Lithostratigraphy and Microbiostratigraphy of the Ruteh Formation in Northwest of Khur, Central Alborz, Iran

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Received: 29 January 2009 / Revised: 18 May 2010 / Accepted: 30 August 2010

Abstract

A sequence of Permian rocks crops out in Northwest of Khur in Central Alborz, North of Iran. This sequence consists of the Dorud (Asselian-Sakmarian), Ruteh (Artinskian-Murgabian) and Nesen (Early Djulfian) formations. The Ruteh and Nesen formations in Alborz Range were deposited in a shallow marine environment of the continental margin in the Paleo-Tethys. The Ruteh Formation with a thickness of 221m unconformably overlies the Dorud Formation and consists of fossiliferous limestones. This formation in the studied section can be subdivided into three informal members and overlain disconformably by the Nesen Formation (Early Djulfian). This sequence is disconformably overlain by the Elikah Formation (Scythian-Ladinian). The rich foraminiferal fauna indicates an Artiniskian to Early Djulfian age of the succession that can be established with the *Schubertella-Mesoschubertella* Assemblage Zone (Artinskian), *Dunbarula-Deckerella* and *Neoendothyra-Pachyphloia* Assemblage zones (Murgabian), and *Paraglobivalvulina-Ichtyolaria* Assemblage Zone (Early Djulfian).

Keywords: Permian; Foraminifera; Biozonation; Khur area; Centeral Alborz

Introduction

Lower to Upper 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 [13]. These rocks have been named as the Dorud, Ruteh and Nesen formations [3, 8, 1]. The main purpose of this research is lithostratigraphy and microbiostratigraphy of the succession based on the foraminiferal contents and to establish biozones. The research on the Khur area has been carried out by Sieber [20]. Annells et al. [2] prepared geological map of Shakran with scale of 1:100.000, Central Alborz that includes the studied area. For the foraminiferal biostratigraphy, one hundred and twenty four limestone samples were collected from the Ruteh and Nesen formations. The samples were collected at an interval of two meters and one or some times two to four thin sections were prepared.

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Lithostratigraphic Description of the Section

Well-defined outcrops of the Lower to Upper Permian rocks lie along the Khur area, northwest of Khur in central Alborz, northern Iran with the following coordinates:

N 36°.03', E 50°.41' (Fig. 1). Permian rocks overlie non-conformably the black volcanic rocks Devonian and are covered disconformably by the Elikah Formation that has not shown in the map. The Permian rocks of the Khur area consists of three formations: The Dorud, Ruteh and Nesen formations with Asselian to Early Djulfian age (Fig. 2).

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 [3]. It overlies nonconformably the Jeirud Formation (Upper Devonian) and consists of red sandstones, shales, conglomerate, fossiliferous limestones and quartzite. This Formation in the Khur area consists of red to purple, thick-bedded sandstones, white quartzite and red shales with Early Permian (Asselian-Sakmarian) age (Fig. 3: c, d, e), which is covered unconformably by the Ruteh Formation. (Fig. 3b).

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 [3]. In the Khur area, this formation with a thickness of 221 meters unconformably overlies the Dorud Formation and consists of fossiliferous limestones. This Formation in the study section can be subdivided into three informal members as following:

member 1 (7.5 m)

Alternating dark gray, thin-bedded limestones to medium-bedded fossiliferous shaly and wavy limestones. The bedding shows N 297° W strike and 36°SW dip (Fig. 3f). This member contains macrofossils such as Bellerophontid, brachiopoda, ostracoda, ichnofossil of the *Zoophycos* and cyanobacteria of the *Tubiphytes obscurus* Maslov. *Tubiphytes* is commonly interpreted as a calcified cyanobacterium [15]. Senowbari-Daryan and Flugel [17] asserted that a combination of non-preserved soft organism (central tube) and a cyanobacterial envelope is the original interpretation of Maslov regarding *Tubiphytes*. Riding [16] emphasized that the correct name of *Tubiphytes obscurus* is *Shamovella obscura*. The traditional name is consequently used in the articale.

This member also includes the following microfossils (thin sections no. M. KH-1~5): Foraminifera: Climacammina sphaerica Potieskaya, Eotuberitina reitlingerae MikLukho-MakLay, Geinitzina reperta Bykova, Geinitzina uralica Suleimanov, Langella perforata Lange, Mesoschubertella thompsoni Kanuma & Sakagami, Pachyphloia cukurkoyi De Civrieux & Dess., Schubertella transitoria Staff & Wedekind, Tuberitina collosa Reitlinger; Algae: *Permocalculus* sp., Pseudovermiporella sp., Vermiporella sp., Vermiporella nipponica Endo; Cyanobacteria: Tubiphytes sp., Tubiphytes obscurus Maslov.

Conodont species *Sweetognathus whitei* Clarck [23], has been obtained from member 1 of the Ruteh Formation that is an index for the *Whitei* biozone. This confirms an Artinskian age. Another species, *Hindeodus* sp. and *Hindeodus minatus* Ellison, has also been recorded in this member.

member 2 (119 m)

Alternating dark gray, medium to thick-bedded and massive limestones with medium-bedded shaly limestones. The bedding shows N 271° W strike and 43° SW dip. (Fig. 3g). This member contains macrofossils similar to member 1 and includes the following microfossils (thin sections no. M. KH-6~47): Foraminifera: Climacammina sphaerica Potieskaya, Climacammina valvulinoides Lange, Codonofusiella nana Erk, , Deckerella composita Reitlinger, Dunbarula mathieui Ciry, Frondinodosaria cf. Pyrula De Civrieux & Dess, Geinitzina chapmani Schubert Var. Longa Suleimanov. Geinitzina postcarbonica Spandel. Geinitzina primitiva Potievskaia, Geinitzina reperta Bykova, Geinitzina cf. taurica De Civrieux & Dess., Geinitzina uralica Suleimanov. Globivalvulina biserialis Cushman, Globivalvulina vonderschmitti Reitlinger, Kahlerina pachytheca Koch. Devide et Ramors, Langella cf. acantha Lange, Langella conica De Civrieux & Dess., Langella cukurkoyi De Civrieux & Dess., Langella ocarina De Civrieux & Dess., Langella perforata Lange, Minojapanella elongata Fujimoto and Kanuma, Nankinella orbicularia Lee., Pachyphloia iranica Bozorgnia, Pachyphloia pedicula Lange, Pseudolangella fraglis De Civrieux & Dess., Tuberitina collosa Reitlinger; Algae: Gymnocodium sp., Gymnocodium bellerophontis Rothpletz, Gymnocodium nodosum Rothpletz, Permocalculus sp., Pseudovermiporella sp., Vermiporella sp., Vermiporella nipponica



Figure 1. Geological map of the Khur area in Central Alborz, North Iran (Annells et al., 1977).

System	Series	Stage	Formation	Informal member	Thickness	Stratigraphic column	Conodont Comodont Sample no. Foraminifera	Field Description	Assemblage Zone	Microfossil occurrences
TRIASSIC	LOWER TRIASSIC	SCYTHIAN	ELIKAH	2			М.КН _Б м кн102	Alternations of dark gray, medium-bedded vermicular limestones (with <i>Claraia</i> beds) and buff, massive dolomites.		Very 15t Linestone Wary 15t Emerginal Wary 15t Emerginal Ouartrite
z	R	I A N SULFIAN	H		13		100 H23 92 M.KH90 H20 85 83 82 80 M.KH79	Alternations of dark gray, medium-bedded limestones with abaundant algae and bellerophons.	Paraglobivalvulina - Ichtyolaria	Cribrogenerina sumatrana Ichtyolaria primitiva Pachyphlola schwageri Paraglobivalvulina mira
I A	Е	LATE MURGAB	Е	3	95		78 75 73 70 M.KH69a M.KH69 68 64 0.KH15 58 55 53 50 M.KH47	Alternations of dark gray, thick-bedded and massive, fossilifereous cherty limestones with medium-bedded cherty limestones in the upper part, abaundant algae, bellerophons and crinoids bearing.	Neoendothyra - Pachyphloia	Climacammina valvulinoides Cribrojenerina sumatrana Geinitzina chapmani Globivalvulina vonderschmitti Kahlerina pachyteca Neoendothyra broennimanni Neoendothyra reicheli Pachyphloia cukurkoyi Pachyphloia iranica Pachyphloia pedicula
R M	Р	A U R G A B I A N	u T	2	119	M.KH12	45 44 43 32j 32h M.KH32g 32d 32d 32d 32d 32d 32a 22 32b 32a 22 22 22 24 24 22	Alternations of dark gray, medium to thick- bedded and massive limestones with medium-bedded shaly limestones, algae, bellerophons, brachiopods, bryozoan, crinoids, Zoophycos isp. bearing.	Dunbarula - Deckerella	Codonofusiella nana Deckerella composita Dunbarula mathieui Geinirzina postcarbonica Geinitzina taurica Langella acantha Langella cukurkoyi Langella ocarina
	-	ARLYM			1	<u> </u>	5 20 M.KH19 17 4 15 M.KH12	Paraconformity		
ш	ER U	ARTIN- SKIAN	R	1	30 15 0 7.5	М.КН3	10 8b 8a 8 6 M.KH5 M.KH1	Alternations of dark gray, thin-bedded limestones to medium-bedded fossiliferous shaly and wavy limestones.	Schubertella - Mesoschubertella	Climacammina sphaerica Geinitzina uralica Langella conica Langella perforata Mesoschubertella thompsoni Schubertella transitoria
٩	LOWE	ASSELIAN-	DORUD				M.KHa	Alternations of red to purple thick-bedded sandstones, white quartzites and red shales.		

True thickness: 221m

Figure 2. Lithostratigraphical characteristics and biozones of the Ruteh Formation in northwest of Khur, Central Alborz, North of Iran.

Lithostratigraphy and Microbiostratigraphy of the Ruteh Formation in...



Figure 3. (a) Volcanic rocks of the Jeirud Formation. (b) The contact between Dorud and Ruteh Formations. (c) Sandstone of the Dorud Formation. (d) Quartzite of the Dorud Formation. (e) Shale of the Dorud Formation. (f) Thin to medium-bedded fossilifereous shaly and wavy limestones of the Ruteh Formation (member 1). (g) Alternating medium to thick-bedded and massive limestones of the Ruteh Formation (member 2). (h) Ichnofossil (*Zoophycos*) in limestone of the Ruteh Formation (member 2).

Endo; *Cyanobacteria*: Girvanella permica Pia, Tubiphytes obscurus Maslov.

member 3 (95 m)

Alternating dark gray, thick-bedded and massive fossiliferous cherty limestones with medium-bedded cherty limestones in the upper part. The bedding shows S 92° E strike and 44° NE dip (Fig. 4: c, d).

This member includes the following microfossils (thin sections no. M. KH-48~89): *Foraminifera: Climacammina sphaerica* Potieskaya, *Climacammina* sp., *Cribrogenerina sumatrana* Volz, *Deckerella composita* Reitlinger, *Dunbarula mathieui* Ciry, *Geinitzina chapmani* Schubert, *Geinitzina postcarbo*



Figure 4. (a) Gastropoda in limestone of the Ruteh Formation (member 2). (b) Alternating limestones of Ruteh Formation (member 3). (c) Chert nodules in alternating limestones of the Ruteh Formation (member 3). (d) The contact between Ruteh and Nesen Formations. (e) Alternating medium-bedded limestones of the Nesen Formation. (f) Brachiopoda in the Nesen Formation. (g) The contact between Nesen and Elikah Formations. (h) Vermicular limestones and dolomites of the Elikah Formation.

nica Spandel, Geinitzina reperta Bykova, Globivalvulina biserialis Cushman, Globivalvulina vonderschmitti Reichel, Kahlerina pachytheca Koch. Devide et Ramors, Langella conica De Civrieux & Dess., Langella perforata Lange, Minojapanella elongata Fujimoto and kanuma, Nankinella orbicularia Lee., Neoendothyra broennimanni Bozorgnia, Neoendothyra reicheli Reitlinger, Pachyphloia cukurkoyi De Civrieux & Dess., Pachyphloia iranica Bozorgnia, Pachyphloia pedicula Lange, Tuberitina collosa Reitlinger; Algae: Gymnocodium sp., Gymnocodium bellerophontis Rothpletz, Gymnocodium nodosum Rothpletz, Permocalculus sp., Pseudovermiporella sp., Vermiporella sp., Vermiporella nippnica Endo; Cyanobacteria: Tubiphytes sp., Tubiphytes obscurus Maslov.

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 [8]. 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 dark gray, medium-bedded limestones. These beds show N 320° W strike and 57° SW dip (Fig. 4f).

This Formation includes the following microfossils (thin sections no. M. KH-90~102): Foraminifera: Climacammina sp., Deckerella composita Reitlinger, Ichtyolaria primitiva De Civrieux & Dess, Langella perforata Lange, Nankinella orbicularia Lee., Neoendothyra reicheli Reitlinger, Pachyphloia cukurkoyi De Civrieux & Dess., Pachyphloia iranica Bozorgnia, Pachyphloia pedicula Lange, Paraglobivalvulina mira Reitlinger, Tuberitina collosa Reitlinger; Algae: Gymnocodium sp., Gymnocodium bellerophontis Rothpletz, Gymnocodium nodosum Rothpletz, Mizzia sp., Permocalculus sp., Pseudovermiporella sp., Vermiporella sp., Vermiporella nippnica Endo; Cyanobacteria: Tubiphytes sp., Tubiphytes obscurus Maslov.

The Nesen Formation overlies disconformably the Ruteh Formation and is covered disconformably by the Elikah Formation (Scythian-Ladinian), (Fig. 4g).

List of the foraminifera species in the Ruteh Formation are shown in (Fig. 5) and list of the algae and cyanobacteria species are shown in (Fig. 6).

The Elikah Formation

The Elikah Formation in the study section consists of dark gray, medium-bedded vermicular limestones (with *Claria* beds) and buff, massive dolomites with Early to Middle Triassic (Scythian-Ladinian) age. (Fig. 4h). 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 [9,21], elsewhere along the Alborz Zone, the Elikah Formation overlies a distinct disconformity Upper Permian or even older strata [18, 19] and may have thickness up to 1000 meters.

Foraminiferal Biozones of the Permian System in the Study Section

Four informal foraminiferal biozones have been established in the study section as the following:

Schubertella-Mesoschubertella Assemblage Zone

This biozone includes member 1 of the Ruteh Formation with a thickness of 7.5 meters. It indicates an Artinskian age and includes foraminifers of the *Climacammina sphaerica* Potieskaya, *Geinitzina uralica* Suleimanov, *Langella perforata* Lange, *Mesoschubertella thompsoni* Kanuma & Sakagami, *Schubertella transitoria* Staff & Wedekind.

Dunbarula-Deckerella Assemblage Zone

This biozone includes member 2 of the Ruteh Formation with a thickness of 119 meters. It indicates an Early Murgabian age and includes foraminifers of the *Codonofusiella nana* Erk, *Deckerella* sp., *Deckerella composita* Reitlinger, *Dunbarula mathieui* Ciry, *Geinitzina postcarbonica* Spandel, *Geinitzina taurica* De Civrieux & Dess, *Langella acantha* Lange, *Langella cukurkoyi* De Civrieux & Dess, *Langella ocarina* De Civrieux & Dess.

Neoendothyra-Pachyphloia Assemblage Zone

This biozone includes member 3 of the Ruteh Formation with a thickness of 95 meters. It indicates a Late Murgabian age and includes foraminifera of the Climacammina sp., Climammina valvulinoides Lange, Cribrogenerina sumatrana Volz, Geinitzina chapmani Schubert Var. Longa-Suleimanov, Globivalvulina vonderschmitti Reichel, Kahlerina pachytheca Koch. Devide et Ramors, Langella vensoa Neoendothyra broennimanni Bozorgnia, Neoendothyra reicheli Reitlinger, Pachyphloia cukurkovi De Civrieux & Dess, Pachyphloia iranica Bozorgnia, Pachyphloia pedicula Lange. The Foraminifer assemblage of the Ruteh Formation is similar to the fauna of other outcrops of the Ruteh Formation in the central Alborz [4] and also is similar to an assemblage reported from Afghanistan [5]. Both works indicated an Artinskian-Murgabian age for the foraminifer assemblages of those areas.

Paraglobivalvulina-Ichtyolaria Assemblage Zone

This biozone include of the Nesen Formation with a thickness of 13 meters. It indicates an Early Djulfian age and includes frominifers of the *Climacammina*

n Stare	Formation	a- Assemblage Zone	sample no.	Agathemnina sp.	Agathannina pusilla	Baisalina sp.	Climacamurina sp.	Climacamutha major	Climacamutina cf. moelleri	Climacamarina valvulinoides	Codonofusiella sp.	Codonofusiella paradoxica	Cribrogenerina sp.	Cribrogenerina sumatrana	 Deckerella sp. 	Deckerella composita	Dumberula sp.	Durbarula mathleul	Durbarula cf. nana	Endathyra sp.	Eotaberitiaa sp.	Eotuberitina reitlingerae	 Geinitzina sp. 	Geinitzina chapmani	Geinitzina postcarbonica	Geinitzina primitiva	Geinitzina reperta	Geinitzina taurica	Geinitzina uralica	 Globivalvalina sp. 	Globivalvulina vonderschmitti	 Henrigordius sp. 	 Hemigordius ovatus 	 Ichtyokarla primitiva 	Kahlerina sp.	Kahlerina puchyteca
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Figure 5. List of foraminifera species of the Ruteh and Nesen formations in Khur area, Central Alborz, North of Iran.

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Figure 5. Continued.



Figure 6. List of algae and cyanobacteria species of the Ruteh and Nesen formations in Khur area, Central Alborz, North of Iran.



Plate 1.

Figure 1. Hemigordius sp. GEINITZ, thin section no. M. KH-1.
Figure 2. Climacammina major REITLINGER, thin section no. M. KH-53.
Figure 3. Deckerella composita REITLINGER, thin section no. M. KH-4.
Figure 4. Cribrogenerina sp., thin section no. M. KH-1.
Figure 5. Climacammina valvulinoides LANGE, thin section no. M. KH-36.
Figure 6. Codonofusiella sp., thin section no. M. KH-20.
Figure 7. Codonofusiella sp., thin section no. M. KH-21.
Figure 8. Deckerella composita REITLINGER, thin section no. M. KH-36.
Figure 9. Schubertella transitoria STAFF & WEDEKIND, thin section no. M. KH-31.
Figure 10. Mesoshubertella thompsoni KANUMA & SAKAGAMI, thin section no. M. KH-21.
Figure 12. Neoendothyra reicheli BOZORGNIA, thin section no. M. KH-78.
Figure 13. Parafusulina yabei HAZAWA, thin section no. M. KH-20.
Figure 14. Langella perforata LANGE, thin section no. M. KH-32.
Figure 15. Codonofusiella sp., thin section no. M. KH-32.



Plate 2.

Figure 1. Dunbarula mathieui CIRY, thin section no. M. KH-14.
Figure 2. Langella acantha LANGE, thin section no. M. KH-55.
Figure 3. Langella perforata LANGE, thin section no. M. KH-55.
Figure 4. Langella conica DE CIVRIEUX & DESS, thin section no. M. KH-15.
Figure 5. Langella ocarina DE CIVRIEUX & DESS, thin section no. M. KH-34.
Figure 6. Langella perforata LANGE, thin section no. M. KH-34.
Figure 7. Pachyphloia sp., thin section no. M. KH-38.
Figure 8. Geinitzina uralica SCHUBERT var. Longa - SULEIMANOV, thin section no. M. KH-32d.
Figure 9. Langella perforata LANGE, thin section no. M. KH-87.
Figure 10. Globivalvulina Vonderschmitti REITLINGER, thin section no. M. KH-20.
Figure 11. Climacammina valvulinoides LANGE, thin section no. M. KH-32g.
Figure 13. Cribrogenerina sp., thin section no. M. KH-37.
Figure 14. Codonofusiella cf. nana ERK, thin section no. M. KH-26.
Figure 15. Langella perforata LANGE, thin section no. M. KH-37.



Plate 3.

Figure 1. Pachyphloia pedicula LANGE, thin section no. M. KH-98.
Figure 2. Pachyphloia cukurkoyi DE CIVRIEUX & DESS, thin section no. M. KH-22. Figure 3. Paleotextularia sp., thin section no. M. KH-52. Figure 4. Globivalvulina sp., thin section no. M. KH-99.
Figure 5. Paraglobivalvuina mira REITLINGER, thin section no. M. KH-90.
Figure 6. Tetrataxis planolocula DE CIVRIEUX & DESS, thin section no. M. KH-38.
Figure 7. Neotuberitina maljavkini MIKHAILOV, thin section no. M. KH-20.
Figure 8. Deckerella cf. composita REITLINGER, thin section no. M. KH-25.
Figure 9. Cribrogenerina sumatrana VOLZ, thin section no. M. KH-99.
Figure 10. Pseudovermiporella nipponica ENDO, thin section no. M. KH-71
Figure 11. Tubiphytes obscurus MASLOV, thin section no. M. KH-54.
Figure 12. Vermiporella nipponica ENDO, thin section no. M. KH-65.
Figure 14. Codonofusiella sp., thin section no. M. KH-60.
Figure 15. Langella perforata LANGE, thin section no. M. KH-90. moelleri Reitlinger, Cribrogenerina sumatrana Volz, Ichtyolaria primitiva De Civrieux & Dess., Pachyphloia Schwageri De Civrieux & Dess., Paraglobivalvulina mira Reitlinger.

Results and Disscussion

The Permian sequence in the Khur 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 221 meters can be subdivided into three informal members. In the Present study, three foraminiferal biozones were differentiated for the Ruteh Formation these include: Schubertella-Mesoschubertella Assemblage Zone (Artinskian), Dunbarula-Deckerella and Neoendothyra-Pachyphloia Assemblage zones (Murgabian). The Ruteh Formation is equivalent to the Surmag 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 eastern parts of Alborz shows that the Permian sediments decrease in thickness from west to eastern Alborz.

Acknowledgements

The authors wish to thank Dr. E. Ghasemi-Nejad, Department of Geology, Faculty of Science, University of Tehran, for reading the manuscript and making useful comments and Dr. M. R. Majidifard at the Geology Survey of Iran for his comments.

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