

Microbiostratigraphy of the Asmari Formation in Northeastern and Southwestern Ilam, West Iran**¹Kobra Mirbeik- Sabzevari, ²Seyed Hamid Vaziri, ³Mahmoud Reza Majidifard, Mohsen Pourkerman**¹*Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, Iran*²*Department of Geology, North Tehran Branch, Islamic Azad University, Tehran, Iran*³*Research Institute for Earth Sciences, Geological Survey of Iran, Tehran, Iran*Kobra Mirbeik- Sabzevari, Seyed Hamid Vaziri, Mahmoud Reza Majidifard, Mohsen Pourkerman:
Microbiostratigraphy of the Asmari Formation in Northeastern and Southwestern Ilam, West Iran**ABSTRACT**

In this research is studied the microbiostratigraphy of the Asmari Formation in northeastern (Arghavan section) and southwestern (Banroshan section) Ilam. The Asmari Formation in Arghavan (108 m) and Banroshan (232.5 m) sections consists of medium-bedded to massive limestones which in the Banroshan section also includes the Kalhor evaporated Member. Based on paleontological studies in the Arghavan section were recognized 23 genera and 10 species, and in Banroshan section 12 genera and 6 species of foraminifera, some non-foraminifera and macrofossils. According to the foraminifera scattering in the studied sections the four of biozones were recognized, and suggested Aquitanian-Burdigalian? and Rupelian-Burdigalian ages for the Asmari Formation in Banroshan and Arghavan sections respectively.

Key words: Asmari Formation, microbiostratigraphy, foraminifera, Ilam**Introduction**

The carbonate platform sediments that form the Asmari Formation involve a number of the largest oil reserves in the world [2]. In the most Zagros region, this formation is located on the Pabedeh Formation and Gachsaran subformation. In Khuzestan zone, Ahvaz sandstone member and, in Lorestan, Kalhor evaporate member were identified in the Asmari Formation [7]. According to benthic foraminifer's accumulation, the formation is separated into lower, middle, and upper sections [1]. Based upon benthic foraminifer's dispersion and strontium isotope stratigraphy, Rupelian to Burdigalian age was considered for this formation [1,3,4,6,9]. In spite of the formation wide spreading in Ilam zone, no study has been conducted on its stratigraphy and paleontology yet. Therefore, this research intends to study the biostratigraphy of the Asmari Formation and to determine its age in the regions.

Research Method:

This research, intending to study the lithostratigraphy and microbiostratigraphy of the Asmari Formation in the Arghavan and Banroshan sections which was conducted in some phases. First,

the sections were studied on the field and based on thickness of the calcareous member of the Asmari Formation and facies variations were collected 102 samples in Arghavan section and 106 samples in Banroshan section systematically (with a distance of about one meter). Moreover, some samples were collected from the lower Pabedeh Formation. The thin sections were carefully studied in the laboratory and microfauna were identified. Then, four biozones were introduced according to foraminifer's dispersion.

Geographical Situation and Regional Access Routes:

The Arghavan section is situated in northeastern Ilam, at the city entrance, from Sarablah towards Ilam (between Azadi Tunnel and Arghavan Square) at Arghavan gorge (Fig. 1). It is situated at latitude 33°38'58.2" north and longitude 46°26'53.1" east, being 1519 meters above sea level. The section, leading to Arghavan Square through the main road, is readily accessible. The Banroshan section is located in southwestern Ilam, 25 kilometers distant from Ilam –Mehran Road (Fig. 1). It is situated at latitude 33°32'57" north and longitude 46°11'42" east, being 584 meters above sea level.

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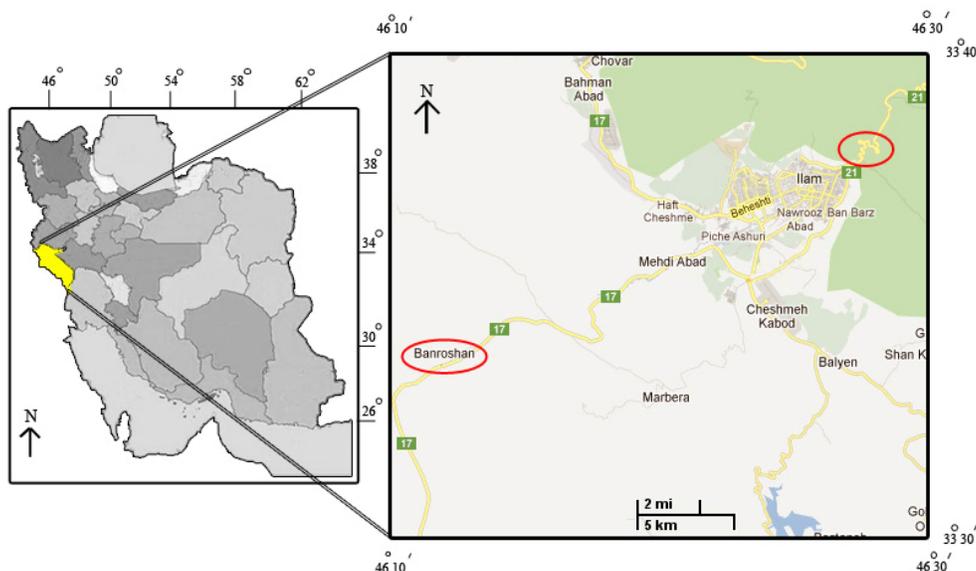


Fig. 1: Map showing the location of the study areas in Northeastern and Southwestern Ilam, West Iran, adopted from <http://maps.google.com/>

Stratigraphic description of the Arghavan section:

The Asmari Formation in the Arghavan section, with an actual thickness of 108 meters, involves medium-bedded, thick-bedded, and massive limestone. The dip and strike of beds at the section is N80E/24NW on the average. At this section, the deposits of the Asmari Formation are placed on the Pabedeh Formation, which is a frequency of limestone and shale (Fig. 2a), and under gypsiferous beds of Gachsaran, both in a conformable and continuous contact (Fig. 2b).

In this research, some samples were collected from the upper limestone of the Pabedeh Formation for determining the lower boundary of the Asmari Formation, and Roupelian age was considered for the upper part of the formation. However, no sample was taken from the Gachsaran Formation due to its lack of fossils. Therefore, boundary determination between the Asmari and the Gachsaran formations was merely conducted by their lithology specifications. The Asmari Formation in the Arghavan section involves a calcareous member whose bottom-up lithology specifications are as follows, respectively:

(1) Three meters of gray, thick-bedded limestone in which traces of stylolite and dispersed fractures are observed. According to its foraminifers, Roupelian-Chattian age was considered for it. For example, a number of these foraminifers are *Eouvigerina iranica* (Thomas), *Eouvigerina khuzistanica* (Thomas), *Haplophragmium slingeri* (Thomas), and *Operculina complanata* (De France).

- (2) Fourteen meters of gray, thick-bedded limestone that its foraminifers indicated Roupelian-Chattian age. A number of its major foraminifers are *Eouvigerina iranica* (Thomas), *Eouvigerina khuzistanica* (Thomas), *Haplophragmium slingeri* (Thomas), *Lepidocyclina (Eulepidina) dilitata* (Michelotti), *Operculina complanata* (DeFrance), *Rotalia viennoti* (Greig et. Vars), and *Triloculina trigonula* (d'Orbigny).
- (3) Eight meters of gray, medium-bedded limestone that its foraminifers indicated Roupelian-Chattian age. A number of its foraminifers are *Eouvigerina iranica* (Thomas), *Eouvigerina khuzistanica* (Thomas), *Lepidocyclina (Eulepidina), dilitata* (Michelotti), *Operculina complanata* (DeFrance), and *Rotalia viennoti* (Greig et. Vars).
- (4) Twelve meters of gray, thick-bedded limestone on which many large foraminifers are witnessed. Its foraminifers were the same as those in part three, and Roupelian-Chattian age was also considered for it.
- (5) Twenty-five meters of gray, thick-bedded limestone including many pelecypod fossils. Roupelian-Chattian age was also considered for these limestones. A number of its foraminifers are *Eouvigerina iranica* (Thomas), *Lepidocyclina (Eulepidina), dilitata* (Michelotti), and *Operculina complanata* (DeFrance).
- (6) Forty-six meters of gray, thick-bedded to massive limestone in which traces of solution and crystallization are observed. This alternation has quite changed into calcite megacrysts upward, lacking any macrofossil. However, its

main foraminifers are *Asterigerina rotula* (Kaufmann et. Vars), *Miogypsinoides complanatus* (Schlumberger), and *Sphaerogypsina globules* (Reuss). The age of (7)

this section, based upon its foraminifers and stratigraphical situation was considered as Aquitanian- Burdigalian (?).

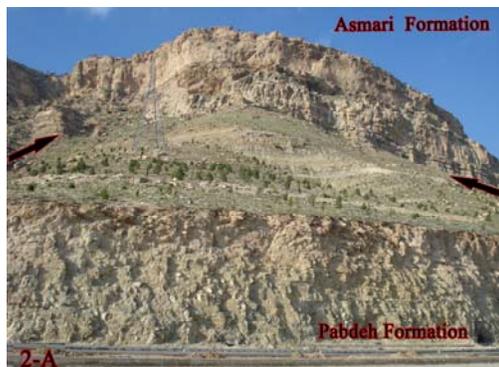


Fig. 2.A: The lower boundary of the Asmari Formation with the Pabdeh Formation in Arghavan section (photo is looking to NE),

Fig.2.B: The upper boundary of the Asmari Formation with the Gachsaran Formation in Arghavan section (photo is looking to E).

Stratigraphic description of the Banroshan section:

The Asmari Formation in Arghavan section, with an actual thickness of 232.5 meters, involves an evaporate member (Kalhor member) with 144.5 meters thick, and a calcareous member, 88 meters thick. The dip and strike of beds at the section is N310W/40SE on the average. The lower boundary of the formation (Kalhor member) is conformable and continuous with the Pabdeh Formation, which involves a frequency of limestone and shale. In addition, its upper boundary is conformable and continuous with the evaporate beds of the Gachsaran Formation. In this research, some samples were collected from the upper limestone of the Pabdeh Formation for determining the lower boundary of the Asmari Formation. These limestones lack any Index microfossil. However, based upon the studies by Sahandi [8] on the microfossils of shale and marl members, Roupelian-Chattian age was considered for the formation. However, no sample was collected from the evaporate beds of the Gachsaran Formation due to its lack of fossils. Therefore, boundary determination between the Asmari and the Gachsaran Formations was merely conducted by their lithologic description (Fig.3). The Asmari Formation in Banroshan section involves two members whose lithology specifications are as follows: (A) The evaporate member (Kalhor member) with 144.5 meters thick, involving gypsiferous white beds which lack fossils, and its age is considered as Aquitanian from Early Miocene due to its stratigraphic situation [1,4,7] (B) The calcareous member (88 m), whose bottom-up lithologic specifications are as follows:

- (1) Sixteen meters of cream to gray, thick-bedded limestone including a few pelecypod fossils. A number of its foraminifers are *Austrotrilina howchini* (Schlumberger), *Dendritina rangi* (d'Orbigny), *Peneroplis evolutus* (Henson), and *Triloculina trigonula* (d'Orbigny) according to which the age of the member was considered as Aquitanian.
- (2) Sixteen meters of cream, medium-to thick-bedded limestone involving some traces of fractures, in which some pieces of pelecypod and gastropod fossils are witnessed upward. The age of this member, based upon its foraminifers, is Burdigalian. A number of its foraminifers are *Austrotrilina howchini* (Schlumberger), *Borelis melo* (Fichtel and Moll), *curdica* (Reichel), *Dendritina rangi* (d'Orbigny), *Meandropsina iranica* (Henson), and *Peneroplis evolutus* (Henson).
- (3) Twelve meters of cream, thick-bedded limestone in which traces of solution and geode are observed. Its age was considered as Burdigalian based upon its foraminifers. Its foraminifers are *Borelis melo* (Fichtel and Moll), *curdica* (Reichel), *Dendritina rangi* (d'Orbigny), and *Meandropsina iranica* (Henson).
- (4) Fifteen meters of cream to gray, thick-bedded limestone, including a few pelecypod and gastropod fossils. Its foraminifers are similar to those of the third member, and its age is considered as Burdigalian.
- (5) Twenty-nine meters of gray, thick-bedded to massive limestone in which many traces of fracture and porosity are observed. The age of this member, based upon its foraminifers and

stratigraphical situation was considered as Burdigalian. A number of its foraminifera are (6)

Dendritina rangi (d'Orbigny), *Meandropsina iranica* (Henson), and *Peneroplis* sp.

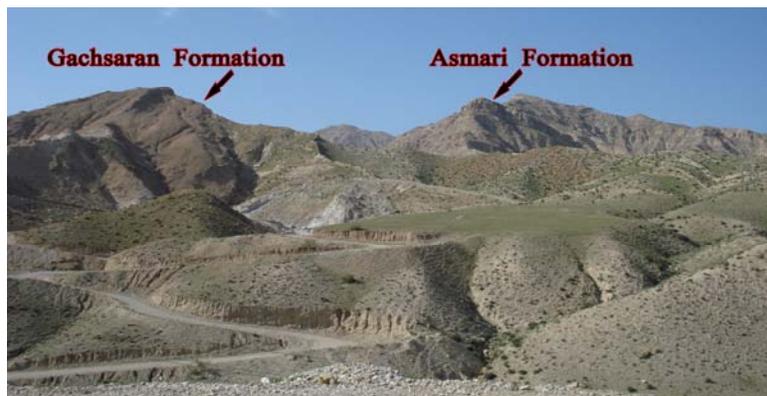


Fig. 3: The Asmari and Gachsaran formations in Banroshan section (photo is looking to NE)

Biostratigraphy of the Asmari Formation in Arghavan section:

In this section, 22 genera and 10 species of foraminifera and a number of non-foraminifera were identified (Fig.4). Considering the foraminifera, the following biozones were identified from its base upward:

1. *Lepidocyclina (Eulepidina) dilitata* – *Operculina complanata* Assemblage Zone

This biozone with 53 meters thick involves Ar.1-Ar.77 rock samples from rock succession of the section. The assemblage zone lies at the outset of the Asmari Formation deposits, and is correspondent to the genesis of *Operculina complanata* species and the frequency of *Lepidocyclina (Eulepidina) dilitata*. Other microfossils of this biozone includes: **Foraminifera:** *Eouvigerina iranica*, *Eouvigerina khuzistanica*, *Haplophragmium slingeri*, *Rotalia viennoti*, *Triloculina rignonula*, *Amphistegina* sp., *Asterigerina* sp., *Bigenerina* sp., *Bolivina* sp., *Cibicides* sp., *Discorbis* sp., *Elphidium* sp., *Globigerina* sp., *Globorotalia* sp., *Gyroidina* sp., *Heterostegina* sp., *Lenticulina* sp., *Lepidocyclina* sp., *Lepidocyclina (Eulepidina)* sp., *Lepidocyclina (Nephrolepidina)* sp., *Operculina* sp., *Planorbulina* sp., *Rotalia* sp., *Rupertia* sp., *Textularia* sp., *Uvigerina* sp., *Valvulina* sp., Miliolid, Rotalid, Textularid; **Non Foraminifera:** *Ditrupea* sp., *Lithophyllum* sp., *Lithothamnium* sp., *Onyocella* sp., *Tubucellaria* sp.

According to the microfossils, this biozone is equal to biozone No. 3, introduced by Adams and Bourgeois [1], and to the biozone *Lepidocyclina-Operculina-Ditrupea* Assemblage Zone expressed by Laursen *et al.* [5]. This assemblage zone also corresponds with biozone No. 56 [10]. In general, the age of this member is Oligocene (Roupelian-Chattian). It is rather impossible to identify the

boundary of Roupelian and Chattian stages at this region due to the absence of *Nomolites*.

2. *Asterigerina rotula-Miogypsinoides complanatus* Assemblage Zone

This biozone with 20 meters thick involves Ar.78-Ar.90 rock samples from rock succession of the section. This biozone is correspondent to the genesis of *Asterigerina rotula* and *Miogypsinoides complanatus* species. Other microfossils of this biozone include: **Foraminifera:** *Eouvigerina iranica*, *Sphaerogypsina globulos*, *Amphistegina* sp., *Discorbis* sp., *Elphidium* sp., *Gyroidina* sp., *Heterostegina* sp., *Lenticulina* sp., *Lepidocyclina* sp., *Operculina* sp., *Planorbulina* sp., Miliolid, Rotalid, Textularid; **Non Foraminifera:** *Ditrupea* sp., *Lithophyllum* sp., *Lithothamnium* sp., *Onyocella* sp., *Tubucellaria* sp.

According to the microfossils mentioned above, this biozone is equal to biozone No. 2 introduced by Adams and Bourgeois [1], and corresponds with biozone No. 59 [10], and is also equivalent to the biozone of *Miogypsina-Elphidium* sp.14 – *Peneroplis farsensis* assemblage zone [5]. Its age is considered as that of Aquitanian.

Few fossils are observed at this member (35 meters) due to the crystallization of its upper limestone. Therefore, no biozone may be considered for it. However, the age of this member, based upon its stratigraphical situation, was considered as Aquitanian- Burdigalian (?).

Biostratigraphy of the Asmari Formation in Banroshan section:

In this section, 12 genera and 6 species of foraminifera, as well as a number of non-foraminifera were identified (Fig. 5). At the section under study, considering the foraminifera fossils, the

following biozones were identified from its base upward:

1. *Austrotrillina howchini* – *Peneroplis evolutus* Assemblage Zone

This biozone with 28 meters thick involves Ba.1-Ba.46a samples from the section. The biozone is correspondent to the genesis of *Austrotrillina howchini* species and the extinction of *Peneroplis evolutus* species. Other microfossils of this biozone include: **Foraminifera:** *Dendritina rangi*, *Triloculina trigonula*, *Bolivina* sp., *Discorbis* sp., *Lepidocyclina* sp., *Miliola* sp., *Pyrgo* sp., *Quinqueloculina* sp., *Spirolina* sp., *Textularia* sp., Miliolid; **Non Foraminifera:** *Kuphus arenarius* sp., and *Lithothamnium* sp.

This biozone is equal to biozone No. 2 introduced by Adams and Bourgeois [1], and corresponds with biozone No. 59 [10], and is equivalent to the biozone of *Miogypsina-Elphidium* sp.14 – *Peneroplis farsensis* assemblage zone [5]. Its age shows that of Aquitanian.

2. *Borelis melo curdica* – *Meandropsina iranica* Assemblage Zone

This biozone with 50 meters thick involves Ba.46b-Ba.103 samples from the section. This biozone is correspondent to the genesis and association of *Borelis melo curdica* and *Meandropsina iranica* species. Other microfossils of this biozone include: **Foraminifera:** *Dendritina rangi*, *Elphidium* sp., *Massilina* sp., *Meandropsina* sp., *Peneroplis* sp., *Quinqueloculina* sp., Miliolid; **Non Foraminifera:** *Lithophyllum* sp. This biozone is equal to biozone No. 1 introduced by Adams and Bourgeois [1], and corresponds with biozones No. 61 and 62 [10], and is equivalent to the biozone of *Borelis melo curdica* – *Borelis melo melo* assemblage zone [5]. and its age is considered as that of Burdigalian. No fossil is observed in this zone due to the crystallization of upper limestones (10 meters). Therefore, no biozone may be considered for it. However, the age of this member, based upon its stratigraphic situation, was considered as Burdigalian.

Correlation:

In the Arghavan section, the lower boundary of the Asmari Formation with the Pabedeh Formation is conformable and continuous. The Asmari Formation has 108 meters thickness and is composed of medium-bedded to massive limestones (Fig. 6). At the base of the formation, plankton fossils along with the benthic foraminifera ones are abundant. However, towards the top, only benthic foraminifera are witnessed. The age of the formation in this section, considering the identified biozones, is from Roupelian to Burdigalian (?) [1]. Then, Asmari

limestones change their facies in a vertical way to Gachsaran evaporate sequence due to marine regression [7]. In the Banroshan section, the Asmari Formation comprises an evaporate member (Kalhor member) at the bottom and a calcareous member at its top. Kalhor evaporite member, 144.5 meters thick, is located on the Pabedeh Formation, on which the Asmari limestone member, 88 meters thick, is formed in a conformable and continuous sequence (Fig. 6). The microfossils of the Asmari Formation in this member are of benthic foraminifera species, and the Asmari Formation age is Aquitanian-Burdigalian based upon the identified biozones [1]. At last, the Gachsaran Formation replaces the Asmari in this section due to marine regression [7]. By comparing the Asmari Formation in the sections under study, in Banroshan section, the base of the Asmari Formation has been much younger than that of the Arghavan section so that the Pabedeh Formation has been depositing prior to early Miocene due to the depth of the basin in the Banroshan section. However, the lower Asmari has deposited in the Arghavan section at the same time [4]. In addition, Wynd [10] believes that, in the regions where the lower member of the Asmari Formation (the part belonging to Oligocene) is not observed, it has been replaced by the upper member of the Pabedeh Formation. Therefore, in the Arghavan section, the lower, middle, and upper Asmari, and in the Banroshan section, the middle and upper Asmari are observed. Here, the identified biozones I and II are not comparable; however, no fossils were witnessed at their terminal members due to the crystallization of the limestones.

Results:

In the Arghavan section, the Asmari Formation merely involves one limestone member. In the Banroshan section, however, it is composed of an evaporate (Kalhor member) and a limestone member. In the Arghavan section, 22 genera and 10 species, and in Banroshan section, 12 genera and 6 species of foraminifera were identified. Moreover, a number of non-foraminifera were recognized in both sections. Two biozones were determined at each section from the Asmari Formation. Hence, for the Asmari Formation in Arghavan section, the age of Roupelian to Burdigalian was considered. However, in Banroshan section, its age was determined as Aquitanian to Burdigalian [1]. In Banroshan section, the Asmari Formation base has become younger than that in Arghavan section so that the Pabedeh Formation has been depositing in Banroshan section due to the basin depth. However, the lower Asmari has deposited in the Arghavan section at the same time [4]. Therefore, in the Arghavan section, the lower, middle, and upper Asmari, and in Banroshan section, the middle and upper Asmari are observed.

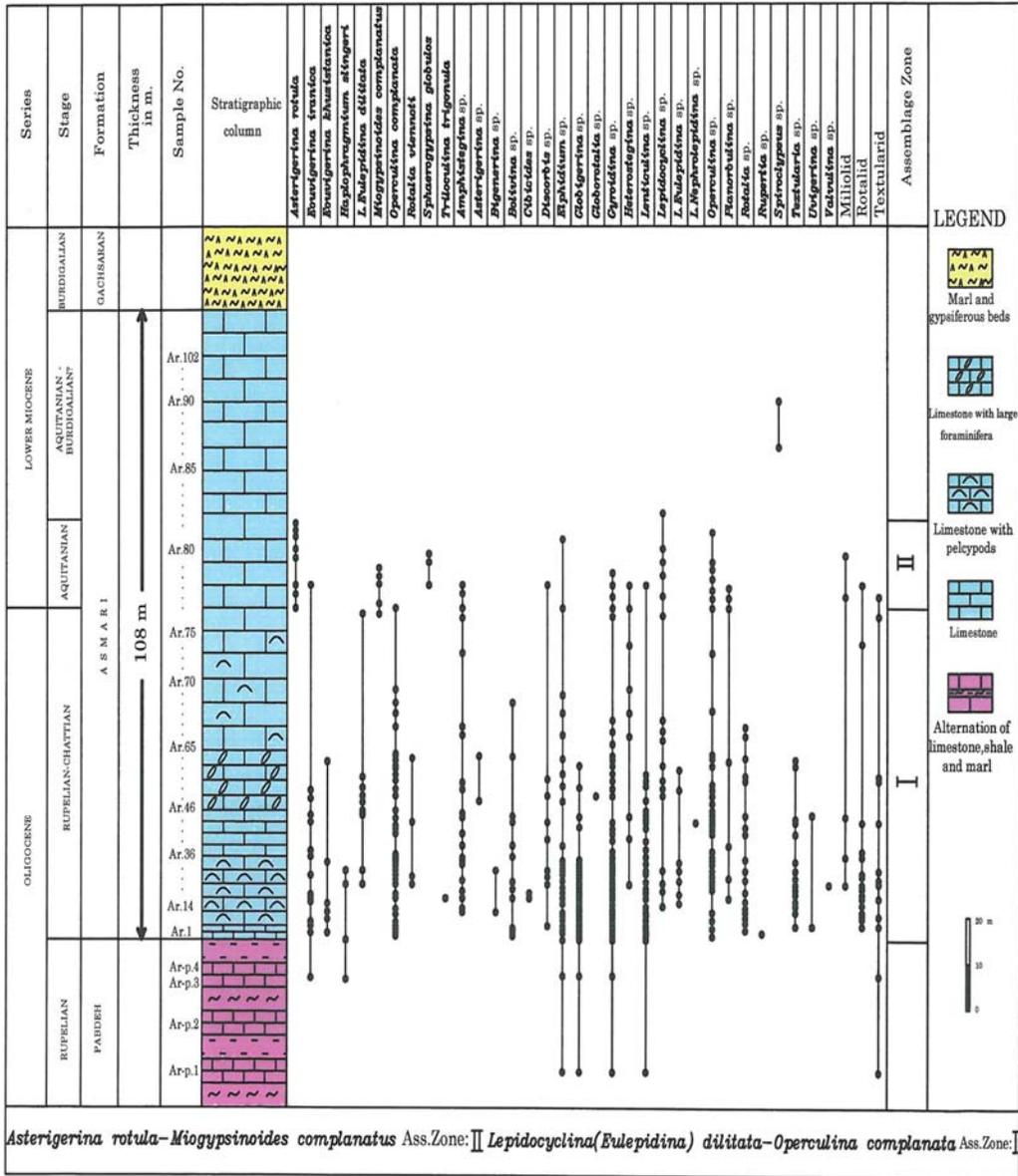


Fig. 4: Distribution and the time spread of the identified foraminifer's of the Asmari Formation in the Arghavan section

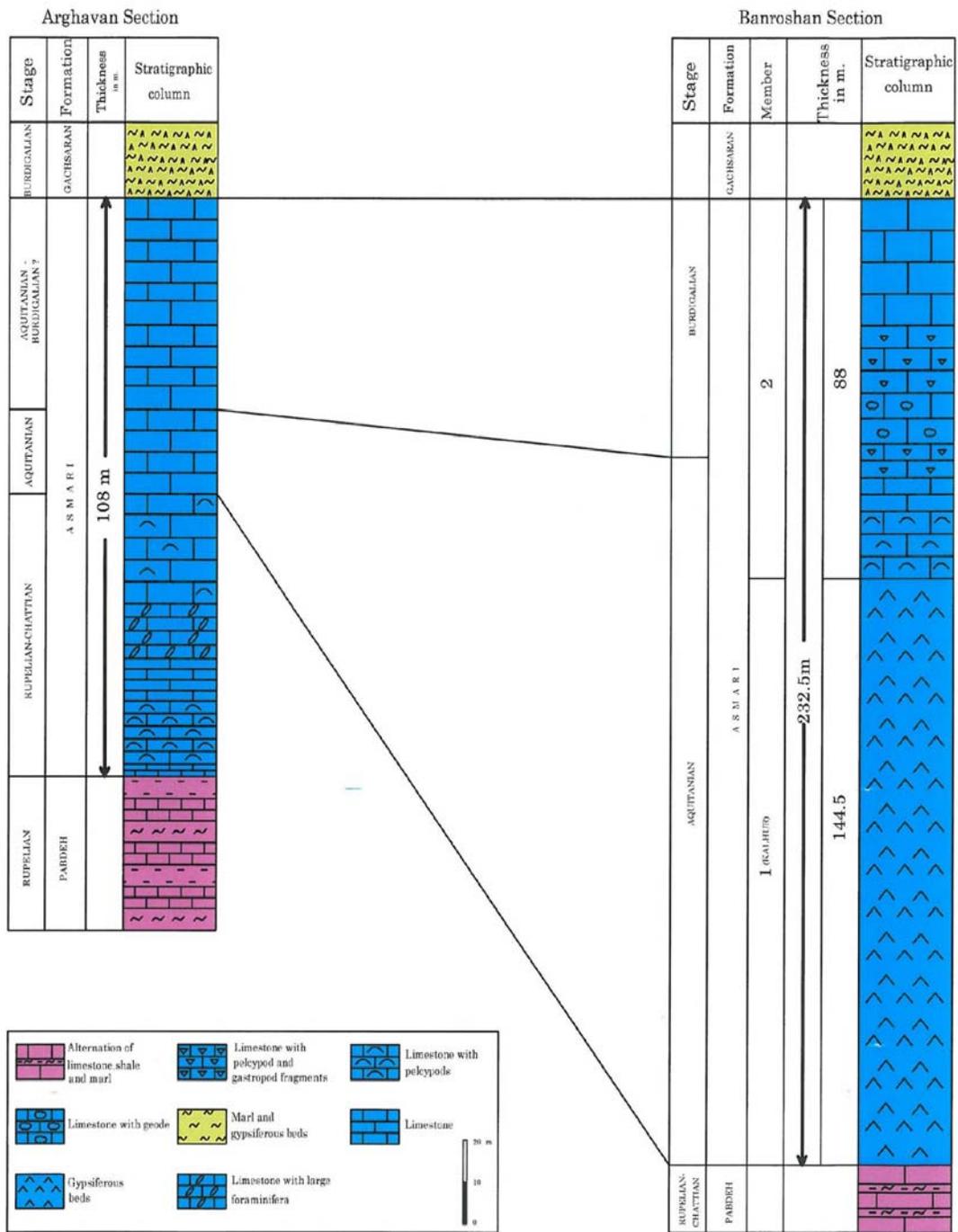


Fig. 5: Distribution and the time spread of the identified foraminifer's of the Asmari Formation in the Banroshan section

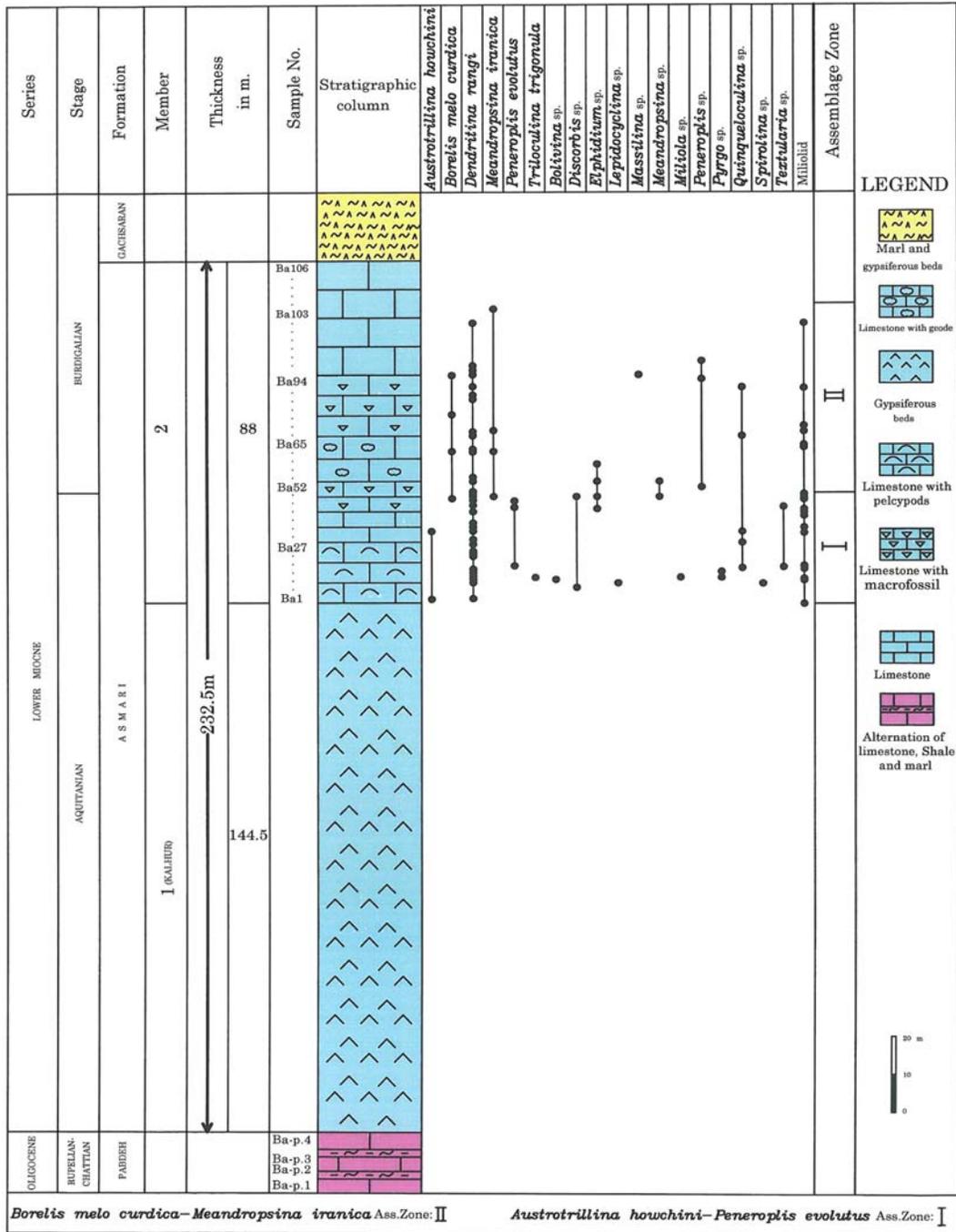
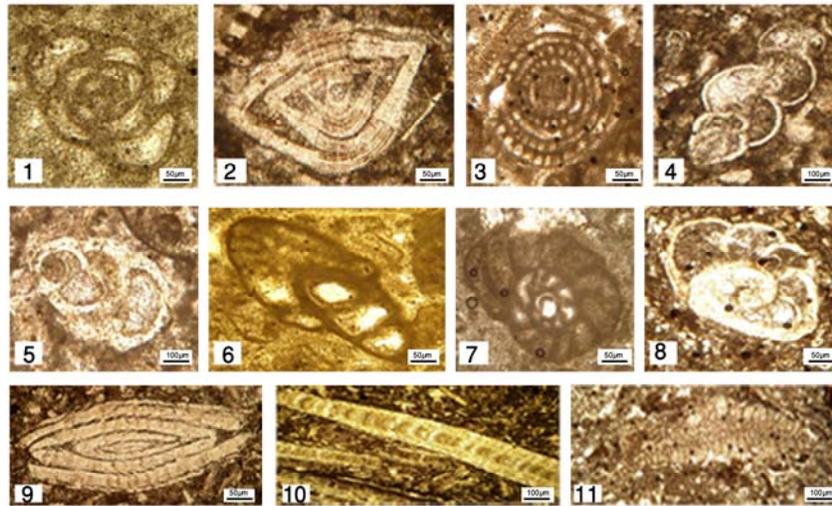
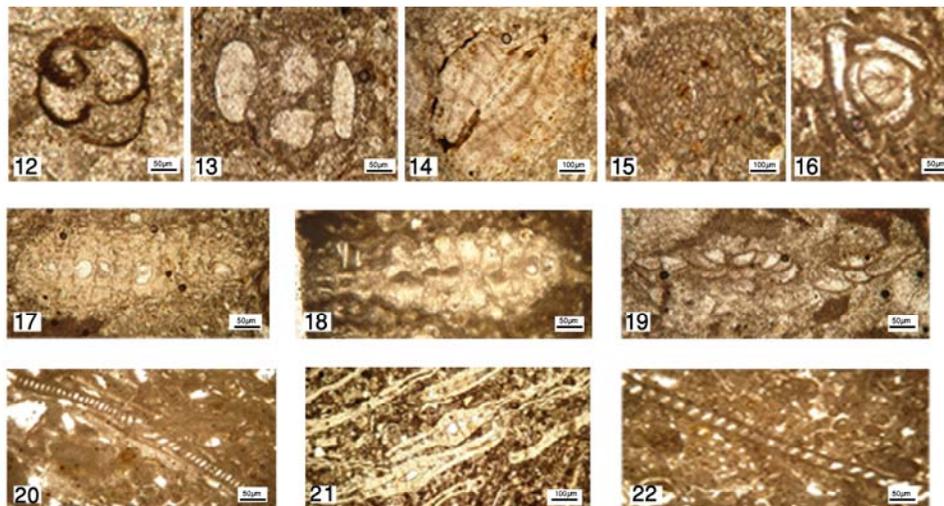


Fig. 6: A comparison of stratigraphic columns in the Arghavan and Banroshan sections



1. *Austrotrillina howchini*, Banroshan section 2. *Asterigerina rotula*, Arghavan section 3. *Borelis melo curdica*, Banroshan section 4. *Eouvigerina iranica*, Arghavan section 5. *Eouvigerina khuzistanica*, Arghavan section 6. *Dendritina rangi*, Banroshan section 7. *Dendritina rangi*, Banroshan section 8. *Rotalia viennoti*, Arghavan section 9. *Amphistegina* sp., Arghavan section 10. *Lepidocyclina (Eulepidina) dilitata*, Arghavan section 11. *Spiroclypeus* sp., Arghavan section



12. *Valvulina* sp., Arghavan section 13. *Haplophragmium slingeri*, Arghavan section 14. *Heterostegina* sp., Arghavan section 15. *Sphaerogypsina globulos*, Arghavan section 16. *Triloculina trigonula*, Banroshan section 17. *Miogypsinoidea complanatus*, Arghavan section 18. *Miogypsinoidea complanatus*, Arghavan section 19. *Planorbulina* sp., Arghavan section 20. *Peneroplis evolutus*, Banroshan section 21. *Operculina complanata*, Arghavan section 22. *Meandropsina iranica*, Banroshan section

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