DZIRULA MASSIF IN EARLY MESOZOIC

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Lower Mesozoic sediments are wide-spread within Dzirula massif (Western Georgia), However, Triassic deposits are poorly studied in comparison with Jurassic ones. Hence, some issues concerning Early Mesozoic history should be investigated more specifically.

The Triassic formations (the Narula suite) within the studied territory are represented by continental-littoral marine facies (Gamkrelidze, Chikhelidze, 1932; Vakhania, 1976; Svanidze, Lebanidze, Iacobidze, 2000), wich in geological publications are known as the "lower tuffites" suite of the Shrosha-Narula zone.

The Narula suite can be divided into two-lower and upper subsuites. In the sandy argillites and micaceous sandstones of the lower subsuite (within the basal layers) the following floristic complex has been identified: Neocalamites hoerensis (Schimp.) Halle, Dictyophyllum cf. exile(Brauns) Nath., Cladophlebis ex gr. denticulata (Brongn.) Font.,Cl. haiburnensis (Lindl.et. Hutt.) Brongn., Cl. suluktensis Brick., Cl. whitbiensis (Brongn.) Brongn., Anomozamites minor (Brongn.) Nath., A. nitida Harris, A. cf. varians Stanisl., Pterophillum cf. aequale (Brongn.) Nath., Pt.aequale (Brongn.) Nath.var longifolium Leban.,Pt. andreanum Schimp., Pt. aff. ptilum Schimp., Pterophyllum sp.a, Pterophyllum sp.b, Pterophyllum sp.c, Anthrophyopsis narulensis Dolud. et Svan., Pseudoctenis nelii Leban., Pseudoctenis sp., Ginkgoites cf. taeniatus (Braun.) Sixt.et. Sav., Baiera minuta Nath.,B. aff. concinna (Heer) Kavasaki, Podozamites angustifolius (Eichw) Heer, P. gramineus Heer, P. et gr. lanceolatus (Lindl.et Eichw.) Broun, Stachyotaxus elegans Nath., Stachyotaxus sp., Elatocladus laxus (Phill.) Harris(Svanidze et al., 2000).

The Lower Jurassic deposits of Dzirula massif bearing fossil plants are known as the Martotubani suite (Vakhania, 1976; Svanidze, 1996; Lebanidze, 2000). The flora-bearing formations of the mentioned suite were found in the vicinities of the villages of Shrosha (the river Kotroula) and Kandari. The suite is located on the Paleozoic formations and is built up with conglomerates, coarse- and medium-grained quartzy sandstones, schistose sandstones (65-75m), in analogues of which Sinemurian fauna is found within the Dzirula gorge (Topchishvili).

Within the Martotubani suite, thin-bedded and fine-grained sandstones and argillaceous sandstones fossil plants have been identified: Neocalamites hoerensis (Schimp.) Halle, Equisetites beanii (Bunb.) Sew., Dictyophyllum nilssonii (Brongn.) Goepp., Cladophlebis haiburnensis (Lind. et Hutt.) Brongn, Cladophlebis sp., Anomozamites nitida Harris, Pterophyllum sp. d, Ginkgoites

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ex gr. huttonii (Sternb.) Heer, G.Mzia Svan., Sphenobaiera spectabilis (Nath.) Fl., Czekanowskia ex gr. rigida Heer, Cz. setaceae Heer, Czekanowskia sp., Phoenicopsis ex gr. angustifolia Heer, Podozamites angustifolius (Eichw.) Heer, P. ex gr. eichwaldii Schimp., P. et. gr. lanceolatus (Lindl. et Hutt) Braun, Pityophyllum latifolium Tur.-Ket, P. ex gr. nordenskioldii (Heer) Nath. (Svanidze et al., 2000).

The given lists demonstrate that Naruta and Martotubani suites significantly differ from each other by composition of flora which points to the presence of two independent floristic complexes. The data derived from rank correlation method also supports this conclusion (see table 1).

Table 1

№	Order of plants	Triassic flora		Liassic flora		Difference of ranks-d_i
		Number	Rank	Number	Rank	
1	Asterocalamitales	1	2	1	2,5	0,5
2	Equisetales	0	1	1	2,5	1,5
3	Filicales	6	0,5	3	1,5	1,0
4	Bennettitales	10	8	2	4	4
5	Cycadales	4	4,5	0	1	3,5
6	Ginkgoales	4	4,5	3	5,5	1,0
7	Czekanowskiales	3	3	4	7	4
8	Coniferales	6	6,5	7	8	1,5

Rank correlation calculation

Rank correlation among the orders of fossil plans of Triassic and Liassic age was calculated using the following formula:

$$\rho = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)},$$

where ρ is a correlation, d_i is a rank difference, n is the number of taxonomic units, which in our case is equal to 8. Calculated correlation is small enough and is equal to 0,39, which proves the conclusion that comparable floras have very little in common. They clearly differ from each other, which does not seem unexpected taking into consideration quite a long period separating them.

According to paleobotanic data (Vakhrameev et al., 1970; Dobruskina, 1980, 1982), the continental layers spread along Triassic-Jurassic boundary of Western Europe (Germany and Sweden) and Greenland contain flora of two different ages: 1 "Lepidopteris"-flora ot Late Norian-Rhaetian and 2. "Taumatopteris"-flora of Early Liassic.

The presence of such fossils as N. hoerensis, D. exile, A. minor, A. cf. varians, B. minuta, St. elegans and A. narulensis in floristic complex of the Narula suite points to their similarity with "Lepidopteris" flora, whereas, flora of the Martotubani suite, featured by poor presence of dipteridal ferns and abundant representatives of Cladophlebis and Czekanowskia genera, resembles the Early Jurassic floras found in south-western area of Middle Asian province

(Vakhrameev et al., 1970); and from this point they come close to known "Taumatopteris" flora.

The fossils found in the sediments of Narula suite of Shrosha-Narula zone, are hosting only vegetative remains, that is why flora species play crucial role in dating of constituent layers. As it was mentioned above, the flora of Narula suite resembles European "Lepidopteris"-type flora, thercfore, the constituent layers should be assigned to Upper Norian-Rhaetian age. As flora remains were found in basal beds of the suite, it may be assumed, that its lowerest age-line is bound to Norian stage, whereas, the issue whether Narula suite involves Hettangian stage or its uppermost part is bound just to Triassic, needs additional study.

It is known (Dobruskina, l980,1982), that Late Triassic floras are featured by abundant presence of hydrophilous plants and by this characteristic these floras are very similar to that of Narula formation. Presence of Filicales, Cycadales, Bennettitales and Ginkgoales supports the assumption that humid, subtropical-like climate was characteristic for Dzirula massif in Late Triassic.

In Early Jurassic Dzirula massif was located in Euro-Sinian subdomain of Indo-European paleofloristic domain (Vakhrameev et al., 1970), related to subtropical, mainly humid, climatic belt. However, Martotubani flora analyses show that among the studied flora there is nether diversity of ferns related to subtropical climate (they are represented just by formal genus - Cladophlebis), nor such Cycadophitcs, which indicate subtropical conditions (genera Pterophyllum, Anomozamites), even more, forest plants were fully represented by leave- and branch-deciduous gymnosperms and the oldest conifers, that were common for moderate-warm climate of Siberian paleofloristic domain. Besides this, there were abundant Czekanowskiales among the Early Jurassic flora of Dzirula massif that were spread within Middle Asian paleofloristic province of Euro-Sinian subdomain (Vakhramecv et al., 1970). The province itself was stretched at the southern verge of the extensive Sibirian and Kazakhstan continent, some plant groups common for Siberian domain reached the remaining zones of Middle Asia where from, supported by favorable climatic conditions, they also extended to Georgia. Thus, according to paleofloristic data, humid and moderate-warm climate was characteristic for Dzirula massif in the first half of Early Jurassic.

At north-western periphery of the Dzirula massif there arc widely-spread carbonaceous deposits hosting fauna complexes rich with brachiopods. Complete geological cross-sections in the vicinities of the villages of Salieti and Katskhi show Liassic limestones directly overlying Paleozoic granitoids. Lithology of the limestones is quite uniform. The lowermost part of this member is built up of hight-reddish brecciated limestones that upward grade into massive, but in the middle of this member into more or less clastic, recrystallized limestones. The fauna from these sections is described in publication by Nutsubidze K. (1964) and another part was selected and classified by one of the authors of this publication, Koiava: Spiriferina alpina Opp., Sp. möshi

Haas, Sp. angulata Opp., Sp. obtusa Opp., Sp. tumida Buch., Sp. walcotti Sow., Rhynchonella plana Koiava, Terebratula punctata Sow., T. katchkiensis Koiava, Zeilleria subdigona Opp., Z. indentata Sow., Dakhirhynchia dakhensis Kamysh., Squamirhynchia zagarellii Koiava, Sq. ketevanae Koiava, Schroshaerhynchia shroshaensis Kamysh., Kvirilaerhynchia kvirilaensis Koiava, Calcirhynchia plicatissima Quenst. The mentioned fauna proves Pliensbachian-Lower Toarcian age of the sediments.

Based on analyses of calcite component in shells of Pliensbachian- Early Toarcian brachiopods, inhabitants of Dzirula massif shallow marine, it was concluded that ambient temperature here was 22-24^{o}C. Therefore, the temperature of sea- basin surface was more then 22^{o}C that is typical for tropical climate. According to paleozoologic data, the Pliensbachian and Early Toarcian climate within Dzirula massif was of tropical-like type.

Thus according to paleobotanic and paleozoologic data, in Triassic Georgian intermountain massif within Dzirula salient was featured by subtropical-like, humid climate, which, at the beginning of Early Jurassic turned into moderately warm and humid one, and then, within Pliensbachian- Early Toarcian, was altered by hot, tropical-like one.

Alteration of Georgian climate in Early Jurassic corresponds with the data (Vachrameev. 1988; Krasilov, 1977) according to which after Norian-Rhaetian, at the beginning of Liassic, there occurred cold spell (its comparative maximum falls on Early Pliensbachian), which was followed by warm spell achieving its top in Early Toarcian.

Updated interpretation of age of volcanogenic-terigenic Narula suite of Dzirula massif and composition of volcanites to some extent specifies the age of the Dzirula crystalline basement and its paleotectonic nature. Particularly, so far, Narula suite has been considered as low Jurrasic formation. This fact together with the presence of fauna-bearing marine sediments defined pre-Jurasic age of the Dzirula basement. After dating of flora-bearing sediments of Narula formation as Triassic (Middle Norian - Rhaetian) the age of the Dzirula basement canld be attributed to Pre-LateTriassic.

Presence of volcanites, mainly, of rhiolitic composition as well as rhiolitic and basaltic lava flows within the Narula suite, evidences that it represents an ensialic island arc-type structure.

Continental conditions have been replaced by marine in the beginning of Jurassic, and as a result continental Narula formation was covered whith littoral-marine and normal marine Martotubani, Kvirila and Shrosha suites. As one can see, sinking started at the latest Triassic or at the very beginning of Liassic was followed by transgression wich achieved its maximum at the middle of Liassic.

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