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Discovery of shallow-marine biofacies conodonts in a bioherm within the Carboniferous–Permian transition in the Omolon Massif, NE Russia near the North paleo-pole: Correlation with a warming spike in the southern hemisphere☆

Vladimir I. Davydov [a,c,*], Alexander S. Biakov [b,c]

[a] Permian Research Institute, Boise State University, 1910 University Drive, Boise, ID, 83725, USA
[b] North-East Interdisciplinary Scientific Research Institute n. a. N.A. Shilo, Far East Branch of the Russian Academy of Sciences, 16 Portovaya, Magadan 685000, Russia
[c] Kazan Federal University, 18 Kremlyovskaya St., Kazan, Republic of Tatarstan 420008, Russia

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ABSTRACT

The conodont genera *Hindeodus* and *Streptognathodus* are reported for the first time within the Carboniferous–Permian transition in the northern high latitudes of the Paren' River, Omolon Massif, NE Russia. Several fossil groups, including brachiopods, bivalves, scaphopods and microgastropods were found to be prolific in the invertebrate-dominated bioherms. These bioherms occur within predominantly siliciclastic sequences with extremely poor fauna, whereas in the studied bioherms the diversity of the bivalves and brachiopods exceeded observed diversity elsewhere in coeval facies in NE Russia. The bioherms are biostratigraphically constrained as uppermost Pennsylvanian to lowermost Cisuralian based on ammonoids. The very unusual peak of bivalve and brachiopod diversity and the occurrence of conodonts that require minimum sea water temperatures of at least 10–12 °C indicate a short lived, but significant warming event at that time, at least of provincial significance. This event most likely corresponds with a short-lived warming event recently discovered in the east of the southern hemisphere, in Timor and Australia. Thus, the event is possibly of global significance.

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1. Introduction

High latitudes in the northern hemisphere during the Late Paleozoic are areas that are quite poorly studied. The only data from the mid- to high latitudes (30–50°N paleolatitudes) are known from Spitsbergen, North Greenland and the Canadian Arctic (Beauchamp, 1995; Davydov et al., 2001; Stemmerik and Worsley, 2005; Reid et al., 2007). Information is lacking on areas around the northern paleo-pole (60–80°), especially in the regions in northeastern Russia in Verkhoyansk, Kolyma–Omolon and Chukotka (Zavodovsky, 1960; Andrianov, 1966; Zavodovsky, 1966; Zavodovsky et al., 1970; Ganelin, 1984, 1997). In the Russian literature, however, more data has become available in the last couple of decades (Kashik et al., 1990; Biakov, 2004; Klets, 2005; Biakov, 2006; Ganelin and Biakov, 2006; Klets et al., 2006; Biakov, 2007, 2010, 2011; Biakov and Shi, 2010; Biakov, 2012). The Carboniferous and Permian shallow- and deep-water sequences in the subpolar areas, such as Southern Verknoyansk and Okhotsk regions around 60–70°N, near the paleo-pole (Cocks and Torsvik, 2007) are predominantly sandstones, siltstones and mudstones with very few and rare horizons that are enriched with a carbonate matrix. The successions there are divided and correlated on the basis of bivalves, rare brachiopods and very rare ammonoids (Ganelin, 1984, 1997; Biakov, 2004; Klets, 2005; Ganelin and Biakov, 2006; Klets et al., 2006; Kutygin, 2006; Biakov, 2007, 2010). In the latitudes at the Omolon Massif, Pre-Kolyma and the Omulevka Blocks, the shallow-water Late Paleozoic rocks become more calcareous, with a relatively diverse fauna including abundant foraminifers, brachiopods, bivalves, gastropods, rare ammonoids, solitary rugose corals, bryozoans, ostracods, and crinoids (Zavodovsky et al., 1970; Kashik et al., 1990; Ganelin and Biakov, 2006). Obviously, the shallow-water fauna in these regions are highly endemic and used mostly for local–regional correlation. Extremely rare ammonoids, although endemic, were the only fossils that provided wider correlation with mid-latitudinal sections in the Canadian Arctic, Primorie (south Far East of Russia), Russian Platform, Urals, N. America, Australia and other sections in Peri-Gondwana (Glenister and Furnish, 1961; Nassichuk, 1970; Andrianov, 1985; Kutygin, 2006).

☆ Collection of all fossils reported in this paper housed in the Museum of North-East Interdisciplinary Scientific Research Institute n. a. N.A. Shilo, Far East Branch of the Russian Academy of Sciences, 16 Portovaya, Magadan, 685000, Russia, collection number 02-06.103.

* Corresponding author. Tel.: +1 208 426 1119.
E-mail address: vdavydov@boisestate.edu (V.I. Davydov).

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The other stratigraphically important fossils such as conodonts that potentially could be found in mid-latitude areas have never been found in the Omolon Massif before. Several unsuccessful attempts were made previously to recover conodonts from the Upper Paleozoic in the region. The main targets for the conodont extraction were middle to upper Permian carbonates in the Omolon Massif. Very extensive sampling of several dozens of reasonably large (up to 3 kg) samples did not yield even a fragment of a conodont (Kashik et al., 1990). In 2003, twelve samples (1–2 kg) were dissolved from calcareous concretions of the Upper Permian from the southern Verkhoyanie with no conodonts found (personal data of second author).

Here we are reporting the first discovery of *Hindeodus* and *Streptognathodus* conodonts in the middle part of the Magiveem Fm of the Orochian Regional Stage (Horizon) that approximately corresponds to the uppermost Gzhelian and/or lowermost Asselian. The discovery possesses a significant implication for regional climate and may also clarify our understanding of the global Late Paleozoic climate.

2. Geological setting and material

The area where the conodonts were found is located in the south-east margin of the Omolon Massif in the upper stream of the Paren' River (Fig. 1). The Omolon Massif is a microcontinent with a crystalline Precambrian basement covered with sedimentary successions of Paleozoic–Mesozoic age (Bogdanov and Til'man, 1992; Chekhov, 2000). During the Phanerozoic time, this microcontinent possessed, tectonically, a very quiet platform sedimentation regime. The Upper Paleozoic and Mesozoic sedimentary rocks are folded into relatively simple isometric folds and fractured by numerous faults of different scale. During the Late Paleozoic, the Omolon microcontinent was separated from the Siberian Craton and the Okhotsk microcontinent by a system of deep-water basins: the Verkhoyansk marginal–epicontinental sea, Ayan-Yuryakh Trough, Balygychan and Sugoi Basins (Biakov et al., 2005; Biakov and Shi, 2010). To the south of these structures (in terms of recent coordinates) was located the Okhotsk–Taigonos (the Koni–Taigonos or the Uda–Murgal) volcanic arc (Parfenov, 1984; Sokolov, 1992; Parfenov et al., 2003; Biakov et al., 2005, 2010). The development of this arc started during Pennsylvanian time with the peak of the activity in the Gizhigian (Capitanian) time (Umitbaev, 1963; Biakov et al., 2005). In the south-east, Omolon microcontinent borders with the Gizhiga back-arc basin and in the east with the system of relatively shallow back-arc basins of the Alazeya–Oloi volcanic arc (Fig. 1). Fragments of the latter are preserved in the eastern margin of the Omolon microcontinent and in the western part of the Penzhina Ridge. The Omulevka and Pre-Kolyma Blocks, because of the particular character of their Permian sedimentologic sequences, were probably located far from the Okhotsk–Taigonos volcanic arc (Biakov et al., 2005). The paleomagnetic data in the region are very poor (Kolesov, 2002) and for some regions, such as the Okhotsk microcontinent, entirely lacking. Nevertheless, recent data makes it clear that no major horizontal drifting of the blocks and microcontinents at least from middle Paleozoic exists (Shapiro and Ganelin, 1988; Rodionov, 1991; Sokolov et al., 1997; Biakov and Kolesov, 2006). The tectonics at the Omolon Massif was limited to local thrusts and strike-slip activity during late Mesozoic folding (Terekhov, 1979).

The Upper Carboniferous and lower Permian deposits in the region belong to the Magiveem Formation with a total thickness of around 300 m (Ganelin, 1984). Here, the thick successions of dark-gray, fine to coarse sandy and silty clastics and volcanoclastics contain a series of horizons with bioherms (Fig. 2). We studied one bioherm within a single horizon that possessed an abnormal taxonomic diversity of invertebrates where the conodonts were recovered The lenticular bioherms in this horizon are 0.5–1.5 m in length and 0.2–0.7 m in thickness extended laterally for a distance of several kilometers. An extremely abundant assemblage of bivalves (24 genera and more than 30 species) for the area has been recovered in one of these bioherms (Table 1), including some warm-water forms of Tethyan affinity (Biakov, 2010). The brachiopods and gastropods, including microgastropods, are also very abundant and diverse, but their taxonomy is a matter for further studies.

The bioherm as well as all the rocks at this location are admixed with volcanoclastic material. In order to recover zircons for U/Pb IDTIMS analyses about 0.5 kg of rock was crushed and processed in a water table, a Frantz magnetic separator, and bromoform heavy liquid. The heavy minerals residue yield well-preserved and shaped datable zircons (70–80 μm), which, however, turned out to be detrital (of Devonian age; dating undertaken by Mark Schmitz, Boise State University Isotope Geology Lab). In addition to zircons, two fragments of the conodont *Hindeodus* and one juvenile specimen of *Streptognathodus* were recovered (Fig. 4). The preservation of all specimens is excellent, with CAI values around 1.0–1.5. Unfortunately, the area is quite remote and no additional sampling for conodonts has been possible.

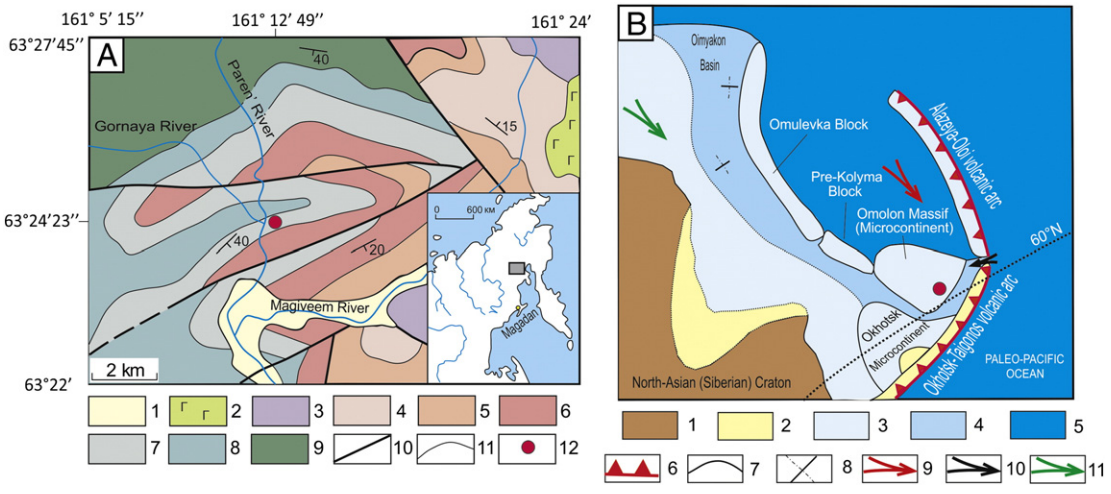

Fig. 1. Location map, geologic map of the upper stream of the Paren' River (A) and Paleogeographic map of the Omolon microcontinent and surrounding regions in Asselian time (B). Note the position of the Omolon microcontinent is around 60°N. A: 1, Quaternary; 2, Cretaceous; 3, Triassic' 4, Armandzha Fm., 5, Aulandzha Fm., 6, Fedorov Fm., 7, Magiveem Fm., 8, Ol'cha Fm., 9, Hayam Fm., 10, faults, 11, geological boundaries; 12, studied location where conodonts were found. B: 1, highlands; 2, lowlands; 3, shallow sea; 4, offshore; 5, deep sea; 6, volcanic arch; 7, the boundaries of tectonic units; 8, zones of initial rifting; 9–12, migrational directions of bivalves, 9, from North American basins; 10, from other tropical regions; 11, from west boreal regions.