Quaternary evolution of the northern North Sea

C. L. Batchelor $^{1,2}$

D. Ottesen$^3$, B. Bellwald$^4$, S. Planke$^{4,5}$, H. Løseth$^6$, S. Henriksen$^6$, S. Johansen$^1$, J. A. Dowdeswell$^2$

Email: clb70@cam.ac.uk
1. The North Sea was a deep basin at the start of the Quaternary ~2.6 Ma

- At present, the North Sea is relatively shallow (generally <200 m) apart from the deeper Norwegian Channel (Fig. 1a).

- Seismic data show that the bathymetry of the North Sea was dominated by the North Sea Basin at the start of the Quaternary (~2.6 Ma) (Fig. 1b) (Lamb et al., 2017; Ottesen et al., 2018; Rea et al., 2018).

- A thick (up to 1 km) Quaternary succession is preserved within the North Sea Basin.

Fig. 1. (a) Present-day bathymetry of the North Sea, overlain by the 500 m contour of the Quaternary basin. (b) Structure map showing the geometry of the base-Quaternary surface in the North Sea. Adapted from Ottesen et al. (2018).
2. The North Sea was infilled mainly during the early Quaternary (~2.6 – 0.8 Ma) by:

- Fluvial-deltaic sediment derived from the Baltic (Eridanos) river system to the south (Fig. 2) (Gibbard, 1988; Overeem et al., 2001; Kuhlmann and Wong, 2008).

- Glacial sediment delivered by the Scandinavian Ice Sheet to the former shelf break in the northern North Sea (Fig. 2).

- Fluvial-deltaic sediment derived from rivers on the East Shetland Platform (ESP)(Fig. 2a).

*There is generally poor age control on the Quaternary sediments of the North Sea

Fig. 2. Sediment thicknesses between Early Quaternary surfaces that are (a) ~2.6 and ~1.6 Ma in age, (b) ~1.6 and ~1 Ma in age. Adapted from Ottesen et al. (2018).
3. Grounded ice first reached the former shelf break beyond Sognefjord, Norway

- A glacigenic depocentre, containing numerous stacked glacigenic debris-flows (GDFs), built out into the northern North Sea from southern Norway since the earliest Quaternary (Fig. 3) (Ottesen et al., 2014, 2018).

- The geometry of the oldest preserved part of this depocentre (Units A and B) (Fig. 3c) shows that grounded ice initially reached a limited area of the former shelf break beyond Sognefjord, Norway (Batchelor et al., 2017; Løseth et al., In Revision).

**Fig. 3.** (a) Interpreted seismic profile of the northern North Sea. (b) Example of GDFs on an early Quaternary palaeo-slope. (c) Isopach map showing the thickness and distribution of Quaternary Units A and B beyond Sognefjord, Norway. Adapted from Batchelor et al. (2017).
4. Infilling of the northern North Sea Basin led to:

- ... reduced accommodation, which caused the focus of sediment deposition to shift northwards towards the Northeast Atlantic Ocean (Fig. 4).

- ... shallower water in the northern North Sea, which enabled confluence of the Scandinavian and British-Irish ice sheets

Ice-sheet expansion and confluence in the North Sea probably encouraged initiation of the Norwegian Channel Ice Stream, which eroded the Norwegian Channel and formed the North Sea trough-mouth fan (TMF) (Fig. 4d).

Fig. 4. Isopach maps of the distribution and thickness of Quaternary units in the northern North Sea. (a) Units A and B (earliest Quaternary), (b) Unit Ci (early Quaternary), (c) Unit Cii (early Quaternary), (d) Unit D (mid-to late Quaternary). Adapted from Batchelor et al. (2017).
References:


- Løseth, H., Ottesen, D., Batchelor, C.L., Dowdeswell, J.A. 3D sedimentary architecture through the inception of an Ice Age 2.6 million years ago. In Review.


Acknowledgements:

We thank PGS, TGS and Equinor for access to seismic data from the North Sea.
CLB was funded by a VISTA post-doctoral scholarship during this work.