GlaciStore: Understanding Late Cenozoic Glaciation and Basin Processes for the Development of Secure Large Scale Offshore CO_2 Storage (North Sea)

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ABSTRACT

The sedimentary strata of the North Sea Basin (NSB) record the glacial and interglacial history of environmental change in the Northern Hemisphere, and are a proposed location for the engineered storage of carbon dioxide (CO_2) captured from power plant and industrial sources to reduce greenhouse gas emissions. These aspects interact in the geomechanical and fluid flow domain, as ice sheet dynamics change the properties of potential seal and reservoir rocks that are the prospective geological storage strata for much of Europe's captured CO_2.

The central part of the NSB preserves a unique history of the depositional record spanning at least the last 3 Ma, which also forms the overburden and uppermost seal to the underlying CO_2 reservoirs. There is good evidence that these ice sheets created strong feedback loops that subsequently affected the evolution of the Quaternary climate system through complex ocean-atmosphere-cryosphere linkages.

An increased understanding of these sequences will assist and improve quantitative predictions of the performance of prospective CO_2 storage sites in glaciated areas in Europe and worldwide; to include improved resolution of glacial cycles, characterise pore fluids, flow properties of CO_2 within glacial features (e.g. tunnel valleys) and the geomechanical effects (quantify compaction, rock stiffness, strength and stress profiles) of advancing and retreating ice on the underlying strata to verify and constrain models of glaciation.

This contribution describes current work and introduces a proposal submitted to the International Ocean Discovery Program (852-Pre) by the authors. The objective of the Joint Drilling Program is to develop and perform scientific appraisal drilling operation(s) in the North Sea aiming at:

• A refined understanding and stratigraphic calibration of the Earth's Plio-Pleistocene climate history in an area where the most complete sequence is preserved;

• Better understanding of the geometry, dynamics, processes and wider impact of ice sheet development;
• Understanding the fluid communication and its evolution during a period of fluctuating pressure conditions in shale-dominated basins and its implications for CO_2 storage;
• Understanding and quantifying the effects of ice sheet loading/unloading on underlying strata, on geomechanical properties, horizontal stress and CO_2 storage site performance