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Abstract - VALERY JA. VUKS - Late Triassic Foraminifers of Caucasus and Pamirs.

A rich foraminifera association has been found in the Naizatasch Formation of the South-East Pamirs. The age analysis of each species and of the whole assemblage as well as the compared foraminifera associations from other regions of the Tethys gives the basis to consider the foraminifera assemblage of the Naizatasch Formation as Late Norian (possibly Sevatian-Lower Rhaetian). The scheme of correlation of the Norian - Rhaetian deposits of the West Caucasus and the South-East Pamirs according to foraminifers is proposed. The scheme of the division of the Norian - Rhaetian deposits of the South-East Pamirs according to foraminifers is submitted for the first time.

Key words: Late Triassic, Caucasus, Pamirs, Biostratigraphy, Foraminifera.

Rich foraminifera assemblages of the Late Triassic of the West Caucasus and the Precaucasus are found in the deposits of the upper part of the Sakhray Group (the Babuk Formation) and the Khodz Group (EFIMOVA, 1991).

The Carnian are represented by the upper part of the Sakhray Group, which consists of claiier siltstones with separated lenses and thin beds of micrograined sandstones. The Pachyphloides klebelsbergi beds with a rich foraminifera assemblage are established in these deposits. The stratotype of the Pachyphliodes klebelsbergi beds is situated in the Upper Tkhach River of the West Caucasus. Foraminifera assemblage is mainly presented by nodosariids as well as the representatives of the *Hyperammina*, *Trochammina*, *Gaudrina*, *Lamelliconus*, *Diplotremmina* genera. The examined foraminifera assemblage is found in the terrigenous deposits, which were formed in the deep sea open basin. The Early Carnian age is confirmed by the findings of ammonoids (*Ioannites klipsteini*

MOIS., etc.) and bivalves. (EFIMOVA, 1991). Thus, the *Pachyphloides klebelsbergi* beds probably correspond to the *Trachyceras aonoides* zone and *Trachyceras aon* zone of the Lower Carnian.

The Norian - Rhaetian are represented by the Khodz Group, which consists of various limestones. The *Angulodiscus friedli* zone (= *Aulotortus friedli* EFIMOVA, 1991, = *Glomospirella friedli* KRISTAN-TOLLMANN, 1962) with a rich and various foraminifera assemblage is established in the lower part of the Khodz Group. The hypostratotype of the *Angulodiscus friedli* zone is situated in the Upper Tkhach River of the West Caucasus. The lower part of the Khodz Group is represented by variegated micrograined organic-clastic limestones with thin beds of limey sandstones. The foraminifera association consists of *Trochammina jaunensis* BRÖNNIMANN & PAGE, *T. alpina* KRISTIAN, *Tetrataxis inflata* KRISTAN, *Agathammina austroalpina* KRISTAN-TOLLMANN, *Planinvoluta carinata* LEISCHNER, *Ophthalmidium fusiformis* TRIFONOVA, *O. lucidum* (TRIFONOVA), *Miliolipora cuvillieri* BRÖNNIMANN & ZANINETTI, *Aulotortus sinuosus* (WEYNSCHENK), *Angulodiscus friedli* (KRISTAN-TOLLMANN), *A. tumidus* (KRISTAN-TOLLMANN), *Involutina turgida* KRISTAN, *Semiinvoluta clari* KRISTAN, *Lamelliconus multispirus* (OBERHAUSER), *Trochobella crassa* (KRISTAN), etc. (EFIMOVA, 1991). There is irregular distribution of the foraminifers along the section. Involutinids are predominant in some beds. Foraminifera association is found in the limestones, which were probably formed in shallow water. The Late Norian age is confirmed by the findings of bivalves (*Monosalinaria* SCHLOTH. etc.) and other fauna. Probably, the *Angulodiscus friedli* zone corresponds to the lower part of the *Rhabdoceras suessi* zone of the Upper Norian.

The *Involutina liassica* beds with rich and various foraminifera assemblage are established in the upper part of the Khodz Group. The stratotype of the *Involutina liassica* beds is situated in the Upper Tkhach River of the West Caucasus. This part of the Group is represented by variegated polydetrital biomorphic limestones. The foraminifera assemblage contains: *Glomospira inconstans* MICHALIK, JENDREJAKOVA ET BORZA, *G. sinensis* HO, *Trochammina alpina* KRISTAN-TOLLMANN, *Duotaxis aff. metula* KRISTAN, *Tetrataxis inflata* KRISTAN, *Agathammina austroalpina* KRISTAN-TOLLMANN, *Planinvoluta carinata* LEISCHNER, *P. irregularis* SALAJ, BORZA & SAMUEL, *Ophthalmidium triadicum* (KRISTAN), *O. fusiformis* TRIFONOVA, *Galeanella panticae* ZANINETTI & BRÖNNIMANN, *Miliolipora cuvillieri* BRÖNNIMANN & ZANINETTI, *Coronipora austriaca* (KRISTAN), *Auloconus permodiscoides* (OBERHAUSER), *Aulotortus sinuosus* (WEYNSCHENK), *Angulodiscus pokornyi* SALAJ, *A. tenuis* KRISTAN, *A. tumidus* (KRISTAN-TOLLMANN), *Involutina liassica* (JONES), *I. turgida* KRISTAN, *Lamelliconus turris* (FRENTZEN), etc. (EFIMOVA, 1991). In this association the predominant genera are *Ophthalmidium*, *Galeanella*, *Miliolipora*, which sometimes form the accumulation. Foraminifera assemblage is found in organic-detrital biomorphic limestones, which were formed in shal-

low water nearby reef. The Late Norian - Rhaetian age is confirmed by the findings of ammonoids (*Placites polidactylus* MOIS., etc.) and other fauna. The *Involutina liassica* beds corresponds to the upper part the *Rhabdoceras suessi* zone of the Upper Norian and the lower part of the *Choristoceras marshi* zone of the Rhaetian. In other regions of the Caucasus the Late Triassic foraminifers occur rarely (Fig. 1)

The Late Triassic foraminifers are found in the some formations of the South-East Pamirs. The Schaimak Formation consists of organic-clastic limestones of the reef and contains poor foraminifera association: *Tolypammmina gregaria* WENDT, *Ophthalmidium* sp., *Alpinophragmium* cf. *perforatum* FLÜGEL, *Aulotortus sinuosus* (WEYNSCHENK), *Angulodiscus communis* KRISTAN (Dronov, Melnikova, 1985). The species of this assemblage are typical for the Norian - Rhaetian of the Alps, Carpathians, Dinarids, Bulgaria, Greece, Turkey, Iran, Tunisia, Burma, etc. (AL-SCHAIBANI, CARTER, ZANINETTI, 1983; ALTINER, ZANINETTI, 1981; KRISTAN, 1957; KRISTAN-TOLLMANN, 1962, 1973; SALAJ, BORZA, SAMUEL, 1983; SALAJ, TRIFONOVA, GHEORGIAN, CORONEOU, 1988; TRIFONOVA, 1984; VUKS, 1988; ZANINETTI, 1976). The age of foraminifera association is impossible established more exactly. Besides foraminifers, brachiopods, corals, alga are determined from this formation. The Schaimak Formation corresponds to the Lower - Middle Norian (DRONOV, MELNIKOVA, 1985).

The Naizatasch Formation overlies the Schaimak Formation conformably and consists of clay detrital limestones with thin beds and lenses of chert. Samples with formainifers were collected from detrital limestones of this formation from the section nearby the Audzhol River of the South-East Pamirs. The thickness of formation is changing from 25 metres to 80 metres in this area. A rich foraminifera assemblage consists of *Gandinella falsofriedli* SALAJ, BORZA & SAMUEL, *Tolypammmina gregaria* WENDT, *Ammobaculites zlabachensis* KRISTAN-TOLLMANN, *Trochammmina almtalensis* KOEHN-ZANINETTI, «*Valvulina*» *metula* (KRISTAN), *Tetrataxis humilis* KRISTAN, *T. inflata* KRISTAN, *Agathammina austroalpina* KRISTAN-TOLLMANN & TOLLMANN, *Planiinvoluta irregularis* SALAJ, BORZA & SAMUEL, *Ophthalmidium triadicum* KRISTAN, *O. lucidum* TRIFONOVA, *Gsollbergella spiroloculiformis* ORAVECZ-SCHEFFER, *Quinqueloculina nucleiformis* KRISTAN-TOLLMANN, *Sigmoilina schaeferae* ZANINETTI, ALTINER, DAGER & DUCRET, *Miliolipora cuvillieri* BRÖNNIMANN & ZANINETTI, *Nodosaria ordinata* TRIFONOVA, «*Fronidularia woodwardi*» HOWCHIN, *Austrocolomia marschalli* OBERHAUSER, *Permodiscus eomesozoicus* (OBERHAUSER), *P. pragsoides* OBERHAUSER, *Auloconus permodiscoides* (OBERHAUSER), *Aulotortus sinuosus* (WEYNSCHENK), *Angulodiscus friedli* (KRISTAN-TOLLMANN), *Semiinvoluta clari* KRISTAN, *Lamelliconus turris* (FRENTZEN), *Diploremmina astrofimbriata* KRISTAN-TOLLMANN, *Variostoma cataliforme* KRISTAN-TOLLMANN, etc. (System of foraminifers by Salaj, Borza, Samuel in the book «Triassic Foraminifers of the West Carpathians»). Aggluti-

nated foraminifers and representatives of Involutinidae, Ophthalmitidae, Hauerinidae, Milioliporidae families are predominant in the described assemblage. Besides foraminifers, bivalves, ammonoids and other fauna occur in this formation. The age of the formation is determined by macrofauna as the Late Norian (the Early Sevatian).

The Kamarutek Formation and its analogue on other area overlies the Naizatasch Formation conformably. The Kamarutek Formation consists of three beds, which are represented by 1. gray bedded organic-clastic limestones with lenses of limestone conglomerates; 2. red marls; 3. red bedded clastic crinoidal limestones, shales and silstones. A poor foraminiferal assemblage is found in the first bed and is represented by *Tolypammina* sp., *Endothyra* sp., *Ophthalmitium* sp., *Quinqueloculina* sp., *Sigmoilina* sp., *Aulotortus sinuosus* (WEYNSCHENK). It is impossible to determine the age of the examined formation according to foraminifers, because *Aulotortus sinuosus* (WEYNSCHENK) is typical form the whole deposits the Upper Triassic. Besides foraminifers, brachiopods, bivalves, ammonoids and other fauna are found in this formation. Age of the formation is determined as the Late Norian (the Early Sevatian).

The Bostanak Formation and its analogue on other structural-facies zone overlies the Kamarutek Formation. The Bostanak Formation and its analogue on other structural-facies zone consists of siltstones, sandstones and mudstones and don't contain fauna.

The Bortepa Formation overlies the Pordzhilga Formation conformably (analogue of the Bostanak Formation) in Bortepa structural-facies subzone and the Dzhilgakochusuj Formation overlies the Bostanak Formation conformably in the Dzhilgakochusuj structural-facies subzone of the South-East Pamirs. The Dzhilgakochusuj Formation corresponds to the lower part of the Bortepa Formation (DRONOV, MELNIKOVA, 1985). The Dzhilgakochusuj Formation consists of organic-clastic limestones, limey sandstones and mudstones. The foraminifera assemblage is found in the most upper bed (the thickness is about 5 metres) of this formation. This bed is represented by organic limestones, which contains *Tolypammina gregaria* WENDT, *Agathammina austroalpina* KRISTAN-TOLLMANN & TOLLMANN, *Aulotortus sinuosus* (WEYNSCHENK), *Angulodiscus friedli* (KRISTAN-TOLLMANN). Species of the considered association are typical for the Norian-Rhaetian deposits of different regions of the Tethys, but *Angulodiscus friedli* (KRISTAN-TOLLMANN) is index-species of foraminifera zone of the Rhaetian of the West Carpathians (SALAJ, BORZA, SAMUEL, 1983). The Bortepa Formation consists of siltstones, mudstones and sandstones with thin beds of organic-clastic limestones. Various fauna occurs in limestones all over the section. Foraminifers are represented by *Ophthalmitium* sp., *Angulodiscus friedli* (KRISTAN-TOLLMANN), *Involutina* sp., *Trochonella permodiscoides* (OBERHAUSER). Species of this foraminifera association are typical for the Norian-Rhaetian of

the Tethys. *Angulodiscus friedli* (KRISTAN-TOLLMANN) occurs in both formations, which corresponds to the Upper Sevatian (the Upper Norian). This species can be index-species for these assemblages (Fig. 1)

The Chichkautek Formation overlies sometimes conformably or sometimes with angular unconformability the above mentioned formations. This formation consists of organic-clastic bioherm and reef limestones. Foraminifers are numerous and occur all over the section in different structural-facies zones. Foraminifera association is represented by three species: *Angulodiscus* cf. *gaschei gaschei* KOEHN-ZANINETTI, *A.* cf. *tumidus* (KRISTAN-TOLLMANN), *Involutina* cf. *turgida* KRISTAN. Involutinids of the composed assemblage are typical for the Norian - Rhaetian of the Tethys. *Involutina turgida* KRISTAN is also index-species of foraminifera zones for determined facies in the Rhaetian of the West Carpathians (SALAJ, BORZA, SAMUEL, 1983). The Chichkautek Formation corresponds to base of the Rhaetian of the South-East Pamirs. Age evaluation of this formation by foraminifers don't contradict to Dronov's scheme (DRONOV, MELNIKOVA, 1985). Above along the section foraminifers were not found.

Thus, the Naizatasch Formation contains a rich and various foraminifera assemblage allowing to establish the *Miliolipora cuvillieri*-*Semiinvoluta clari* beds with the stratotype on the Audzhol River of the South-East Pamirs. Foraminifera association consists of the representatives of different families both agglutinated and secreted calcareous forms, but the predominant species of genera are *Gandinella*, *Tolypammina*, *Trochammina*, *Tetrataxis*, *Agathammina*, *Planiinvoluta*, *Ophthalmidium*, *Sigmoilina*, *Miliolipora*, *Nodosaria*, «*Fronicularia*», *Austrocolomia*, *Permodiscus*, *Auloconus*, *Aulotortus*, *Angulodiscus*, *Semiinvoluta*, *Lamelliconus*, *Diplotremmina*. The species of considered assemblage occur in the Middle - Upper Triassic and the Liassic of the Tethys. A great number of species is more typical for more limited stratigraphical interval - the Norian - Rhaetian: *Gandinella falsofriedli* SALAJ, BORZA, SAMUEL, *Tetrataxis humilis* KRISTAN, *Planiinvoluta irregularis* SALAJ, BORZA & SAMUEL, *Ophthalmidium lucidum* TRIFONOVA, *Sigmoilina schaeferae* ZANINETTI, ALTINER, DAGER & DUCRET, *Miliolipora cuvillieri* BRÖNNIMANN & ZANINETTI, *Permodiscus eomesozoicus* OBERHAUSER, *Auloconus permodiscoides* OBERHAUSER, *Angulodiscus friedli* (KRISTAN-TOLLMANN), *Semiinvoluta clari* KRISTAN, etc. Many of them are typical species or index-species of foraminifera zones of the Alaunian, Sevatian, Rhaetian of the West Carpathians and the West Caucasus and other regions of the Tethys (SALAJ, BORZA, SAMUEL, 1983; EFIMOVA, 1991).

Thus, the great number of species of foraminifera assemblage of the *Miliolipora cuvillieri* - *Semiinvoluta clari* beds are typical for the Norian - Rhaetian of the Tethys.

The examined foraminifera assemblage is similar to foraminifera associations of the Norian-Rhaetian of the Austrian Alps, West Carpathians, West Cau-

Stage	Sub-stage	Zone	West Caucasus (Efimova, 1991)		South-East Pamirs (Vuks)		
			Group	Foraminifera zones and beds	Foraminifera beds	Formation	
Rhae- tian		Choristoce- ras marshi	Khodz Group	Involutina liassica beds	Involutina cf. turgida beds	Chich- kautek	
	Upper	Rhabdoceras suessi			Angulodis- cus fried- li zone	Angulodiscus friedli beds	Bor- tepa
						Not studied	Bost- nak
						Un-named beds	Kama- rutek
						Miliolipora Cu- villieri-Semi- involuta clari beds	Naiza- tasch
Nori- an	Mid- dle	Halorites macer			Un-named beds	Schai- mak	
		Himavatites hogarti					
		Cyrtopleu- rites bicrenatus					
	Lower	Juvavites magnus					
		Malayites paulckeii					
		Guembelites jandianus					

Fig. 1 - Proposed correlation of the Norian - Rhaetian deposits of the West Caucasus and the South-East Pamirs according to foraminifers.

casus. Indonesia (KRISTAN, 1957; KRISTAN-TOLLMANN, 1973; SALAJ, BORZA, SAMUEL, 1983; EFIMOVA, 1991; AL-SHAIBANI *et al.*, 1983, etc.). The most similar foraminifera association is described from the Involutina liassica beds of the Norian-Rhaetian of the West Caucasus (EFIMOVA, 1991). The compared assemblages have very similar genera composition and the great amount of common species. Besides, the similarity of composition of rocks enable us to propose similar conditions of forming of foraminifera association - zone of development of reef.

Thus, the age analysis of intervals of biozones of each species and of the whole association as well as compared foraminifera assemblages from neighbouring regions gives the possibility to consider the foraminifera assemblage of the Naizatasch Formation as the Late Norian (possibly the Sevatian-Early Rhaetian?).

As the species of the poor foraminifera assemblage of the Bortepa Formation are numerous and occur in the most of the sections, but species *Angulodiscus friedli* (KRISTAN-TOLLMANN) is the most typical, it is proposed to established the *Angulodiscus friedli* beds in stratigraphical interval for the whole formation with stratotype nearby the Kuntsej River of the South-East Pamirs. In many sections of the Chichkautek Formation poor foraminifera assemblage is found with great amount of the specimen. *Involutina cf. turgida* KRISTAN is the most typical and numerous species, therefore it is proposed to establish *Involutina cf. turgida* beds in stratigraphical interval the whole formation with the stratotype nearby the Karauldyndala River of the South-East Pamirs. Originality of the most of the Late Triassic foraminifera assemblages of the South-East Pamirs is connected with specific facies conditions in zone of the development of reef. Probably taxonomical variety of a rich foraminifera assemblage of the Naizatasch Formation testifies about the more or less normal marine conditions of formation of foraminifers. It is necessary to mark that the *Angulodiscus friedli* beds and the *Involutina cf. turgida* beds couldn't be exactly correspond to the Sevatian or Rhaetian, but the *Miliolipora cuvillieri-Semiinvoluta clari* beds can be correlated with the Sevatian and Lower Rhaetian. Therefore age evaluations of the Naizatasch Formation and other formations can be changed under more detailed investigations of foraminifera and other fauna of above mentioned formations of the South-East Pamirs.

Thus, the revelation of a rich foraminifera assemblage of Naizatasch Formation allows to submit the first scheme of division of the Upper Triassic of the South-East Pamirs as well as foraminifera associations of this region to correlate authentically with simultaneous assemblages of the Caucasus and other regions of the Tethys. The first described assemblage enable us to supplement common picture of development of the Late Triassic foraminifera associations of the South-East Pamirs and it is interesting material for paleoecological and biogeographical constructions.

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