

Lithostratigraphy and biostratigraphy of the Permian deposits in Sangsar section, North of Semnan, eastern Alborz

Amene Sedighian^{1,*}, Seyed Hamid Vaziri², Mahmoudreza Majidifard³, Masoud Zamani Pedram⁴

- 1- Research Institute for Earth Sciences, Geological Survey of Iran, Tehran, Iran.
- 2- Geology Department, Faculty of Basic Sciences, North Tehran Branch, Islamic Azad University, Tehran, Iran
- 3- Research Institute for Earth Sciences, Geological Survey of Iran, Tehran, Iran
- 4- Areal geology, Geological Survey of Iran, Tehran, Iran

* Corresponding Author: amene.sedighian@yahoo.com

Received: 16 April, 2016 / Accepted: 13 June 2016 / Published online: 30 June 2016

Abstract

The Permian deposits in the stratigraphic section of Sangsar (located in the eastern Alborz), are the best expose in the Semnan area. This sequence consists of the Doroud (Asselian-Sakmarian), Ruteh (Artinskian-Murgabian) and Nessen (Early Djulfian) formations. The Dorud Formation in the studied section with 56 m thickness consists of conglomerate, sandstone and quartzite, which is disconformity overlies on the Mobarak Formation. The Ruteh Formation with a thickness of 116 m consists of fossiliferous limestones. This formation in the studied section can be subdivided into two rock units that is covered the Doroud Formation with a transitional contact and overlain by bauxite-laterite horizon of the Nessen Formation disconformable. The rich foraminifer fauna of the Ruteh Formation can be established three biozones include the *Schubertella-Mesoschubertella* Assemblage Zone (Artinskian), *Dunbarulla-Codonofusiella* Assemblage Zone (Early Murgabian), *Pachyphloia-Neoendothyra* Assemblage Zone (Late Murgabian).

Keywords: Permian, Foraminifera, Biozonation, Sangsar area.

1- Introduction

Permian rocks are widely distributed throughout North of Iran (Alborz Zone). They consist mainly of clastic rocks in the lower part and fossiliferous carbonate rocks in the upper part (Partoazar, 1995). These rocks have been named as the Dorud, Ruteh and Nesen Formations (Assereto, 1963; Glaus, 1964; Aghanabati, 2004). The main purpose of this research is lithostratigraphy and microbiostratigraphy of the succession based on the foraminiferal contents and to establish biozones. Nabavi M. (Nabavi, 1982) prepared geological map of foursquare of Semnan with scale of 1:100,000, Eastern Alborz that includes the studied area. For the foraminiferal biostratigraphy, fifty four limestone samples were collected from the

Ruteh formation. The samples were collected at an interval of two meters and one or sometimes two to four thin sections were prepared.

2- Lithostratigraphy

Well-defined outcrops of the Lower to Upper Permian rocks lie along the Sangsar area, northwest of Mahdishahr in eastern Alborz, northern Iran with coordinates of N 35° 43' 39" _ E 53° 20' 34" (Fig. 1).

Permian rocks overlie disconformably the gray limestone rocks Carboniferous and are covered disconformably by the Elikah Formation that has shown in the map. The Permian rocks of the Sangsar area consists of three formations: The

Dorud, Ruteh and Nesen Formations with Asselian to Early Djujlfian age (Fig. 2).

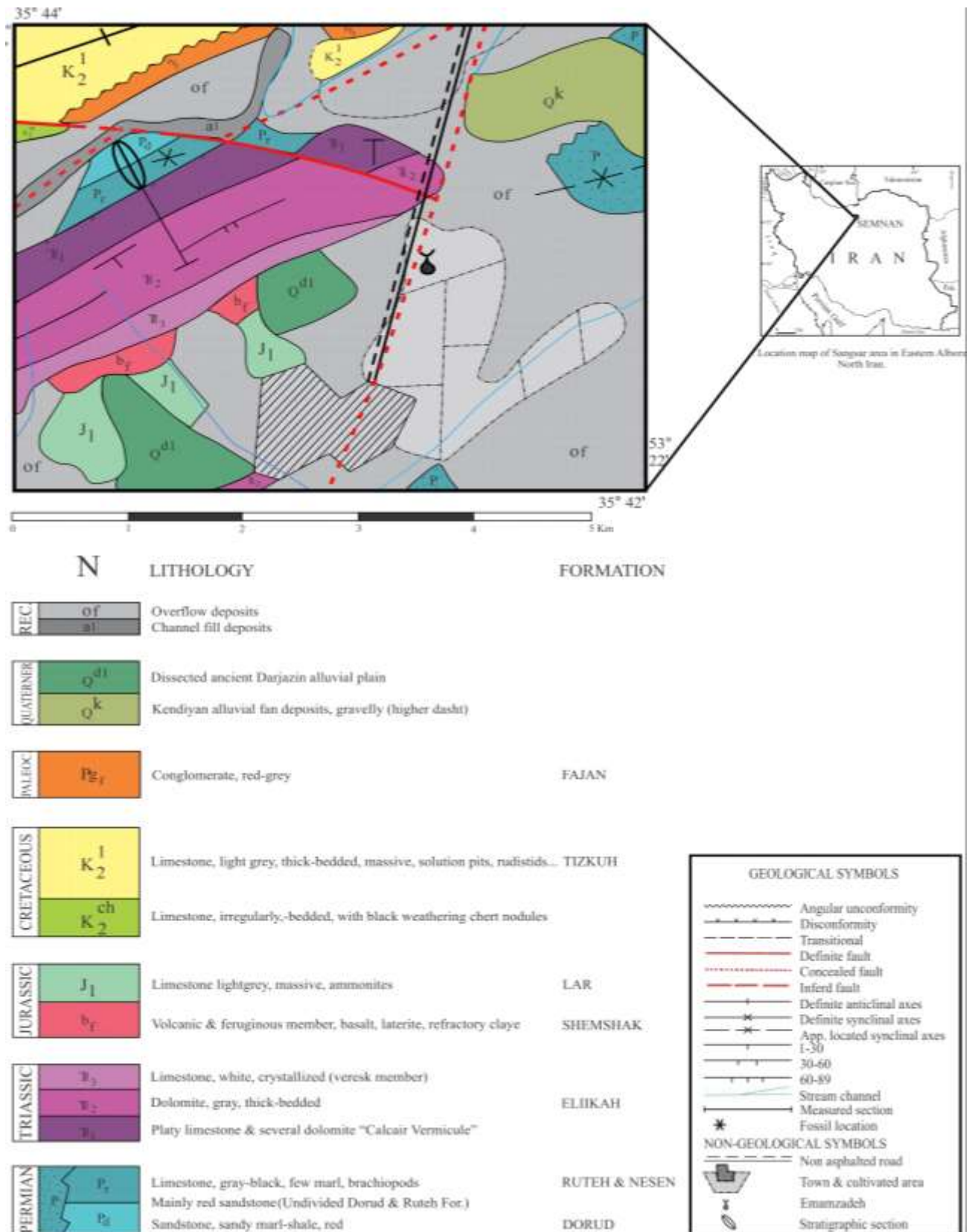


Figure 1) Geological map of the studied area in Eastern Alborz, North of Iran (Nabavi M., 1982).

3.1- The Dorud Formation

The clastic sediments of the Dorud Formation characterize the Lower Permian rocks of the

Alborz Zone. The type section of the Dorud Formation is located in central Alborz near the village of Dorud (North Tehran), where it has a thickness of 180 meters (Assereto, 1963). It

overlies nonconformably the Jeirud Formation (Upper Devonian) and consists of red sandstones, shales, conglomerate, fossiliferous limestones and quartzite. This Formation in the Sangsar section can be subdivided into two informal members as following:

member 1 (3 m): consists of oligomictic, gray to redish medium to thick-bedded conglomerate.

member 1 (53 m): Red thin to medium-bedded sandstone with red to grayish medium to thick-bedded quartzite to sub-quartzite in the upper part with Early Permian age, which is covered disconformably by the Ruteh Formation, (Fig. 3: a, b, c, d).

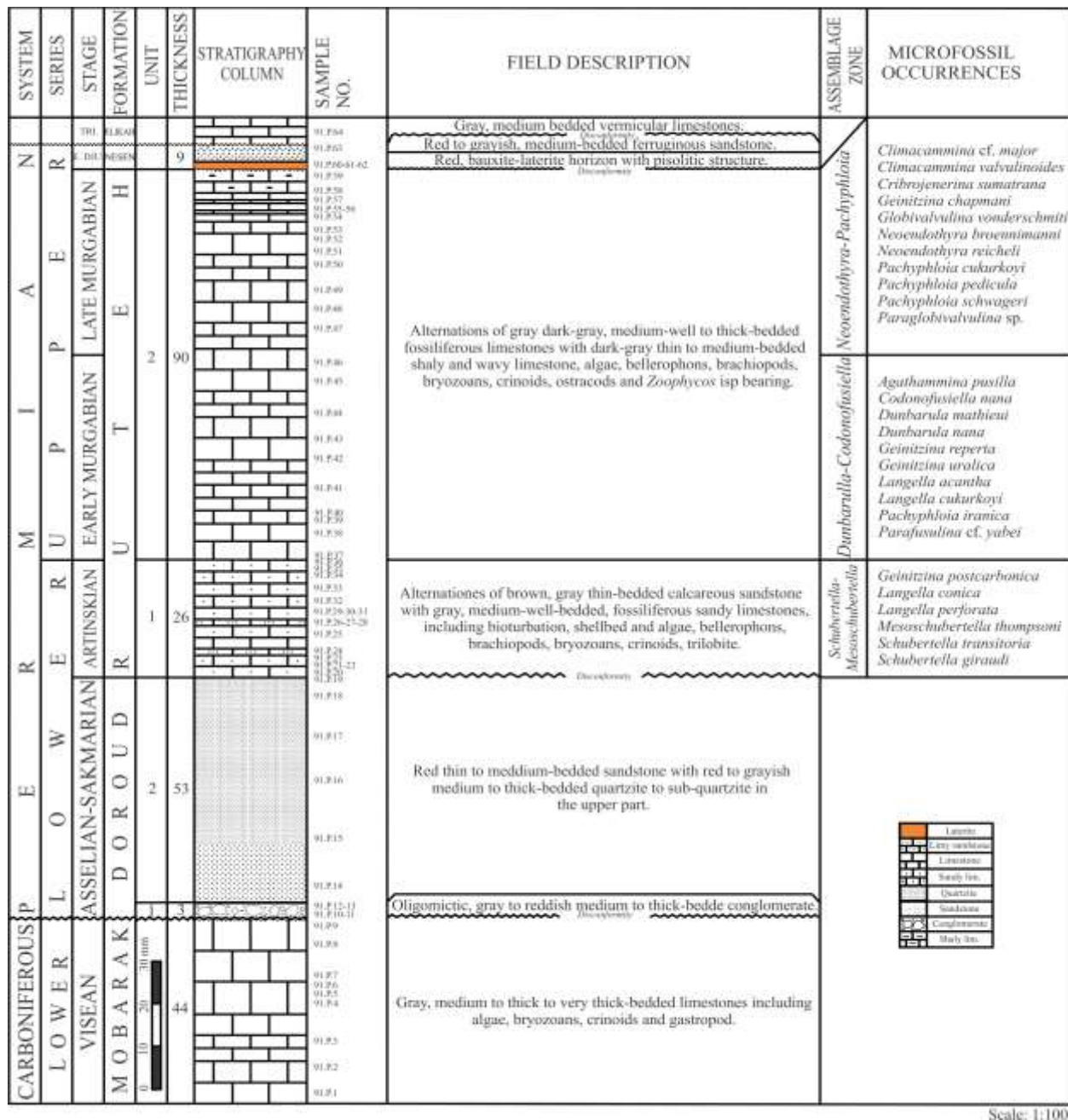


Figure 2) Lithostratigraphical characteristics and biozones of the Permian System in northwest of Sangsar, eastern Alborz, North of Iran.

Since the establishment of this unit according to the stratigraphic position and compare it with similar sections in the Alborz like Abyek–Hiv (Vaziri, 2005), Arou (Ghasemi-Nejad, 2002),

Tilabad (Ghamami, 2004) and Ruteh (Khajehvand, 2005) is considered Asselian-Sakmarian.

3.2- The Ruteh Formation

The type section of the Ruteh Formation is located in central Alborz near the village of Ruteh (North Tehran), where it has a thickness of 230 meters and consists of dark gray, medium-bedded to massive fossiliferous limestones (Assereto, 1963). In the Sangsar area, this Formation with a thickness of 116 meters disconformably overlies the Dorud Formation and consists of fossiliferous limestones, (Fig. 3: e, f, g, h, i) This Formation in the study section can be subdivided into two informal members as following:

member 1 (26 m): Alternating brown, gray thin-bedded calcareous sandstone to Gray medium-well-bedded fossiliferous sandy limestones. This member contains macrofossils such as Bellerophontid, brachiopoda, ichnofossil of the *Zoophycos* and cyanobacteria of the *Tubiphytes obscurus* Maslov (Maslov, 1956). *Tubiphytes* is commonly interpreted as a calcified cyanobacterium (Riding, 1991). (Senowbari-Daryan and Flugel, 1993) asserted that a combination of non-preserved molluscous (central tube) and a cyanobacterial envelope is the original interpretation of Maslov regarding *Tubiphytes*. Riding (Riding, 1991) emphasized that the correct name of *Tubiphytes obscurus* is *Shamovella obscura*. The traditional name is consequently used in the article. This member also includes the following microfossils (thin sections no. 91. P. 19~36):

Foraminifera: *Agathammina* sp., *Chusenella abichi* Miklukho-Maklay, *Climacammina* sp., *Codonofusiella* sp., *Codonofusiella erki* Rauser., *Dicyclina* sp., *Earlandia* sp., *Endothyra* sp., *Endothyra convexa* Rauser., *Geinitzina* sp., *Geinitzina postcarbonica* Spandel, *Geinitzina* cf. *reperta* Bikova, *Geinitzina uralica* Suleimanov, *Globivalvulina* sp., *Globivalvulina bulloides* Brady, *Kahlerina pachythea* Koch. Devide et Ramors, *Langella* sp., *Langella conica* De Civrieux and Dess, *Langella cukurkoyi* De Civrieux and Dess, *Langella*

perforata Lange, *Mesoschubertella* sp., *Minojapanella* cf. *elongata* Fujimoto and Kanuma, *Neoendothyra* sp. *Neoendothyra broennimanni* Bozorgnia, *Pachyphloia* sp., *Pachyphloia cukurkoyi* De Civrieux and Dess, *Paleotextularia* sp., *Pseudolangella* sp., *Pseudolangella* cf. *fragilis* De Civrieux and Dess, *Schubertella* sp., *Schubertella transitoria* Staff and Wedekind., *Tuberitina* sp., *Tuberitina collosa* Reitlinger; **Algae:** *Gymnocodium bellerophontis* Ruthpletz, *Gymnocodium* sp., *Permocalculus* sp., *Vermiporella nipponica* Endo.;

Cyanobacteria: *Tubiphytes* sp., *Tubiphytes obscurus* Maslov.

This member contains ostracoda, trilobite fragments, bryozoan, echinoderm spine, chrinoid, too. This member has Artinskian age.

member 2 (90 m): Alternating gray and dark gray, medium-well to thick-bedded and fossiliferous limestones with dark-gray thin to medium-bedded shaly and wavy limestones. This member contains macrofossils similar to member 1 and includes the following microfossils (thin sections no. 91. P. 37~59):

Foraminifera: *Agathammina* sp., *Agathammina pusilla* Geinitz, *Baisalina* sp., *Bisphaera ovoidea* Conil and LYS, *Climacammina* sp., *Climacammina* cf. *major* Reitlinger, *Climacammina sphaerica* Potieskaya, *Climacammina valovulinoides* Lange, *Climacammina* cf. *grandis* Reitlinger, *Codonofusiella* sp., *Codonofusiella erki* Rauser., *Codonofusiella nana* Erk, *Cribrogenerina* sp., *Cribrogenerina sumatrana* Volz, *Cryptosetida* (*Langella*) *bozorgniansis* Partoazar and Vaziri, *Deckerella* sp., *Deckerella composita* Reitlinger, *Dunbarulla* sp., *Dunbarulla mathieui* Ciry, *Dunbarulla nana* Koch., *Endothyra* sp., *Froncina permica* De Civrieux and Dess, *Geinitzina* sp., *Geinitzina chapmani* Schubert var. *longa* – Suleimanov, *Geinitzina* cf. *reperta* Bikova, *Geinitzina uralica* Suleimanov, *Globivalvulina* sp., *Globivalvulina vondreschmiti* Reitlinger, *Hemigordius* sp.,

Langella sp., *Langella acantha* Lange, *Langella cukurkoyi*
conica De Civrieux and Dess, *Langella*

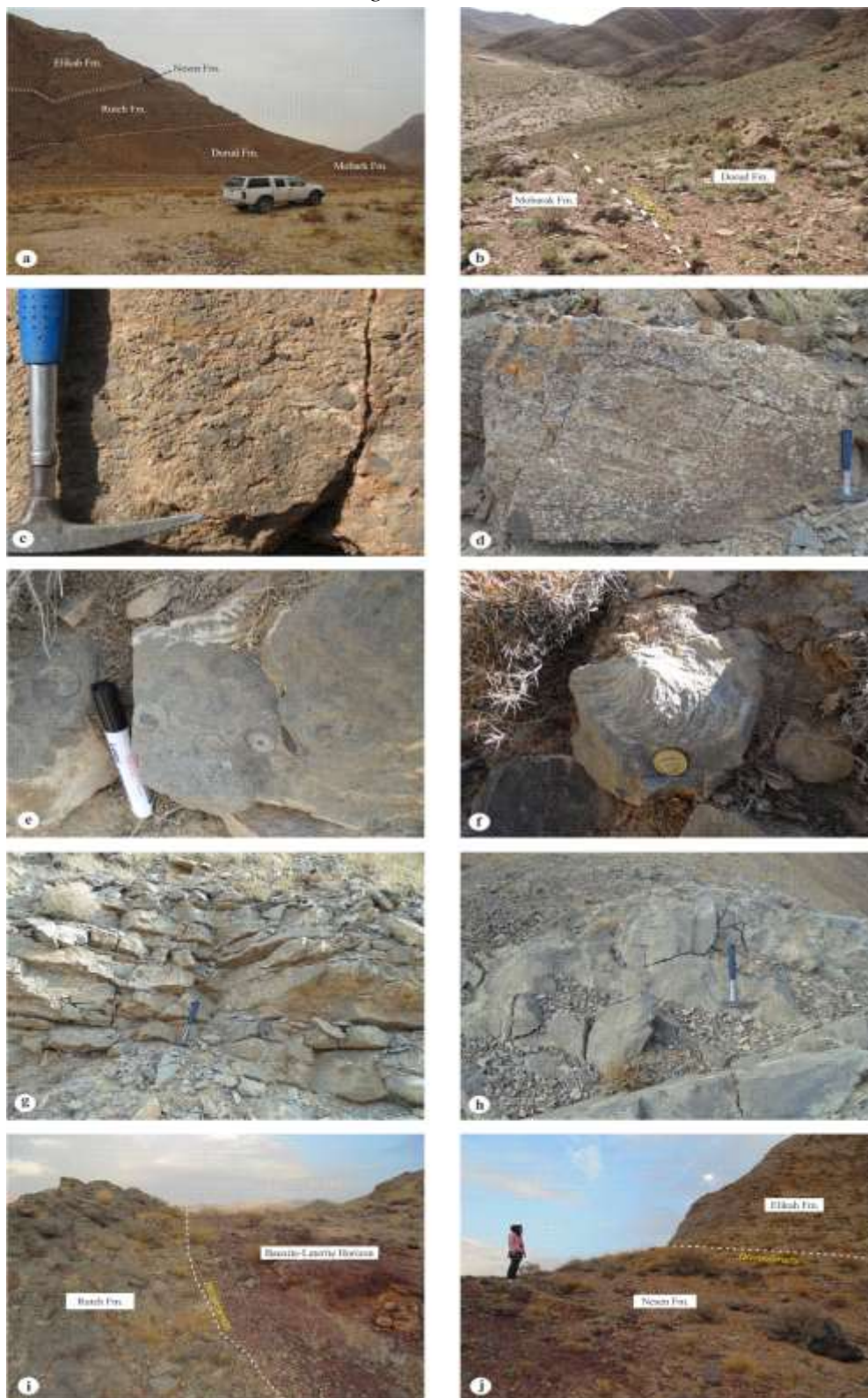


Figure 3a) The contact between Carboniferous, Permian and Triassic Systems. (b) The contact between Mobarak and Dorud Formation. (c) Conglomerate of the Dorud Formation. (d) Sandstone with Cross-bedding of Dorud Formation. (e) Gastropoda in limestone of the Ruteh Formation (member 1). (f) Ichnofossil (Zoophycos) in limestone of the Ruteh Formation (member 2). (g) Medium well-bedded fossiliferous limestones of the Ruteh Formation (member 2). (h) Thin to medium-bedded fossiliferous shaly and wavy limestones of the Ruteh Formation (member 2). (i) The contact between Ruteh and Nesen Formations. (j) The contact between Nesen and Elikah Formations.

De Civrieux and Dess, *Langella perforata* Lange, *Mesoschubertella* sp., *Minojapanella* sp., *Neoendothyra* sp. *Neoendothyra broennimanni* Bozorgnia, *Neoendothyra reicheli* Reitlinger, *Nankinella* cf. *orbicularia* Lee, *Pachyphloia* sp., *Pachyphloia cukurkoyi* De Civrieux and Dess, *Pachyphloia pedicula* Lange, *Pachyphloia* cf. *strica* Sosnina, *Paleotextularia* sp., *Parafusulina* sp., *Paraglobivalvulina* sp., *Pseudolangella* sp., *Schubertella* sp., *Schubertella simplex* Lange, *Schwagerina* sp., *Tuberitina* sp., *Tuberitina collosa* Reitlinger, *Yangcheina inigua* J. S. Lee;

Algae: *Gymnocodium* sp., *Gymnocodium bellerophontis* Ruthpletz, *Permocalculus* sp., *Permocalculus* cf. *solidus* Pia et Osagia, *Pseudovermiporella* sp., *Vermiporella* sp., *Vermiporella nipponica* Endo., *Mizzia* sp.

Cyanobacteria: *Tubiphytes* sp., *Tubiphytes obscurus* Maslov. List of the foraminifera and algae and cyanobacteria species in the Ruteh Formation are shown in (Figs. 4 and 5).

3.3- The Nesen Formation

The type section of the Nesen Formation is located in northeast Nesen village (Central Alborz) and has a thickness of 144 meters (Glaus, 1984). This formation consists of black shales (with abundant brachiopods and corals) and dark gray, cherty fossiliferous limestones. The lower as well as the upper boundary of the Nesen Formation is disconformable. The Elikah Formation (Lower to Middle Triassic) disconformably overlies the Ruteh Formation. The Nesen Formation in the studied section consists of red, bauxite-laterite horizon with pisolitic structure and red to grayish medium-bedded ferruginous sandstones. This Formation has not any fossils. The Nesen Formation overlies disconformably the Ruteh Formation and is covered disconformably by the Elikah Formation (Scythian-Ladinian), (Figs. 3i and j).

3.4- The Elikah Formation

The Elikah Formation in the study section consists of gray, medium-bedded vermicular

limestones (with Claria beds) and buff, massive dolomites with Early to Middle Triassic (Scythian-Ladinian) age, (Fig. 3j). The Elikah Formation was deposited on a vast platform along the shelves of Paleo-Tethys and Neo-Tethys. The rather poor fossil content can deduce the age of the Elikah Formation, mainly concentrated in the lower part. Except in the Jolfa area in northwestern Alborz, where the Permo-Triassic boundary is rather continuous (Golshani *et al.*, 1986; Stepanov *et al.*, 1969), elsewhere along the Alborz Zone, the Elikah Formation overlies a distinct disconformity Upper Permian or even older strata (Seyed-Emami, 1991; Siber, 1970) and may have thickness up to 1000 meters.

4- Foraminiferal Biozones of the Permian System in the Study Section

Three informal foraminiferal biozones have been established in the study section as the following (Figs. 6 and 7):

4.1- Schubertella- Mesoschubertella Assemblage Zone

This biozone includes member 1 of the Ruteh Formation with a thickness of 26 meters. It indicates an Artinskian age and includes foraminifers of the *Geinitzina postcarbonica* Spandel, *Langella conica* De Civrieux and Dess, *Langella perforata* Lange, *Mesoschubertella thompsoni* Kanuma and Sakagami, *Schubertella transitoria* Staff and Wedekind.

4.2- Dunbarula-Deckerella Assemblage Zone

This biozone includes lower part of member 2 of the Ruteh Formation with a thickness of 47 meters. It indicates an Early Murgabian age and includes foraminifers of the *Agathammina pusilla* Geinitz, *Codonofusiella nana* Erk, *Dunbarulla* sp., *Dunbarula nana* Koch., *Geinitzina* cf. *reperta* Bikova, *Geinitzina uralica* Suleimanov, *Langella cukurkoyi* De Civrieux and Dess, *Langella acantha* Lange, *Pachyphloia iranica* Bozorgnia.

Stage Formation		Upper Murgabian		Lower Murgabian		Artinskian	
Assemblage Zone		H		T		U	
Sample no.		Neoendothyra-Pachyphloia		Dunbarulla-Codonofusiella		Schbertella-Mesoschubertella	
Agathammina sp.	91.P.59						
Agathammina pusilla	91.P.58						
Baisalina sp.	91.P.57						
Climacammina sp.	91.P.56						
Climacammina major	91.P.55						
Climacammina cf. moelleri	91.P.54						
Climacammina valvulinooides	91.P.53						
Codonofusiella sp.	91.P.52						
Codonofusiella nana	91.P.51						
Cribrogenerina sp.	91.P.50						
Cribrogenerina sumatrana	91.P.49						
Deckerella sp.	91.P.48						
Deckerella composita	91.P.47						
Dunbarula sp.	91.P.46						
Dunbarula mathieui	91.P.45						
Dunbarula cf. nana	91.P.44						
Endothyra sp.	91.P.43						
Eotuberitina sp.	91.P.42						
Eotuberitina reitlingerae	91.P.41						
Geinitzina sp.	91.P.40						
Geinitzina chapmani	91.P.39						
Geinitzina postcarbonica	91.P.38						
Geinitzina primitiva	91.P.37						
Geinitzina reperta	91.P.36						
Geinitzina cf. taurica	91.P.35						
Geinitzina uralica	91.P.34						
Globivalvulina sp.	91.P.33						
Globivalvulina vondreschmitti	91.P.32						
Globivalvulina bulloides	91.P.31						
Hemigordius sp.	91.P.30						
Hemigordius ovatus	91.P.29						
Kahlerina sp.	91.P.28						
Kahlerina puchytecta	91.P.27						
	91.P.26						
	91.P.25						
	91.P.24						
	91.P.23						
	91.P.22						
	91.P.21						
	91.P.20						
	91.P.19						

Figure 4) List of foraminifera, algae and cyanobacteria species of the Ruteh formation in Sangsar area, Eastern Alborz, North of Iran.

4.3- Neoendothyra-Pachyphloia Assemblage Zone

This biozone includes upper part of member 2 of the Ruteh Formation with a thickness of 43 meters. It indicates a Late Murgabian age and includes foraminifera of the *Climacammina* cf.

major Reitlinger, *Climacammina valvulinooides* Lange, *Codonofusiella nana* Erk, *Cribrogenerina* sp., *Cribrogenerina sumatrana* Volz, *Geinitzina chapmani* Schubert var. *longa* – Suleimanov, *Globivalvulina vondreschmitti* Reitlinger, *Neoendothyra broennimanni*

Bozorgnia, *Neoendothyra reicheli* Reitlinger, *Pachyphloia cukurkoyi* De Civrieux and Dess, *Pachyphloia pedicula* Lange, *Pachyphloia schwageri*, *Paraglobivalvulina* sp. The Foraminifer assemblage of the Ruteh Formation is similar to the fauna of other outcrops of the

Ruteh Formation in the central Alborz (Bozorgnia, 1973) and also is similar to an assemblage reported from Afghanistan (Delapparent and Lys, 1972). Both works indicated an Artinskian-Murgabian age for the foraminifer assemblages of those areas.

Stage Formation	Upper Murgabian		Lower Murgabian		Artinskian	
	H	E	T	U	R	
Assemblage Zone	Neoendothyra-Pachyphloia			Dunbarulla-Codonofustiella		Schubertella-Mesoschubertella
Sample no.						
Langella sp.						
Langella acantha						
Langella conica						
Langella cukurkoyi						
Langella ocarina						
Langella perforata						
Langella venosa						
Mesoschubertella sp.						
Mesoschubertella thompsoni						
Minojapanella elongata						
Nankinella sp.						
Neoendothyra sp.						
Neoendothyra broennimanni						
Neoendothyra parva						
Neoendothyra reicheli						
Neotuberitina majlavkini						
Neotuberitina sympetata						
Pachyphloia sp.						
Pachyphloia cukurkoyi						
Pachyphloia iranica						
Pachyphloia pedicula						
Pachyphloia schwageri						
Paleotextularia sp.						
Paraglobivalvulina sp.						
Parafusulina cf. yabei						
Pseudolangella sp.						
Pseudolangella cf. fragilis						
Schubertella sp.						
Schubertella giraudi						
Schubertella transitoria						
Staffella sp.						
Tuberitina sp.						
Tuberitina collosa						

Figure 5) List of foraminifera, algae and cyanobacteria species of the Ruteh formation in Sangsar area, Eastern Alborz, North of Iran.

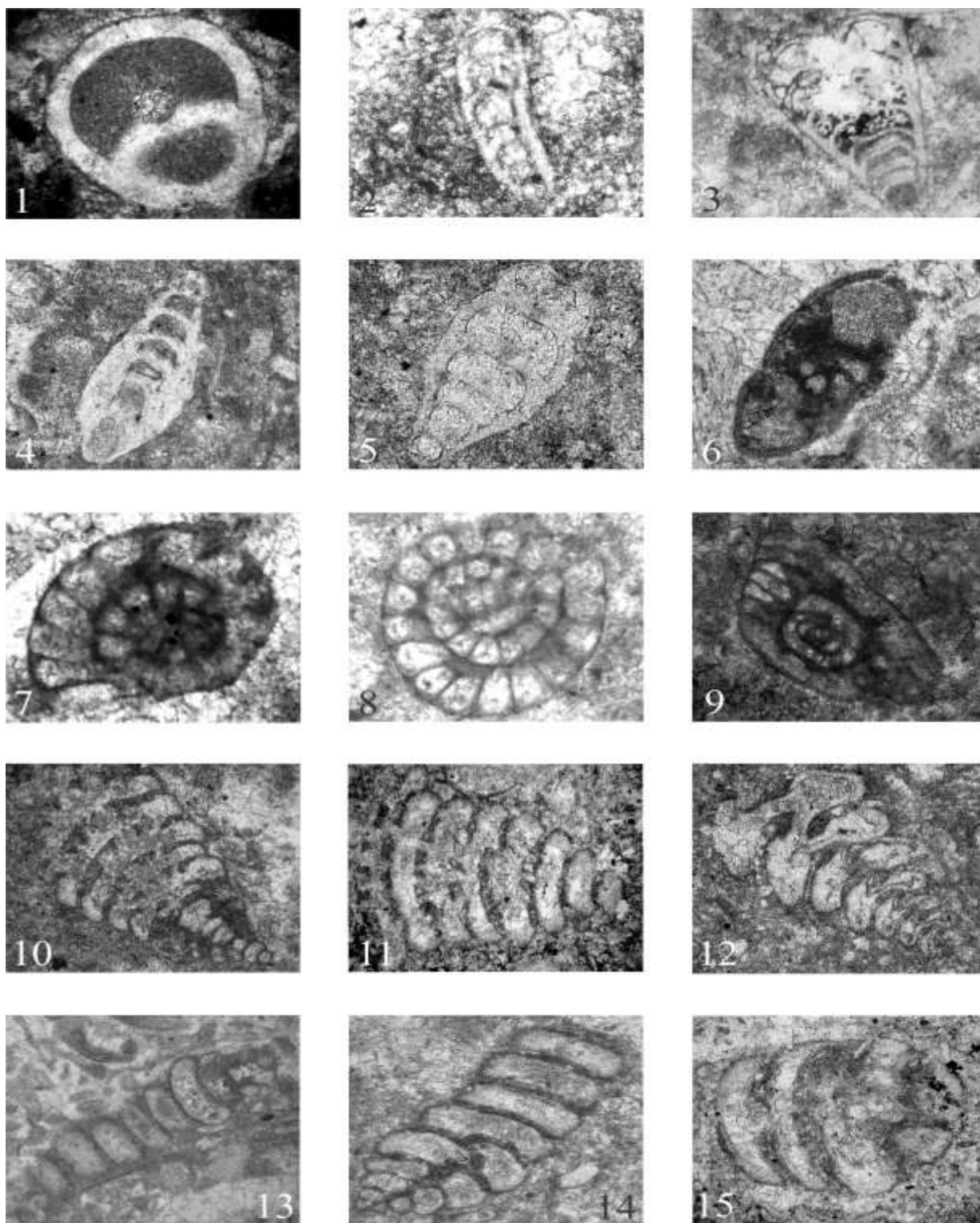


Figure 1) 1) *Langella perforata* Lange, X200, thin section no. 91.P.38. 2) *Cryptosetida* (*Langella*) *bozorgniansis* Partoazar and Vaziri, X250, thin section no. 91.P.50. 3) *Geinitzina uralica* Suliemanove, X100, thin section no. 91.P.31. 4) *Pachyphloia pedicula* Lange, X200, thin section no. 91.P.56. 5) *Pachyphloia* cf. *cukurkoyi* De Civr. and Dess., X200, thin section no. 91.P.41. 6) *Neoendothyra bronnimani* Bozorgnia, X200, thin section no. 91.P.35. 7) *Schubertella* sp., X250, thin section no. 91.P.32. 8) *Dunbarulla* cf. *nana* Kochansky-Devide and Ramovs, X200, thin section no. 91.P.36. 9) *Codonofusiella nana* Erk., X200, thin section no. 91.P.44. 10) *Climacammina valvulinoides* Lange, X80, thin section no. 91.P.58. 11) *Cribrogenerina sumatrana* VOLZ, X80, thin section no. 91.P.59. 12) *Paleotextularia* sp., X200, thin section no. 91.P.53. 13) *Deckerella* sp., X200, thin section no. 91.P.46. 14) *Paleobigenerina* sp., X50, thin section no. 91.P.39. 15) *Cribrogenerina* sp., X200, thin section no. 91.P.38.

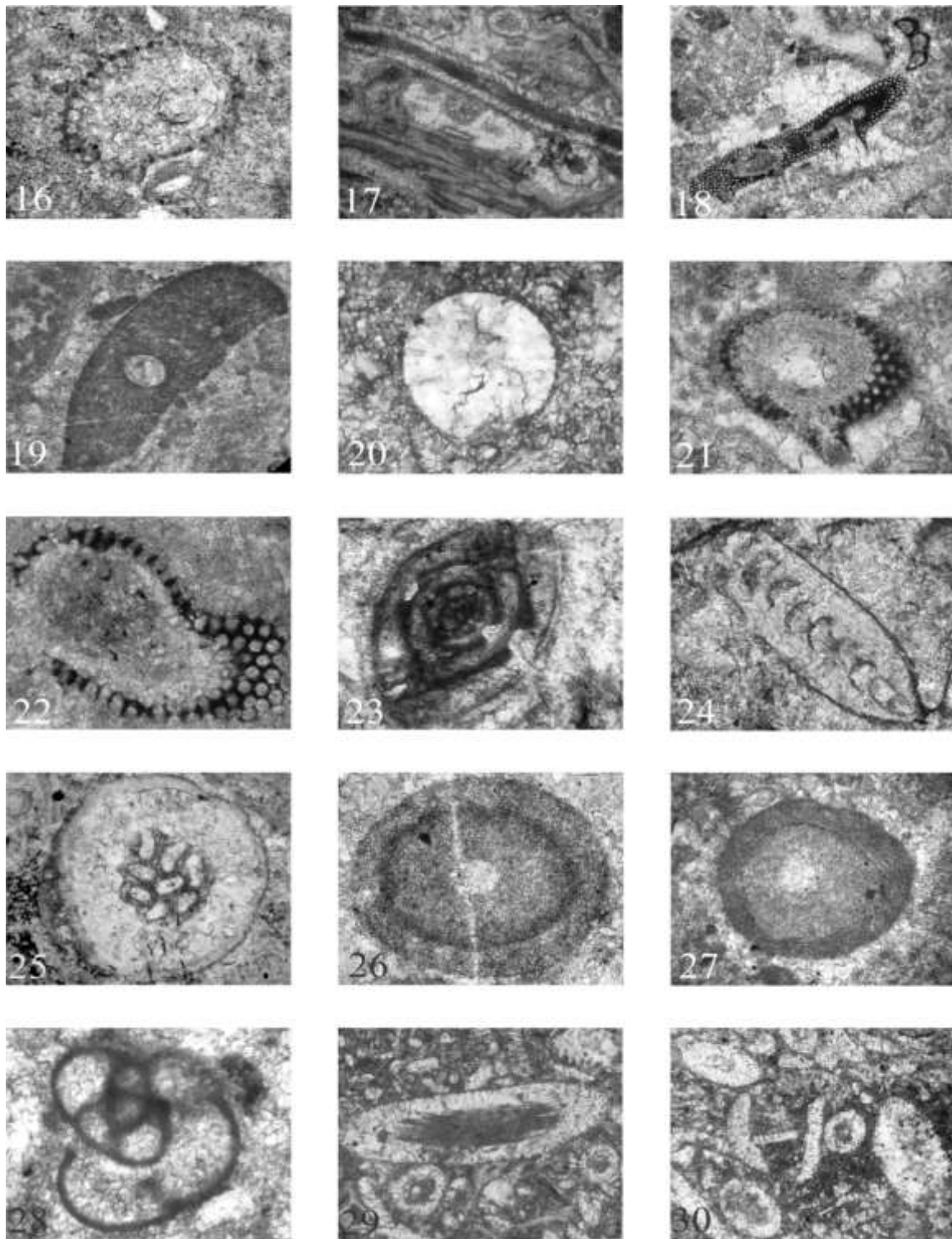


Figure 2) **16)** *Vermiporella nipponica* Endo, X200, thin section no. 91.P.25. **17)** *Gymnocodium cf. bellerophontis* Rothplets, X60, thin section no. 91.P.39. **18)** *Vermiporella* sp., X150, thin section no. 91.P.42. **19)** *Tubiphytes obscurus* MASLOV, X40, thin section no. 91.P.43. **20)** *Tuberitina collosa spinosa* Reitlinger, X250, thin section no. 91.P.42. **21)** *Vermiporella nipponica* Endo., X200, thin section no. 91.P.46. **22)** *Vermiporella nipponica* Endo, X200, thin section no. 91.P.46. **23)** *Mesoschubertella* sp., X200, sample no. 91.P.32. **24)** *Pachyphloia schwageri* Sellier De Civrieux and Dessauvagie, X200, thin section no. 91.P.49. **25)** *Mizzia* sp., X80, thin section no. 91.P.59. **26)** *Tubiphytes cf. obscurus* Maslov, X200, thin section no. 91.P.43. **27)** *Tubiphytes cf. obscurus* Maslov, X200, thin section no. 91.P.43. **28)** *Kahlerina pachythea* Kach, X100, thin section no. 91.P.32. **29)** *Gymnocodium bellerophontis* Rothpletz, X40, thin section no. 91.P.38. **30)** *Gymnocodium bellerophontis* Rothpletz, X40, thin section no. 91.P.44.

5- Conclusions

The Permian sequence in the Sangsar area consists of three formations in the studied section: The Dorud, Ruteh and Nesen formations. The Ruteh Formation in the study section consists mainly of fossiliferous limestones that were deposited in marine shallow environment. The Ruteh Formation with a thickness of 116 meters can be subdivided into two informal members. In the Present study, three foraminiferal biozones were differentiated for the Ruteh Formation these include: Schubertella-Mesoschubertella Assemblage Zone (Artinskian), Dunbarula-Codonofusiella and Neoendothyra-Pachyphloia Assemblage zones (Murgabian). The Ruteh Formation is equivalent to the Surmaq Formation in the Abadeh (Central Iran) and Jolfa (northwestern Iran) regions, middle part of the Jamal Formation in the Shotori Range, Tabas area (eastern Iran) and the lower part of the Dalan Formation in the Zagros Range, Southwestern Iran. Comparing the studied section with those of equivalent sediments in western and central parts of Alborz shows that the Permian sediments decrease in thickness from west to eastern Alborz.

References

- Aghanabati, S. A. 2004. Geology of Iran. Geological Survey of Iran, 586 p. (in Persian).
- Assereto, R. 1963. The Paleozoic formations in Central Elburz (Iran)-(Preliminary note). *Rivista Italiana Palaeontologica e Stratigrafica*: 69, 503–543.
- Bozorgnia, F. 1973. Paleozoic foraminiferal Biostratigraphy of Central and East Alborz Mountains. N.I.O.C. Geological laboratories, Rep. NO. 4.
- Delapparent, A., Lys M. 1972. Etude du Permian et esquisse geologique de la region khwahan (province du Badakhchan, Afganistan septentrional). *Bulletin de la Société Belge de Géologie*, 74, 57–88.
- Flugle, E. 2004. Microfacies of carbonate rocks (Analysis, Interpretation and Application). Springer-Verlag, Berlin, 976 p..
- Ghamami, N. 2004. Biostratigraphic study sediments of Permian-Triassic transition in Tilabad area (Eastern Alborz) with focus on conodonts. Master's Thesis, Institute of Earth Sciences, Geological Survey of Iran, 236 p., (in Persian).
- Ghasemi-Nejad, E. 2002. Biostratigraphy and Depositional History of the Paleozoic Deposits in the South of Central Alborz Basin, Based on Foraminifera. *Iranian International Journal Science*: 3, 93–114.
- Glaus, M. 1964. Trias und oberperm in Zentralen Elburz (Persien). *Eclogae Geologicae Helveticae*: 57, 497–508.
- Golshani, F., Partoazar, H., Seyed-Emami K. 1986. Permian-Triassic Boundary in Iran. *Momorie della Scoieta Geologica Italiana*: 36: 257–262.
- Iranian-Japanese Research Group. 1981. The Permian and the Lower Triassic System in Abadeh Region, Central Iran. *Memoirs of the Faculty of Sciences, Kyoto University. Series of Geology and Mineralogy*: 47, 61–133.
- Khajehvand, Sh. 2005. Biostratigraphy of Late Paleozoic–Early Triassic sediments in Ruteh section with focus on conodonts, Master Thesis, Shahid Beheshti University, (in Persian)
- Maslov, V. P. 1956. Iskopaemye izvestkovye vodorosli USSR {Fossil calcareous algae of the USSR}. *Akademiya Nauk USSR, Trudy Instituta Geologicheskii Nauk {Transactions of the academy of Sciences, USSR Geological Institute}*: 160, 301, (in Russian).
- Nabavi, M. 1982. Geological map of foursquare of Semnan (scale of 1:100.000), Geological Survey of Iran, pp. 1–67.

- Partoazar, H. 1995. Permian deposits In Iran. Geological Survey of Iran, Pub. No. 22 (in Persian).
- Riding, R. 1991. Calcified cyanobacteria, in Riding, R., ed, calcareous Algae and stromatolites Berlin, Springer - Verlag, pp. 55–87.
- Riding, R. 1993. *shamovella obscura*: the correct name for *Tubiphytes obscuras* (Fossil). *Taxon*: 42, 71–73.
- Senowbari-Daryan, B., Flugel, E. 1993. *Tubiphytes* Maslov, enigmatic fossil: classification, fossil record and significance through time. Part 1: Discussion of Late Paleozoic material, in Barattolo, F., ed., *Studies on Fossil Benthic Algae*. *Societa Palaeontologica Italiana Bolletino: Special 1*, pp. 353–382.
- Seyed-Emami, K. 1971. A summary of the Triassic in Iran. Geological Survey of Iran, Report No. 20, pp. 41–53.
- Seyed-Emami, K. 2003. Triassic in Iran. *Facies*: 48, 91–106.
- Siber, N. 1970. Zur geologie des Gebietes Sudlich des Taleghan-Tales Zentral Elburz Iran. *European University Studies*: 41–52.
- Stepanov, D. L., Golshani, F., Stocklin, J. 1969. Upper Permian and Permian-Triassic boyndary in North Iran. Geological Survey of Iran.
- Vaziri, S. H., Yao, A., Kuwahara, K. 2005. Lithofacies and microfocias (foraminifers and radiolarians) of the Permian Sequence in the Shalamzar area, Central Alborz, North Iran, *Journal of Geosciences, Osaka City University*: 48, 39–96.