

Pleistocene environments and glacial history of the northern North Sea

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Based on new geochronological and lithological data combined with analyses of 3D seismic data, the Pliocene-Pleistocene development of the central northern North Sea has been investigated. At the start of the Plio-Pleistocene Transition the study area was dominated by a deltaic, shallow marine or tidal depositional environment with sediments mainly sourced from the west with a local provenance. Directly above the base Quaternary a 60 m thick layer of mud-rich sediments of glacial marine origin were deposited at a rate of ~ 12 cm/ka between ~ 2 -1.5 Ma and up to 80 cm/ka between 1.5 – 1.2 Ma possibly reflecting glacial ice advancing to the Norwegian coastline. The high rate of deposition in the Early Pleistocene occurred immediately before the initiation of the Norwegian Channel Ice Stream at ~ 1.1 Ma. Following this, a large part of the sediment input from Fennoscandia seems to have been directed away from the study area to the shelf break. At the start of the Mid Pleistocene Transition (MPT), sub-aerial conditions allowed the formation of a >50 km long fluvial channel across the study area draining water from the east to the south west. The earliest evidence of grounded ice in the investigated area comes from mega scale glacial lineations formed during the MPT, at or just after ~ 1.2 Ma. Following this, a regional unconformity was formed by one or more grounded ice advances across the study area possibly during or directly after the MPT and likely marks the boundary between the Early and Mid Pleistocene glacial marine sediments. The Mid to Late Pleistocene stratigraphy is dominated by glacial marine sediments and tills and is associated with multiple generations of tunnel valleys observed within the seismic data. A high shear strength till containing chalk clasts transported from the west and/or south of the study area was likely deposited during MIS6 and may have been more conducive to tunnel valley formation in comparison to lower shear strength tills deposited by later ice advances. A thick till unit overlain by a sand layer in the study area was deposited by grounded ice during the Last Glacial Maximum and subsequent drainage of an ice dammed lake in the southern North Sea during the last deglaciation (MIS2) of the study area. This study shows that much of the Quaternary age sediments within the northern North Sea were deposited relatively rapidly during short periods of time probably leaving significant hiatuses within the stratigraphic record. This finding has implications for previous studies that use a chronological framework assuming a relatively continuous sedimentation rate and record for the Early Pleistocene within the North Sea.