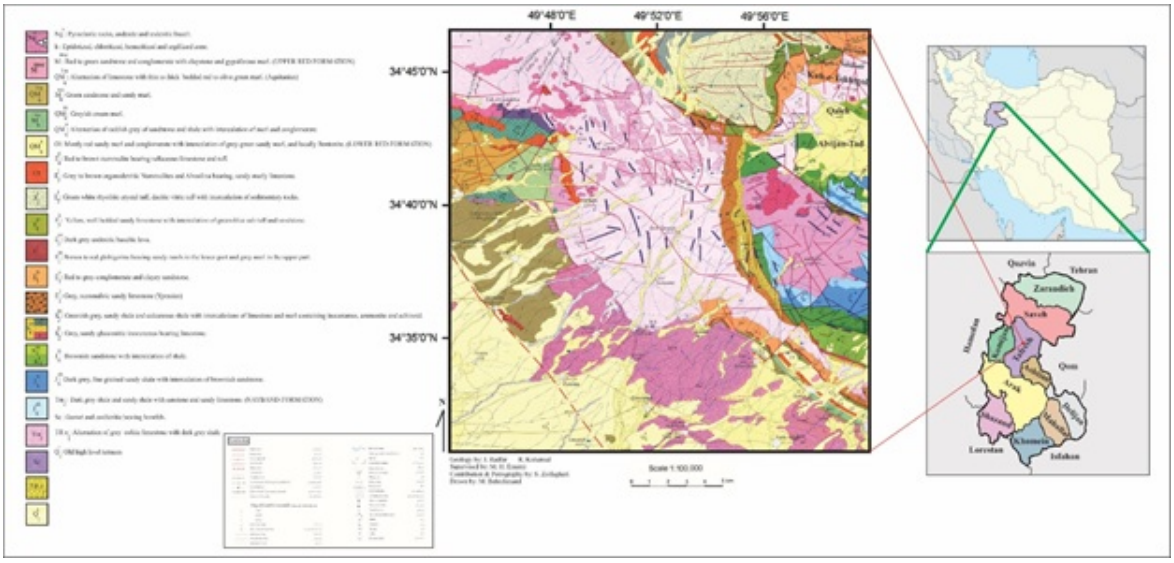

Figure 1. Simplified geological map of the studied area (Modified from Farmahin geology map (scale: 1:100000), Provided by the Geological Survey of Iran, 1981).

Materials and methods

Twenty-seven rock samples were collected from the Lower to Middle Eocene sediments at Naqusan section, northwest of Tafresh and prepared in the paleontology laboratory of the Department of Geology of the PNU University (Payam Noor University) of Markazi state. The microscope slides were investigated under a ZEISS Axioskop 4 light microscope. The slides are housed in the Geology Department of the Industrial University of Arak. For facies analysis, Dunham (1962) and Folk (1959) texture scheme was used together with sedimentary structures and fabrics, diagnostic allochems such as ooids, pelloids, oncoids and shells. In addition, for reconstruction of the depositional environments classification of Flugel (2010) was used. Also, the stratigraphic distribution of identified taxa is drawn and presented as Figure 2.

Discussion

The lithological units given below (from bottom to top) defined the stratigraphical features of studied sequence:

- Gray to green marly limestone with a very thin layering (approximately 3 meters).
- Gray sandy limestone included foraminifera (7 meters).
- Gray to green sandstone encompasses of echinoderms (6 meters).
- Light gray sandy tuff with a medium to thin layering which is an indicator of gradual alluvium sedimentation.

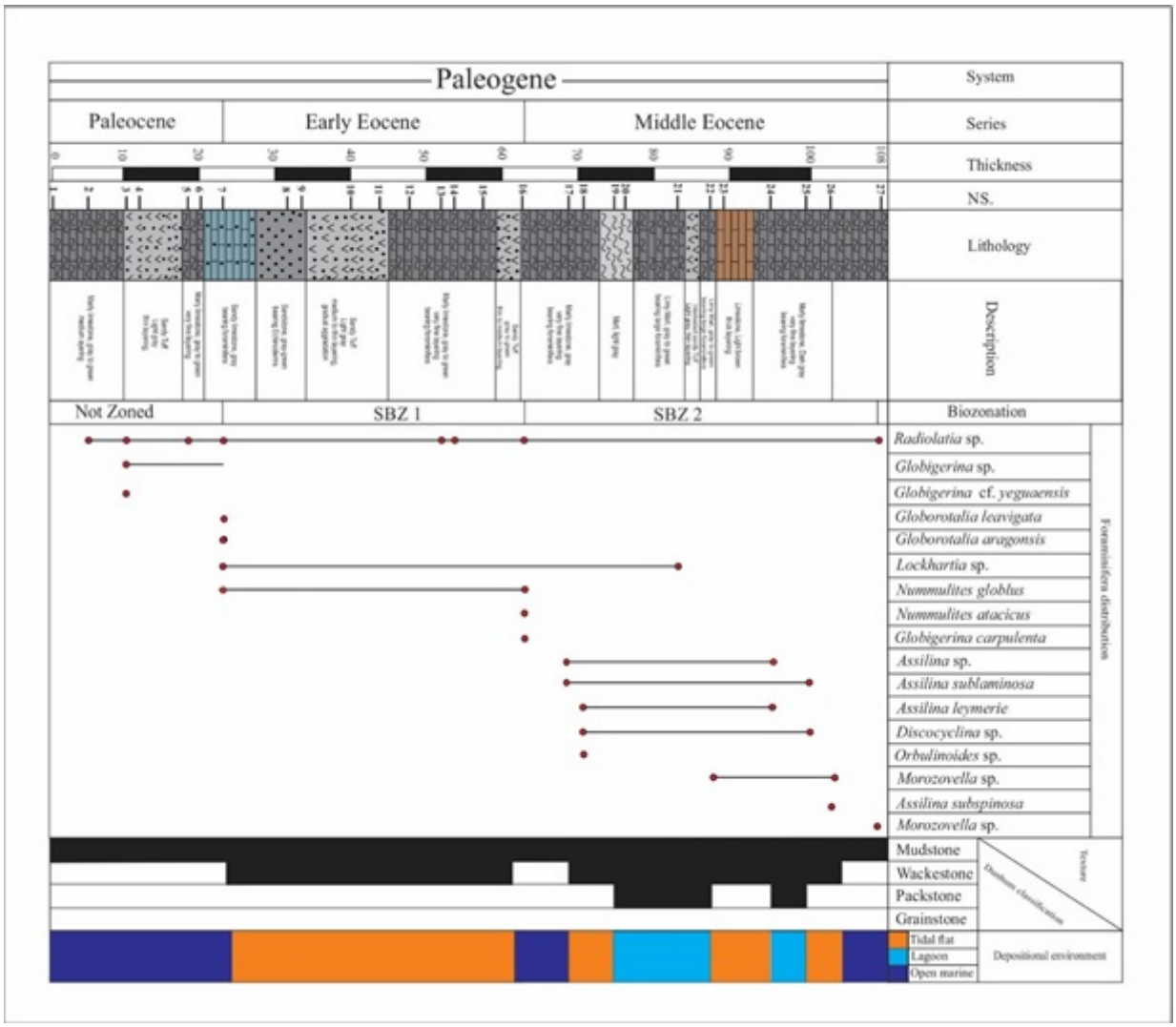

Figure 2. Stratigraphic column, Depositional environment, and facies types through the studied section.

- Gray to green marly limestone included large benthic foraminifera (5 meters).
- Marly limestone, sandy tuff and limy marl with a thickness of 15 meters comprised of large benthic foraminifera.
- Thick bedded light brown limestone included large benthic foraminifera (approximately 5 meters).
- Very thin dark gray marly limestone encompasses foraminifera (approximately 20 meters).

The facies described and interpreted have been classified in terms of overall depositional environment including: 1) shoal 2) lagoon and 3) open marine areas (Figures 2 and 3). In general, Palaeoenvironmental context of this system was a marginal marine shelf setting with an inner flat platform, ramp-like, as could be concluded from the microfacies differentiated. Six distinctive microfacies (MF1, MF2, MF3, MF4, MF5 and MF6) were characterized and differentiated by different texture and sedimentary environments. A summarized description of these microfacies is given below:

MF1: Planktonic foraminifera and radiolaria-rich wackestones to packstones
The microfacies is mainly characterized by pelagic foraminifers and radiolarian dispersed in a micritic mud.

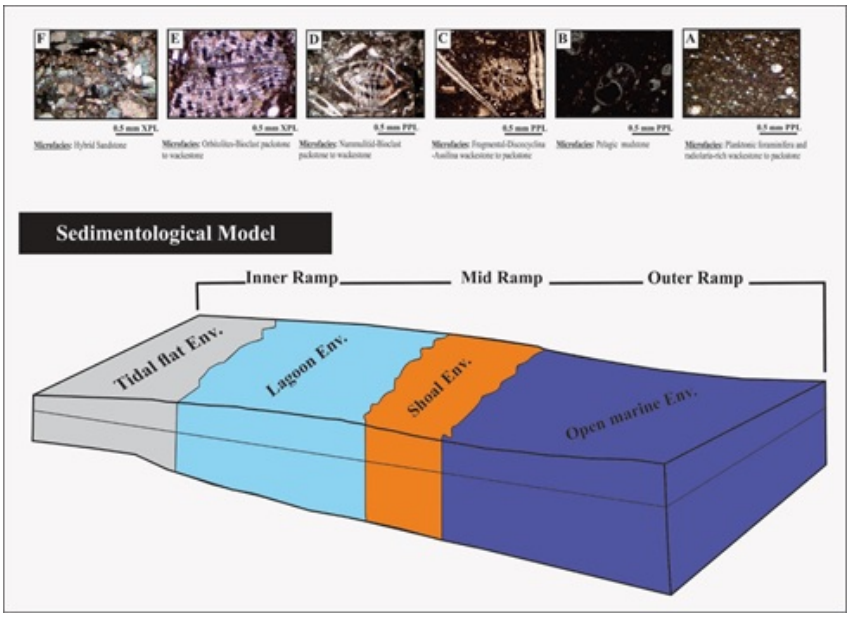

Figure 3. Conceptual depositional model for the studied interval (the Lower to Middle Eocene sediments) in the Naqusan section, northwest of Tafresh together with individual microfacies photographs.

Planktonic foraminifera and radiolaria-rich wackestones to packstones are interpreted as typical low-hydrodynamic deep water deposits of the lower mid- to outer ramp with no or minor terrigenous input. Beds with accumulated planktonic organisms indicate more condensed conditions or transient blooms. Clotted nests of planktonic foraminifera and radiolarians reflect bioturbation (e.g., Keheila and El-Ayyat, 1990; McBride et al., 1999).

MF2: Pelagic mudstone

This microfacies is essentially consisted of planktonic foraminifera and sponge spicules with the scattered echinoid fragments in a micritic context.

Based on the evidences of this micritic microfacies that indicate no widespread presence of fauna and the absence of photic organisms, it was deposited in deeper parts of carbonate ramp which reflects the highest sea levels throughout the studied stratigraphic section (Figure 3B). This environment is characterized by strongly varying oxygen levels, reduced circulation and low sedimentation rates (Koehrer et al., 2010). This microfacies type may correspond to RMF9 of Flugel (2010).

MF3: Fragmental-Discocyclina-Assilina wackestone-packstone

The microfacies contains a coarse to medium grain wackestone-packstone. The fossil content and high preservation are the most important features of this microfacies. The presence of various microfossils, such as echinoderms and nummulites, is an indicative for this microfacies and the fauna are characterized by foraminifers like, *Assilina* sp., *Discocyclina* sp. and *Operculina*. Based on the Loucks et al*.,* 1998 studies, long flated tests of the foraminifera *Discocyclina* considered to have been deposited in shallower waters than the nummulite-rich facies in the middle to outer ramp. Also, according to the fact that the foraminifera *Assilina* can be found in different environments, as larger long forms are more extensive on the sandy and muddy seafloors in a low energy setting (Scheibner *et al*., 2008). According to the mentioned evidences, this microfacies suggest deposition in an open marine environment (outer ramp) which is similar to the Geel, 2000 investigations who assigned this microfacies to the deeper waters where normally occupied by Assilina forms and shallower waters that Operculina forms are the inhabitants (Figure 3C).

MF4: Nummulitid-Bioclastic packstones

These deposits are mainly consisting of *large* lenticular forms of Nummulites sp. along with milliolids, green algae and pelloids in a muddy matrix. It is worth mentioning that *quartz grains* are *also present* to a *lesser extent*. Flat *Nummulites* usually are associated with large, flat '*Assilina*' and *Discocyclina* and proliferated on the seaward side of the shallow shelf and upper part of the deeper shelf (Geel, 2000). The recognized features can be reliable evidences to quoting a middle ramp depositional system to this microfacies. This is confirmed by Racey, 1994 who has investigated the Middle Eocene deposits of Oman region and assigned different types of Nummulites species along with Assilina and Discocyclina to the middle ramp sedimentary environment (Figure 3D).

MF5: Orbitolites-Bioclast packstone to wackestone

The microfacies consists predominantly of a high number of foraminifera orbitolites which has been enhanced in this microfacies. The biota is dominated by larger benthic foraminifera and some gastropods, ostracods, miliolids as well as Micsellanea which occurred in a mud-supported and micritic matrix. It had better be added that the mentioned grains have occasionally indicated a grain-supported form. Interpretation of the MF5 is based mainly on the relatively high-diverse fauna and this microfacies reflects the shallower part of the inner ramp in a lagoonal environment. Enhancement of ostracods,

gastropods and also extensive presence of pelloids and miliolids in a micritic facies occur in restricted environments of the inner ramp. Based on Baevington-Penne (2004) and Geel (2000), the microfacies included of orbitolites has been attributed to shallow marine environments of inner ramp, backreef and restricted areas (Figure 3E).

MF6: Hybrid sandstone

The microfacies comprises hybrid particles in size of sand grains which shows the increasing input of clastic sediments into the basin that can explain the subsidence of sea level and consequently intensification of the energy in the environment. Presence of clastic grains together with sparse intraclasts, bioclasts, foraminifers (like textularia) and vermiculite traces along with the type of microfacies texture, permit to reconstruct the inner ramp environments (Figure 3F).

Interpretation of sedimentary environment and depositional model of studied section

Regarding the survey conducted by this study, all the related microfacies have been identified precisely and named based on Dunham classification and eventually classified according to Flugel, 2010. As a result, 11 microfacies related to three facies belts have been identified which are related to shoal, lagoon and open marine depositional environments. Based on the aforementioned depositional facies, a depositional model was established for the studied section. According to this model, these sediments were deposited in a carbonate ramp (Figure 3). Additional evidences for this conclusion includes:

✓ Absence of slid/slump facies;
✓ The lack of turbidities facies;
✓ Absence of slope break facies.

Conclusion

The study area is a part of the Urumieh-Dokhtar zone (UDZ) which contains the Eocene to Miocene rock units. Based on paleoenvironmental studies on the Lower to Middle Eocene outcrops of Naqusan section, located in the northwest of Tafresh (nearly 110 meters), six principal microfacies (MF) have been identified on the thin sections. These microfacies have been interpreted in terms of depositional environment including: 1) Shoals, 2) Lagoon and 3) open marine. However, the general palaeogeographic context of this system was a marginal marine shelf setting with an inner platform that was very flat, ramp-like, with little topography but with local depressions. Regarding extensive presence of large benthic foraminifera and some algae, the studied section probably have been deposited in tropical waters.

References

Beavington-Penny, S. J., & Racey, A. (2004). Ecology of extant nummulitids and other larger benthic foraminifera application in Palaeonvivonmenta analysis: earthscience,V. 67, p, 219-265.

Flugel, E. (2010). Microfacies of Carbonate Rocks, Springer-Verlag, Berlin.

Folk, R.L. (1959). Practical petrographic classification of limestones: American Association of Petroleum Geologists Bulletin, v. 43, p. 1-38.

Geel, T. (2000). Recognition of stratigraphic sequences in carbonate platform and slope deposits: empirical models based on microfacies analysis of Palaeogene deposits in southeastern Spain. Palaeogeogr Palaeoclimatol Palaeoecol 155:211-238.

Hajian. (1997). Geology of Iran, Paleocene and Eocene in Iran.

Hallock, P., & Glenn E. C. (1986). Larger foraminifera: a tool for paleoenvironmental analysis of Cenozoic depositional facies. Palaios 1:55-64.

Höntzsch, S., Scheibner, C., Kuss, J., Marzouk, A. M., & Rasser, M. W. (2011). Tectonically driven carbonate ramp evolution at the southern Tethyan shelf: The Lower Eocene succession of the Galala Mountains, Egypt. Facies, 57(1), 51-72.

Hottinger, L. (1998). Shallow benthic foraminifera at the Paleocene-Eocene boundary. Strata 9:61-64.

Keheila, E. A., & El-Ayyat, A. A. M. (1990). Lower Eocene carbonate facies, environments and sedimentary cycles in Upper Egypt: evidence for global sea-level changes. Palaeogeogr Palaeoclimatol Palaeoecol 81:333-347.

Koehrer, B., Zeller, M., Aigner, T., Poeppelreiter, M., Milroy, P., Forke, H., & Al-Kindi, S., (2010). Facies and stratigraphic framework of a Khuff outcrop equivalent: Saiq and Mahil formations, Al Jabal al-Akhdar,Sultanate of Oman, Journal of GeoArabia, v. 15, no. 2, 2010, p. 91-156.

Loucks, R. G., Moody, R. T. J., Bellis, J. K., & Brown, A. A. (1998). Regional depositional setting and pore network systems of the El Garia Formation (Metlaoui Group, Lower Eocene), offshore Tunisia. In: Macgregor DS, Moody RTJ, Clark-Lowes DD (eds) Petroleum geology of North Africa. Geological Society Special Publication 132, pp 355-374.

McBride, E. F., Abdel-Wahab, A., El-Younsy, & A. R. M., (1999). Origin of spheroidal chert nodules, Drunka Formation (Lower Eocene), Egypt. Sedimentology 46:733-755.

Racey, A. (1994). Biostratigraphy and palaeobiogeographic significance of Tertiary nummulitids (Foraminifera) from northern Oman. In: Simmons MD (ed) Micropalaeontology and hydrocarbon exploration in the Middle East. Chapman and Hall, London, pp 343-367.

Racey, A., Bailey, H. W., Beckett, D., Gallagher, L. T., Hamfton, M. J. & Mcquilken, J. (2001). The petroleum geology of the Early Eocene El Garia Formation in the Hasdrubal Field, Offshore Tunisia. Journ. Petrol. Geol., 24(1), 29-53.

Rasser M. W, Scheibner C, & Mutti M. (2005). A paleoenvironmental standard section for Lower Ilerdian tropical carbonate factories (Pyrenees, Spain; Corbieres, France). Facies 51:217-232.

Scheibner, C., Speijer, R. P. (2008). Late Paleocene-early Eocene Tethyan carbonate platform evolution-a response to long- and short-term paleoclimatic change. Earth Sci Rev 90:71-102.
Schmidt, D. N., Renaud, S., & Bollman, J. (2003). Response of planktic foraminiferal size to late Quaternary climate change. Paleoceanography 18 (2), 1039. doi:10.1029/2002PA000831.

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