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RESEARCH PAPER

First Report of Ornatorotaliidae Family Representative species and Paleocene-Eocene Biostratigraphy in Hasan Abad section, southeast of Birjand, East of Iran

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Abstract
The present study aimed to investigate the biostratigraphic studies of Hasan Abad section (two sections), located in the southeast of Birjand in the east of Iran. The thickness of the first section of Hasan Abad is 74 meters and the second section is 62 meters thick including conglomerate, sandstone, calcareous sandstone, sandy limestone, limestone and nummulitic limestone. The base of these sections is overlaid on the ophiolites and their tops are eroded. In total, 21 genera and 29 species of benthic foraminifera were identified in the first section and four biozones were consequently determined. These biozones included the *Daviensina* sp. interval zone, *Alveolina ellipsoidalis* interval zone, *Nummulites globulus* interval zone and *Nummulites subramondi* interval zone. In the second section, 16 genera and 21 species were identified and three biozones were introduced based on the identified foraminifera, including *Kathina selveri* assemblage zone, *Alveolina ellipsoidalis* interval zone and *Nummulites globulus* interval zone. According to the identified biozones and foraminiferal assemblages, the age of the studied sequence was speculated to be the first section of Hasan Abad, Thanetian? - Early Cuisian and in the second section the Thanetian -Early Cuisian. Two new species of the Ornatorotaliidae family, *Granorotalia sublobata* and *Ornatorotalia granum*, are the first records from the east of Iran.

Keywords: Biostratigraphy, Benthic Foraminifera, Birjand, Iran, Paleocene- Eocene, Systematic.

Introduction

The structural units in Iran have been recognized by relatively unique information about stratigraphy, tectonics, organic events and magmatic activities. According to (Berberian & King 1981), these structural zones (units) are Zagros, Sanandaj-Sirjan, Central Iran, Koppeh Dagh, Alborz and the east of Iran (Figure 1).

The Sistan Ocean formed between Lut block in the west and Afghan block in the east during Early Cretaceous. In the Late Cretaceous the ocean started to closure and subducted beneath the Afghan block. Sistan Suture Zone (SSZ) exposes a well-preserved subduction zone complex (Tirrul et al., 1983).

The structural evolution of Sistan suture zone began in the Early Cretaceous period (Early Aptian) (Tirrul et al., 1983) and continued to develop until the end of the Eocene age. During the Paleogene, there were different facies due to different parts of the basin, ranging from shallow carbonate facies to relatively deep flysch facies (Fauvelet & Eftekharnezhad, 1990; Vahdati Daneshmand, 1992; Aghanabati, 1990; Berthiaux et al., 1990; Guillou et al., 1983; Stöcklin et al., 1972).

The Paleocene-Eocene carbonate sequences in the east of Iran have considerable thickness,

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distribution, different facies and could be investigated from the perspective of biostratigraphy and paleontology studies. Therefore, extensive research and comprehensive studies are required to provide more detail in this regard. The present study aimed to identify the foraminifera contents in the measured sections of Hasan Abad (1, 2), located in the south of Birjand , east of Iran. The identified foraminifera assemblages were used to propose a biostratigraphic scheme. Biostratigraphic and lithostratigraphic studies have previously been performed in the vicinity of Birjand in the east of Iran. The first study about the geology of eastern Iran was conducted by (Clap, 1940) and following that, the structural history and tectonics of Iran were completed by (Stöcklin et al., 1968;1972). Further research and investigation in the Sistan Suture Zone of eastern Iran have been performed by (Tirrul et al., 1983). Moreover, (Rahaghi 1978, 1983) studied the stratigraphy and faunal assemblage of the Paleocene-lower Eocene in Iran.

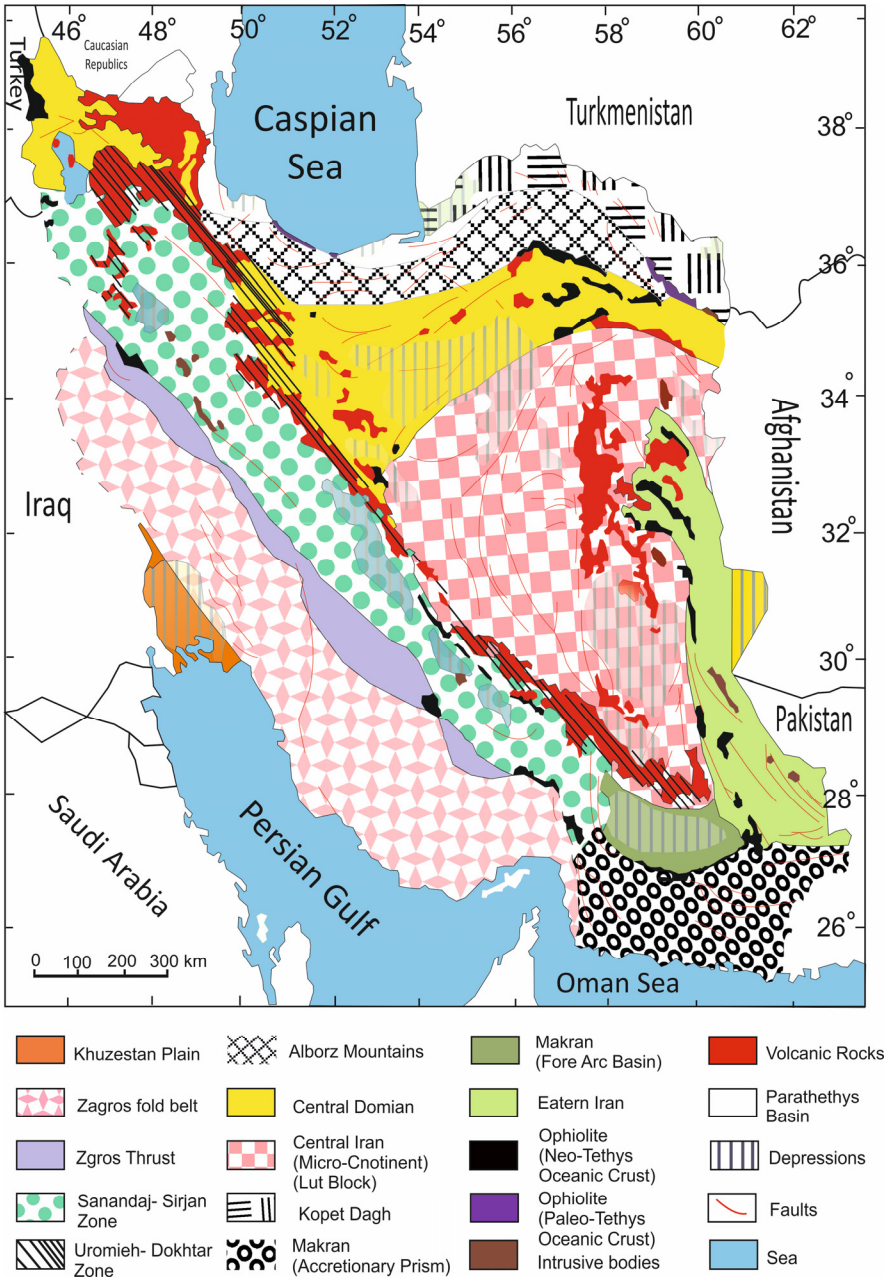


Figure 1. Major geological subdivisions of Iran after Stöcklin (1968) and Nabavi (1976), modified [after Nezafati 2006]

Another study based on the biostratigraphy, microfacies, petrography and geochemistry of Paleocene-Eocene deposits in eastern Iran have been carried out by (Babazadeh, 2005) regarding the presence of *Cuvillierina* (foraminifera) and its different species in eastern Iran. (Babazadeh , 2008) also explored the lower Eocene transgressive successions of Sahlabad province in eastern Iran and suggested the implications of biostratigraphy and microfacies analysis. (Samadi Afkham et al., 2012), researched the lithostratigraphy and biostratigraphy of Paleocene-Eocene deposits in Dahan-Rud section (northwest of Birjand).

Also, (Mohammadi et al., 2016) studied the graphoglyptid trace fossils of Paleocene- Eocene Flysch deposits from the north of Birjand in eastern Iran. (Hadi et al., 2019) provided a larger foraminiferal biostratigraphy and microfacies analysis of Ypresian (Ilerdian-Cuisian) limestones in the Sistan Suture Zone (eastern Iran).

Materials and Methods

In this study, 80 samples were collected at a one-meter intervals. In order to identify foraminifera, thin sections were prepared from the collected samples, examined using a binocular microscope, and photographed at the University of Birjand. Stratigraphic sections were also drawn using computer software packages. For the identification and biozonation of bentonic foraminifera, we referred to several references (Rahaghi 1978, 1983; Loeblich and Tappan, 1988; Serra-Kiel et al., 1998; Mathur et al., 2009; Benedetti et al., 2011; Benedetti, 2015; Hadi et al., 2015; Sirel & Deveciler, 2018; Amirshahkarami & Zebarjadi, 2018).

The two measured sections are located in the eastern margin of Lut block, 42 kilometers to the south of Birjand (Iran) in the east of Hasan Abad village. It is situated within the geological sheet map of Birjand (Ohanian & Tatevosian, 1978). Access to these sections is possible through the Birjand-Zahedan main road 15 kilometers into Behdan-Bahlgerd side road, taking a turn toward Hasan Abad village (Figures 2-4).

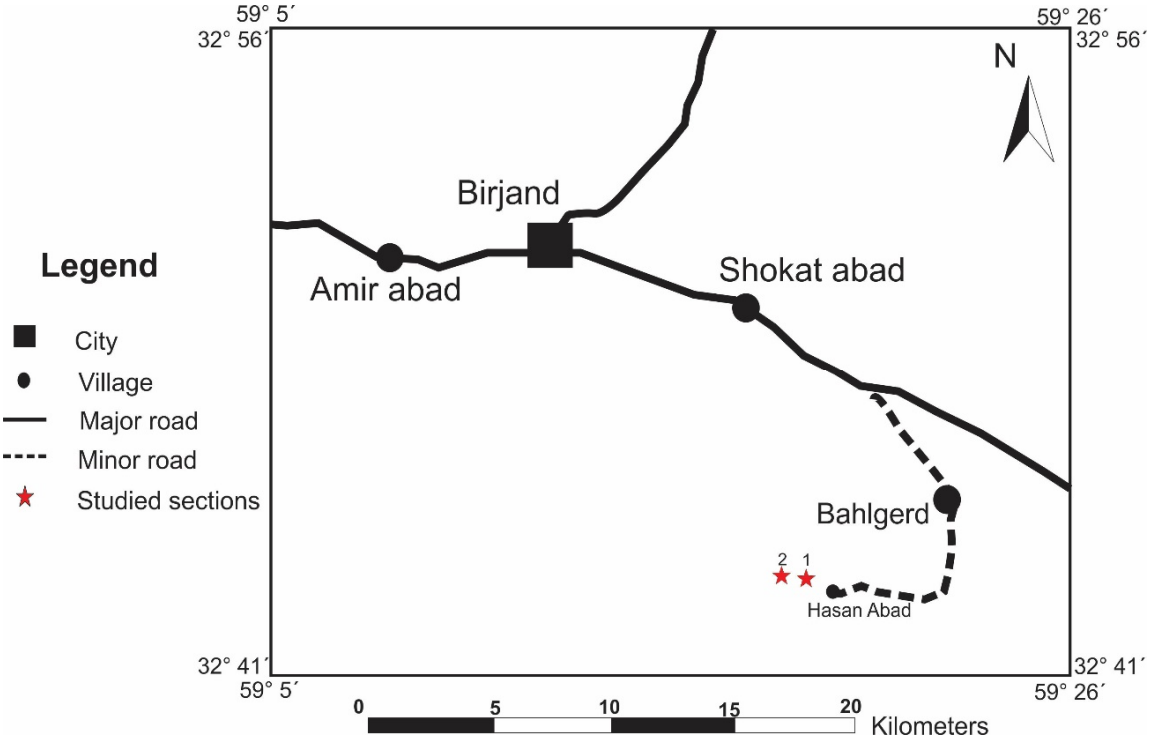


Figure 2. Geographical position of the study area and studied sections

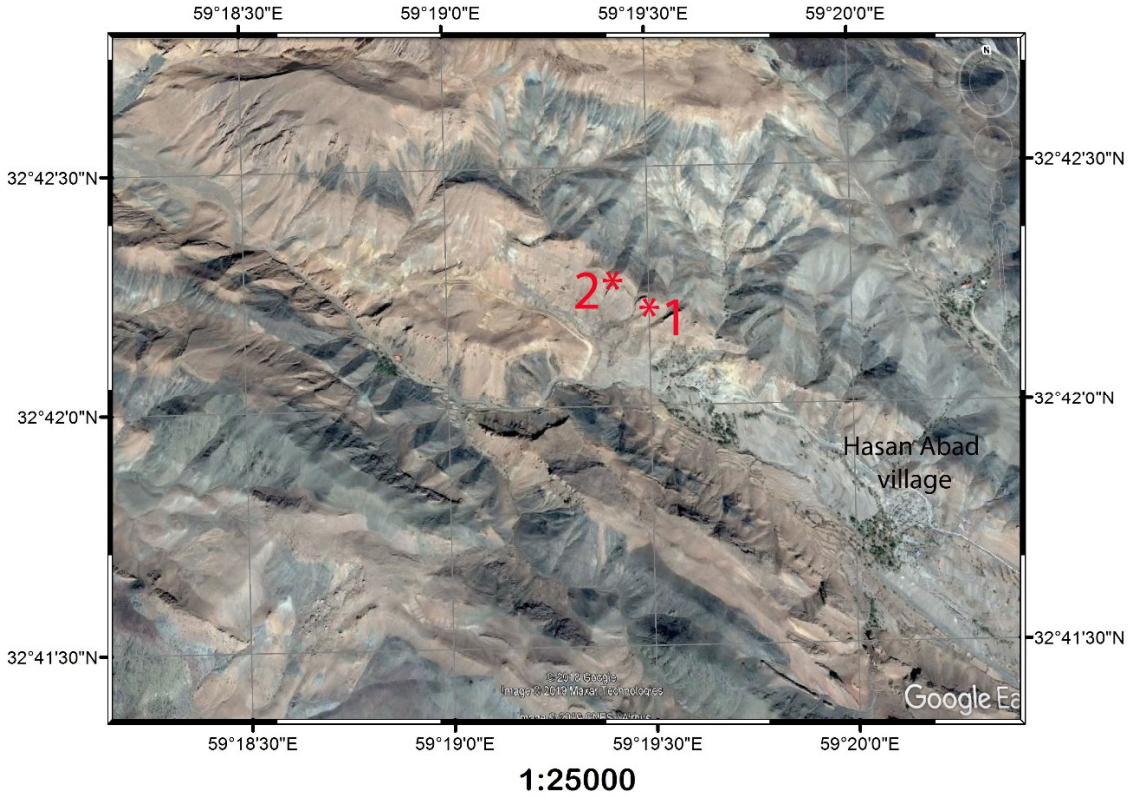


Figure 3. Satellite image of the studied section, the position of the sections on the image are marked with an asterisk (taken from Google Earth)

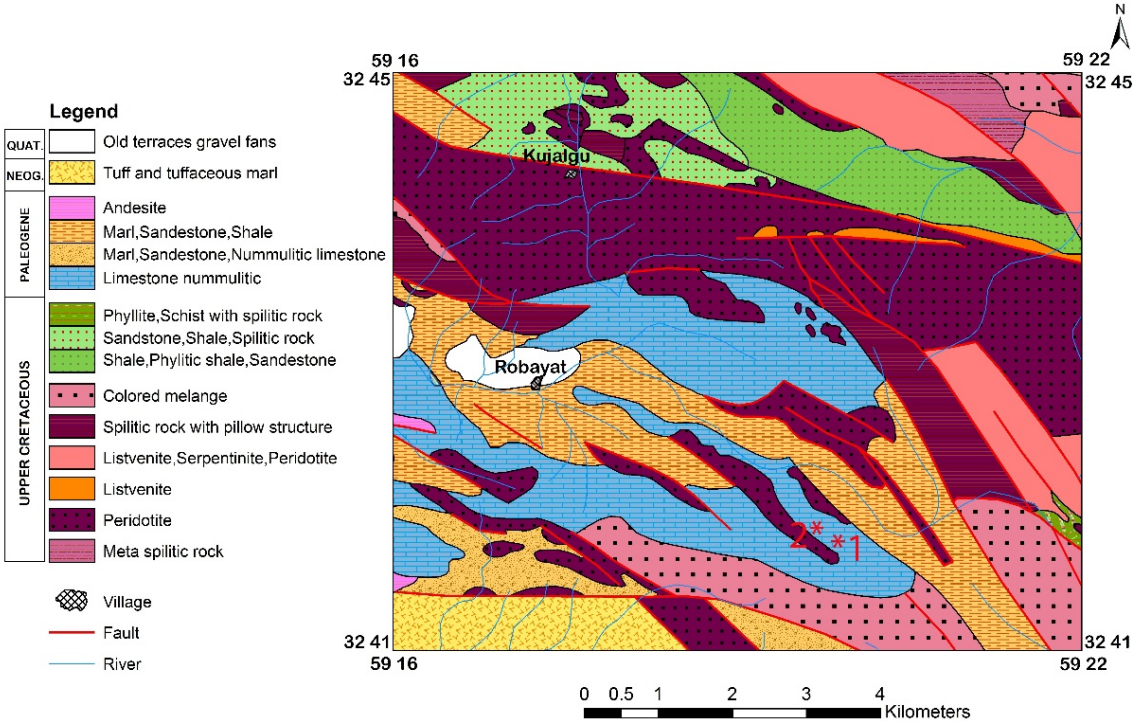


Figure 4. Geological map of study area, the studied sections are shown with red star (re-drawn from Ohanian & Tatevosian, 1978)

Stratigraphy

Section 1 of Hasan Abad

The section 1 were measured at a distance of 1.5 kilometers in the north west of Hasan Abad village. The base of the sections is composed of ophiolites (peridotite). The age of ophiolite and color melange is attributable to before Paleocene, and their placement is from the Upper Cretaceous to Early Paleocene. The measured sequence in the first section of Hasan Abad is described below.

The section starts with a basal conglomerate (Figure 5), which is overly and unconformably on the ophiolites (peridotite). This conglomerate is composed of peridotite fragments, which are gradually converted into grey sandstone and dark-to-light grey calcarenite with coarse grain sandstone. Several layers of sandy limestone are also seen alternately with conglomerates. The succession continues with medium-to-thick layers of light grey foraminifera limestone (Figure 6), and the upper part of the section mostly consists of an alternation of light-to-dark grey, greenish grey, and thin-to-medium bedded calcarenite. The top of the sequence is covered by quaternary sediments, while geological evidence suggests that it is a continuation of the sequence of the marl deposits that were eroded later.

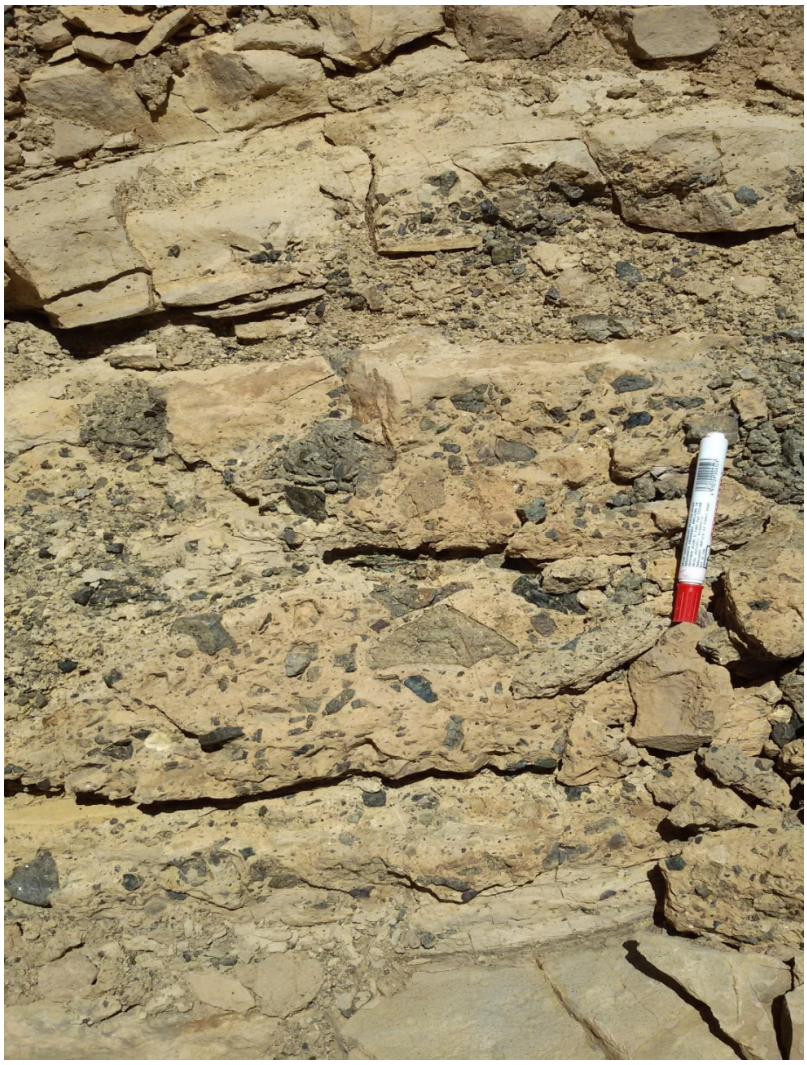


Figure 5. Basal conglomerate in section 1, contains of peridotite fragments

Figure 6. Field photo of medium portion of section 1, medium-to-thick layers of light grey limestones

Section 2 of Hasan Abad

This section is located at a distance of 500 meters of the west of section 1 (Figure 7). it begins with a basal conglomerate, then continues with an alternation of grey calcarenite with coarse grain terrigenous, limy sandstone and a few meters of light-to-dark brown, fine sandy limestone beds, which unconformably overlay ophiolites (peridotite). The subsequent layers of this sequence consist of dark grey and fresh/light grey on the weathered surface of calcarenite, and calcirudite contains fossil debris and microfossils. The top of the sequence is similar to the first section, covered by quaternary sediments. Some geological evidence also suggests that succession has continued with the sequence of the marl deposits that were eroded later.

Biozonation of studied sections

The biostratigraphic studies in Hasan Abad sections led to the identification of twenty four genera and thirty four species of benthic foraminifera in total. The suggested biozones are correlated with the equivalent benthic foraminiferal zonal scheme of (Serra-Kiel et al., 1998). According to the (Serra-Kiel et al., 1998) the Lower Eocene (Yepresian) is including of the Ilerdian and Cuisian stages which have been used in this research.

Biostratigraphic studies of the first section of Hasan Abad led to identify of 21 genera and 28 species of foraminifera as following:

Bolivina sp., *Textularia* sp., *Triloculina* sp., *Pyrgo* sp., *Idalina* sp., *Alveolina gambaensis*, *Alveolina ellipsoidalis*, *Alveolina regularis*, *Alveolina* aff. *corbarica*, *Quinqueloculina* sp., *Nummulites globulus*, *Fallotella* sp., *Opertorbitolites* sp., *Nummulites atacicus*, *Alveolina solida*, *Orbitolites* sp., *Daviesina* sp.1, *Pseudolituonella* sp., *Nummulites subramondi*, *Assilina plana*, *Nummulites partschi*, *Orbitoclypeus* sp., *Granorotalia sublobata*, *Ornatorotalia granum*, *Asterocyclina* sp., *Discocyclina* sp., *Coskinolina* sp. (Figure 8) (plates 1-8). As a result, four biozones were introduced including:

***Daviensina* sp. interval zone**

The lower boundary of this biozone is defined by the first occurrence of *Daviensina* sp. and ended with the first occurrence of *Alveolina ellipsoidalis*.

Figure 7. Field photo of section 2, base of section in the right and top in the left, looking to west

The thickness of this biozone is 18 meters including sample numbers of G4-1 to G4-16.

This biozone contain of *Alveolina gambaensis*, *Bolivina* sp., *Daviensina* sp.1*, Daviensina* sp.2, *Idalina* sp*., Opertorbitolites* sp., *Pyrgo* sp., *Textularia* sp. and *Triloculina* sp. Based on stratigraphic position and assemblage fauna, Thanetian? -early Ilerdian age is suggested for this biozone and could be equal with SBZ 4-5 zones (Serra-Kiel et al., 1998).

***Alveolina ellipsoidalis* interval zone**

This biozone started with the first appearance of *Alveolina ellipsoidalis* and continued to the first appearance of *Nummulites globulus*, including sample numbers G4-16 to G1-12. The thickness of this biozone is 12 meters. The other foraminifera in this biozone are: *Alveolina regularis*, *Alveolina* aff. *corbarica* and *Quinqueloculina* sp. This biozone is equivalent to the SBZ6-7 zones (Serra-Kiel et al., 1998), which represents the early –middle Ilerdian age.

***Nummulites globulus* interval zone**

This biozone with a thickness of 15 meters is defined from the first appearance of *Nummulites globulus* to the first appearance of *Nummulites subramondi* and includes samples from G1-12 to G1-18 and contains of foraminifera for example: *Alveolina solida*, *Coskinolina* sp., *Fallotella* sp., *Nummulites atacicus*, *Orbitolites* sp., *Pseudolituonella* sp*., Quinqueloculina* sp. Which are equivalent to SBZ8 zone (Serra-Kiel et al., 1998) and represent the middle Ilerdian age.

***Nummulites subramondi* interval zone**

This biozone is introduced with the first appearance of *Nummulites subramondi* to the first appearance of *Granorotalia sublobata* and includes samples G1-18 to G1-25 and its thickness is 25 meters which is equivalent to SBZ9-10 zones (Serra-Kiel et al., 1998). Other foraminifera belonging to this biozone are:
Assilina plana, Nummulites partschi, Orbitoclypeus sp., *Granorotalia sublobata, Ornatorotalia granum, Asterocyclina sp., Discocyclina* sp., *Coskinolina* sp., *Assilina granulosa, Nummulites*

globulus, Textularia sp., *Opertorbitolites* sp., *Alveolina ellipsoidalis, Alveolina regularis*

According to the assemblage fossils, this biozone can be considered equivalent to late Ilredian to the early Cuisian age.

Based on the proposed biozones and the identified fossil assemblages, the age of the proposed section of Hasan Abad (1) is attributed to Thanetian to early Cuisian.

In the second section of Hasan Abad 17 genera and 21 species of foraminifera recognized. These foraminifera are: *Idalina* sp., *Kathina selveri*, *Triloculina* sp., *Coskinolina* sp., *Brockinella* cf. *arabica*, *Nummulites carcasonensis*, *Nummulites mamillatus*, *Assilina granulosa, Granorotalia sublobata*, *Neorotalia alicantina, Asterocyclina* sp., *Orbitolites* sp., *Alveolina ellipsoidalis*, *Alveolina regularis*, *Alveolina conradi*, *Quinqueloculina* sp., *Nummulites atacicus*, *Nummulites globulus*, *Pseudolituonella* sp*., Textularia* sp., *Opertorbitolites* sp. (Figure 9) (plates 1-8).

Three biozones based on foraminifera assemblage have been introduced.

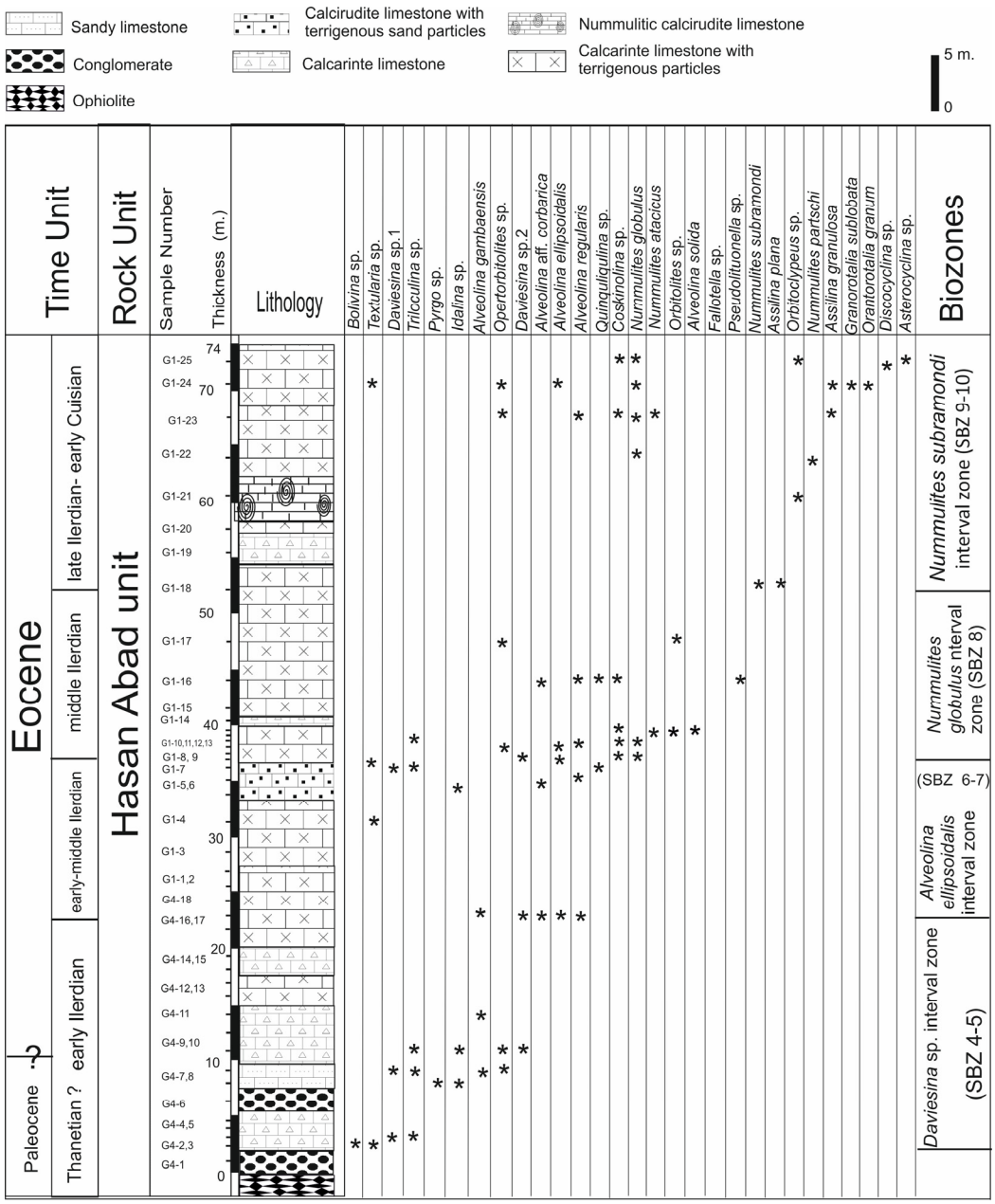


Figure 8. Lithology column and range chart of Hasan Abad section (1)

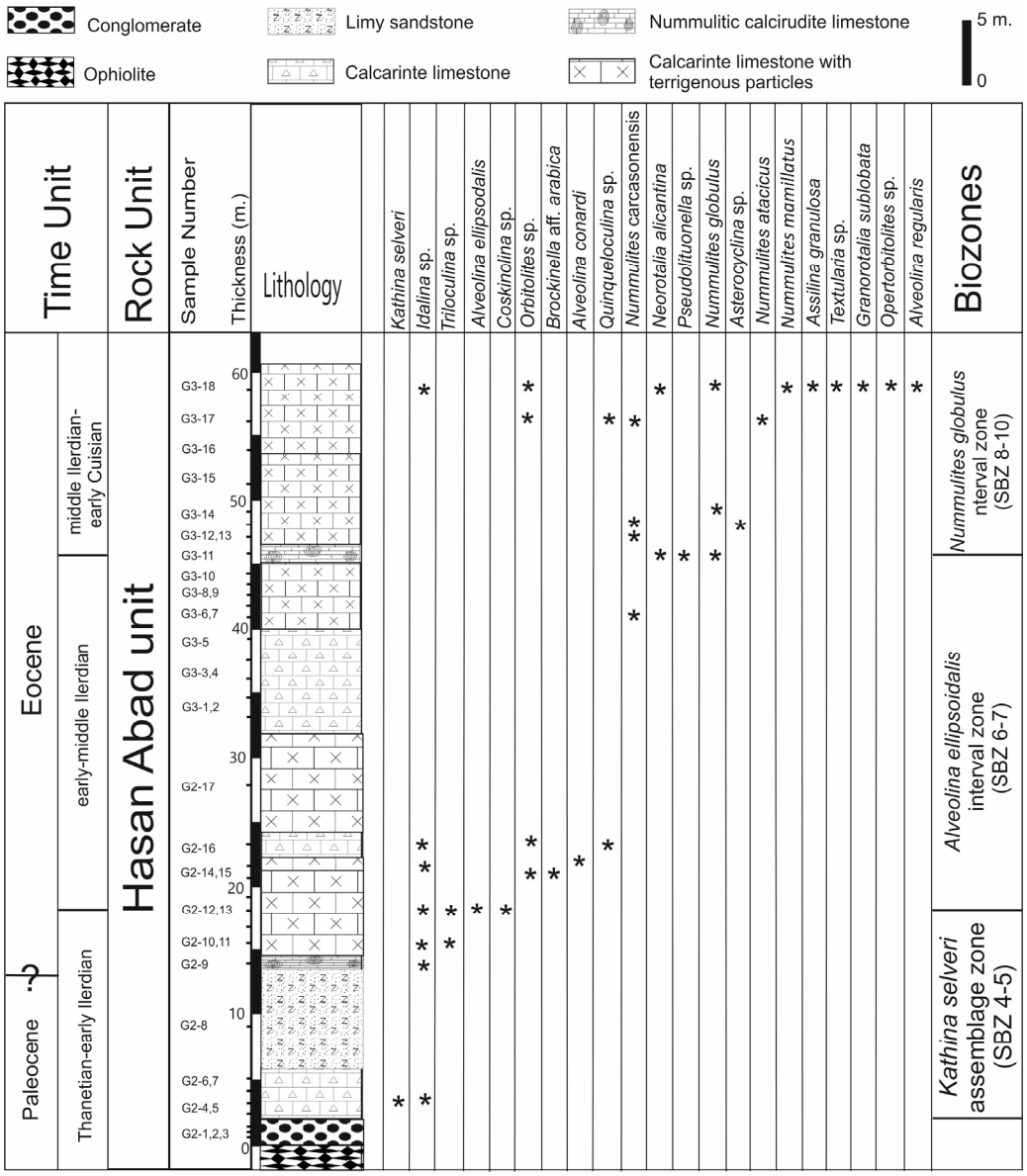


Figure 9. Lithology column and range chart of Hasan Abad section (2)

Kathina selveri assemblage zone

This biozone is characterized by the first appearance of *Kathina selveri* to the first appearance of *Alveolina ellipsoidalis* and includes samples G2-4 to G2-12. Its thickness is 15 meters. Other microfossils in this biozone including *Idalina* sp., *Triloculina* sp. and *Coskinolina* sp.

According to (Bassi, 2014), stratigraphic position and correlation with section 1, this biozone can be considered equivalent to the zones of SBZ4-5 (Serra-Kiel et al., 1998). The age of this biozone attributed to Thanetian-early Ilerdian.

Alveolina ellipsoidalis interval zone

This biozone is taken based on the first appearance of *Alveolina ellipsoidalis* to the first appearance of *Nummulites globulus*. The thickness of this biozone is 27 meters and covers samples G2-12 to G3-11. This biozone is equivalent to the SBZ6 -7 Zone (Serra-Kiel et al.,

1998), which represents the early-middle Ilerdian. Other foraminifera in this biozone are including *Alveolina conradi*, *Brockinella* aff. *arabica*, *Coskinolina* sp., *Idalina* sp., *Nummulites carcasonensis, Orbitolites* sp., *Quinqueloculina* sp. and *Triloculina* sp.

Plate 1

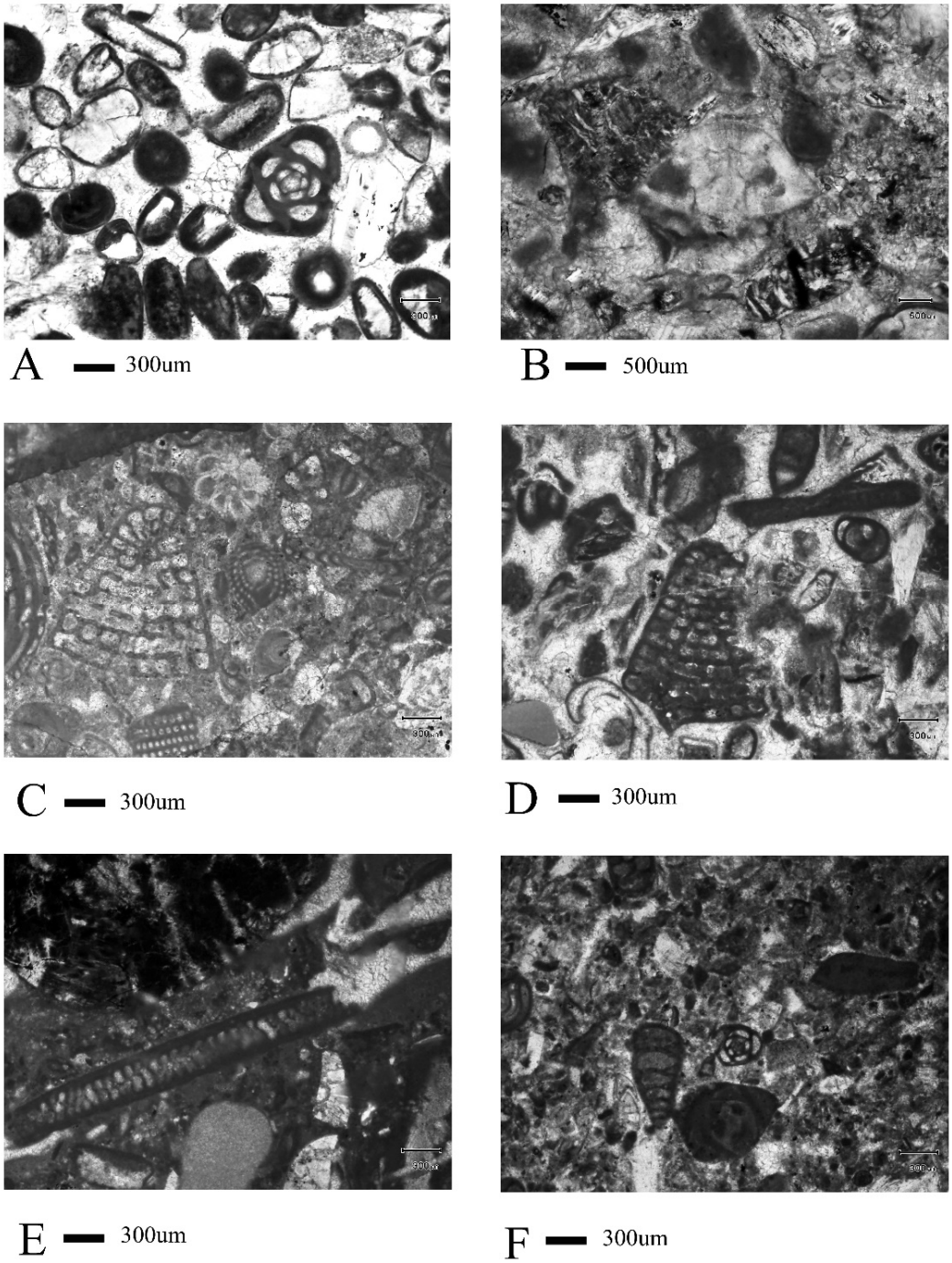


Plate 1. A- *Triloculiana* sp., Sample number G4-2, scale 300 µm, B- *Kathina selveri*, Sample number G2-5, scale 500 µm, C- *Coskinolina* sp., Sample number G1-8, scale 300 µm, D- *Fallotella* sp., Sample number G1-12, scale 300 µm, E- *Broeckinella* cf. *arabica*, Sample number G2-14, scale 300 µm, F- *Pseudolituonella* sp., Sample number G3-10, scale 300 µm

Plate 2

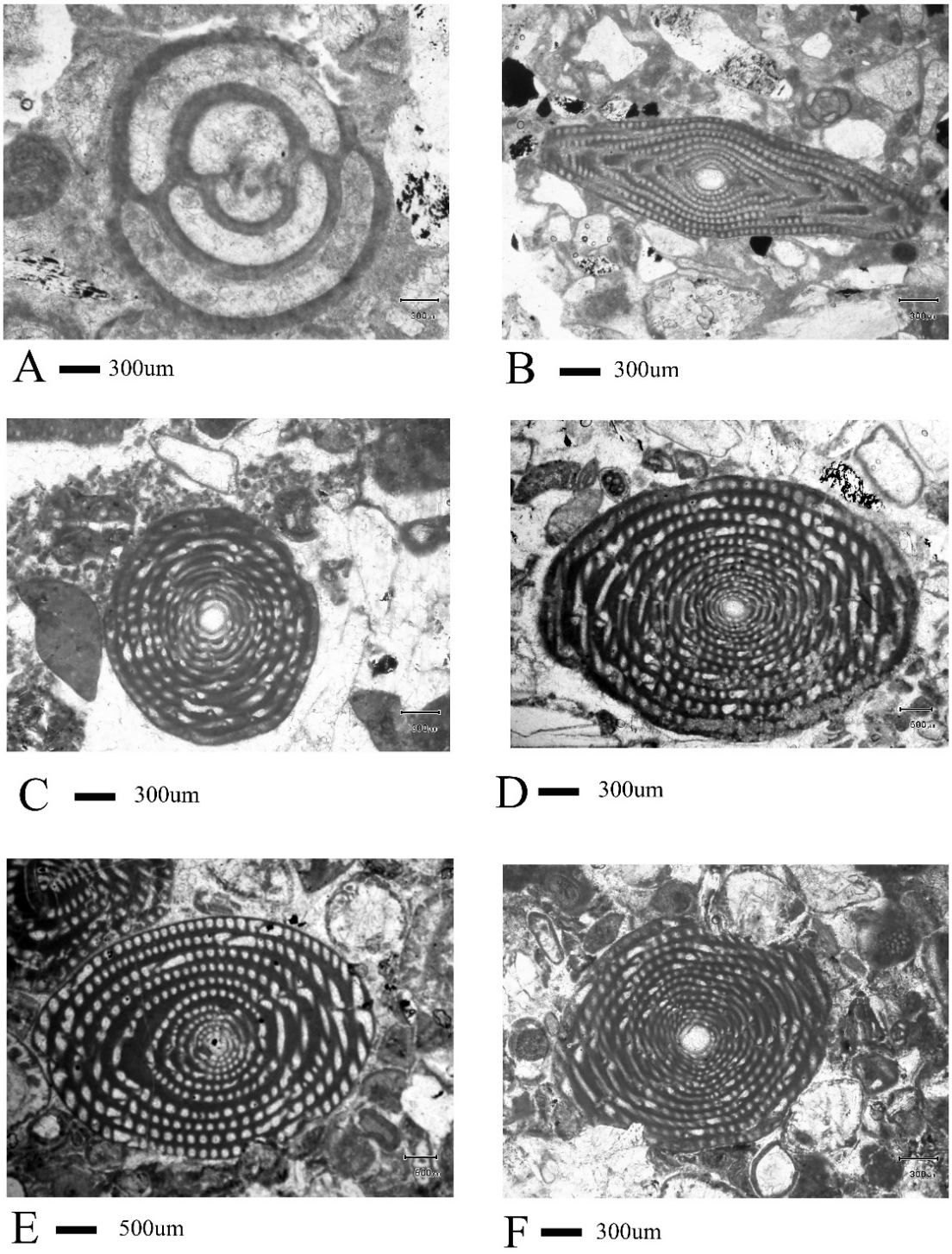
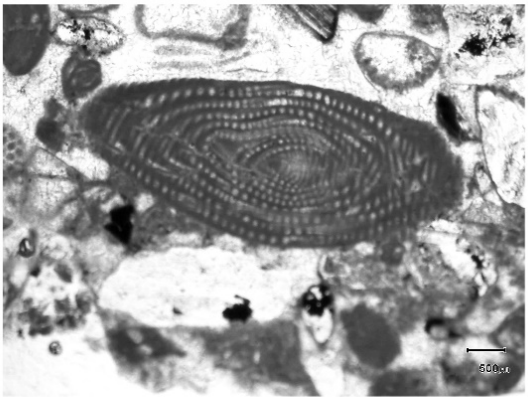
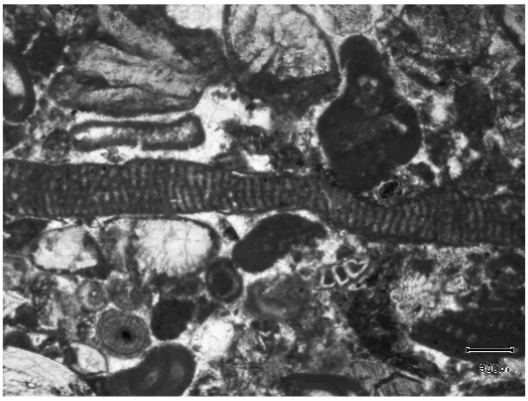


Plate 2. A- *Pyrgo* sp., Sample number G4-8, scale 300 µm, B- *Alveolina gambaensis*, Sample number G4-8, scale 300 µm, C- *Alveolina ellipsoidalis*, Sample number G4-17, scale 300 µm, D- *Alveolina ellipsoidalis*, Sample number G4-17, scale 300 µm, E- *Alveolina regularis*, Sample number G1-8, scale 300 µm, F- *Alveolina regularis*, Sample number G1-8, scale 300 µm (fig A. pl.5)

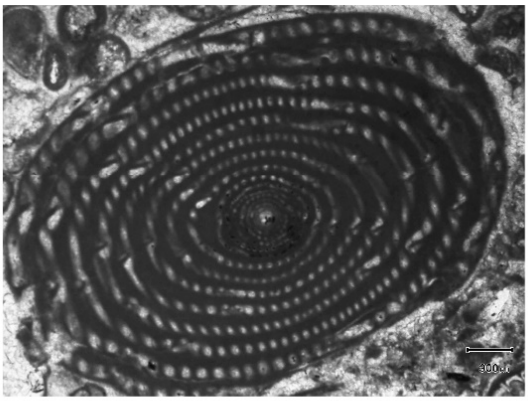
Plate 3



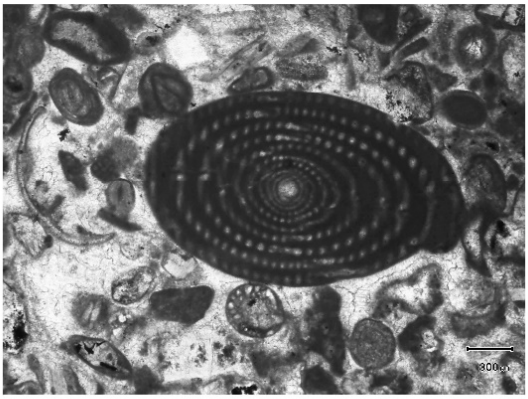
A — 500um



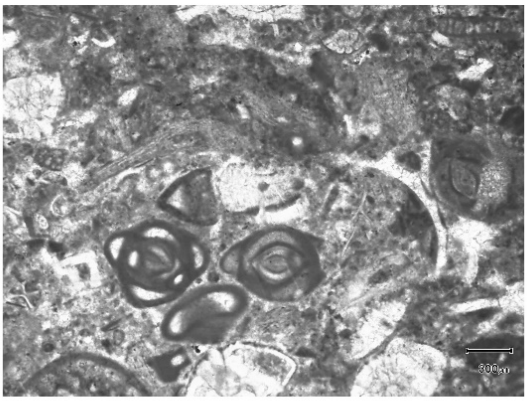
B — 300um



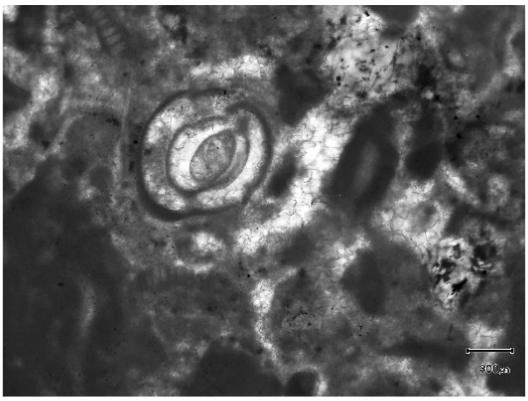
C — 300um



D — 300um



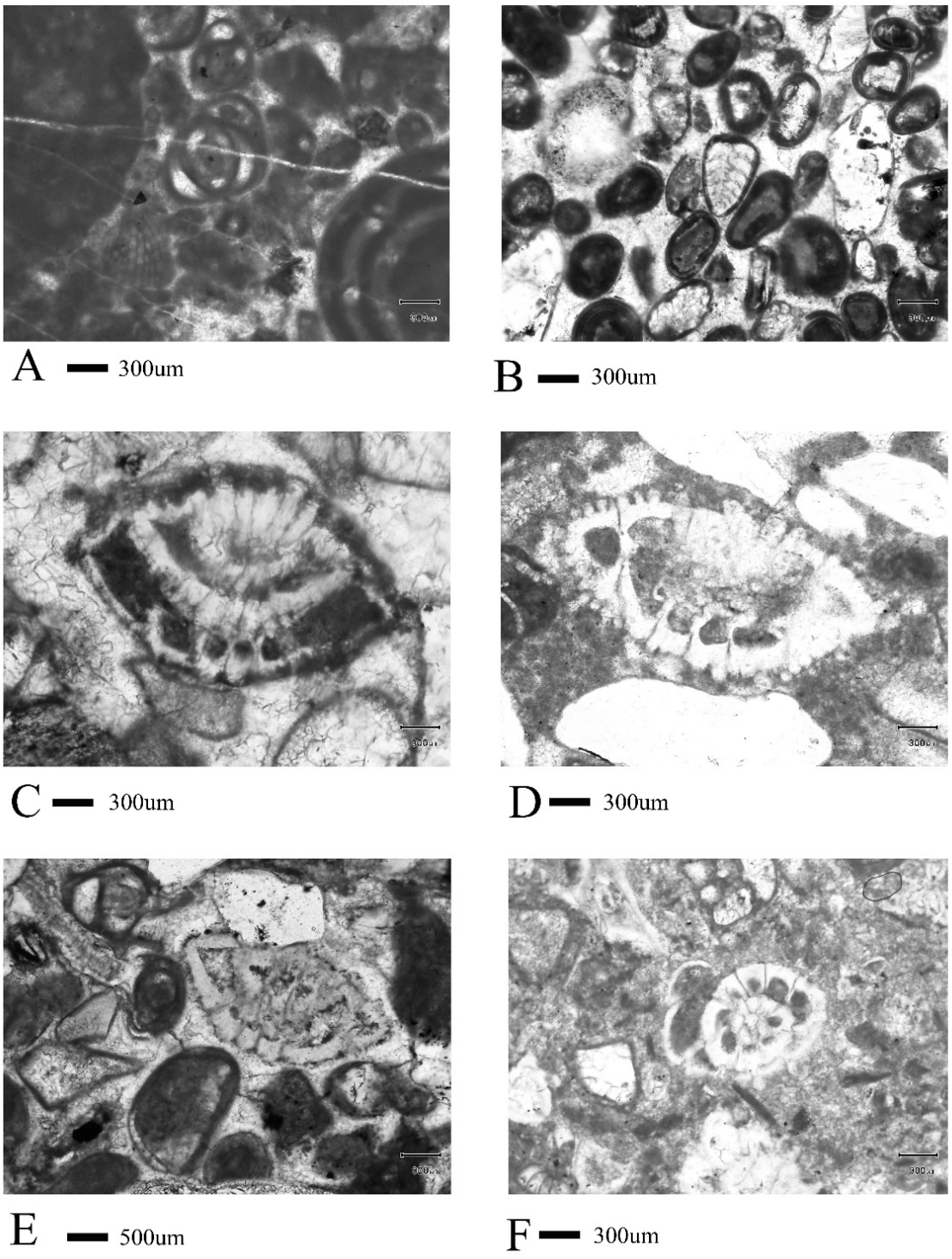
E — 300um



F — 300um

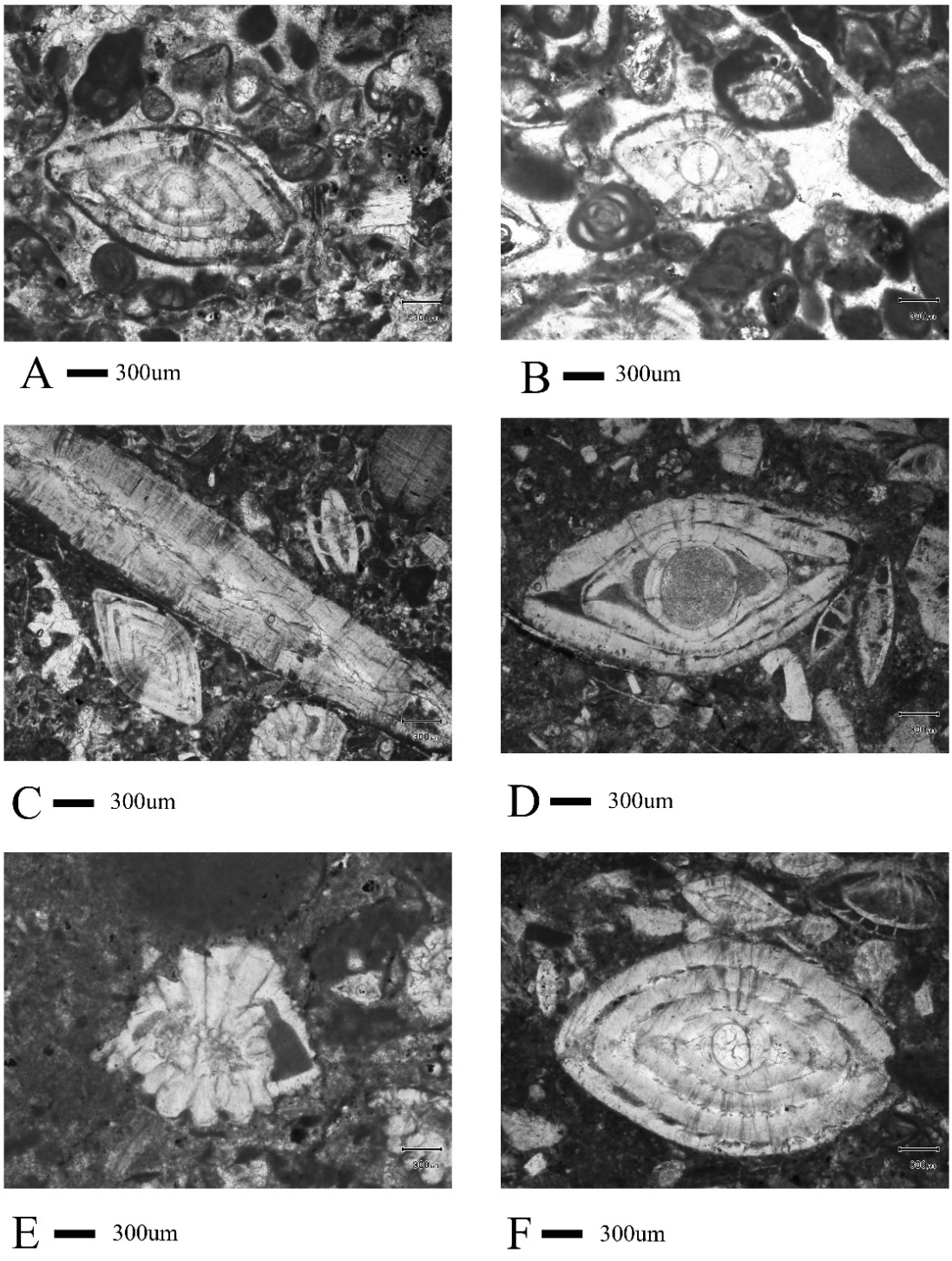
Plate 3. A- *Alveolina* aff. *corbarica*, Sample number G4-17, scale 300 µm, B- *Orbitolites* sp., Sample number G1-10, scale 300 µm, C- *Alveolina solida*, Sample number G1-12, scale 300 µm, D- *Alveolina ellipsoidalis*, Sample number G1-12, scale 300 µm, E- *Quinquliqulina* sp., Sample number G1-16, scale 300 µm, F- *Idalina* sp., Sample number G2-9, scale 300 µm

Plate 4



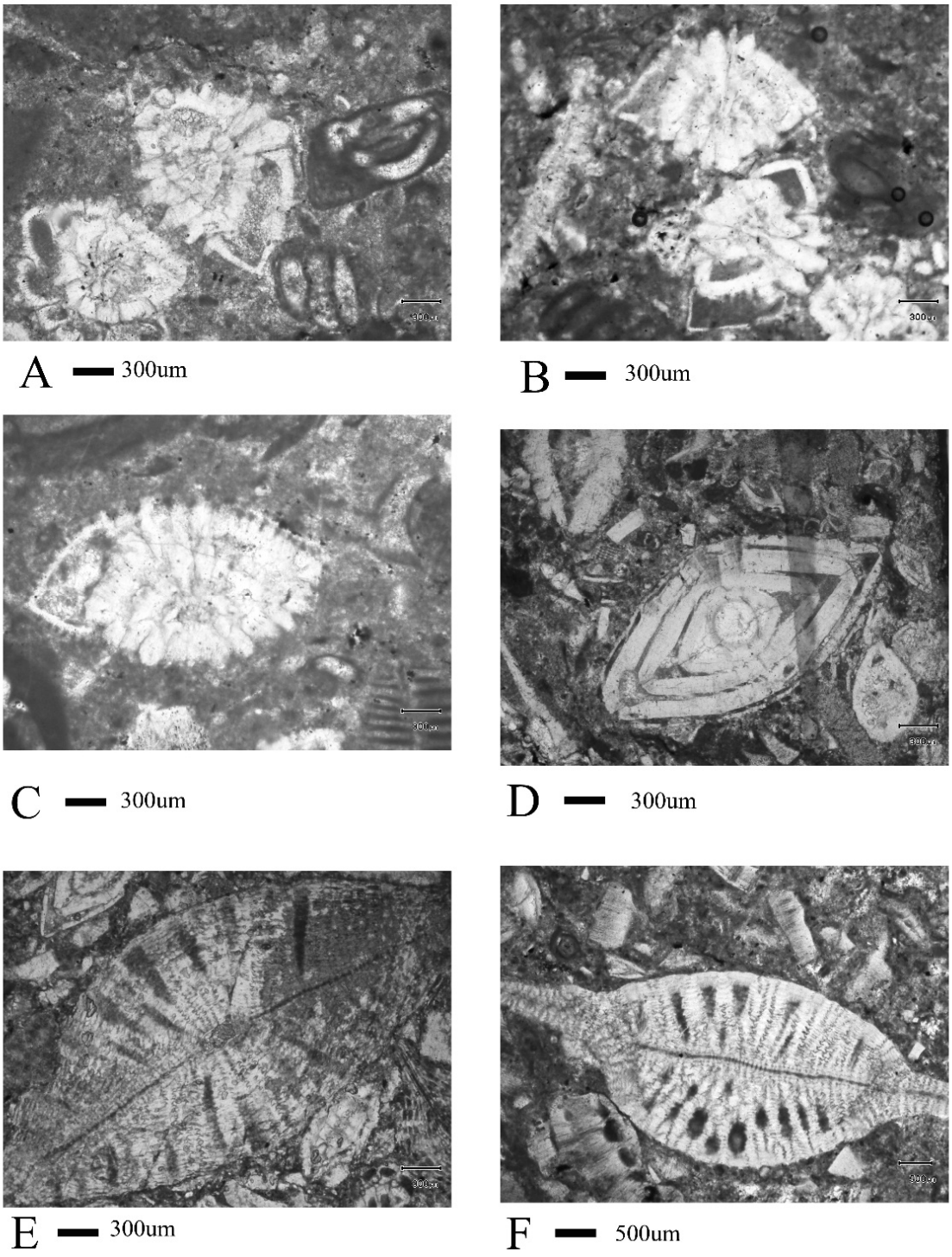
Plete 4. A- *Triloculina* sp.1, Sample number G2-10, scale 300 µm, B- *Bolivina* sp., Sample number G4-2, scale 300 µm, C- *Daviesina* sp. 1, Sample number G4-8, scale 300 µm, D- Ornatorotaliid Sample number G4-17, scale 300 µm, E- *Daviesina* sp. 2, Sample number G4-9, scale 300 µm, F- *Ornatorotalia granum* sample number G3-18, scale 300 µm

Plate 5



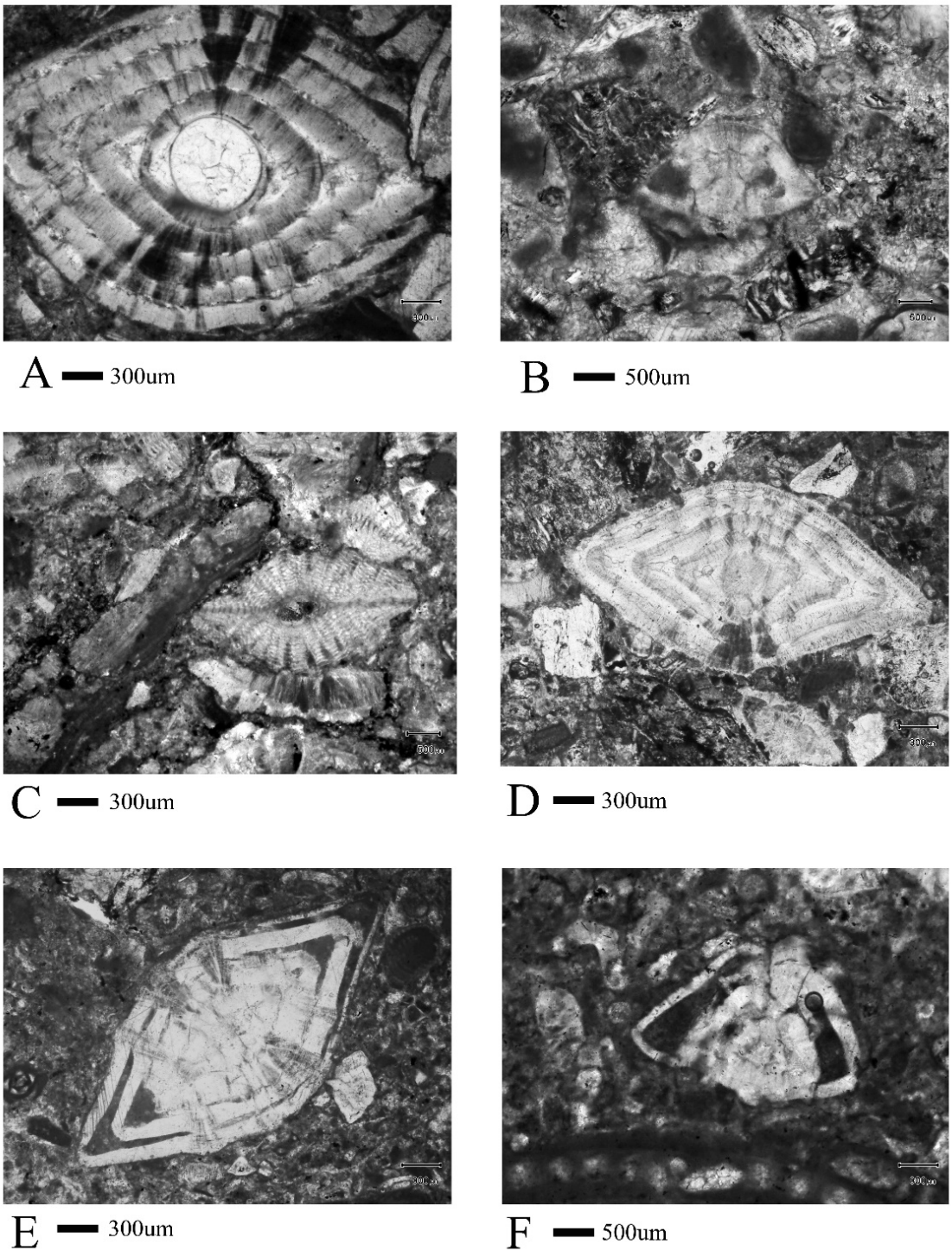
Plete 5. A- *Nummulites atacicus*, Sample number G1-12, scale 300 µm, B- *Nummulites globulus*, Sample number G1-8, scale 300 µm, C- *Nummulites subramondi, Assilina. plana,* Sample number G1-18, scale 300 µm, D- *Nummulites partschi*, Sample number G1-22, scale 300 µm, E- *Ornatorotalia granum*, Sample number G1-24, scale 300 µm, F- *Nummulites atacicus*, Sample number G1-23, scale 300 µm

Plate 6



Plete 6. A- *Ornatorotalia granum*, Sample number G1-24, scale 300 µm, B-. *Granorotalia sublobata*, Sample number G3-18, scale 300 µm, C- *Granorotalia sublobata*, Sample number G1-24, scale 300 µm, D- *Nummulites partschi*, Sample number G1-22, scale 300 µm, E- *Orbitoclypeus s*p., Sample number G1-21, scale 300 µm, F- *Discocyclina* sp., Sample number G1-25, scale 500 µm

Plate 7



Plete 7. A- - *Nummulites globulus*, Sample number G3-14, scale 300 µm, B- *Kathina selveri*, Sample number G2-5, scale 500 µm, C- *Orbitoclypeus s*p., Sample number G3-1, scale 500 µm, D- *Nummulites carcasonensis*, Sample number G3-6, scale 300 µm, E- *Nummulites mamillatus*, Sample number G3-18, scale 300 µm, F- *Neorotalia alicantina*, Sample number G3-18, scale 300 µm

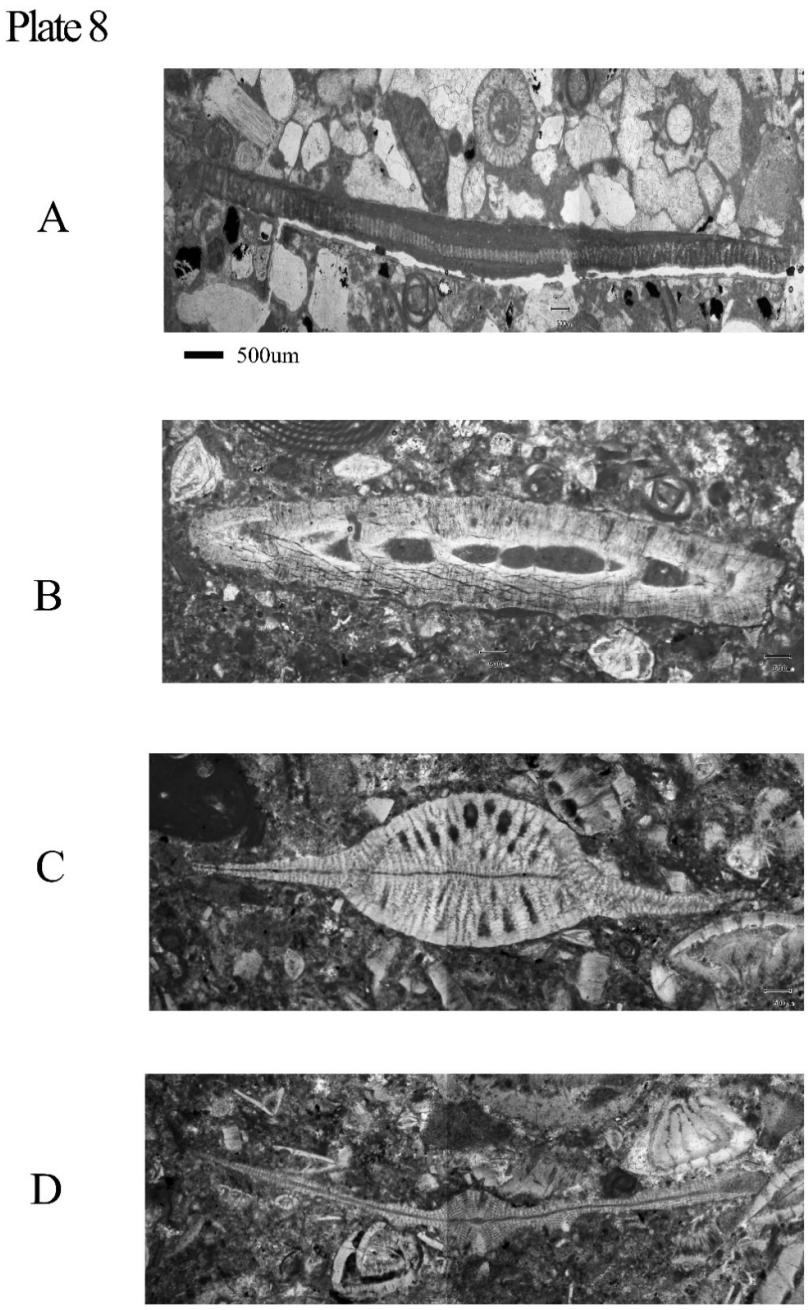


Plate 8. A- *Opertorbitolites* sp., Sample number G4-8, scale 500 µm, B- *Assilina granulosa*, Sample number G3-18, scale 500 µm, C- *Orbitoclypeus* sp., Sample number G1-25, scale 500 µm, D- *Asterocyclina* sp., Sample number G1-25, scale 500 µm

Nummulites globulus interval zone

This biozone starts from the first appearance of *Nummulites globulus*, continued until the end of the studied section. The thickness of this biozone is 14 meters and includes samples G3-11 to G3-18. This biozone is equivalent to the zones of SBZ8-10 (Serra-Kiel et al., 1998). Other foraminifera in this biozone including the following species; *Alveolina regularis*, *Assilina granulosa, Asterocyclina* sp., *Granorotalia sublobata*, *Idalina* sp., *Nummulites atacicus*, *Nummulites carcasonensis, Neorotalia alicantina, Nummulites mamillatus*, *Orbitolites* sp.,

Opertorbitolites sp., *Psedolituonella* sp. and *Textularia* sp.

Based on assemblage foraminifera, middle Ilredian to the early Cuisian age is suggested. Based on the proposed biozones and the identified fossil assemblages, the age of the proposed section of Hasan Abad (2) is attributed to Thanetian to the early Cuisian (Table 1).

Systematic paleontology

Family Ornatorotaliidae Benedetti, 2015
Subfamily Ornatorotaliinae Benedetti, 2015
Genus *Ornatorotalia* Benedetti, Di Carlo & Pignatti, 2011

Type species: *Ornatorotalia spinosa* Benedetti, Di Carlo & Pignatti, 2011

Ornatorotalia granum Benedetti, Di Carlo &Pignatti, 2011

Pl. 5, Fig. E, Pl. 6, Fig. A

2011 *Ornatorotalia granum* Benedetti, Di Carlo &Pignatti, p. 710, figs 8a-g, 9a-f, 10a-d.

2017 *Ornatorotalia granum* Benedetti, Di Carlo & Pignatti, Sirel and Devecíler p. 70, Pl. 2, figs 9-14.

Material: sample G1-24.

Description: The wall is calcareous, fibrous and thick, perforate. The periphery is rounded to subarcute. Test is biconvex involute and trochospiral, coarse pillars are seen in both sides. The chambers are almost evolute in dorsal side and involute on the ventral side. Dorsal and ventral side are characterized by strong ornamentation composed by canal orifices, pustules and pillars (Figures 10 & 11, C-D). The diameter of the test varies from 1.32 to 1.88 mm and thickness varies from 1.71 to 2.61 mm. The ratio D/T ranges from 0.72 to 0.77.

The dimension of measured species are as follows;

Ornatorotalia granum, Sample number G1-24, T= 2.61 mm and D= 1.88 mm, D/T =0.72

Ornatorotalia granum, Sample number G1-24, T= 1.71 mm and D= 1.32 mm, D/T= 0.77

Remarks. *O. granum* differs from *O. spinosa* (Benedetti et al., 2011, pl. 2, figs 9-14) by having a smaller test, shorter and less numerous pustules and a smaller proloculus (Benedetti et al., 2011).

Stratigraphic range: *O. granum* occurs in association with *Nummulites atacicus*, *Alveolina solida*, *Orbitolites* sp., *PseudoLituonella* sp., *Nummulites subramondi*, *Assilina. plana*, *Nummulites partschi*, *Orbitoclypeus* sp., *Granorotalia sublobata*, *Asterocyclina* sp., *Discocyclina* sp., in Hasan Abad section (1) which confirming a late Ilerdian-early Cuisian (SBZ 10) age of the taxon.

Genus *Granorotalia* Benedetti, Di Carlo & Pignatti, 2011

Type species: *Granorotalia sublobata* Benedetti, Di Carlo & Pignatti, 2011

Granorotalia sublobata Benedetti, Di Carlo & Pignatti, 2011

Pl. 6, Figs B and C

2011 *Granorotalia sublobata* Benedetti, Di Carlo & Pignatti, p. 715; figs. 11a-e, 12a-b, 13a-f, 14a-h.

2015 *Granorotalia sublobata* Benedetti, Di Carlo & Pignatti - Benedetti, text-fig. 1.1-3.

2017 *Granorotalia sublobata* - Sirel & Devecíler, p. 70, Pl. 2, fig. 15; Pl. 3, figs 10-17.

Material: sample G3-18.

Description: Test is calcareous, fibrous. The periphery is usually subrectangular and ornamented (Figure 11, A). Chambers increasing rapidly in numbers in successive whorls. 2–3 thick pillars in the umbilical region. The diameter, ranging from 1.11 to 1.32 mm and thickness varies from 1.58 to 2.31 mm. The ratio D/T ranges from0.57 to 0.7٠.

The dimension of measured species are as follows;

Granorotalia sublobata, Sample number G3-18, T=1.58 mm, D= 1.11 mm

Granorotalia sublobata, Sample number G1-24, T= 2.31 mm, D= 1.32 mm

Remarks: *G. sublobata* shows some similarities to *Neorotalia alicantina* Colom, 1954. However, it differs in having vertical funnels on the dorsal side and a more irregular pattern of the pillars.

Stratigraphic range: *Granorotalia sublobata* occurs in association with *Nummulites atacicus*, *Alveolina solida*, *Orbitolites* sp., *Pseudolituonella* sp*., Nummulites subramondi*, *Assilina. plana*, *Nummulites aturicus*, *Nummulites partschi*, *Orbitoclypeus* sp., *Granorotalia sublobata*, *Asterocyclina* sp., *Discocyclina* sp., *Nummulites mamillatus*, *Assilina granulosa, Neorotalia alicantina, Asterocyclina* sp., *Alveolina regularis*, *Nummulites atacicus*, *Borelis* sp., *Opertorbitolites* sp., confirming a late Ilerdian-early Cuisian (SBZ 10) age of the taxon.

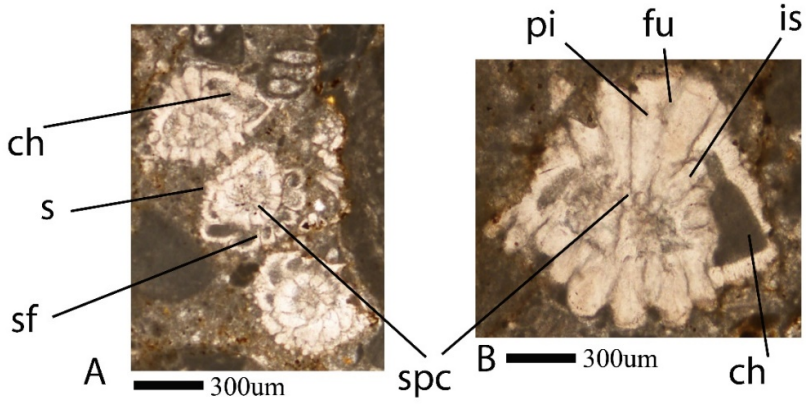


Figure 10. Structural elements of *Ornatorotalia granum* Benedetti, Di Carlo & Pignatti, 2011. A: Axial and Subequatorial sections, Sample number G1-24; B: Axial section, Sample number G1-24; ch: chamber, f: funnel; is: intraseptal canal; pi: pillar; s: spine; sf = septal flap; spc = spiral canal

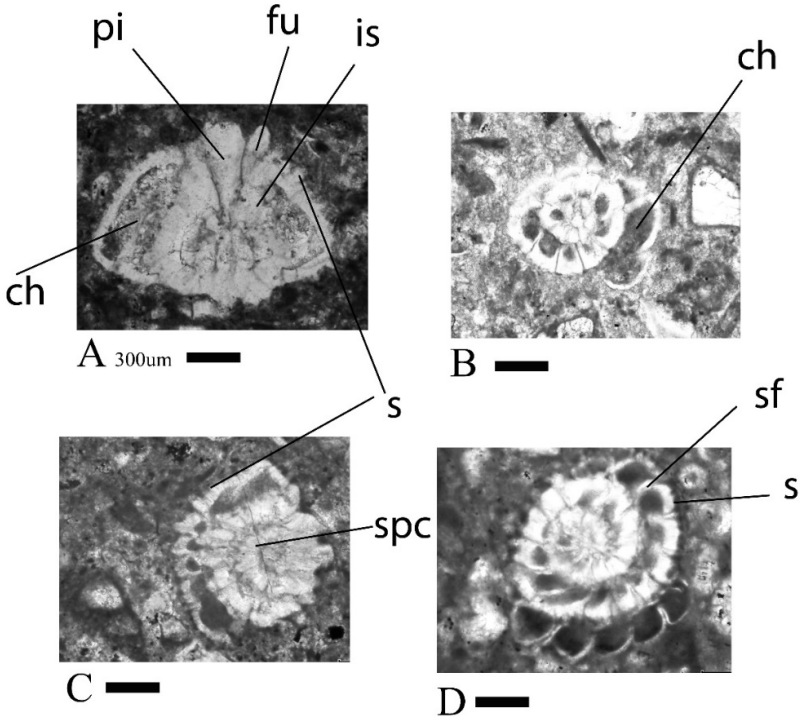


Figure 11. Structural elements of *Ornatorotalia* Benedetti, Di Carlo & Pignatti, 2011 and *Granorotalia* Benedetti, Di Carlo & Pignatti, 2011; A- *Granorotalia sublobata*, sample number G1-23; B-D- *Ornatorotalia granum* sample number G3-18; ch: chamber, f: funnel; is: intraseptal canal; pi: pillar; s: spine; sf = septal flap; spc = spiral canal

Table 1. Correlation of suggested biozones in the studied sections with Shallow Benthic Zones (Serra-Kiel et al., 1998)

Section 1	Section 2	(Serra-Kiel et al., 1998)
Daviensina sp. interval zone	*Kathina selveri* assemblage zone	SBZ4-5
Alveolina ellipsoidalis interval zone	*Alveolina ellipsoidalis* interval zone	SBZ6 -7
Nummulites globulus interval zone	*Nummulites globulus* interval zone	SBZ8-10
Nummulites subramondi interval zone-		

Conclusion

In this study, two sections of Hasan Abad, located in the southeast of Birjand in the east of Iran, were investigated from biostratigraphic perspective and for the first time, two new species of the Ornatorotaliidae family were evaluated the species were *Granorotalia sublobata* and *Ornatorotalia granum,* which have been recorded in this area in Iran. In total, 24 genera and 34 species of benthic foraminifera were identified in two sections and seven biozones were determined. The suggested biozones in the first section included the *Daviensina* sp. interval zone, *Alveolina ellipsoidalis* interval zone, *Nummulites globulus* interval zone and *Nummulites subramondi* interval zone. In the second section, three biozones were introduced based on the identified foraminifera, including the *Kathina selveri* interval zone, *Alveolina ellipsoidalis* interval zone and *Nummulites globulus* interval zone. According to the proposed biozones and the identified foraminifera assemblages, the age of the first and second section of Hasan Abad were determined to be Thanetian probability up to the Early Cuisian and Thanetian-Early Cuisian periods.

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