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## **Ice-grounding along the East Siberian margin and on the Lomonosov Ridge during the Pleistocene: Implications for circum-arctic ice shelves in the Arctic Ocean?**

**NIESEN, F.<sup>1</sup>, STEIN, R.<sup>1</sup>, JENSEN, L.<sup>1</sup>, SCHRECK, M.<sup>2,1</sup>, MATTHIESSEN, J.<sup>1</sup>, JOKAT, W.<sup>1</sup>, HONG, J.K.<sup>2</sup> & NAM, S.-I.<sup>2</sup>**

<sup>1</sup> Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany; frank.niessen@awi.de

<sup>2</sup> Korea Polar Research Institute, Incheon, Republic of Korea; sinam@kopri.re.kr

Over many years there was a general acceptance that thick ice sheets of marine isotope stages 2, 4 and 6 were restricted largely to continental Eurasia, Greenland and North America including the adjacent shelves of the Arctic Ocean. With this "Beringia" was understood as an ice-free land bridge between the continents of Asia and America during glacial times with low sea levels and exposed shelves. However, since about 15 years a growing number of evidence is found in water depth up to more than 1000 m that grounding of ice has occurred in various places of the Arctic Ocean since MIS 6 and/or before including the "Beringian" continental margin north of the present Chukchi and East-Siberian seas. With the decline in Arctic Ocean summer sea ice during the last decade it has been possible to hydro-acoustically survey areas so far sparsely investigated because of operational constrains. Glacial landforms were discovered on many continental slopes as well as ridges and seamounts of the Arctic Ocean, which rise up to less than about 1000 m below present sea level. These landforms include moraines, drumlinized features, glacial debris flows, till wedges, mega-scale glacial lineations (MSGSL), and iceberg plough marks. They suggest that thick ice has occurred not only on nearly all margins of the Arctic Ocean but also covered pelagic areas. In our studies we present submarine glacial landforms from the western and central Arctic Ocean, which are interpreted as a result of a complex pattern of Pleistocene glaciations along the continental margin of the East Siberian Sea. This was discovered during the cruises of RV "Polarstern" in 2008 and RV "Araon" in 2012. Orientations of these landforms suggest thick ice has flown north onto the deep Arctic Ocean, thereby grounded on plateaus and seamounts of the Medeleev Ridge. In addition, during RV "Polarstern" cruise in 2014, hydro-acoustic data is presented from the Lomonosov Ridge (Siberian side to close to the North Pole), which support the hypothesis of widespread grounding of ice in the Arctic Ocean from different sources. The data suggest that thick ice-shelves have developed from continental ice sheets on a nearly circum-arctic scale. These ice shelves extended far north and covered large areas of the Arctic Ocean. Further analysis of bathymetric and sub-bottom acoustic data is needed to interpret ice-flow directions. Also, it now depends on the stratigraphical analysis of existing and future sediment cores to find out whether or not these ice shelves have occurred contemporaneously and when the individual grounding events have occurred.

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<sup>1</sup>Geological Institute, Country

<sup>2</sup>Department of Mineral Resources, Ministry of Mines, Country

<sup>2</sup>e-mail: corresponding author@kigam.re.kr

### Abstract

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**Keywords:** earthquake, tsunami, volcano, landslide, Asia

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