CenoStore: MagellanPlus Workshop Report

Queen's University Belfast, Northern Ireland

10th – 13th January 2023

QUEEN'S UNIVERSITY BELFAST

Summary:

A workshop was held from 10-13 January 2023 at Queen's University Belfast, Northern Ireland. This came at the end of a year-long UK research council-funded project between the University of Manchester, British Geological Survey, and Queen's University Belfast. This project produced a virtual site survey in the North Sea Basin (NSB) that investigated the "Late Cenozoic palaeo-climate of NW Europe and implications for subsurface CO_2 containment (CenoStore)". The workshop was an opportunity to introduce the results of this project to colleagues from different North Sea countries and to scope out the potential for a future IODP proposal. The workshop was a hybrid event attended by 37 colleagues (25 in-person and 12 online – of which 8 were early-career researchers) from UK, Netherlands, Germany, Denmark, Belgium, Norway, Portugal, and US. Participants were from a range of research backgrounds, and from both academia and industry. After a welcome icebreaker the evening before, on Day 1, colleagues provided a number of presentations on their recent research in the NSB. Speakers also presented some of their ideas about their motivations for drilling in the NSB. We finished our speaker session with presentations from colleagues who have complimentary IODP ambitions from the region in order to explore where synergies may be possible. After completion of the talks, participants broke out into individual groups where they discussed the 'wish list' of questions they would like answered by a potential drilling campaign in the NSB. On the evening of Day 1 we convened our workshop dinner, where discussions continued. On Day 2, we had presentations on how to plan scientific drill site locations in a petroleum province, the results from the CenoStore project, and the logistics of an MSP drilling campaign and how this could feed into proposals. In the afternoon, the wish list was jointly synthesised into the over-arching questions that a future drilling campaign might answer and discussions followed on where the best places in the NSB were for answering these questions. On Day 3, participants discussed their final thoughts on a possible drilling campaign and any remaining issues that had not been covered. On conclusion of the workshop, it was agreed that there was a very strong scientific case for pursuing a drilling proposal. A core team of lead proponents was agreed and an initial timetable was presented for the preparation of a pre-proposal to be submitted to the IODP and by 1st April.

Scientific Background:

The intensification of the global glacial-interglacial cycle at the onset of the Quaternary (~2.6 Ma) was a critical tipping-point in Earth's recent climate history. The increased severity of cold conditions at the Plio-Pleistocene boundary triggered the development of large-scale continental ice sheets in the Northern Hemisphere. Since then, the NSB of Northwest Europe has experienced multiple glacial-interglacial cycles in terrestrial and shallow marine settings. Unlike the onshore record, the NSB uniquely preserves an almost complete record of glacial erosion and deposition from European ice sheets, as well as sediment input from large rivers systems. This dynamic growth and retreat of ice sheets bordering the NSB, and its subsidence history, have resulted in a thick (up to ~1.2 km) Quaternary sedimentary sequence containing a detailed stratigraphic record of environmental change of Northwest Europe. While the last glacial cycle is relatively well understood, little is known about older Quaternary ice sheet fluctuations except for estimates on global ice volume with poor chronological control. Indeed, there is increasing evidence that shows the extent of early Quaternary ice sheets of North America, Greenland, and Northwest Europe poorly align with estimates on global sea level change – e.g. the extent of ice sheets inferred from geological records, requires higher magnitude sea level changes than are currently documented. There is also complimentary evidence that Quaternary ice sheets generated strong feedback loops that subsequently affected the evolution of the global climate system through complex ocean-atmosphere-cryosphere linkages. Thus, the Quaternary sedimentary sequence preserved in the North Sea is a significant palaeo-climate archive capturing environmental changes across millions of years. As the NSB is a mature petroleum basin, it benefits from an extensive seismic and borehole database that provides a significant seismo-stratigraphic knowledge base for planning a successful IODP drilling campaign. Additionally, the NSB is generally <120 m deep, meaning that the bathymetry of the study area is ideal for using a Mission Specific Platform such as a jack-up rig to complete the coring.

Workshop Day 1:

The first day of the workshop began with an introduction to the CenoStore project and its overarching aims and objectives by Mads Huuse (University of Manchester). We then had a talk from Christine Batchelor (Newcastle University) that covered the broadscale history of Northern Hemisphere glaciation and its relative importance to the NSB. The talks then moved in a north to south transect, discussing basin infill and environmental reconstructions. Helge Løseth (Equinor) started in the northern NSB with an online presentation from Norway, before we moved onto the contrasting interpretations of North Sea depositional history and glaciological reconstructions presented by Dag Ottesen (NGU) and Brice Rea (University of Aberdeen). Moving further south, we then had Johan ten Veen (TNO), Timme Donders (Utrecht University), and Frank Wesselingh (Naturalis) talk about further basin evolution and biodiversity turnover. Natasha Barlow (University of Leeds) and Sara Benetti (Ulster University) finished the presentations by talking about their ongoing work and the potential for synergies. All presenters were asked to finish their presentations with some ideas on what they felt were the unanswered questions and where a drilling campaign might be located. In the late afternoon this was developed further as attendees brain-stormed in groups to develop 'wish lists' and the 'Hollywood message' for any future drilling campaign in the NSB. This was designed to ascertain the variety of ambitions for drilling and to determine where common ground may lie. In the evening we had our workshop dinner in the Deanes at Queens restaurant.

Workshop Day 2:

The second day of the workshop began with a presentation from David Cox (BP) who presented his work on scientific drill site selection in a petroleum province. This workflow was implemented with success for IODP Proposal 909 in Baffin Bay, which has since been scheduled as Expedition 400. Georgina Heldreich (University of Manchester) presented the results of the CenoStore project and the possible drill site locations for a future drilling campaign in the NSB. This was followed by two online talks from David McInroy (BGS) and Patrizia Gepraegs (Marum), and an in-person talk from Tim Van Peer (University of Leicester) that focused on the logistics of a mission-specific platform, the general workflow after core collection, and the process of wireline logging. Paul Knutz (GEUS) then presented some insights and advice from the IODP Proposal 909 process, before outlining some thoughts on where a NSB drilling campaign might focus. After much discussion about tunnel valleys in the NSB, we had a bonus presentation from Kelly Hogan (British Antarctic Survey) on high-resolution seismic imaging of tunnel valleys. The lead organiser then presented a brief summary of the previous day's brainstorming and the participants discussed how to refine these into specific research questions. Discussions continued on the sorts of strata that might be required for these questions to be answered, where they might be located in the NSB, and the trade-offs between different elements such as continuity of records, drill and logging timescales, and how these all fit into answering the research questions. Ideas on developing a land-to-sea project were presented and IODP-ICDP logistics were discussed. Participants also discussed the potential for an Ancillary Project Letter. After a group photo, the discussions continued late into the evening in a more informal setting of a local bar, where topics included future site survey collection, additional collaborators, and possible contributions.

Workshop Day 3:

On the final day of the workshop, participants gathered to discuss the plan forward. It was agreed that there was a strong case for a proposal. Colleagues discussed commitments, collaborations, synergies, and follow-up actions (such as setting up a number of ways to digitally collaborate on the project). A core team of proponents was provisionally agreed and an expected timeline for the preparation of the pre-proposal, due in April, will be discussed shortly after the workshop. Colleagues also discussed other potential collaborators who's skillsets and insight would benefit the project. The workshop was drawn to a close with some final remarks thanking colleagues for making the effort to participate in the workshop, before a brief, and unexpected cameo, from Sir Keir Starmer, the leader of the UK's main opposition political party, officially ended the workshop.

Outcome and Future Plans:

The MagellanPlus workshop provided a successful setting for developing the foundations of the future drilling proposal by bringing together a range of expertise and experience. As the lead organiser (Andrew Newton) remarked, bringing together colleagues from around the NSB provided not just the opportunity for high-level discussions, but it also afforded the opportunity for early-career researchers to avail of the wisdom and insight from established colleagues who's work they had read, but never had the opportunity to previously meet. Agreement of key research questions will allow proponents to refine drill site locations in the coming weeks to meet these objectives. Future discussions in the coming weeks will focus on the preparation of the pre-proposal (timeline to be agreed within one week of the workshop), the possibility of a joint IODP-ICDP collaboration, and the potential for site survey work over prospective drill sites. Colleagues will develop the pre-proposal over the next two months and aim to submit it to the IODP by April.

Final Remarks:

The committee that organised the workshop wishes to place on record its gratitude to colleagues who made the effort to attend and whole-heartedly participate in the workshop, both online and in-person. The discussions were of the highest quality and have provided significant insights that will strengthen the future proposal.

Photos:

Mads Huuse (University of Manchester) kicks the conference off with the first presentation on what the CenoStore project set out to achieve and in-person attendees pose for the group photo alongside the statue of Galileo in the entrance hall of the historic Lanyon Building at Queen's University Belfast.

Programme:

Day 1 | 10 Jan	Arriving in Belfast
19:00-20:00	Icebreaker Reception in the Elmwood Building

Day 2 | 11 Jan	Background on the North Sea and discussion on what we want out of it
09:00-09:30	Arrival coffee/tea
09:30-09:45	Andrew Newton | Official Welcome
09:45-10:00	Mads Huuse | Introduction to Cenostore
10:00-10:20	Christine Batchelor | Northern Hemisphere Quaternary glaciations
10:20-10:40	Helge Løseth | Northern North Sea
10:40-11:00	Coffee/tea break
11:00-11:20	Dag Ottesen | Northern/Central North Sea
11:20-11:40	Brice Rea | Central/Southern North Sea
11:40-12:00	Johan ten Veen | Southern North Sea
12:00-13:00	Lunch
13:00-13:20	Timme Donders | Late Pliocene-Early Pleistocene Southern North Sea
13:20-13:40	Frank Wesselingh | Southern North Sea Biodiversity and Ecosystems
13:40-14:00	Natasha Barlow | Potential Synergies
14:00-14:20	Sara Benetti | Potential Synergies
14:20-15:30	Break-out Discussions | Proposal Aims/Objectives/Priorities
15:30-15:45	Coffee/tea break
15:45-16:45	Break-out Discussions | Proposal Aims/Objectives/Priorities
16:45-17:00	Final Remarks
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19:00-21:00	Workshop Dinner in Deanes at Queens

Day 3 | 12 Jan	Drilling in petroleum provinces and choosing sites to meet objectives
09:00-09:30	Arrival coffee/tea
09:30-10:00	David Cox | Site Selections in a Hydrocarbon Province
10:00-10:45	Georgina Heldreich | CenoStore Site Selection
10:45-11:00	Coffee/tea break
11:00-11:40	IODP/BGS | Petrophysics and Logistics
11:40-12:00	Paul Knutz | IODP and Baffin Bay
12:00-13:00	Lunch
13:00-13:20	Kelly Hogan | High-resolution imaging of tunnel valleys
13:20-15:30	Break-out Discussions | Drill Site Selections
15:30-15:45	Coffee/tea break
15:45-16:45	Break-out Discussions | Drill Site Selections
16:45-17:00	Final Remarks, Actions, and Timelines

Day 4 | 13 Jan	Final Discussions
09:00-09:30	Arrival coffee/tea
09:30-11:30	Break-out Discussions | Synergies/Collaboration/Contributions

Attendees:

(O) = Online

Last Name	First Name	Institution	Country
Barlow	Natasha	University of Leeds	UK
Batchelor	Christine	Newcastle University	UK
Benetti	Sara	Ulster University	UK
Brackenridge	Rachel	University of Aberdeen	UK
Buckley	Francis	Cuillin Geoscience	UK
Busschers	Freek	Geological Survey of the Netherlands	Netherlands
Caruso	Simona	University of Aberdeen	UK
Cox	David	BP	UK
Donders	Timme	Utrecht University	Netherlands
Fuhrmann (O)	Arne	Federal Institute for Geosciences and Natural Resources	Germany
Gamboa	Davide	Instituto Português do Mar e da Atmosfera	Portugal
Gepraegs (O)	Patrizia	Marum	Germany
Gibbard (O)	Philip	University of Cambridge	UK
Harding (O)	Rachel	University of Bradford	UK
Heldreich	Georgina	University of Manchester	UK
Hogan	Kelly	British Antarctic Survey	UK
Huuse	Mads	University of Manchester	UK
Juul Andresen	Katrine	Aarhus University	Denmark
Knutz	Paul	Geological Survey of Denmark and Greenland	Denmark
Kuhlmann	Gesa	Federal Institute for Geosciences and Natural Resources	Germany
Kurjanski	Bartosz	University of Aberdeen	UK
Lloyd (O)	Christopher	Equinor	Norway
Løseth (O)	Helge	Equinor	Norway
McInroy (O)	David	British Geological Survey	UK
Mukhatzhanov	Aldiyar	Rutgers University	USA
Newton	Andrew	Queen's University Belfast	UK
Ottesen	Dag	Norges Geologiske Undersøkelse	Norway
Plets	Ruth	Flemish Institute for the Sea	Belgium
Rea	Brice	University of Aberdeen	UK
Sliwinska (O)	Kasia	Geological Survey of Denmark and Greenland	Denmark
Stewart (O)	Margaret	British Geological Survey	UK
Stewart	Heather	British Geological Survey	UK
ten Veen	Johan	Geological Survey of the Netherlands	Netherlands
Thöle (O)	Hauke	Federal Institute for Geosciences and Natural Resources	Germany
van Peer	Tim	University of Leicester	UK
Wesselingh	Frank	Naturalis	Netherlands
Winesmann (O)	Jutta	University of Hannover	Germany