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Deglaciation of the central Barents Sea

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ABSTRACT

The marine-based Barents Sea Ice Sheet covered the polar continental shelf north of Norway and western Russia during the Last Glacial Maximum. Initial ice sheet retreat along the western margin is well established, while the retreat pattern in the interior parts of the ice sheet remains poorly known. Here we present new geological data from the central Barents Sea. The results are based on analysis of several marine geophysical datasets, including geomorphological mapping of multibeam swath bathymetry data and analysis of seismic and acoustic stratigraphy. The new results provide insights into the configuration and dynamics of the ice sheet during its retreat across the central Barents Sea. In particular they show clear changes in the location of the main ice divides and domes, with ice flow becoming gradually more topographically controlled as deglaciation progressed. Major troughs were characterised by episodic retreat and reoccurring cycles of fast and slow ice flow, sometimes leading to stagnation and ice shelf formation. Meanwhile, adjacent bank areas were covered by comparatively slowly retreating ice, although evidence of streaming ice is also seen locally.

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1. Introduction

Glacial geomorphology is a useful tool for reconstructing the configuration, dynamics, ice flow direction, subglacial thermal regime and retreat dynamics of former ice sheets (e.g. Ó Cofaigh et al., 2002; Ottesen et al., 2005). This paper describes hitherto unmapped glacial landforms on the seafloor of the central Barents Sea, and uses these, in combination with previously published accounts, to make a new reconstruction of the pattern and dynamics of deglaciation in the central Barents Sea. We expect this paper to be of interest to those working with the glacial history of the Barents Sea and neighbouring areas, as well as those working on modern and former ice stream environments, ice sheet dynamics and stability.

1.1. Regional setting

The Barents Sea (Fig. 1) is an epicontinental sea characterised by several shallow bank areas (100–200 m bsl) and deeper troughs (200–500 m bsl), which have been subject to repeated glaciations during the late Cenozoic (Elverhøi and Solheim, 1983; Vorren et al., 1988). Early reconstructions of the Barents Sea Ice Sheet were based on relatively limited marine geophysical datasets (e.g. Elverhøi and Solheim, 1983; Kristoffersen et al., 1984; Solheim and Kristoffersen, 1984; Solheim et al., 1990; Svendsen et al., 2004), whilst early modelling attempts were based mainly on the elevations and age of raised shorelines on islands fringing the Barents Sea (Andersen, 1981; Elverhøi et al., 1993; Forman et al., 1995; Lambeck, 1996). These lacked information from the central part of the palaeo-ice sheet and were not able to resolve palaeo-glacidynamics. Later reconstructions have, to a larger degree, incorporated effects of glacial dynamics, showing the location of major ice streams and domes (Landvik et al., 1998; Ottesen et al., 2005; Winsborrow et al., 2010), and deglaciation stages along the western margin of the Barents Sea are becoming

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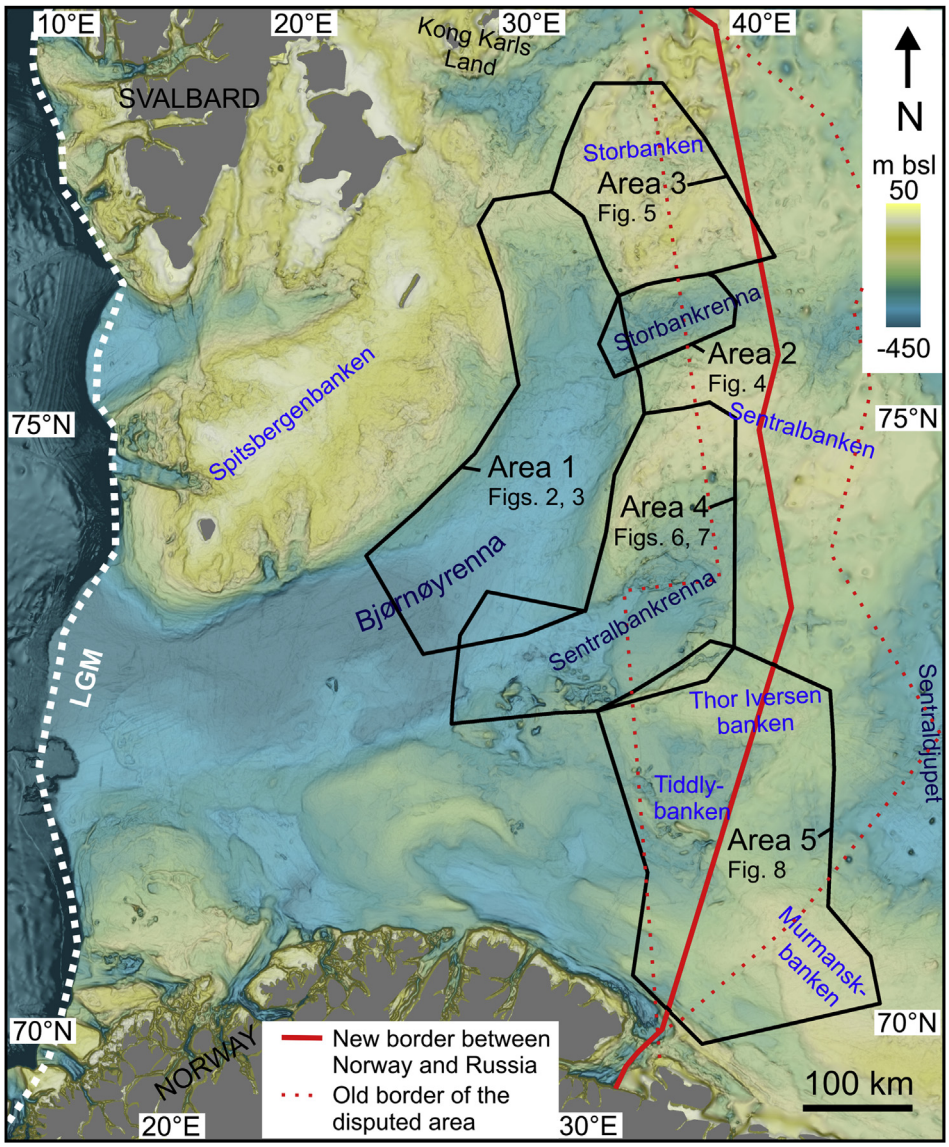

Fig. 1. Map of study areas in the central Barents Sea. Areas 1–5 (Figs. 2–8) are indicated with black polygons. The white broken line represents the ice extent during the Last Glacial Maximum (LGM; Svendsen et al., 2004). Also shown are the old border of the disputed area and new territorial border between Norway and Russia.

increasingly well constrained (Landvik et al., 1998; Mangerud et al., 1998; Winsborrow et al., 2010; Rüther et al., 2011; Bjarnadóttir et al., 2013; Ingólfsson and Landvik, 2013). Favourable sea ice conditions over the past few years have allowed data collection east of Svalbard and new, more detailed reconstructions have emerged (Dowdeswell et al., 2010; Hogan et al., 2010a, 2010b; Rüther, 2012; Andreassen et al., 2013). The central Barents Sea, however, has remained largely unsurveyed due to a long-standing dispute between Norway and Russia regarding the location of territorial boundaries (Fig. 1). The resolution of this in 2011 means that data collection in this area is now possible, and this paper presents some of the first datasets collected in the formerly disputed area.

2. Datasets and methods

Landforms were mapped in Esri ArcMap v.10.0 based on several different marine geophysical datasets. The fisheries database Olex (www.olex.no, 2012), and the International Bathymetric Chart of the Arctic Ocean (IBCAO; version 3.0) have the broadest coverage but relatively low resolution. Olex is a compilation of seafloor echosoundings and covers the majority of the western Barents Sea. The Olex seafloor image has a vertical resolution of 0.1–1 m (depth-dependent), a lateral resolution of 5 m up to a few tens of metres and positional accuracy of <10 m (http://www.olex.no; Bradwell et al., 2008). IBCAO v.3 has a cell size of 500 m and consists of several different bathymetric datasets of varying resolution merged together (Jakobsson et al., 2012).

Higher resolution multibeam swath bathymetry data, acquired during several cruises using the University of Tromsø vessel R/V Helmer Hanssen (formerly R/V Jan Mayen) in the summers of 2008, 2010, 2011 and 2012, and the 18th Training Through Research (TTR-18) cruise using R/V Akademik Strakhov in 2011, are also used. The multibeam system on R/V Helmer Hanssen consists of a Kongsberg Simrad EM-300 multibeam (135 beams) echo sounder operating at 30 kHz, with 63° by 63° beam configuration and automatic continuous pinging. Sound speeds were calibrated by CTD profiles acquired with a Seabird 911. The data were processed in Kongsberg Neptune and gridded to 10 × 10 m. The multibeam system on R/V Akademik Strakhov is a Reson Seabat 8111/7111 multibeam swath echo

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