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Environmental conditions of accumulation of Cambrian carbonaceous rocks in the Siberian Platform

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Abstract

Based on results of deep drilling and the CDP-2D seismic profiling, the relations between the Early and Middle Cambrian carbonaceous rocks and the underlying, overlying, and synchronously formed deposits in the Siberian Platform are analyzed, and the lithologo-paleogeographic, paleotectonic, and tectonic conditions of their formation are considered. It is shown that these carbonaceous rocks are intimately related to the Cambrian organogenic structures, up to their mutual transitions.

Keywords: Carbonaceous rocks; organogenic structures; paleogeographic and tectonic correlations; seismic prospecting; deep drilling; Early and Middle Cambrian; lithologo-paleogeographic, paleotectonic, and tectonic conditions of hydrocarbon formation; Siberian Platform

The major areas of Cambrian carbonaceous (enriched in organic matter (OM)) deposits are located in the eastern Siberian platform (Fig. 1). They are confined to the Lena Substage of the Lower Cambrian strata and the Amga Substage of the Middle Cambrian strata. Their sedimentation conditions have been the subject of long debates (Evtushenko, 1977; Staroseltsev, 2011; Starosel'tsev and Shishkin, 2012). The most comprehensive directed research into this problem was carried out by V.M. Evtushenko during the preparation of his PhD Thesis under the guidance of Prof. A.E. Kontorovich and Prof. V.E. Savitskii in the late 1960s–early 1970s. They drew an unambiguous conclusion: Such rocks have many structural features of shallow-water sediments. Later on, S.S. Sukhov repeatedly considered their accumulation in deep-water uncompensated troughs. He proposed a paleoprofile stretching in the NE direction from southwestern to northeastern margin of the Siberian Platform (Fig. 2), with its smoothening along the base of the Cambrian carbonaceous deposits and along the base of synchronous salt–carbonate deposits. Since the latter were about 2.0–2.5 km in total thickness and the former were only about 100 m thick, the depth of the undercompensated trough was estimated at 1.5–2.0 km.

The scheme in Fig. 2 does not take into account the specific features of the tectonic evolution of the Siberian Platform zones crossed by the paleoprofile. As early as the Riphean, the southwestern part of the platform differed seriously in the amplitude of deposit-compensated downwarping from the northeastern part (Fig. 3). In the Paleozoic, this tendency significantly increased, which led to the formation of the largest Anabar anteclise in the northeast and the Kureika and Cis-Sayan–Yenisei syneclise in the west of the platform (Fig. 4). Throughout the Phanerozoic geologic history, the Anabar anteclise, like the Aldan anteclise in the southeast, lagged behind the western Siberian Platform in downwarping and, correspondingly, in the total thickness of accumulated sediments.

It is hardly possible that the direction of tectonic movements changed in the opposite way in the short period from late Early Cambrian to early Middle Cambrian. We realize that a reasonable recognition of the sedimentation environments requires a substantive analysis of the lithologic, paleogeographic, and tectonic conditions of accumulation of the deposits under study. Therefore, we present the established relations between these and the underlying, overlying, and synchronous deposits (Staroseltsev and Shishkin, 2012).

The results of deep drilling and modern CDP-2D seismic prospecting in the Khochom area in the east of the Aldan anteclise are the most informative. The Khochomskaya well 1 was drilled in the lower reaches of the Amga River in the apical zone of the Amga structure recognized by S.S. Oksman

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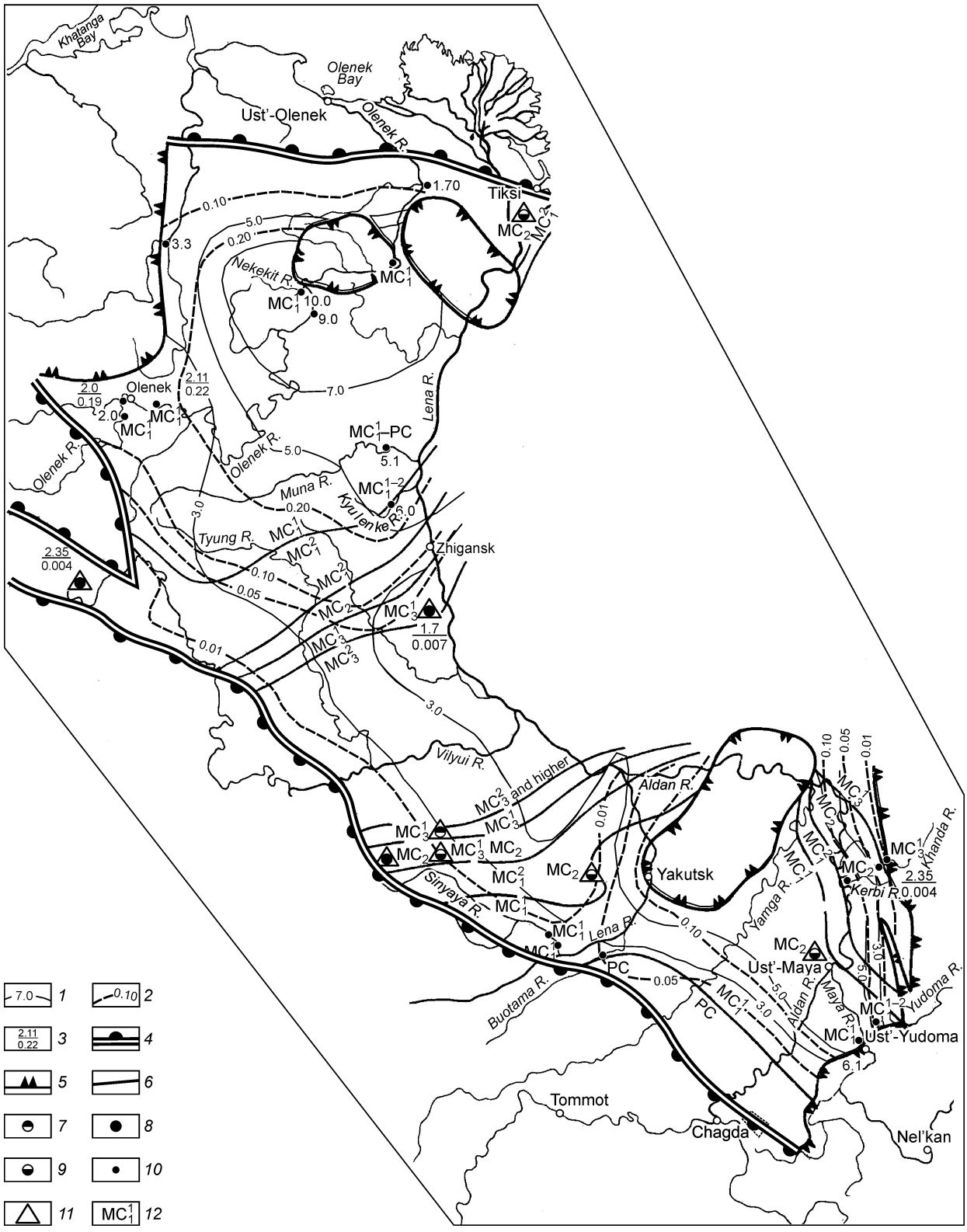

Fig. 1. Schematic map of the geochemical parameters of the Kuonamka-type black-shale deposits in the eastern Siberian Platform. *1*, concentrations of C_{org} (% per rock); *2*, concentrations of chloroform source-rock extract (% per rock); *3*, location of the studied section and weighted average concentrations of C_{org} (% per rock) (above the line) and chloroform source-rock extract (% per rock) (below the line); boundaries of the Kuonamka Horizon: *4*, facies; *5*, erosion; *6*, predicted boundaries of zones with dispersed organic matter (DOM) of different degrees of catagenesis; points of measurement of the degrees of DOM catagenesis: *7*, in overlying deposits; *8*, in Kuonamka Horizon deposits; *9*, in underlying deposits; *10*, in outcrops; *11*, in wells; *12*, catagenesis grades.