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BIODIVERSITY OF MICROORGANISMS (FORAMINIFERS) AS ENVIRONMENTAL INDICATORS ON THE BOUNDARY OF TRIASSIC AND JURASSIC IN CAUCASUS.

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A study of foraminifers from Triassic deposits was conducted in the area of the Peredovoy Range (Laba and Belaya river basins) of the western Caucasus. The uppermost Triassic deposits in the western Caucasus are represented by the Khodz Group that overlies the Ladinian – Lower Carnian deposits (Sakhray Group) with an erosional contact and is unconformably overlain by eroded lower Jurassic sediments. These deposits are dated as Upper Norian – Rhaetian (?) and contain diverse assemblages of foraminifers, algae and nautiloids. The Khodz Group contains two distinct foraminiferal assemblages: one with *Aulotortus friedli* and one with *Involutina liassica* that define two successive foraminiferal zones with the same names. The upper foraminiferal assemblage (*Involutina liassica* local zone) occurs in massive reefal limestoneof the upper part of the Upper Norian and Rhaetian (?). The characteristic species of this association are: *Auloconus permodiscoides* (Oberhaus.), *Coronipora austriaca* (Krist.), *Involutina liassica* (Jones), *Trocholina turris* Frentz., *Galeanella panticae* Zanin. et Broenn., *Miliolipora cuvillieri* Broenn. et Zanin., *Semiinvoluta clari* Krist. and others. This foraminiferal association predominantly consists of involutinids, miliolids and nodosariids associated with algae and brachiopods. The *Involutina liassica* assemblage of the western Caucasus is very similar to the *Miliolipora cuvillieri-Semiinvoluta clari* associations of the Crimea and Pamirs, and there are many common species in coeval associations from the Carpathians-Balkans, the Hellenic Realm, Turkey, and Indonesia.

The Lowest Jurassic deposits of the Bugunzha Formation (upper part of the Lower Sinemurian-lower part of the Lower Pliensbachian) overlie the Upper Triassic with an erosional contact. In the lower part of the Bugunzha Formation (Upper Sinemurian) there is an assemblage with *Cornuloculina clausa* (*Cornuloculina clausa* local zone). This lower Jurassic foraminiferal association consists of miliolids and dominant nodosariids with some species in the *Cornuloculina clausa* assemblage typical for Triassic associations. Besides foraminifers, there are rare ammonoids and brachiopods. The foraminiferal assemblage from *Cornuloculina clausa* local zone is similar to or has common species with coeval associations from Bulgaria, Poland, North Germany and North France.

The western Caucasus has a unique geographic position at the transition between the Tethyan and Peri-Tethyan paleobiogeographic areas. The generic compositions of the foraminiferal assemblages are very different and there are only a few common species. The uppermost Triassic assemblage with *Involutina liassica* is typical of reefal facies, but the lowest Jurassic assemblage with *Cornuloculina clausa* is typical of terrigenous facies of marginal continental basins. The sedimentological and faunal characteristics of the basin in the area of the western Caucasus varied over this time. An analysis of the taxonomic composition of uppermost Triassic and lowest Jurassic foraminiferal assemblages of the Caucasus area shows two stages of foraminiferal development. The uppermost Triassic assemblage is similar to coeval associations from Tethyan regions and the lowest Jurassic one is similar to coeval assemblages from Peri-Tethyan regions. The foraminifers indicate an essential restructuring of the basin environment and important changes of faunal migration patterns. The structural reconstruction of the paleobasins of Europe and Asia probably also contributed to these differences in stage development and faunal composition. Consequently, it

is possible to use foraminifers as environmental indicators in the paleobasins and as indicators of tectonic rebuilding outside.

The Upper Triassic – Lower Jurassic deposits of the western Caucasus contain rather diverse faunal assemblages through out most of the interval that could be used as a standard for correlating coeval faunal associations over the entire Caucasus area and adjacent regions. These faunal assemblages are characterized by many similar species of foraminifers and ammonoids that are similar to those found in coeval faunal associations of Europe and Asia and allow these taxa to be used for interregional correlation and paleobiogeographic reconstructions. Thus, the comparison of the foraminiferal diversity and rate of their changes with the various lithofacies of Upper Triassic and Lower Jurassic deposits permit possible correlation of the evolutionary development of the faunal communities and their connection to the history of the evolution of the basin.

Key words: Triassic, Jurassic, Caucasus, foraminifers, biodiversity, Tethys, Peri-Tethyan

INTRODUCTION

The main purpose of this research is to define the uppermost Triassic foraminiferal association and its relationship with the Lower Jurassic foraminiferal association from the western Caucasus area, and to establish a connection between these foraminiferal assemblages and paleoenvironmental changes. The western Caucasus has a unique geographic position at the transition between the Boreal and Tethyan paleobiogeographic areas. The Upper Triassic – Lower Jurassic of the western Caucasus contains rather complete and varied assemblages of foraminifers and ammonoids throughout most of the interval (except possibly the uppermost part of the Rhaetian (?) and the lower part of the Lower Sinemurian), and could be used as a standard for correlating coeval faunal associations over both the entire Caucasus area and adjacent regions. Furthermore, these faunal assemblages of the western Caucasus are characterized by many species similar to those in coeval faunal associations of Europe and Asia. Thus, they can be used for interregional correlation and paleobiogeographic reconstructions of the Tethyan and Peri-Tethyan regions, making the western Caucasus area a key region for understanding the geological evolution of this area. The northern Caucasus is the oldest oil and gas-bearing region of Russia, therefore biostratigraphic and paleogeographic investigations are very important to local petroleum geologists. In addition, this research is applicable to the Lithosphere Dynamics Program, the International Geological Correlation Program (IGCP), and also to the International Subcommissions on Triassic and Jurassic Stratigraphy.

GEOLOGICAL SETTING AND RESULTS

The studied outcrops of Triassic deposits are located in the area (Figure 1) of the Peredovoy Range, Laba and Belaya river basins, western Caucasus. The Triassic deposits lie unconformably with deep erosion on various Paleozoic horizons, and are overlain unconformably by Lower Jurassic strata. The uppermost Triassic deposits of the western Caucasus are represented by the Khodz Group that overlies the Ladinian – Lower Carnian deposits of the Sakhray Group with an

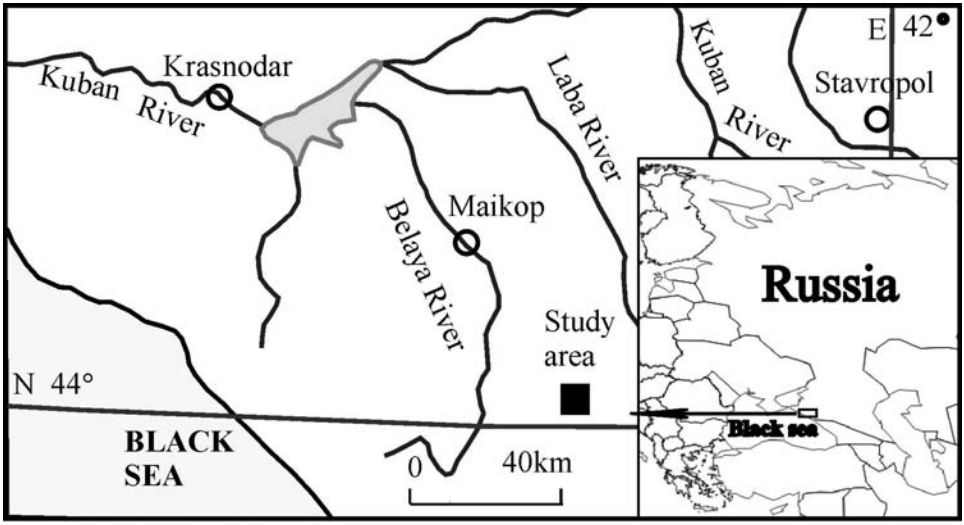

Figure 1 Location of the study area (western Caucasus, Russia).

erosional contact. Various lithofacies of limestone are present, including sandy limestone, red and brown massive reefal limestone, and pink, red and gray bioclastic limestone. The thickness of the Khodz Group is about 500-600m (Oleynikov and Rostovtsev, 1979). These deposits correspond to the Upper Norian - Rhaetian (?) according to Shevyrev (1995) and contain diverse faunal assemblages of foraminifers and other micro- and macroorganisms. The Khodz Group contains two distinct foraminiferal assemblages – one with *Aulotortus friedli* and a second with *Involutina liassica*, that define two foraminiferal zones with same names. Efimova (1991) proposed a scheme for dividing the Triassic of the western Caucasus based on the foraminifera, in which the *Involutina liassica* local zone was situated above the *Aulotortus friedli* zone. A second foraminiferal assemblage (*Involutina liassica* local zone) was found in red and brown massive reefal and subreefal limestone (grainstone-packstone, sometimes recrystallized) correlated to the upper part of the Upper Norian and the Rhaetian (?) *Sagenites reticulatus* zone, *Vandaites sturzenbaumi* zone and *Choristoceras marchi* zone (?) (Figures 2 and 3). The existence of the *Choristoceras marchi* zone in the Khodz Group is controversial and is discussed by Shevyrev (1995). The characteristic species of this association in the *Involutina liassica* local zone are *Lamelliconus turris* (Frentz.), *Auloconus permodiscoides* (Oberhaus.), *Aulotortus tenuis* Krist., *Coronipora austriaca* (Krist.), *Involutina liassica* (Jones), *Semiinvoluta clari* Krist., *Ophthalmidium triadicum* (Krist.), *Galeanella panticae* Zanin. and Broenn., *Miliolipora cuvillieri* Broenn. and Zanin. and others. Besides foraminifers, there are algae, bryozoans, echinoids, corals, gastropods, ammonoids - *Megaphyllites insectus* (Mojs.), *Arcestes liostracus* (Mojs.), *Cladiscites beyrichi* Welter, *Placites polydactylus* (Mojs.) and others, brachiopods - *Laballa suessi* (Winkl.), *Zugmayerella koessenensis* (Zugm.),

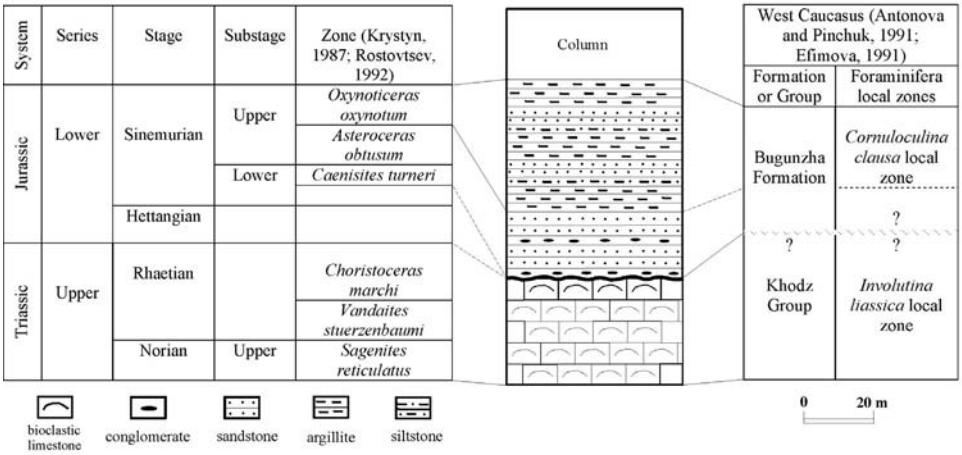

Figure 2 Foraminiferal zonation of the uppermost Triassic - lowest Jurassic in the Khodz River basin of the western Caucasus, Russia.

Figure 3 The Upper Norian - lower part of the Rhaetian limestone of the "Mramornyi" quarry (the uppermost part of the Khodz Group, the Khodz River basin, western Caucasus, Russia).

is mainly represented by species of the genera *Lamelliconus*, *Coronipora*, *Semiinvoluta*, *Ophthalmidium*, *Galeanella,* and *Nodosaria.* Thus, among secreted foraminifers, representatives of the families Involutinidae, Ophthalmidiidae, Milioliporidae and Nodosariidae are dominant. Agglutinated foraminifers play a minor role in this microbiotic community. They are mainly represented by the genera *Glomospira, Trochammina,* and *Duotaxis*. Efimova (1991) noted layers in this local zone that contain only representatives of miliolids or nodosariids. The foraminifers are irregularly distributed, *i e.*, there are beds with abundant foraminifers and some beds in which they are absent. It has been proposed that some limestone beds of the Khodz Group were formed in shallow water and were included in reefal constructions (Efimova, 1991; Shevyrev, 1995).

The foraminiferal association from the *Involutina liassica* local zone of the western Caucasus is very similar to the Norian-Rhaetian assemblages (*Miliolipora cuvillieri-Semiinvoluta clari* associations) of the Pamirs (Vuks, 1996; Vuks, 2000) and Crimea (Pronina and Vuks, 1996; Vuks, 2000). There are a number of species common to the coeval communities from these regions (fig 4.) and also similarities to the Late Norian (Lacian-Sevatian) assemblage from the *Miliolipora cuvillieri* standard zone of the Carpathians-Balkans and Hellenic Realm (Salaj and others, 1988), the Late Norian association from the Kocagedik unit of Turkey (Altiner and Zaninetti, 1981), and the Norian-Rhaetian assemblage from the Asinepe Limestone of Seram, Indonesia (Al-Shaibani and others, 1983). The above-noted associations are usually found in the reefal and subreefal bioclastic limestone.

The lowest Jurassic deposits (Bugunzha Formation - upper part of the Lower Sinemurian-lower part of the Lower Pliensbachian) overlie those of the Upper Triassic with an erosional angular unconformity and consist of sandy clay and argillites with calcareous concretions and lenses of bioclastic limestone. Antonova (1975) proposed a division of the Lower Jurassic of the western Caucasus according to foraminifers. A *Cornuloculina clausa* local zone (Antonova and Pinchuk, 1991) is present in the lower part of the Bugunzha Formation (Upper Sinemurian) whose assemblage consists of *Cornuloculina clausa* (Ant.), *Labalina kunaensis* (Ant.), *L. rostovcevi* (Ant.), *Dentalina subtenuicolis* Franke, *Nodosaria mitis* Terq. and Berth., *Lingulina tenera* (Born.), *Lenticulina acutiangulata* (Terq.), *Astacolus aargovensis* (Kuebl. and Zw.), *Planularia filosa* (Terq.), and others (Figure 2).

This foraminiferal association primarily consists of miliolids and more prevalently nodosarids. Representatives of the families Ophthalmidiidae and Vaginulinidae dominate the secreted foraminifers and this foraminiferal association is mainly represented by the genera *Cornuloculina*, *Labalina*, *Nodosaria*, *Lingulina*, *Lenticulina*, *Astacolus* and *Planularia.* The agglutinated foraminifers play a minor role in this microbiotic community and are mainly represented by the genera *Reophax, Tolypammina, Trochammina, Gaudryina, Gaudryinella, "Tetrataxis".* There are some species in the assemblage with *Cornuloculina clausa* that are typical for Late Triassic foraminiferal associations from other regions – *Tolypammina discoidea* Trif., *Trochammina alpina* Krist.-Tollm., *Gaudryina triassica* Trif., *Gaudryinella elegantissima* Krist., "*Tetrataxis" inflata* Krist. , and others. Some foraminifers from the above-noted

Figure 4 Distribution of the closed foraminifera associations in the Upper Triassic (x) and Lower Jurassic (o) assemblages of the West Caucasus, Russia.

assemblage also occur in the *Involutina liassica* local zone. In addition to foraminifers, there are rare ammonoids and brachiopods. The assemblage with *Cornuloculina clausa* is similar to and has a number of species common to coeval associations from Bulgaria (Trifonova and Ivanova, 1995), Poland (Malinowska, 1980), northern Germany (Bartenstein and Brand, 1937) and northern France (Ruget and Sigal, 1967) (Figure 4.)

The considered assemblages from the uppermost Triassic and lowest Jurassic are rich and very diverse, but their generic compositions are very different and there are only a few common species. The latest Triassic association with *Involutina liassica* is typical for reefal facies, but the earliest Jurassic assemblage with *Cornuloculina clausa* is typical for terrigenous facies of the margin of continental basins. Thus, the sedimentological and faunal characteristics of the basin present in the western Caucasus area clearly changed during this time.

CONCLUSIONS

An analysis of the taxonomic composition of foraminiferal assemblages from the uppermost Triassic and lowest Jurassic of the Caucasus permits identification of the first and older assemblage with coeval associations from the

Tethyan region. However, the second and younger one is similar to coeval assemblages from the Peri-Tethyan region. The foraminifers exhibit an essential restructuring of the environment in this basin and indicate important changes of the faunal migration patterns. The analysis of taxonomic composition and comparison of the foraminiferal associations of the western Caucasus and coeval foraminiferal communities from others regions during Late Triassic time suggest that foraminifers could migrate freely from paleobasins ranging from the area of present Indonesia and Europe. During Early Jurassic time, migration was evident from northern France to the Caucasus (Figure 4.). An analysis of the generic and species composition of the foraminiferal assemblages in time and space permit the definition of two different stages of evolutionary development during the Late Triassic (Late Norian - Rhaetian) and Early Jurassic (Late Sinemurian-Pliensbachian). Furthermore, two different types of foraminiferal communities developed as a result of the influence of the Tethyan and Peri-Tethyan basins, and the structural reorganization of paleobasins in Europe and Asia during this time period. Consequently, it is possible to use the foraminifers as environmental indicators in these paleobasins and as indicators of the tectonic reconstruction outside.

Thus, the unique development of the Late Triassic and Early Jurassic faunal communities of the western Caucasus represent a time of transition and reflect the successive influence of foraminiferal faunas of the Tethyan and Peri-Tethyan basins. The comparison and diversity of the foraminiferal associations and rate of their evolutionary change with the lithofacies permit correlation of these faunal communities their interconnection to the history of the basin evolution.

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