Late Quaternary Geology of the Norwegian Margin

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Montserrat Compa[a], César Gomes[b] & Serginio Remmelzwaal[c]

[a]University of the Balearic Islands, 07122 Palma de Mallorca, Spain [b]University of Algarve, 8005-139 Faro, Portugal [c]University of Bristol, BS8 1RJ Bristol, UK

INTRODUCTION

The Norwegian Margin has a northern region shaped by the carving of fast-flowing ice streams during the LGM (Ottense *et al.,* 2005). These streams reached the edge of the shelf transporting copious amounts of sediment to the shelf break and deep sea. Southwards, continental shelves have a lower relief with the exception of the Norwegian Channel - the largest cross-shelf trough. During the earlier stages of the deglaciation diamicton, angular clasts were deposited at the edges of the calving ice sheet. As the ice retreated the cross-shelf troughs filled with water to form fjords and river valleys during which rounded clasts were deposited. These deglaciation sediments are overlain by fine rhythmites and homogeneous muds deposited by meltwater plumes and may contain some ice-rafted debris in shallow marine environments. Post-glacial sediments then gradually change into a homogeneous and bioturbated mud at around 6 ^{14}C ka BP (Knies *et al.,* 2007). These changes in the cryosphere had an effect on the thermohaline circulation and changed the dominant currents flowing along the Norwegian margin.

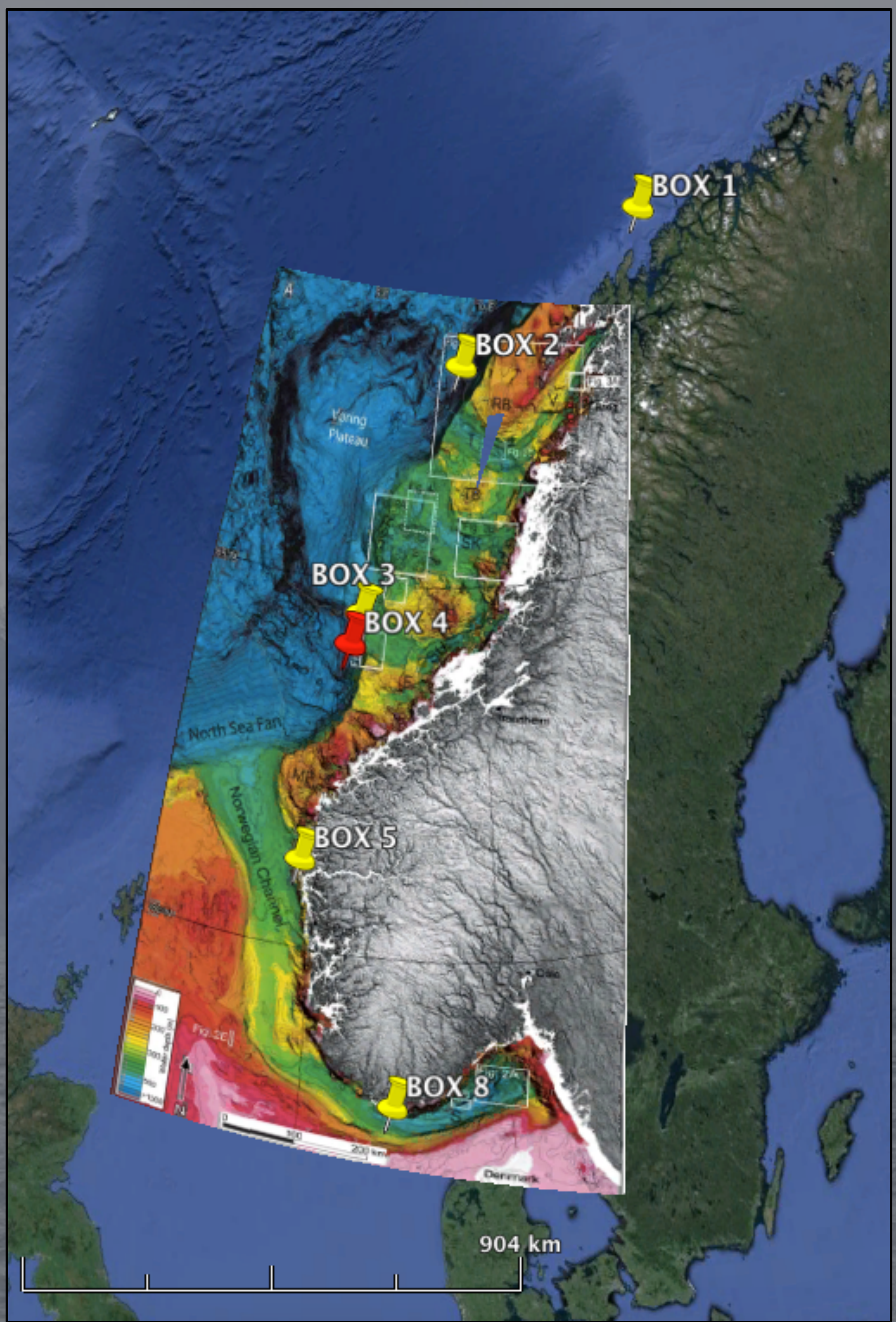

Figure 1 - Overview colour shaded-relief map of the Norwegian margin, including the sites where samples were taken (After Ottesen *et al.,* 2005)

STATION 1

Age: >14,000 yrs BP
Depth: 320m

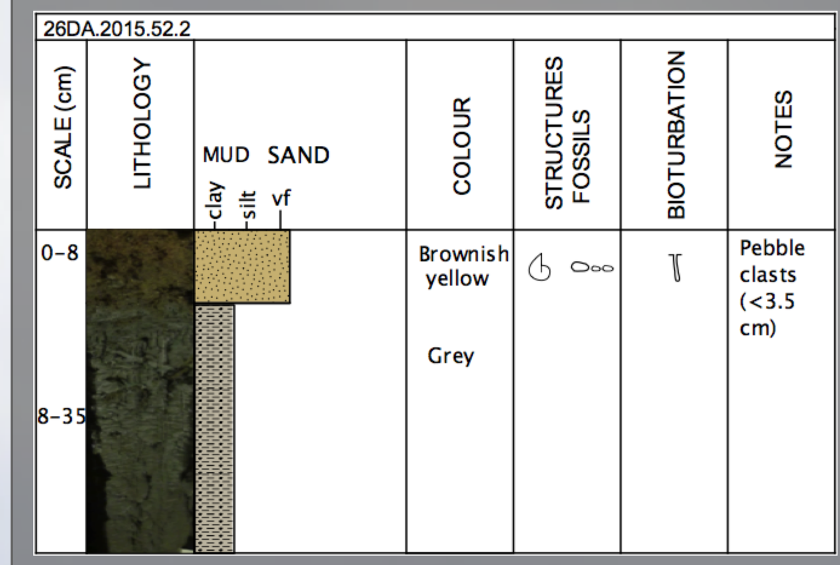

Figure 2 - Log sheet for Station 1

0 - 8 cm: well-sorted yellow sand with shell fragments and pebbles
This well-sorted sand has been deposited by the Norwegian Atlantic Slope Current. The Norwegian Coastal Current can be excluded, as the salinity at this site is >35 psu. This current commenced after the Younger Dryas and therefore the current regime changed within the last 14,000 years. The pebble clasts are ice rafted debris deposited through coastal erosion of shorefast sea ice. The thickness points towards low sedimentation rates.

8 - 35 cm: homogeneous grey mud
Pelagic glacio-marine deposition through sediment plumes from the melting ice sheet and therefore must be older than the Younger Dryas.

STATION 2

Maximum age: Late Pleistocene
Depth: 1326m

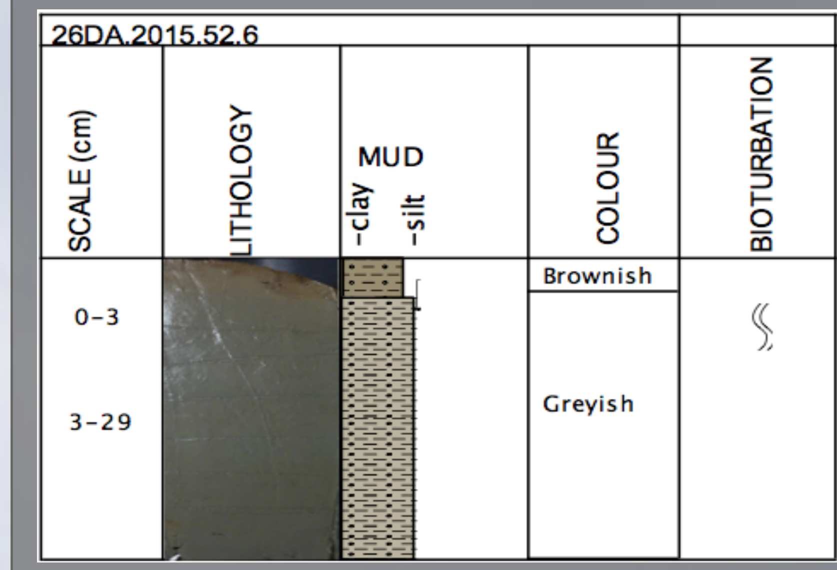

Figure 5 - Log sheet for Station 2

0 - 29 cm: homogeneous grey and brown mud with sparse bioturbation
Located in front of Vestfjorden trough just off the continental shelf and glacial ice sheet (Knies *et al.* 2007). The grey mud most likely has a glacio-marine origin from the ice sheets. This deep location is unmodulated by the NwASC and is in the flow regime of the Norwegian Sea Arctic Intermediate Water. The brown layer at the top (0 - 3 cm) is more oxidised and likely post-glacial of origin, indicating very low sedimentation rates.

STATION 3

Maximum Age: unknown
Depth: 475 m

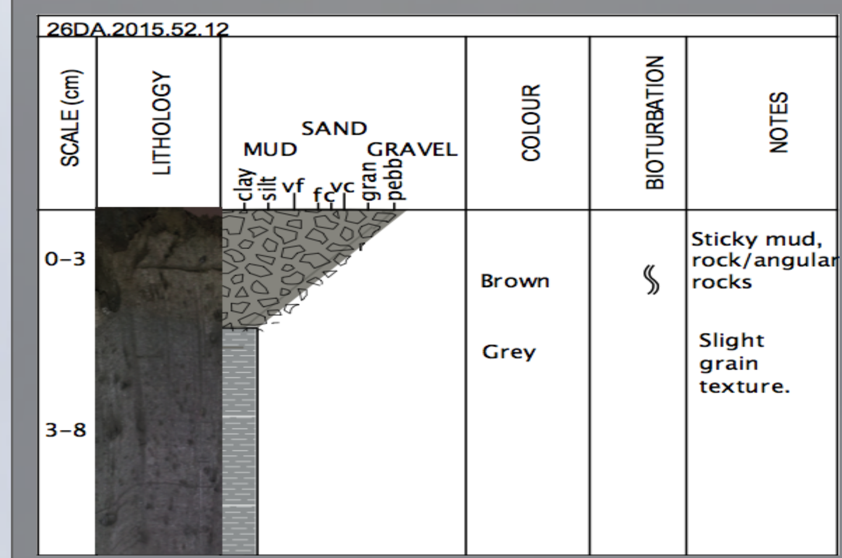

Figure 3 - Log sheet for Station 3

0 - 3 cm: rounded and angular clasts (<5cm) in brown mud matrix
Possible debris flow of ice age material. Large clasts within brown mud matrix above pelagic deposits. The pebbles likely are of a glacial (angular clasts) and fluvial (rounded) origin.

3 - 8 cm: grey homogeneous silty clay
Likely to be of glacio-marine origin and deposited by meltwater plumes from the retreating Fennoscandian ice sheet.

STATION 5

Maximum Age: ~ 1300 yrs*
Depth: 352m

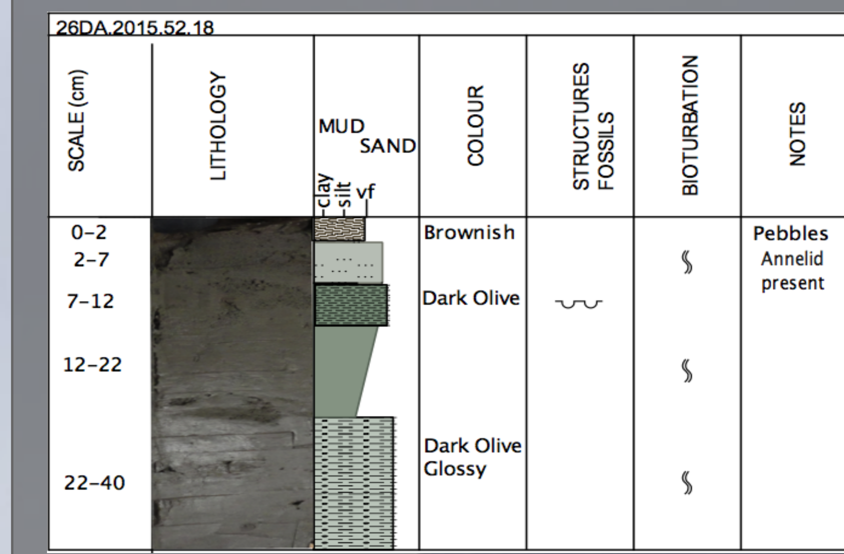

Figure 6 - Log sheet for Station 5

* Calculation rate considering constant sediment deposition and sedimentation rate of 0.3MMyr^{-1} (Rise et al., 2007).

0 - 2 cm: brown sandy silt with pebbles
2 - 13 cm: greenish sandy silt with organic material and presence of load cast
Brown silt and pebbles due to modern deposition. Green colour caused by anoxia in the sediment. Lack of oxygen inhibits decomposition of organic material. Possibly caused by inflow from hypoxic water from the Baltic Sea or the Sognefjord (Paetzel & Dale, 2010). The load cast suggest rapid deposition by a slump, which can be explained by the location of the core on the flank of the Norwegian Channel.

13 - 40 cm: olive silty clay to dark olive mud, bioturbation present
Silty layer possibly deposited through change in current regime 400 - 700 years ago to stronger current such as Norwegian Atlantic Slope Current. The mud is likely deposited by a weaker current, such as the Baltic Current.

STATION 8

Maximum Age: 130 yrs BP*
Depth: 306 m

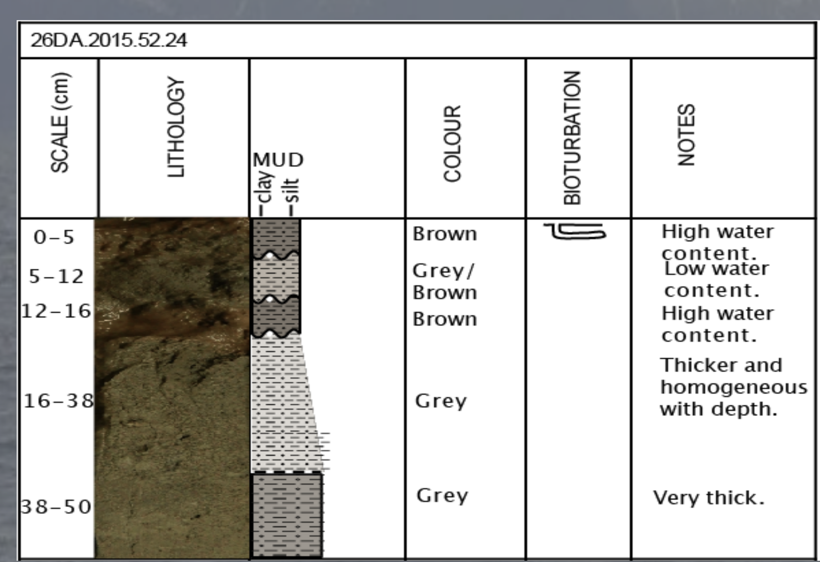

Figure 4 - Log sheet for Station 8

* Calculation rate considering constant sediment deposition and sedimentation rate of 3MMyr^{-1} (Rise et al., 2007).

0 - 16 cm: structureless, brown mud, variable water content
High accumulation rate of sediment and organic material. The high water content of the sediment indicates low compaction, which can possibly be related to high sedimentation rates..

16 - 50 cm: homogeneous grey mud
The grey mud is younger than the glacio-marine muds found in the Northern parts of the margin and are likely to be of pelagic origin. Calmer Baltic Sea currents produce higher sedimentation rates in the Norwegian Channel with young sediment. This is enhanced by the fact that the Channel acts as a sediment trap (Rise *et al.,* 2007).

DISCUSSION

- The homogeneous grey muds along the northern Norwegian margin are most likely formed by sediment plumes of glacial origin and hence are of Pleistocene age.. The top layer of well sorted sands can be attributed to modulation by the NwASC. These sands are not present at deep locations, where the main current is the weaker Norwegian Arctic Sea Intermediate Water. These areas experience very low accumulation rates, as is evident from the thickness of the Holocene sand layer in more shallow areas.
- During the LGM the Fennoscandian Ice Sheet transported coarse material to the shelf break. This material is deposited at the fronts of the cross-shelf trroughs cut by fast-flowing ice and is unstable. Therefore travels down the continental slope as a debris flow.
- Sediments recovered from along the southern Norwegian coastal sites are post-glacial. The areas around the Norwegian Channel experience high accumulation rates This is caused by the lower energy environment of the Channel and its function as sediment trap. Changes in the current regime have occurred over the past few thousand years. These can be seen as coarser sediment layers (silt). These layers can either extend all along the Norwegian Channel, but are not at the same depth due to different sedimentation rates or these represent more local variations.

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References

Knies, J., Vogt, C., Matthiessen, J., Nam, S., Ottesen, D., Rise, L., Bargel, T., Eilertsen, R. S. (2007). Re-advance of the Fennoscandian Ice Sheet during Heinrich Event 1. *Marine Geology*, 240: 1–18.
Ottesen, D., Dowdeswell, J. A., Rise, L. (2005). Submarine landforms and the reconstruction of fast-flowing ice streams within a large Quaternary ice sheet: The 2500-km-long Norwegian-Svalbard margin (57°–80°N). *Geological Society of America Bulletin*, 117(7-8): 1033-1050.
Rise, L., Bøe, R., Ottesen, D., Longva, O., Olsen, H. A. (2007). Postglacial depositional environments and sedimentation rates in the Norwegian Channel off southern Norway. *Marine Geology*, 251: 124–138.

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