Final conference, Rome October 11, 2016

Lithostratigraphic reconstruction of a nearly 20 m-long piston core collected in the sediment drift area west of Svalbard

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Abstract
Two long Calypso cores were collected during Eurofleets 2 cruise PREPARED with the geological objectives to 1) define a high-resolution, detailed age model for stratigraphic cross correlation still lacking in this area; 2) to reconstruct past climatic changes including minor scale fluctuations within each climate stage with special emphasis on the Holocene. One of the two cores collected an expanded Holocene sequence nearly 6 m-thick suitable for high-resolution climate reconstruction. Preliminary results seem to confirm the existence of sediment drift originated from the oceanographic configuration determined by the interplay between the shallow Western Spitsbergen Current and the deep Norwegian Deep Sea Water.

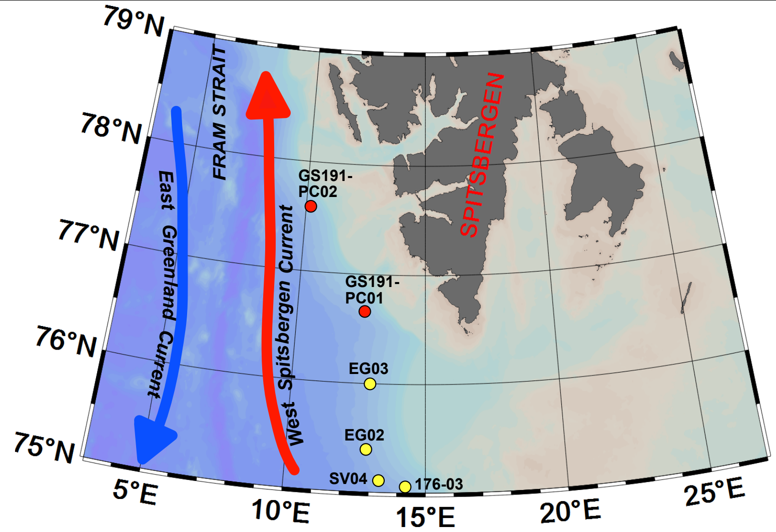

Figure 1: Location map the Calypso cores collected during the Eurofleet-2 PREPARED Cruise (red dots) and other Arctic projects (yellow dots). General ocean circulation is also indicated.

Introduction
The study of contourite drifts is useful for the reconstruction of the oceanographic and climate history of continental margins since these sedimentary deposits typically form along the pathways of major bottom currents (Rebesco et al., 2008). Contourite drifts are characterized by relatively high and continuous accumulation rates, in contrast to adjacent condensed pelagic sequences, generating expanded sedimentary sequences suitable for high-resolution detailed palaeo-reconstructions (Knutz, 2008).

The Fram Strait in the north polar area is the only deep-sea open gate through which water masses are exchanged between the Nord Atlantic and Arctic Oceans (Fig.1). Warm Atlantic waters forming the West Spitsbergen Current (WSC, northern continuation of the North Atlantic/Norwegian current) are advected northward across the eastern side of the Fram Strait. The warm WSC is responsible for almost ice-free conditions in the west and north Svalbard area during winter, exerting a strong control on Arctic climate. At the same time, cold Arctic waters (East Greenland Current, Fig.1) descend southward across the western side of the Fram Strait contributing to the maintenance of the Greenland ice cap. According to Eiken and Hinz (1993) bottom currents influenced the sedimentation in the Fram Strait area since the Late Miocene. Two contourite drifts were identified on the seismic profiles collected along the western continental margin of the Svalbard Archipelago between 76-78°N, north of the Storfjorden glacial trough (Rebesco et al., 2013; Fig. 1). Two Calypso cores were collected during the Eurofleets 2-PREPARED cruise on board the *RV G.O. Sars* (June 2014) with the geological objectives to 1) define a high-resolution age model for stratigraphic cross correlation still lacking in this area; 2) to reconstruct past climatic changes including minor scale fluctuations within each climate stage with special emphasis on the Holocene. The PREPARED-cores were collected on the Bellsund (core GS191-PC01, 19.67 m long) and Isfjorden (core GS191-PC02, 17.37 m long) sediment drifts at water depths of 1647 m and 1322 m respectively (Fig. 1). The sediment cores were logged through an X-ray CT scan, visually logged and analysed for sedimentological and compositional characteristics (grain size, water content, wet bulk density, and Corg/Ntot, on more than 380 samples) and stratigraphic purposes (palaeomagnetic and rock magnetic properties along 37 m of sediments, identification of tephra on 62 samples, and radiocarbon dating of 22 samples). We report on the preliminary results obtained from the investigation of the Holocene interval.

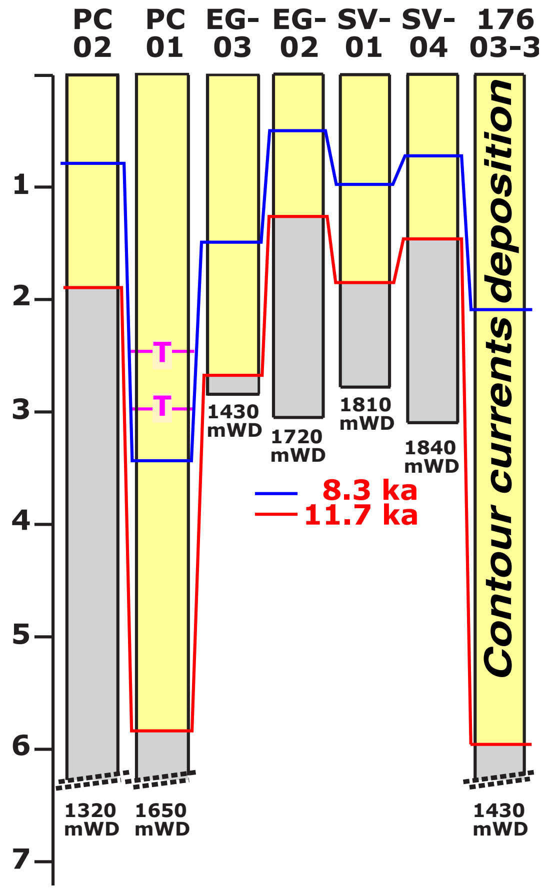

Figure 2: *Holocene contouritic sedimentation along the NW Barents Sea margin (south and west of Spitsbergen). Cores PC=PREPARED; EG=EGLACOM; SV=SVAIS; 176=CORIBAR. WD=water depth; T=tephra. The yellow pattern indicate the contourites whereas the grey pattern represent the deglaciation. Note: cores PC01, PC02, and 17603-3 contain a longer sedimentary record that is not reported in the figure.*

Preliminary results and discussion

The two PREPARED Calypso cores contain very similar sedimentary sequences spanning last 50 cal ka BP with an expanded Holocene sequence in core PC01 (5.70 m-thick in PC01 and 1.85 m-thick in PC02). The younger part of the stratigraphic sequence down to Last Glacial Maximum (LGM) is remarkably similar to that observed on the continental margin south of Spitsbergen on the Storfjorden-Kveithola Trough Mouth Fans (TMFs). The younger sequence is composed by heavily bioturbated and crudely laminated sediments containing abundant microfossils assessing good environmental/climatic conditions. This interval deposited during Holocene time (interglacial MIS-1) under the effect of contour bottom currents. The Holocene sediments overlay terrigenous deposits containing sparse, and locally massive, Ice Rafted Debris (IRD), and laminated sediments deposited from meltwater plumes (*plumites*). The terrigenous interval was associated to the main phase of glacial melting and retreat after LGM. The older part of the sequence was not recovered in the previously studied short (about 3 m long) cores collected on the middle slope, south of Svalbard (yellow dots in Fig. 1). It consists of terrigenous deposits that were associated to glacial stage MIS-2 and microfossils-bearing sediments that deposited during interglacial MIS-3.

High-resolution core correlation was performed between the post-LGM sequences recovered west and south of Spitsbergen, on the basis of palaeomagnetic and rock magnetic parameters, radiocarbon dating and lithostratigraphy (Fig. 2). The thickness and distribution of the contouritic deposits along the Western margin of Svalbard, confirm that their origin can be associated to deposition from the slow northwards flowing Norwegian Deep Sea Water (NSDW) (Rebesco et al., 2013, Fig. 3). Sediment deposition occurs beneath the local maximum of the northward flowing Norwegian Sea Deep Water (NSDW) that is episodically fed by sediments transported by dense shelf water plumes (core PC01). Conversely, reduced deposition occurs beneath the high-velocity WSC shallow core (core PC02). The high sedimentation rate recorded in core 17603-3 located on the Kveithola Trough Mouth Fan, can, instead, be associated to direct deposition from dense shelf water plumes (Fohrmann et al., 1998). A preliminary investigation of tephra occurrence, outlined

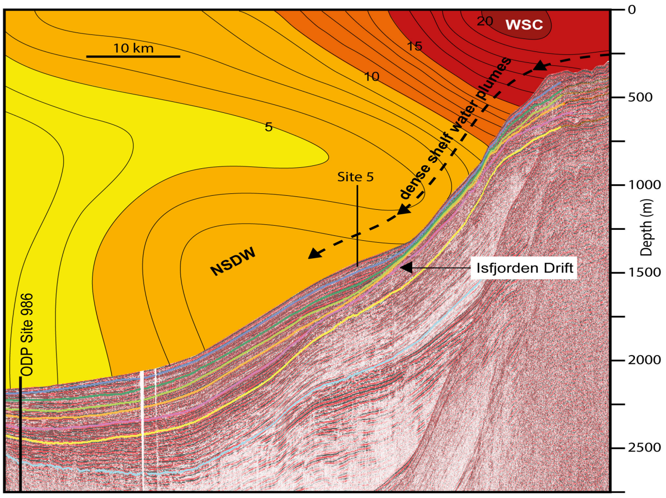

***Figure 3**:* Conceptual diagram on the mechanism of sediment accumulation in contour current drifts: sediments deposit beneath the local maximum of the slow northward flowing Norwegian Sea Deep Water (NSDW) episodically fed by sediments transported by dense shelf water plumes. Conversely, reduced deposition occurs beneath the high-velocity WSC shallow core. Contouring labels of the coloured pattern refer to current velocity (cm/s) (after Rebesco et al., 2013).

the presence of two volcanic events occurred during the Holocene at 248 cm and 298 cm bsf. According to radiocarbon dating the two events occurred between 5–7.5 cal ka BP. Both ash layers consist of micropumices with spherical or slightly elongated vesicles and glass shards ranging in shape from blocky and dense fragments to y-shaped thin-walled bubbles junction. Both tephra have a bimodal composition having the majority of glass shards in the trachyte fields of the total alkali-silica diagram and a minor number of glass shards in the rhyolite field of the total alkali-silica diagram. The first group of composition is consistent with the composition of alkalic products from Jan Mayen suite (Chambers et al., 2004). The second minor group of glass compositions lies into the geochemical Icelandic volcanic province and have Katla-like major element composition. These compositions are also consistent with that of some tephra found in SE Greenland shelf core MD99-2322, that were also attributed to Katla volcano (Iceland). The identification of the volcanic events responsible for deposition of the studied tephra will represent a very efficient, additional tool for absolute sediment dating and core correlation in support to palaeomagnetism and radiocarbon dating. In addition it would be interesting to verify whenever the volcanic activity may or may not influence minor climatic variation in the area.

Finally, the paleomagnetic record of the core provides an unprecedented high-resolution record of Holocene variability of the geomagnetic field in the Barents Sea, which is of great value for geomagnetic field modeling both at regional and global scales.

References

Chambers, F.M., Daniell, J.R.G., Hunt, K., Molloy, K., O'Connell, M., 2004. Tephrostratigraphy of An Loch Mór, Inis Oírr, western Ireland: implications for Holocene tephrochronology in the northeastern Atlantic region. The Holocene, 14, 703-720.

Eiken, O., Hinz, K., 1993. Contourites in the Fram Strait. Sedimentary Geoleology 82, 15–32

Fohrmann, H., et al., 1998. Sediments in bottom-arrested gravity plumes: numerical case studies. J. Phys. Oceanogr. 28, 2250–2274.

Knutz, P.C., 2008. Palaeoceanographic Significance of Contourite Drifts. In: Rebesco, M., Camerlenghi, A. (Eds.), Contourites. Developments in Sedimentology 60, pp. 511–535.

Lucchi, R.G., et al., 2013. Postglacial sedimentary processes on the Storfjorden and Kveithola trough mouth fans: Significance of extreme glacimarine sedimentation. Global and Planetary Change 111, 309–326.

Lucchi, R.G., et al., 2015. Marine sedimentary record of Meltwater Pulse 1a in the NW Barents Sea continental margin. αrktos online DOI 10.1007/s41063-015-0008-6

Rebesco, M., et al., 2008. Contourite research: A field in full development. In: Rebesco, M., Camerlenghi, A. (Eds.), Contourites. Developments in Sedimentology, 60, pp. 1–10.

Rebesco, M, et al., 2013. Quaternary Contourite drifts of the Western Spitsbergen margin. Deep Sea Research Part I: Oceanographic Research Papers 79, pp. 156-168.