Late Paleozoic climate bipolarity: glaciation signs in Siberia

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Climate is one of the most important factors in the Earth's biosphere evolution. It is involved in the Earth thermodynamic state and influential to the internal and partially external energy transfer. Global warmings and glaciations in the history of the Earth were extreme climatic events that are of great importance for the present and the future state of our planet. Five glacio-eras with the complex chronological structure have been established in the history of the Earth. One of the most significant, but still insufficiently studied, is the Late Paleozoic glacioera, which is often considered as an analogue of the Oligocene-Quaternary glacioera of the Late Cenozoic. Until recently, the Late Paleozoic glacial and glacial-marine deposits were known and studied only in Gondwana, i.e. in the Southern Hemisphere of the Earth. The presence of bipolarity of glaciation, which is known in Late Cenozoic, was also assumed for the Late Paleozoic, but so far these assumptions remain either doubtful and/or purely speculative and are not documented with the definite data. The Upper Paleozoic deposits of the Northern Hemisphere in the northern part of the Siberian continent (Angarida), conventionally described as glacial, are still poorly studied. The so-called "the Late Perm glaciation" in the North-East of Russia are widely known in the literature. However, a recent study of these sediments has shown their volcanic marine landslide nature. The other existing data are too scarce and/or not credible. Recent glacial-marine deposits are well studied in Russia. A particular type of sea-ice sedimentation is distinguished and widespread in the Arctic Ocean.

The configuration and location of continents and oceans in the Late Paleozoic, with respect to climatic zones, determines the fact that glacial or glacial-marine deposits potentially could be present in the Northern Hemisphere only on the northern periphery of the Siberian Craton. We need to reconstruct the paleogeography of the Siberian continent in the Late Paleozoic with respect to the equilibrium line altitude (ELA) on the Earth's surface. In the existing Pz3 paleogeographic reconstructions that are developed with paleomagnetic and detrital zircons provincial data, the Siberian craton is placed at 70–80 degrees northern latitude. Biotic data are rarely considered in such reconstructions. However, they can often justify a more accurate position of the continents relative to climatic zones. For example, our preliminary data suggest the position of the Verkhoyanie in Pennsylvania and Permian around midlatitudes (approximately 40-45 degrees north latitude), that is, significantly south of ELA lines that proposed by paleomagnetic and zircon provenance data (Fig. 1). Thanks to the Russian Science Foundation grant (project 19-17-00178), this year we conducted a study of the Middle Upper Permian successions along the Kobyume River in South Verkhoyanie. Several glendonite horizons (lithological indicators of cold-water deposits) and diamictites were found

in the section. Diamictites may have a different origin, but most often characteristic for glacial deposits, especially in combination with the occurrence of glendonites. In addition, angular boulders and pebbles (dropstones) were found in the section, which were dumped into a soft sediment with the consequent deformation. Possible ice scars were found on one boulder. We studied in detail the section including sedimentology of diamictites, collected glendonites, fossils, rocks for geochemistry and paleomagnetic study. A volcanic ash beds evenly distributed over the section were found as well and thus potential radioisotopic calibration of the succession is feasible. We plan to integrate all data into a database, which we already developed in the previous (Kuzbass) project. Particular attention will be paid to the findings of warm-water faunas and their distribution in time and in space in order to establish the paleoposition of Verkhoyansk during the Late Paleozoic. A model of the paleogeographic position of the Siberian continent with respect to climatic zones during the Late Paleozoic will be constructed, based on data on the distribution and taxonomic composition of biota and other climatic indexes. A model of the regional paleoclimate of Verkhoyanie and adjacent areas of the North-East of Russia will be developed. This model will be compared with existing Late Paleozoic models of climate change in the Southern Hemisphere.

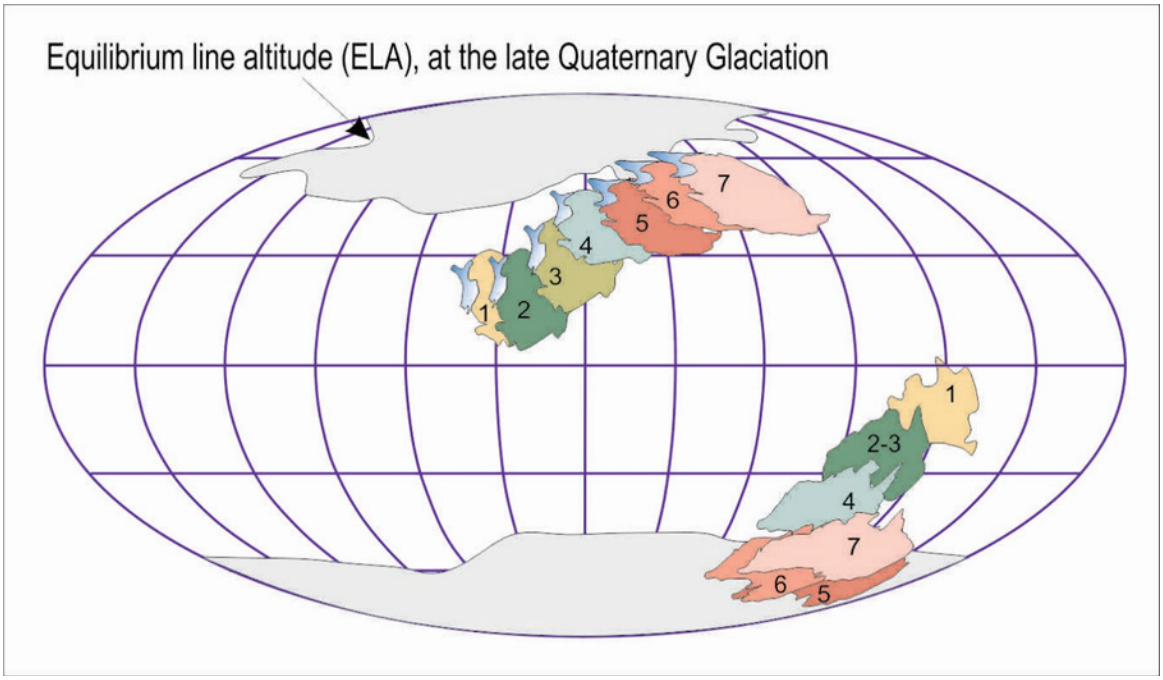

Fig. 1. Suggested position of Siberian and Australian Cratons with respect to climatic zones during late Paleozoic (biotic data). 1-7, Late Devonian through Lopingian positions of Siberian and Australian Cratons