Marine Geology 382 (2016) 68–79

Contents lists available at ScienceDirect

Marine Geology

journal homepage: www.elsevier.com/locate/margo

Buried iceberg-keel scouring on the southern Spitsbergenbanken, NW Barents Sea

Massimo Zecchin [a,*], Michele Rebesco [a], Renata G. Lucchi [a], Mauro Caffau [a], Hendrik Lantzsch [b], Till J.J. Hanebuth [b,c]

[a] OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), 34010 Sgonico, TS, Italy
[b] MARUM - Center for Marine Environmental Sciences, University of Bremen, 28334 Bremen, Germany
[c] School of Coastal and Marine Systems Science, Coastal Carolina University, Conway, SC 29526, United States

A R T I C L E   I N F O

Article history:
Received 30 June 2016
Received in revised form 12 October 2016
Accepted 14 October 2016
Available online 15 October 2016

Keywords:
Iceberg-keel scouring
Ploughmarks
Barents Sea
Meltwater pulses
Spitsbergenbanken

A B S T R A C T

PARASOUND (3.5 kHz) subbottom echosounder profiles acquired on the southern Spitsbergenbanken, NW Barents Sea, show iceberg-keel scouring features which are buried by sediment that accumulated during the post Last Glacial Maximum (LGM) sea-level rise. Four acoustic units (Units 1 to 4 in stratigraphic order) were differentiated, based on the characterization of their acoustic facies and reflection surfaces. Unit 1 shows a chaotic internal structure and is interpreted as a glacial till, whereas the laminated Units 2 to 4 accumulated by sediment settling from suspension clouds and bottom currents during the last deglaciation phase. The top of Unit 2 was frequently incised by iceberg keels, resulting in up to 12 m deep ploughmarks which were later filled and buried by Unit 3 and 4 sediments. Three main paleo-evironmental changes controlled the evolution of the facies succession: (1) The major shift from till formation (Unit 1) below grounded ice to the accumulation of laminated sediments (Unit 2) which are inferred to reflect ice lifting and meltwater release; (2) Iceberg-keel scouring after sedimentation of Unit 2; (3) the probable abrupt termination of iceberg-keel scouring related to the glacio-eustatic sea-level rise. A linkage between these episodes of changes and short-lasting phases of rapid post LGM sea-level rise, such as meltwater pulses, is inferred, although further studies are needed to better understand the temporal and genetic relationships between the sedimentary events recognized in the Barents Sea and climate changes.

1. Introduction

Ploughmarks related to iceberg-keel scouring and mega-scale glacial lineations are well-known features on high-latitude continental margins, as they are commonly found in both Arctic and Antarctic continental shelf areas and in shelf-margin topographic troughs carved by grounding ice (e.g., O'Cofaigh et al., 2005; Dowdeswell and Bamber, 2007; López-Martínez et al., 2011; Rebesco et al., 2011; Robinson and Dowdeswell, 2011; Bjarnadóttir et al., 2013; Andreassen et al., 2014). In particular, among shelf-margin troughs, km-long ploughmarks were found in the Kveithola Trough (western Barents Sea Shelf) down to 350 modern water depth on top of grounding zone wedges that accumulated during the last deglacial phase (Rebesco et al., 2011; Bjarnadóttir et al., 2013; Hanebuth et al., 2014). This finding indicates that ploughmarks scoured by the keels of icebergs formed just after the break-up of previously grounded ice, i.e., during the post Last Glacial Maximum (LGM) glacio-eustatic sea-level rise. Ploughmarks can be linear to curvilinear and may exhibit abrupt changes in direction (Dowdeswell et al., 2007; López-Martínez et al., 2011; Rebesco et al., 2011; Andreassen et al., 2014).

Previous studies in the Barents Sea have mapped the seabed morphology and reconstructed glacimarine sedimentary processes during the deglaciation in the Storfjorden and Kveithola Troughs and shelf margins (Pedrosa et al., 2011; Rebesco et al., 2011, 2012, 2014a; Lucchi et al., 2012, 2013; Rüther et al., 2013; Andreassen et al., 2014; Bjarnadóttir et al., 2014). The present study aims at illustrating buried iceberg-keel ploughmarks on the southern Spitsbergenbanken, near the northern margin of the Kveithola Trough, by means of PARASOUND subbottom echosounder profiles (Fig. 1). The recognition of buried ploughmarks is uncommon (e.g., Long and Praeg, 1997), and their burial reflects locally abundant sediment supply during the post-LGM glacio-eustatic sea-level rise. The study of sediments burying these erosional features is important, as they likely record main environmental changes

* Corresponding author.
E-mail address: mzecchin@ogs.trieste.it (M. Zecchin).

http://dx.doi.org/10.1016/j.margeo.2016.10.005
0025-3227/© 2016 Elsevier B.V. All rights reserved.

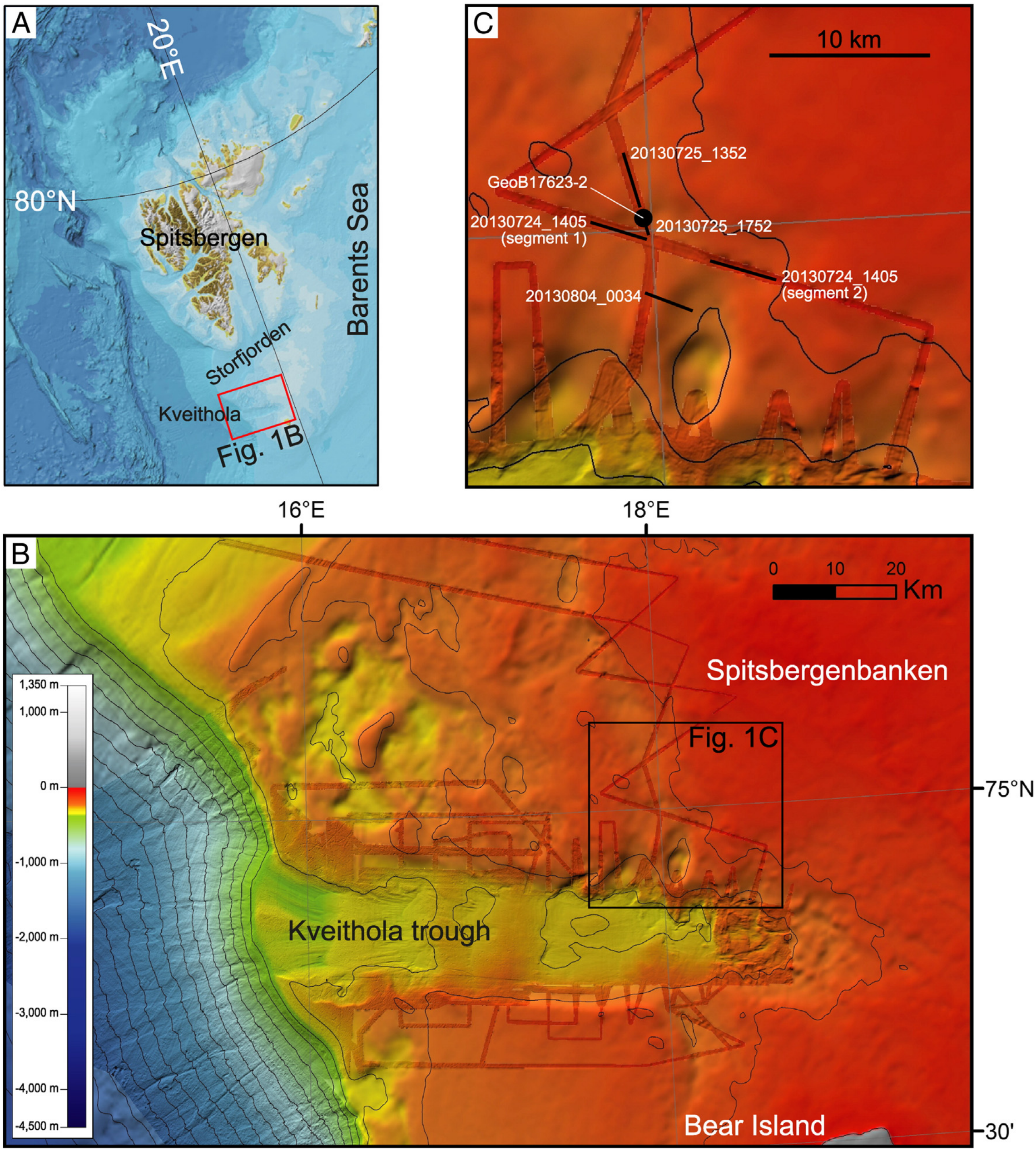

Fig. 1. (A) Location map with the study area (red box) in the NW Barents Sea (bathymetry from IBCAO, Jakobsson et al., 2012). (B) Shaded relief map of the study area, showing the Kveithola Trough and the SW margin of the Spitsbergenbanken (bathymetry from IBCAO with superimposed available mutibeam data, modified from Rebesco et al., 2016a, 2016b). (C) Detail of (B) showing the position of the PARASOUND profiles and core GeoB17623–2. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

and meltwater episodes, helping to improve the knowledge on post-LGM climate changes at high-latitudes.

2. Geological setting

The study area is located in the NW Barents Sea, on the southern part of the Spitsbergenbanken, just NE of the Kveithola Trough (Fig. 1A,B). A rifting phase between Greenland and Spitsbergen, leading to the opening of the Fram Strait, started during the Oligocene, and a narrow oceanic corridor developed during early Miocene (Engen et al., 2008). The Barents Sea, which covers one of the widest continental shelves in the world, is dissected by glacially-carved troughs (e.g. the Bear Island Trough, the Storfjorden and Kveithola Troughs (Andreassen et al., 2004, 2014; Winsborrow et al., 2010; Pedrosa et al., 2011; Rebesco et al., 2011) that are associated with wide trough mouth fans at the continental slope (Fig. 1A,B).

A Plio-Pleistocene progradational phase favored by tectonic uplift and high sediment supply, initially related to fluvial discharge and to subglacial sediment discharge later on, led to the seaward expansion of the shelf margin by up to 150 km and to the formation of the topographic troughs (Forsberg et al., 1999; Dahlgren et al., 2005). An ice sheet covered the northern part of the Barents Sea since the late Pliocene, progressively expanding to the south (Vorren and Laberg, 1997; Knies et al., 2009). The Spitsbergenbanken was covered by a marine-based ice dome during the LGM, whereas paleo-ice streams flowed in the Storfjorden and Kveithola troughs (Lucchi et al., 2013) (Fig. 1A,B). *E*-W trending mega-scale glacial lineations, recording ice stream movement, developed inside the Kveithola Trough during LGM, and got in parts overprinted by grounding-zone wedges during the early