IODP Proposal Cover Sheet

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British-Irish Ice Sheet history

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Title	Inception, growth and decay of the British-Irish Ice Sheet
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Keywords	glaciations, ice-sheets, North-Atlantic, paleoclimate, gateways
Area	UK and Ireland continental margin

Proponent Information

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Abstract

One of the key uncertainties in the projections of future sea-level rise comes from an imperfect understanding of ice sheet processes and their internal variability in response to climate and ocean forcing, especially for marine-terminating ice sheets such as the West Antarctic and Greenland ice sheets. An improved understanding of palaeo-ice sheet dynamics has important implications for modelling and forecasting of future changes in modern ice sheets. The British-Irish Ice Sheet (BIIS), that extended over the UK and Ireland during the Quaternary, was marine-terminating, drained by large ice streams, and was particularly sensitive to oceanographic and climatic changes due to its geographical position bordering the North Atlantic. This makes it an excellent analogue to gain further insight into the dynamics of modern marine-terminating ice sheets. However, surprisingly little is known about BIIS inception and older glaciations prior to the last glaciation. This proposal aims to fill this scientific gap through drilling 5 sites along the UK and Irish continental margin for the reconstruction of the inception, and cycles of growth and decay of the BIIS throughout its history. These sites capture the main outlets of the BIIS and can provide a record of intervals of meltwater release, downslope transport of glacial and glaciomarine sediments and ice-rafted debris deposition that will shed light on the timing and nature of expansion and retreat of the marine-terminating sectors of the BIIS. Using offshore sediments to reconstruct former ice sheets is a tested methodology, one which has been used across many former and current glaciated regions, from the Arctic to Antarctica, and which allows the recovery of almost complete records of glaciation, unlike onshore deposits. The proposed sites target locations that can provide the least disturbed, early Pliocene to Holocene stratigraphy of the continental margin, and allow the recovery of both glaciomarine and hemipelagic/contouritic sediments. The aim of this approach is to provide key long-term datasets on the glacial history of the BIIS but also on the background oceanographic and atmospheric conditions at the time through multi-proxy data that can be obtained from marine sediments. This proposal fits perfectly within the “2050 Science Framework: Exploring Earth by Scientific Ocean Drilling” as it addresses some of its key strategic objectives and, in particular, #3 Earth’s Climate Systems, #4 Feedback in the Earth System and #5 Tipping Points in Earth’s History and Flagship Initiative #1 Ground Truthing Future Climate Change.

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Scientific Objectives

The overall aim of the drilling campaign is to reconstruct the inception, and cycles of growth and decay of the BIIS throughout its history. Specific objectives/themes are:

1. To determine the inception of the marine-terminating BIIS and its sectoral synchronicity along the NE Atlantic margin, as well as with other circum-North Atlantic ice sheets.

2. To investigate glacial-interglacial periodicity and the magnitude of glaciations and in particular address the following:
- What was the number and frequency of glaciations since BIIS inception and was there a change in glacial-interglacial cyclicity across the Mid-Pleistocene Transition?
- What was the magnitude of each glaciation and were there contrasts in ice sheet extent during different glacial periods? Specifically, were shelf-edge glaciations a persistent feature of the BIIS throughout the Cenozoic?
- What was the nature and rate of transitions between glacial and interglacial periods?
- Were ice streams a persistent feature of the BIIS throughout its history and have there been spatial and temporal variations in the dominance of different ice streams and different ice sheet sectors in pre-MIS 5 glaciations?
- What were the controls on ice dynamics over the Cenozoic (e.g. buttressing from ice shelves or sea ice, bed conditions and paleotopography, sediment budgets)?

3. To develop a better understanding of the forcing and feedback mechanisms of BIIS growth and decay, in particular related to Atlantic Meridional Overturning Circulation and the Polar front.

These objectives will allow a better understanding of Earth's climate systems, including feedback mechanisms and climate's tipping points.

Non-standard measurements technology needed to achieve the proposed scientific objectives

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

yes

Science Communications Plain Language Summary

Using simple terms, describe in 500 words or less your proposed research and its broader impacts in a way that can be understood by a general audience.

Global warming and climate change caused by human activities are increasingly evident, with one of the most pressing concerns being the sea level rise from the melting of polar ice sheets, such Greenland and Antarctica. Sea level rise poses significant risks to coastal populations, including increased vulnerability to flooding and the loss of freshwater resources. To effectively anticipate the full impacts of climate change, it is imperative for scientists to develop a better understanding of how modern ice sheets will react to changing temperatures in the atmosphere and the oceans. This understanding relies heavily on the availability of comprehensive datasets to run forecasting models, projecting how ice sheets and glaciers respond to changing climates. However, existing datasets from modern times cover only a limited time span, typically up to a century or less, and may not adequately capture the full range of temperature changes experienced by these ice masses. A proven method to supplement these modern datasets and enhance our understanding of ice sheet dynamics is to utilize data from past ice sheets. We are currently in an interglacial period characterized by relatively warmer global temperatures, but throughout the Quaternary period, spanning the last 2.6 million years, Earth experienced tens of glacial periods, marked by prolonged periods of colder temperatures and significant glacier advances, at times even larger than the last. The record of these glacial advances is preserved in landforms and sediments both on land and on and underneath the ocean floor. In the marine environment, glacial and glaciomarine sediments were often less disturbed by subsequent geological and glacial processes and offer longer and less disrupted records of past glacial activity. By analysing the properties of these sediments, along with the microfossils contained within them, and studying the composition of sand and gravel grains deposited on the seafloor from melting icebergs, researchers can reconstruct the frequency, extent, and conditions under which ice sheets extended over entire land masses and into the marine environment. Through this comprehensive analysis, we can gain insights into the factors driving past glacial cycles, refine our understanding of ice sheet flow dynamics, and therefore provide data to improve the accuracy of predictive models for modern ice sheets. This proposal aims to achieve such a long-term reconstruction for the British-Irish Ice Sheet, which covered Britain and Ireland in the past, at times even merging with other European ice sheets. We know from previous studies that the sediments offshore UK and Ireland can provide key data for this reconstruction and that this ice sheet, due to its location and proximity to the North Atlantic Ocean, would have been greatly affected by changes in ocean circulation and atmospheric temperatures. It is therefore a very suitable analogue for modern ice sheets. This research is critical to better understand past climate variability, the forcing and feedback mechanisms of such variability and its implications for future climate projections.

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Proposed Sites (Total proposed sites: 11; pri: 5; alt: 6; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SSF-01A (Primary)	59.3606 -7.1651	835	530	0	530	Minch Ice Stream outlet and Sula Sgeir Trough Mouth Fan: SSF01A is targeting the RPa megasequence representing the early Pliocene to Holocene stratigraphy of the Sula Sgeir trough mouth fan.
SSF-02A (Alternate)	58.6156 -8.5139	514	170	0	170	SSF02A is targeting the RPa megasequence representing the early Pliocene to Holocene stratigraphy on the continental shelf SW of the Sula Sgeir trough mouth fan.
DBF-01A (Primary)	55.8041 -11.3879	2667	417	0	417	Malin Sea Ice Stream outlet and Donegal-Barra Trough Mouth Fan: DBF01A is targeting the RPa megasequence representing the early Pliocene to Holocene stratigraphy of the Donegal-Barra Fan.
DBF-02A (Alternate)	55.7021 -11.6465	2765	340	0	340	Malin Sea Ice Stream outlet and Donegal-Barra Trough Mouth Fan: DBF02A is targeting the RPa megasequence representing the early Pliocene to Holocene stratigraphy of the Donegal-Barra Fan.
DBF-03A (Alternate)	55.8725 -11.5716	2713	383	0	383	Malin Sea Ice Stream outlet and Donegal-Barra Trough Mouth Fan: DBF03A is targeting the RPa megasequence representing the early Pliocene to Holocene stratigraphy of the Donegal-Barra Fan.
CF-01A (Primary)	53.0615 -12.1009	244	267	0	267	Western Ireland ice sheet outlet and Connemara Fan: CF01A is targeting the early Pliocene to Holocene glacigenic sediment wedge of the Connemara Fan on the Irish Mainland Shelf.
CF-02A (Alternate)	53.5705 -11.4808	202	215	0	215	Western Ireland ice sheet outlet and Connemara Fan: CF02A is targeting the early Pliocene to Holocene glacigenic sediment wedge of the Connemara Fan on the Irish Mainland Shelf.
WPB-01A (Primary)	53.0072 -14.3616	259	219	0	219	Western Ireland ice sheet outlet and Porcupine Bank: WPB01A is targeting the early Pliocene to Holocene stratigraphy of the western-most extent of the British-Irish Ice Sheet
GS-01A (Primary)	49.6445 -11.9413	1100	380	0	380	Irish Sea Ice Stream outlet and Goban Spur: GS01A is targeting the early Pliocene to Holocene stratigraphy to capture the southernmost outlet of the BIIS.
GS-02A (Alternate)	49.7024 -11.8197	1066	302	0	302	Irish Sea Ice Stream outlet and Goban Spur: GS01A is targeting the early Pliocene to Holocene stratigraphy to capture the southernmost outlet of the BIIS.
GS-03A (Alternate)	49.6464 -11.8051	1004	308	0	308	Irish Sea Ice Stream outlet and Goban Spur: GS01A is targeting the early Pliocene to Holocene stratigraphy to capture the southernmost outlet of the BIIS.