Iceberg discharge from the Laurentide ice sheet to the western Arctic Ocean during the last glacial period

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The last glacial was characterized by millennial-scale abrupt climate changes, such as the Dansgaard-Oeschger (DO) cycles. The Heinrich events (HE) are a potential trigger of the abrupt warming from stadial to interstadial states, but the DO cycles were not always associated with the HE. The rate of cooling from interstadial to stadial states were variable, and its factor controlling the rates remains an open question. To answer these questions, the reconstruction of icebergs discharges in the western Arctic Ocean is necessary.

In this study, we established the stratigraphy of the Chukchi Borderland sediments during last 76,000 years and assigned the provenances and transport processes of sediments. We tried to discuss the iceberg discharges from the Laurentide ice sheet and their influences on the warming and cooling of glacial millennial climate changes. For this purpose, we used five sediment cores retrieved from the western Arctic Ocean by during 2011 and 2012 RV “Araon” cruises. We analyzed ice-rafted debris (IRD) content, mineral composition, grain size distribution, color, organic carbon, total nitrogen and total sulfur contents, stable carbon isotopes of organic matter, and glycerol dialkyl glycerol tetraethers (GDGT) compositions in those sediments.

Dolomite-rich layers were recognized at 9 ka, 11 ka, 42-35 ka, 45 ka, and 76 ka. Sedimentological properties suggest that they were derived from the Canadian Arctic Archipelago by iceberg rafting. Their deposition occurred when the sea level was 40-80 m lower than today. We suppose that the northern margin of the Laurentide ice sheet reached to the Arctic Ocean, and the calving of icebergs was not prevented by thick ice shelf nor sea ice during the periods. The deposition of dolomite-rich layers at 9 ka and 45 ka corresponded to H0 and H5 events, respectively. At both timings, interstadials continued longer than other interstadials. We speculate that the large collapse of the Laurentide ice sheet delayed ice-sheet build-up and a resultant cooling. Evidence of no iceberg discharge into the western Arctic during 53-11 ka indicates that the warming of interstadials 1 to 4 was not related to the collapse of the Arctic sector of the Laurentide ice sheet. A kaolinite-rich layer was found during the last deglaciation, which enables us to speculate that the deposition was related to the collapse of ice dam and an event of freshwater discharge.

