

# IODP Proposal Cover Sheet

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Eastern Fram Strait Paleo Archive

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Title	Eastern Fram Strait Palaeo-archive		
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## Proponent Information

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## Abstract

The North Atlantic-Arctic Oceans are unquestionably major players in the climatic evolution of the Northern Hemisphere and in the history of the meridional overturning circulation of the Atlantic Ocean. The establishment of the modern North Atlantic Water has been indicated as one of the main forcing mechanisms for the onset of the North Hemisphere Glaciation. North Atlantic Water control the extent and dynamics of circum-Arctic and circum-North Atlantic ice sheets and sea ice in addition to deep water and brine production. How the ocean system and cryosphere worked during past warmer intervals of either/ both high insulation and/or high atmospheric CO<sub>2</sub> content, is still unknown and debated. The required information can only be attained by offshore scientific drilling in high-resolution, continuous and undisturbed sedimentary sequences at the eastern Fram Strait along the main pathway and northern penetration of the North Atlantic Water flowing into the Arctic Ocean. As matter of fact, this area around Svalbard can be considered as a "sentinel of climate change". The reconstruction of the dynamic history of the paleo Svalbard-Barents Sea Ice Sheet, is important as it is considered the best available analogue to the West Antarctic Ice Sheet (WAIS), whose loss of stability is presently the major uncertainty in projecting future global sea level in response to the present global climate warming induced by the anthropogenic rising of atmospheric CO<sub>2</sub> content.

The lack of a robust marine sediment chronostratigraphy, caused by low and variable sedimentation rates on Arctic ridges and variable calcareous microfossil abundance due to low productivity and/or poor preservation, hampers a proper understanding of the past Arctic climate evolution. Moreover, limited or equivocal oxygen isotope stratigraphy and magnetostratigraphy represent major impediments. Potential high-resolution marine records from continental shelves and/or upper slopes rarely extend beyond the last glaciation and/or contain stratigraphic discontinuities related to ice sheet dynamics on the shelves and sediment dynamics on the slopes.

FRAME IODP drill proposal is motivated by the necessity of retrieving long and inter-connected sedimentary records along the eastern side of the Fram Strait in order to establish a robust chronostratigraphy, and to improve our understanding of the boundary conditions and forcing mechanisms determining the evolution of the Northern North Atlantic and Arctic regions and their past and present connections with global climate.

## Scientific Objectives

The general objective of FRAME is the reconstruction of the West Spitsbergen Current (North Atlantic Water) variability, its influence on climate changes particularly during key climate transitions (late Pliocene–Pleistocene Transition, Mid-Pleistocene Transition, Mid-Brunhes Transition, and sub-orbital Heinrich-like events), and its impact on the Arctic glaciations, ice shelves development and stability, and sea ice distribution.

Specific objectives:

- 1) The development of a high-resolution, Plio-Quaternary chronostratigraphic record based on biostratigraphy, stable isotope, tephrochronology, and magnetic stratigraphy to constrain palaeoceanographic and palaeoclimatic events, and dynamism of the SBSIS.
  - 2) The generation of multi-proxy data sets to better constrain the potential concurrent forcing mechanisms responsible for main climatic transitions (Plio-Pleistocene transition, MPT, MBT).
  - 3) The identification of orbital, sub-orbital, millennial scale climate variations such as Heinrich events and possible associated prominent meltwater events (i.e. pulses of water discharge from ice sheet margins).
  - 4) The evaluation of the impact of past prominent sediment laden meltwater events on water masses properties, ocean circulation, slope stability and living biota.
  - 5) The reconstruction of paleo SBSIS dynamic history in relation to changes in the WSC pathways and characteristics as mechanisms inducing ice sheet instability and fast retreat.
- Such objectives will contribute to a better understanding of the growth and collapse of marine-based polar ice sheets and sea ice, rates and magnitudes of climate variability at high latitudes and its implication for future global climate and ice sheet response to elevated CO<sub>2</sub> levels.

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

## Proposed Sites (Total proposed sites: 10; pri: 5; alt: 5; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
BED-01A (Primary)	76.521597 12.738673	1647	390	0	390	BED-01A is located on the Bellsund Drift on the western margin of Svalbard (eastern side of the Fram Strait) along the pathway of the deep core of the WSC (1700 mbsl). The site is characterised by a continuous, extremely high-resolution (sub-centennial) paleo-archive since the onset of shelf-edge glaciation (R4A, 1.3 Ma). This site appear ideal to particularly fulfil Objective 7: comparison between land surface (ice cores) and marine (sediment cores) records to establish feedbacks between atmospheric and marine realms in relation to paleoclimatic changes.
BED-02A (Alternate)	76.5290 12.5522	1805	363	0	363	Site BED-02A is the alternate of Site BED-01A. The site is located on the Bellsund Drift (western margin of Svalbard) along the pathway of the deep core of the WSC, and crossing a very expanded (centennial) paleo-archive since the onset of shelf-edge glaciation (R4A, 1.3 Ma). Although the resolution is lower with respect of primary site BEDR-01A, and the sequence locally contains Mass Transport Deposits, BED-02A appears suitable for FRAME purposes and adequate to fulfil also Objective 7: comparison between the record of ice and sediment cores.
ISD-01A (Primary)	77.59038 10.08559	1399	258	0	258	Site ISD-02A is located on the Isfjorden Drift (western margin of Svalbard) along the upslope limit of the pathway of the deep core of the WSC. This site cross an expanded (sub-millennial) paleo-archive since the onset of shelf-edge glaciation (R4A, 1.3 Ma). Because of its closer location to the shelf edge, with respect to the sites located on the Bellsund drift, Site ISDR-01A can give both complementary palaeoceanographic information about the variability of the deep core of the WSC, and detailed information on the SBSIS dynamics after the onset of shelf-edge glaciation in this area.
ISD-02A (Alternate)	77.52639 9.82167	1665	374	0	374	Site ISD-02A is alternate to site ISD-01A both located on the Isfjorden Drift (western margin of Svalbard) along the pathway of the deep core of the WSC. This site cross an expanded (sub-millennial) paleo-archive since the onset of shelf-edge glaciation (R4A, 1.3 Ma), and can give complementary palaeoceanographic information about the variability of the deep core of the WSC, and information on the SBSIS dynamics after the onset of shelf-edge glaciation in this area.
VRE-01A (Primary)	79.0321 7.0581	1293	539	0	539	VST-05A penetrates flat, stratified, undisturbed sediments down to the Plio-Pleistocene boundary which is at ca. 400 mbsf. Objectives relate to Plio-Quaternary chronostratigraphy, main climatic transitions (Plio-Pleistocene transition, MPT, MBT), identification of orbital, sub-orbital, millennial scale climate variations and the onset of northern hemisphere glaciations.
VRE-02A (Alternate)	78.8723 7.5116	1129	592	0	592	VST-04A penetrates flat, stratified, undisturbed sediments down to the Plio-Pleistocene boundary which is at ca. 400 mbsf. Objectives relate to Plio-Quaternary chronostratigraphy, main climatic transitions (Plio-Pleistocene transition, MPT, MBT), identification of orbital, sub-orbital, millennial scale climate variations and the onset of northern hemisphere glaciations.
VRW-01A (Primary)	79.1826 4.5700	1536	631	0	631	VST-03B lies at the western termination of the Vestnesa Ridge. Important objectives are extending the stratigraphic and paleoclimate record into the Pliocene and possibly the Miocene over a condensed Pleistocene sedimentary succession. Objectives relate to study the Earth climate system during Pliocene Earth orbital changes and the significant climate changes in the Arctic from a much warmer climate with ephemeral ice sheets to a colder climate with the onset of extensive glaciation over Greenland and the formation of an Arctic ice cap.
VRW-02A (Alternate)	79.1587 04.6219	1607	567	0	567	VST-08A lies at the western termination of the Vestnesa Ridge. Important objectives are extending the stratigraphic and paleoclimate record into the Pliocene and possibly the Miocene over a condensed Pleistocene sedimentary succession. Objectives relate to study the Earth climate system during Pliocene Earth orbital changes and the significant climate changes in the Arctic from a much warmer climate with ephemeral ice sheets to a colder climate with the onset of extensive glaciation over Greenland and the formation of an Arctic ice cap.
SVR-01A (Primary)	78.2656 05.8985	1572	582	0	582	SVG-03A site penetrates stratified, undisturbed sediments through the Plio-Pleistocene boundary in a sediment drift on the western flank of the northern Knipovich Ridge. This drift is hypothesized to be once part of the drifts on the western flank of the Svalbard margin but has since been separated by mid-ocean spreading. Objectives relate to understanding the role of tectonics and the opening of the Fram Strait with respect to and as potential drivers for paleoclimate evolution, ice-sheet dynamics and stratigraphy.

## Proposed Sites (Continued; total proposed sites: 10; pri: 5; alt: 5; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SVR-02A (Alternate)	78.2683 05.8766	1556	534	0	534	SVG-04A site penetrates stratified, undisturbed sediments through the Plio-Pleistocene boundary in a sediment drift on the western flank of the northern Knipovich Ridge. This drift is hypothesized to be once part of the drifts on the western flank of the Svalbard margin but has since been separated by mid-ocean spreading. Objectives relate to understanding the role of tectonics and the opening of the Fram Strait with respect to and as potential drivers for paleoclimate evolution, ice-sheet dynamics and stratigraphy.