



Paleomagnetism and rock magnetism from sediments along a continental shelf-to-slope transect in the NW Barents Sea: Implications for geomagnetic and depositional changes during the past 15 thousand years

C. Caricchi^{a,*}, R.G. Lucchi^b, L. Sagnotti^a, P. Macrì^a, C. Morigi^{c,d}, R. Melis^e, M. Caffau^b, M. Rebesco^b, T.J.J. Hanebuth^{f,g}

^a Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605, 00143 Rome, Italy

^b Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Borgo Grotta Gigante 42/c, 34010 Sgonico, TS, Italy

^c GEUS (Stratigraphy Department Geological Survey of Denmark and Greenland), 1350 Copenhagen, Denmark

^d Dipartimento di Scienze della Terra, Università di Pisa, 56126 Pisa, Italy

^e Dipartimento di Matematica e Geoscienze, Università di Trieste, 34128 Trieste, Italy

^f MARUM – Center for Marine Environmental Sciences, University of Bremen, 28359 Bremen, Germany

^g Department of Coastal and Marine Systems Science, Coastal Carolina University, Conway, SC 29526, USA

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ABSTRACT

Paleomagnetic and rock magnetic data were measured on glaciomarine silty-clay successions along an E-W sediment-core transect across the continental shelf and slope of the Kveithola paleo-ice stream system (south of Svalbard, north-western Barents Sea), representing a stratigraphic interval spanning the last deglaciation and the Holocene.

The records indicate that magnetite is the main magnetic mineral and that magnetic minerals are distinctly less abundant on the shelf than at the continental slope. The paleomagnetic properties allow for the reconstruction of a well-defined characteristic remanent magnetization (ChRM) throughout the sedimentary successions. The stratigraphic trends of rock magnetic and paleomagnetic parameters are used for a shelf-slope core correlation and sediment facies analysis is applied for depositional processes reconstruction. The new paleomagnetic records compare to the PSV and RPI variation predicted for the core sites by a simulation using the global geomagnetic field variation models SHA.DIF.14k and CALS7K.2 and closest PSV and RPI regional stack curves. The elaborated dataset, corroborated by available ¹⁴C ages, provides a fundamental chronological framework to constrain the coupling of shelf-slope sedimentary processes and environmental changes in the NW Barents Sea region during and after deglaciation.

1. Introduction

Rock magnetic analyses are known to be a very powerful tool for sedimentary reconstructions of changes in sediment provenance, patterns and strength of oceanic currents and diagenetic effects linked to paleoenvironmental changes (Kissel et al., 1997, 1999; Brachfeld, 2006; Brachfeld et al., 2009, among others). The stratigraphic trends indicated by rock magnetic parameters depend on the environmental variability and can be used for correlating between different depositional settings. In particular, stratigraphic trends in grain size, as well as concentration and type of magnetic minerals provide valuable information on changes in the environmental conditions that have an effect on the geochemical composition of pore water and sediments

(e.g., Snowball and Torii, 1999; Sagnotti et al., 2001; Larrasoña et al., 2003, 2007; Brachfeld et al., 2009). Moreover, concentration, composition, and grain size of the magnetic minerals contain evidence for sediment source, sediment transport processes, and marine productivity (Robinson, 1986; Kissel et al., 1997, 1999, 2003; Stoner and Andrews, 1999; Brachfeld et al., 2002, 2013; Muhs et al., 2003; Hounslow and Morton, 2004; Rousse et al., 2006). As observed by several studies, changes in rock magnetic stratigraphic trends coincide with climatic changes during glacial and interglacial phases (Dearing, 1999; Liu et al., 2012 and reference therein). The concentration of magnetic minerals may reflect dilution effect due to the presence of biogenic carbonate and silica, and of organic matter (Thompson and Berglund, 1976; Thompson et al., 1985; Zolitschka and Negendank, 1996;

* Corresponding author.

E-mail address: chiara.caricchi@ingv.it (C. Caricchi).

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Dearing, 1999), but it is also primarily controlled by dissolution of ferromagnetic minerals under anoxic conditions, where these minerals (as magnetite) become thermodynamically unstable (Leslie et al., 1990; Nowaczyk et al., 2000; Roberts, 2015).

Moreover, paleomagnetic data sets allow for the reconstruction of geomagnetic field paleosecular variations (PSV) and relative paleointensity (RPI) trends, which in turn are useful to define high-resolution age models for sedimentary successions.

Previous studies proposed regional reference records based on both stacked PSV curves (Turner and Thompson, 1981, 1982; Hagstrum and Champion, 2002) and global geomagnetic field models (Korte and Constable, 2005; Korte et al., 2005, 2009; Donadini et al., 2009; Pavón-Carrasco et al., 2014), mainly based on paleomagnetic and archeomagnetic data from low and mid-latitudes. In the last few years, some authors proposed paleosecular variation records measured in sedimentary cores at high latitudes highlighting the pivotal importance of these geomagnetic field variation reconstructions to define and refine geomagnetic field models (Haltia-Hovi et al., 2010; Sagnotti et al., 2011; Stoner et al., 2013; Loughheed et al., 2014).

The paleomagnetic and rock magnetic characteristics of the sedimentary succession forming the Storfjorden-Kveithola Trough Mouth Fan (TMF) system, located in the North-western Barents Sea continental margin, south of Svalbard (Fig. 1), has been studied in the framework of the SVAIS (Spanish IPY activity; <https://sites.google.com/site/ipynicestreams/svais>) and OGS-EGLACOM (Italian contribution to IPY; <https://sites.google.com/site/ipynicestreams/eglacon> Italian contribution to IPY) projects (Sagnotti et al., 2011, 2016). TMFs are cone-like bathymetric features located on the continental slope area that originated by the pile-up of detritic sediments delivered by fast-flowing ice (ice streams) during shelf-edge glaciations, and pelagic deposition occurring during interglacial stages. Therefore, TMFs contain the record of past climatic changes, and represent suitable areas for reconstruction of paleoclimatic, paleoceanographic, and paleoglacial history of polar continental margins (Alley et al., 1989; Vorren et al., 1989, 1998; Vorren and Laberg, 1997; Laberg et al., 2005; Dowdeswell et al., 2008, among others). At the same time, the study of the

sedimentary record contained in glacial troughs, formed by basal erosion of the former ice streams advancing during glacial maxima, can give information on the modality of the ice sheet retreat and related sea level rise during deglaciation especially during their latest phases when sediment meltwater deposition was confined to the shelf area (Lucchi et al., 2013). Indeed shelf and slope areas contain complementary paleo-depositional information the merge of which would allow a more reliable reconstruction of the Svalbard-Barents Sea Ice Sheet history after Last Glacial Maximum (LGM).

Although previous studies attempted to correlate shelf and slope cores on the basis of sediment magnetic susceptibility and radiocarbon dating (e.g., Jessen et al., 2010), this region still lacks a proper paleomagnetic stratigraphy and rock magnetic characterization that allow for establishing a reliable and original framework for along- and across-slope core-correlation purposes. To fill this gap, the present study, conducted within the Italian PNRA project CORIBAR-IT, aims at correlating the sedimentary successions, collected along an E-W-oriented transect of sediment cores across the slope and shelf of the Kveithola glacial system, through paleomagnetic and rock magnetic analyses. The Storfjorden-Kveithola glacial depositional system was chosen as study area because sustained by a relatively small ice catchment area (Elverhøi et al., 1995; Mangerud et al., 1998). The short distance (some kilometers only) from the source of ice to the calving areas resulted in a rapid response to climatic changes. In this work, we compare our data with the recent stacked PSV curves and with geomagnetic field variations extrapolated by global and regional (mid-latitude) PSV models adding a piece of knowledge about geomagnetic field variations at high latitude during the last 15 ka.

2. Geomorphological setting and climate-related depositional processes

The Kveithola glacial system is located in the Northwestern Barents Sea, south of the Svalbard archipelago (Fig. 1). The Kveithola Trough hosted ice-streams during last glaciation (Marine Isotope Stage/MIS-2) that reached the shelf edge during the Last Glacial Maximum

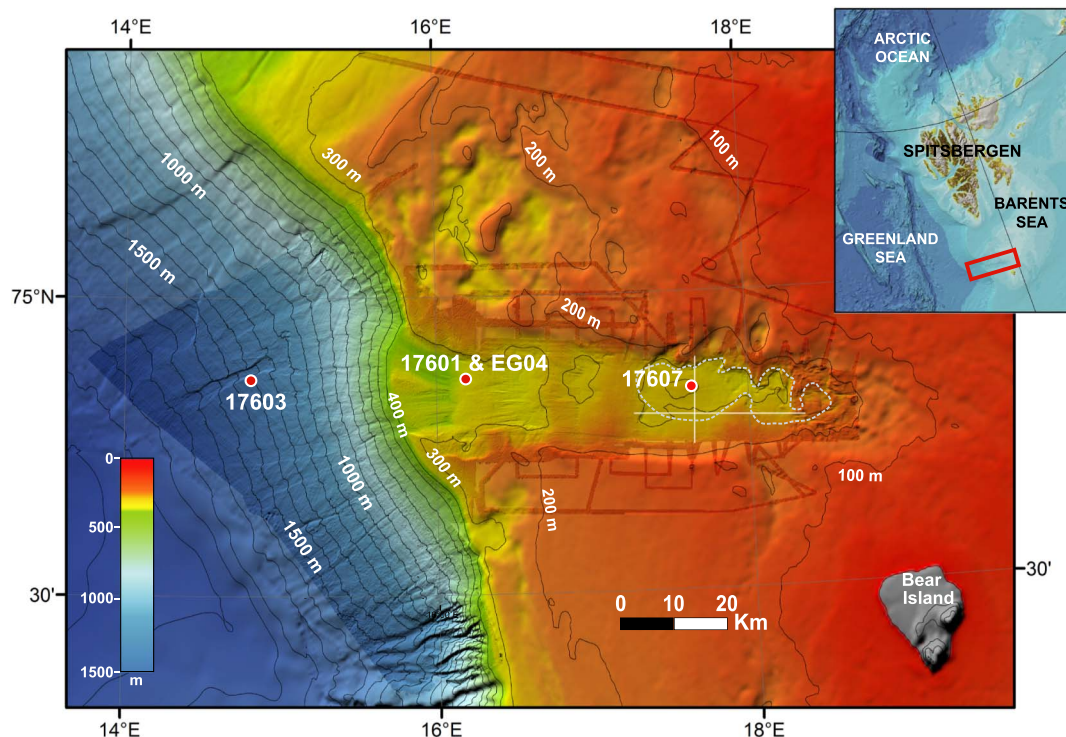


Fig. 1. Bathymetric map of the Kveithola glacial trough with location of the discussed CORIBAR and EGLACOM cores.

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