Forum Reply

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Possible bipolar global expression of the P3 and P4 glacial events of eastern Australia in the Northern Hemisphere: Marine diamictites and glendonites from the middle to upper Permian in southern Verkhoyanie, Siberia

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We are pleased to receive the Comment of John Isbell (Isbell, 2023), who is a leading specialist in the Late Paleozoic glacial studies. We have to agree with Isbell that the origin of the Siberian sediments of interest is complicated and not fully documented or understood (Davydov et al., 2022). The region is so large, and currently so remote, that we were not able to study all the necessary aspects of glacial-marine sediments, especially laterally toward the areas where the real continental glaciation might have developed.

In our paper, we proposed that the middle–late Permian glacial events were expressed as glacial-marine sediments originating from perennial oceanic and coastal sea ice, similar to the setting in the present-day Arctic Ocean. The recent investigations of the evolution and extent of sea ice in modern seas and oceans demonstrate that sea ice appears only after the formation of a large ice sheet (DeConto et al., 2007; Gowan et al., 2021). Therefore, in the present-day Arctic Ocean, perennial oceanic and coastal sea ice along the northern coast of Siberia is a derivative of the Greenland Ice Sheet (Törnqvist and Hijma, 2012; Vernal et al. 2020).

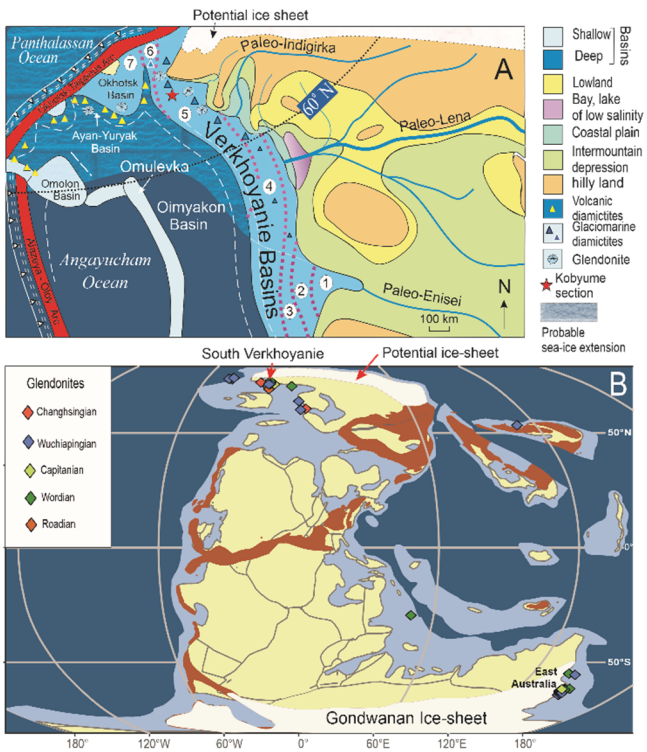

Figure 1. Potential distribution of the ice sheet and sea-ice in the northern Hemisphere compare with the glacial development in the southern Hemisphere (middle–late Permian).

The Southern Verkhoyanie foredeep, during the middle–late Permian, was bordered to the northeast by the Siberian continent, and glacial ice sheets potentially could have developed in the highlands and mountains in the north and northeast of the continent and in the adjacent Argun (Stanovoy) terrane (Parfenov et al., 2011) (Fig. 1). The occurrence of the yet-undiscovered ice sheet would have facilitated the development of sea ice in the areas surrounding the ice sheet and along the western margin of the Siberian continent (Fig. 1). During Late Paleozoic, the Southern Verkhoyanie and adjacent areas, including the Okhotk-Taigonos Arc, the Okhotsk Massif, and the northern margin of the Siberian Platform (recent southern and southeast Siberia), were the only areas in the Northern Hemisphere where glacial deposits could have developed (Fig. 1). Our previous study in the Aiyan-Yuryak and Priokhotie regions (Isbell et al., 2016) suggested that the Capitanian volcanoclastic sediments of the Atkan Formation (widely distributed in northeastern Russia) are turbidites deposited as prograding and abandoning sediment gravity-flow fans, with chaotic and folded strata having formed as slumps. In our current study, the Capitanian rocks from the Kobume River were interpreted as an ice-free area (Davydov et al., 2022). We are expecting to soon obtain radioisotopic ages from the glacial-marine sediments in Kobume, which might clarify the model and the chronostratigraphic constraints on the glacial episodes in this intriguing, but still very poorly studied region.

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