

Ordovician—Silurian Carbonate Platforms on the Western Slope of the Urals: Conventional Model Revised

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Received September 20, 2024; revised October 22, 2024; accepted October 22, 2024

Abstract—Based on analysis of taxonomic identifications of previously collected fossils combined with the results of a lithological study, some traditional models are revisited, and the nature of cyclic units in the sections of the western megazone of the Urals is re-interpreted. Lists of ichthyofauna from the Kuba River Formation stratotype (Middle Ural, Silurian, Ludlow) suggest a gap in the transgressive sequence of shelf carbonates. It is expressed as a blended unconformity corresponding to most of the Gorstian Stage. The sedimentary nature of the cyclic units of the Ordovician—Silurian mega-sequence are due to the irregular rate of tectonic subsidence and not related to eustatic fluctuations.

Keywords: ichthyofauna, brachiopods, biostratigraphic correlation, eustasy, blended unconformities, sedimentary cyclicity, western slope of the Urals

DOI: 10.1134/S0031030124601798

INTRODUCTION

The Ordovician-Silurian carbonate platforms of the Western Ural Basin form an extended belt that can be traced from Pay-Khoy to the Middle Urals for a distance of over 2000 km. In the Late Paleozoic, during the collision of the Baltica passive margin with the island-arc terranes of the Paleo-Ural Ocean (Ruzhencev, 1976; Puchkov, 1979, 2000, 2010; etc.), the shelf complex of the continental margin was deformed and accreted to the Ural folded structure. In some segments of the western slope of the Urals (e.g., in the central part of the Ufa Amphitheater), the carbonate platforms of the passive margin were tectonically displaced and thrust onto the inner part of the foredeep (Kamaletdinov, 1974; Zhivkovich and Chekhovich, 1985; etc.). Although the general structural-geodynamic interpretation of the Ural region is now more or less clear (Puchkov, 2010; etc.), many questions remain regarding the facies models of individual paleogeographic units and their biostratigraphic substantiation. In this paper, based on an analysis of taxonomic identifications of previously collected fossils and our own lithological studies, an attempt is made to reconsider some traditional ideas regarding the sedimentary nature of cyclic units of the regional sequence of the western megazone of the Urals.

Currently, the most thoroughly studied sections are those in the Kozhim River basin in the Subpolar Urals and in the Ufa Amphitheatre (Middle Urals; Fig. 1). In the historical depositional context, the Ordovician-

Silurian deposits form the most of a large sedimentary cycle (megacycle, or mega-sequence). Its lower boundary is usually drawn at the base of the Upper Cambrian—Lower Ordovician coarse-grained strata (“graben formations”), unconformably overlying the Rhiphean basement—the Telpas Mountain Formation and Obe-Iz Ridge Formation in the Polar and Subpolar Urals, the Shunut Mountain Formation and Kozya River Formation of the Middle Urals (Puchkov, 1979; Zhivkovich and Chekhovich, 1985, Nikulova et al., 2018; etc.). The upper part of the mega-sequence also includes all Lower Devonian sequences underlying the base of the Takaty Ridge sandstones. In a number of places where these sandstones are absent (for example, in the Ufa Amphitheatre), the transition to the overlying sequence is more gradual. In such cases, the upper boundary of the Ordovician—Lower Devonian mega-sequence is the base of the sedimentary dolomite member (synchronous with the Takaty Ridge sandstones) (Zhivkovich and Chekhovich, 1985; etc.), which was deposited in the inner shelf lagoons, in the back-reef platforms.

ORDOVICIAN

Ordovician carbonate platforms are best represented in the Kozhim sections in the Subpolar Urals. They began to form here at the beginning of the Middle Ordovician. In the more southern regions of the Urals, Lower Paleozoic carbonate complexes are usu-

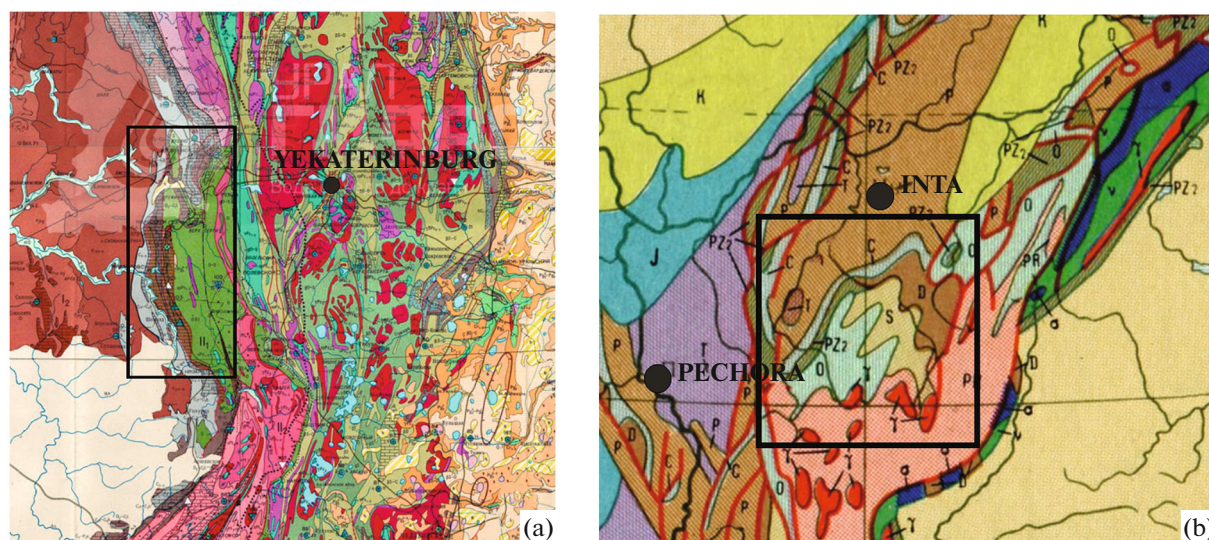


Fig. 1. Type regions within which the reference sections of Ordovician-Silurian deposits are located. (a) the central part of the Ufa Amphitheater in the Middle Urals; (b) the Kozhim River basin in the Subpolar Urals (*Geologicheskaya karta...*, 1983).

ally exposed in the framing of ancient cores of the Central Ural uplifts, where they are usually metamorphosed and for a long time did not have reliable paleontological datings. At present, this has been resolved due to the emerging information on conodont identifications from these sections (Maslov et al., 2008; Ryazantsev et al., 2008; Mavrinskaya, 2011; Mavrinskaya and Yakupov, 2016; Yakupov, 2023).

The chronostratigraphic subdivision scheme of the Ordovician carbonate strata (Fig. 2) is based on the Unified Stratigraphic Schemes of the Urals (*Ob'yasnitelnaya zapiska...*, 1994) and also takes into account later clarifications and modifications (Zhemchugova et al., 2001; Beznosova et al., 2006; 2020; etc.). The carbonate deposits of the Middle–Upper Ordovician represent the middle (“transgressive phase”) and upper (“highstand phase”) parts of a single Ordovician mega-sequence (macrocycle according to Zhemchugova et al., 2001). Its lower part is formed by terrigenous suites dated to the Lower Ordovician and is considered as deposits of the “lowstand phase”. This is not entirely consistent with the later (Nikulova et al., 2018) datings of detrital zircons from the sandstones of the Saledy Ridge Formation. They contain a large number of “young” grains with an age of 459 ± 5 Ma, corresponding to the top of the Middle Ordovician. The age discrepancy of the diachronous straton base thus exceeds 10 million years and completely covers the chronostratigraphic volume of two stages of the standard scale—Dapingian and Darriwilian. The eustatic nature of this boundary seems questionable in light of these data.

The overlying carbonate beds of the macrocycle in the scheme by Zhemchugova et al. (2001) is subdivided into seven cyclic units of lower rank (“ordinary cyclites”) with a thickness from several tens to several

hundred meters (the right part of the scheme in Fig. 2). The uppermost part of the Ordovician sequence, corresponding to the top of the traditional Ashgill Stage, begins a new macrocycle, with a gradual transition to the Silurian part of the section.

Each of the ordinary cyclites consists of a large number (up to two or three dozen) of elementary cyclites of a meter scale (with a thickness from several to 2030 m), usually with a falling stages system tract appearance. Such units are especially characteristic of the upper parts of ordinary cyclites, interpreted as deposits of “highstand phases” of the relative sea level. The formation of elementary cyclites is presumably associated with periodic increases in the relative sea level and, in some cases, with the pulsating progradation of deltas into the basin.

The same interpretation is given to the ordinary cyclites themselves. In their lower part, deposits of the lowstand tract are usually distinguished (sometimes they are missing in the section), followed by deposits of the transgressive systems tract, and the ordinary cyclite is completed by beds of the highstand tract. This pattern is typical of a sequence in the generally accepted sense (*Sea-Level Change*, 1990; etc.). It remains unclear, however, to what class the above-mentioned ordinary cyclites can be assigned. Their duration cannot always be reliably estimated due to the difficulties in correlating the local scale with the biozonal standards of Europe and North America. Most of these correlations are provisional because of the predominance of endemic taxa in the conodont assemblages of the Subpolar Urals. The most definitive comparison is the upper parts of the Telashor and both Vodoshor cyclites (O2-1, O2-2 and O2-3 in the scheme of V.A. Zhemchugova et al.) with the Darriwilian stage, based on the occurrences of index species