



## **Volgian black-shale sediments of the Ivkino section, northern Russian Platform: sedimentary structure, geochemical and biotic record**

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Volgian organic carbon-rich sediments are widespread in large territories of the Russian Platform. Well-known Gorodishche and Kashpir sections, middle Volga reaches, are significantly condensed showing frequent short hiatuses and discontinuous sedimentary record. Black-shale sequence (BSS) of Ivkino section (Unzha R., Kostroma Oblast, N Russian Platform) seems to be much more complete and demonstrative for the northern part of basin. Wide occurrence of Dorsoplanites, Pavlovia, and Zarismites ammonite genera attests middle Volgian panderi zone interval for the whole BSS. Nanofossils are presented in the lower part of the sequence only and show stratigraphic assignment to the NJ20A-NJKA zones. BSS overlying Kimmeridgian calcareous claystone is built up of 15 cycles composed of black shale (TOC up to 25%) at the base gradually changing to calcareous-clayey sediment (TOC 0.4-3%). Black shale kerogen is of I and II types (HI 402-690) and carbonate sediment kerogen is of II and III types (HI 17-302). Organic matter is made up of colloalginite with rare chorate dinocysts. V, Mo, As, Cu, Cr, P and some other trace elements show significant increase within black shales, while Ni, Mn, Co, Zn are featured by inversed trend. These regulations in the trace element distribution were formed at both sedimentation stage and early diagenesis as a result of element redistribution. Macro- and microfossils strongly decline within black shales and become small sized and poorly preserved. Besides, they reduce toward the top of BSS up to total disappearance. Volgian nanofossil assemblages of Ivkino section differ from earlier found in southward Gorodshche and Kashpir sections by lacking of boreal Stephanolithion atmetros, Crucibiscutum salebrosum, presence of scarce low latitude Conusphaera mexicana, Polycostella beckmannii, and

few eutrophic *Biscutum constans*, *Zeugrhabdotus erectus*. Common for all localities feature is the wide occurrence of abundant *Watznaueria* spp. (*W. barnesae*, *W. britannica*, *W. fossacineta*, *W. ovata*) forming oligotaxonic assemblage in the black shales of Ivkino section. Toward the BSS middle part, *W. barnesae* became strongly dominate over other species. Biometric study of *W. britannica* placoliths showed the strong differentiation to two morphotypes. One of them, which is more common in the lower part of BSS, is characterized by small thick placolith with narrow central opening, while another morphotype representing large thin placoliths with large central opening becomes more frequent in the BSS upper part. Remarkable is the lack of transitional form between these two morphotypes throughout the BSS that more likely indicates their habitat in different depths of photic zone and stratification of water column. We speculate the trend to increased placolith size and reduced calcification might correspond to warming and calcium carbonate deficit developed toward the middle part of BSS. *W. britannica* being the most resistant to diagenetic alteration taxon does not show significant morphological variations. BSS accumulation is featured by general regressive trend and frequent short-term sea-level fluctuations. The intensified input of biophile elements during short transgressive pulses caused enhanced algae and picoplankton productivity and organic-rich sediment accumulation. Recycling of biophile elements favored high bioproductivity. During black shale accumulation anoxic conditions evidently occurred, but anoxia in the shallow Volgian basin was not stable and became frequently interrupted by spreading of oxic environment. Sedimentary architecture of BSS in the Ivkino section is generally similar to other Volgian sections and evidently displays the common regularities of the Russian Platform basin at this time span. RFBR Project no. 06-05-65282.