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Biostratigraphy and important biotic events in the Western Verkhoyansk Region around the Sakmarian–Artinskian boundary

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Abstract

A diverse marine invertebrate fauna was found in the Echij Formation (Sakmarian–Artinskian) at the Arkachan, Chelge, and Nizhnyaya Dielendzha sections, all Western Verkhoyansk Region, North-East of Russia. The biostratigraphic sequence of ammonoid, brachiopod, bivalve, and foraminiferal assemblages in the Echij Formation of the Western Verkhoyansk Region is studied. Five ammonoids units are identified in the Echian Regional Stage ("Horizon"): *Uraloceras subsimense*, *Uraloceras omolonense*, *Neoshumardites triceps hyperboreus*, *Eotumaroceras endybalense*, and *Eotumaroceras subyakutorum* beds. The first two divisions contain ammonoids of the Arkachanian association, and the last three contain the Endybalian association. The boundary between the Sakmarian and Artinskian stages is established at the base of *Neoshumardites triceps hyperboreus* beds. In the Sakmarian interval of the Echij Regional Stage of the Verkhoyansk Region, a brachiopod biostratigraphic sequence similar to that of the Kolyma–Omolon Region is observed: *Jakutoproductus insignis*, *Jakutoproductus terechovi*, and *Jakutoproductus rugosus* zones. In the lower part of the Artinskian stage, *Uraloproductus stuckenbergianus* beds are identified, which are characterized by a rich brachiopod assemblage (Peregoedov et al., 2009), not typical for Verkhoyansk Region. The bivalves, identified in the Lower Echij Subformation, presumably belong to the *Merismopteria permiana*, *Cypricardinia eopermica*, and *Cypricardinia borealica* zones of the Ogonerian Horizon of the Kolyma–Omolon Region. Bivalves of the Middle and Upper subformations are characteristic of the *Edmondia gigantea* and *Aphanaia lima* zones of the Koargychanian Regional Stage ("Horizon"). The foraminifera complex identified in the Echij Formation is compared with the complex of the lower part of the Sandy Foraminifera horizon of the northeast of the Siberian platform, to which the Tustakh Formation belongs. The beginning of the wide distribution of the Early Permian foraminifera in the Western Verkhoyansk Region was recorded at the base of the Artinskian. The Sakmarian–Artinskian boundary interval in the Verkhoyansk Region is characterized by three significant biotic events: the replacement of the brachiopod *Jakutoproductus* by *Inoceramus*-like bivalves, the first appearance of the Endybalian ammonoid association, and biotic invasions from the Uralian and North American regions. An important factor of the Late Sakmarian–Early Artinskian events was a large sea level rise (the Echian transgression), which significantly changed the environmental conditions for East Siberian marine invertebrates, and contributed to the spread of new faunas.

Keywords: Lower Permian; Ammonoids; Brachiopods; Bivalves; Foraminifers; Paleobiogeography

1. Introduction

To determine the Sakmarian–Artinskian boundary in the Verkhoyansk Region, it is very important to identify invertebrates that characterize this boundary in the stratotype region of the Artinskian Stage. Previously, the global stratotype section and point (GSSP candidate) for the base of the Artinskian Stage

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