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The investigation of microfossils in ancient rocks: the comparison of different techniques

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Abstract

Traditionally microfossils in ancient Archaean – Proterozoic (AR-PR_1) silicified rocks were investigated in thin sections and macerates (preparations obtained by the chemical decomposition of rocks) by polarized optical microscopy. These methods produced great results and greatly changed the investigation of ancient rocks and our mental picture of world. Among these achievements, the modern concepts concerning the evolution of the Earth's biosphere evolution and processes of sedimentation are the most important. Pioneers in this research included E. S. Barghoorn,[2], J. W. Schopf[9], J. F. Banfield[1], K. H. Nealson[1], A. H. Knoll[7], B. V. Timofeev[10] and many others.

Another method of studying ancient rocks and the microfossils contained within them is the method of examining freshly fractured interior surfaces of rock chips using the Scanning Electron Microscope (SEM).

The wide application of this method began with the study of microfossils in the ancient phosphorites of Khubsugul (the Lower Cambrian, Tommotian stage, Mongolia) [8, 15]. It is possible to say that the investigation of fresh phosphorites chips in the SEM gave rise to a new epoch in the understanding of many problems such as, for example, the rate of fossilization[3, 5, 4] the possibility of bacterial preservation in different types of sedimentary rocks and meteorites [6, 11, 13, 14, 12] and, finally, the resolution of many interesting questions of bacterial paleontology.

The method of the SEM study of fresh chips has many advantages over the prior techniques (e.g., the study of thin sections and macerates).

While working with thin sections we are dealing with thin (0.003mm) smooth (polished) rock surfaces. So, we have little opportunity to trace mutual relations (interrelationships) of the microfossils encountered and the host rock. While preparing macerates (i.e. while dissolving host rock by strong acids) we can usually only observe the separate microorganism fragments without the knowledge about their relationships.

The study of fresh rock chips avoids most of these disadvantages. While examining them in the Scanning Electronic Microscope we can observe not only peculiarities, including three-dimensional form of microfossils, but also the interrelationships between the host rock and the biomorphs. Thus we can judge if the microfossils are embedded within and indigenous to the rock matrix or if they "lie" on the surface of rock (in this case the possibility of later contamination is great). Furthermore, the elemental compositions of the possible microfossils and the surrounding rock matrix can be investigated using the microprobe.

Investigations of different rock types were conducted in order to compare the different methods of research of ancient (AR) rocks (carbonaceous shales, volcanogenic-sedimentary etc.) of the Khizovaar green-stone structure of Karelia, the Archaean and Proterozoic weathering crusts of Karelia, the Proterozoic pillow-lavas and volcanic glasses of different regions, etc.

It is quite clear that in the course of the investigation of rocks and the study of ancient microfossils, we are need to know the chemical composition of the fossil by itself and rock matrix as a whole. In this point of view the method of the study of fresh chips are of intermediate position.

Macerates are practically unsuitable for this kind of investigation. Thin-sections are of great value in this respect, because their smooth surfaces are very good for chemical scanning by the microprobe while working in modern scanning electron

microscopes. Uneven surfaces of fresh chips are not so good for the need of chemical analyses, but nevertheless it is possible to receive chemical analyses using this method.

The bacterial-paleontological study of numerous and diverse samples of fresh chips of Archaean-Proterozoic rocks (metasedimentary, weathering crusts, volcanogenic-sedimentary, volcanogenic etc.) showed, that the data received by this method is more informative, more reliable and more difficult to dispute.

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