CRUISE REPORT

SciencePub UiT 2007/I

Marine geological cruise to
West Svalbard Margin

RV "Jan Mayen" April 26 – May 1 2007

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Introduction

This cruise was carried out within the International Polar Year (IPY) project: Arctic Natural Climate and Environmental Changes and Human Adaptation: From Science to Public awareness (SciencePub) funded by the Research Council of Norway.

The overall goal of the SciencePub project is to advance our knowledge of climate warming in the Arctic, by studying past climate change. The present climate in the Arctic shows signs of rapid change with decreasing sea ice cover and increasing temperature of the Atlantic Water. The implications of this warming are highly uncertain, as modelling experiments projecting temperatures for the next 100 years show a large scatter at high northern latitudes. The project aims to:

1) Advance our fundamental knowledge on natural climate and environmental change in the Arctic by improving system understanding and quantifying certain climate components

2) Advance our understanding of human adaptation strategies to past rapid and large-scale changes in the physical environment

3) Generate public outreach strategies that will leave a lasting legacy of increased public awareness of the natural environmental systems of the Arctic

In order to obtain data on temperature, salinity etc in the water masses from the past when it was not possible to get instrumental measurements of these factors; we study fossil micro-flora and micro-fauna in the sediments in addition to their chemical composition. Their composition and abundance depend on these factors, thus showing how the environment was on the sea bottom and in the water masses back in time (paleoclimate data). The objectives of the cruise were to: 1) collect sediment samples from the uppermost part of the sea bottom at stations from a transect at the West Svalbard Margin in order to improve our reconstructions, 2) obtain marine environmental records covering the last glacial – interglacial cycle at the West Svalbard shelf and slope, and 3) generate public awareness by having high school teachers and journalists participating in the cruise (Appendix 1).

Background and objectives

The last glacial - interglacial period in the Polar North Atlantic region was characterized by high amplitude, millennial scale variations in climate and water masses (Bauch *et al*. 2001; Hald *et al*. 2001; Rasmussen & Thomsen 2004; Spielhagen *et al*. 2004). This variation had a large impact on the growth and decay of the Svalbard Barents and northern Fennoscandian ice sheets (Knies *et al*. 1999; Spielhagen *et al*. 2004). Glacial build-up phases and subsequent deglaciations were associated to influx of "warm" Atlantic Water during e.g. the last glacial maximum and during marine isotope stage, MIS 4. These periods were followed by oceanic cold extremes associated with meltwater, perennial sea-ice cover and inert oceanic circulation (Hald *et al*. 2001; Knies *et al*. 2003). Thus, we aim to quantify sea surface temperatures and salinity during well known glacial - deglacial sequences during MIS 4 and, MIS 2/1 in high-resolution sediment cores from the continental slope off western and northern Svalbard.

We also aim to test climate model predictions that the Arctic warming may be as much as twice the global mean (IPCC 2001). Further, modelling experiments also predict an inverse relationship between influx of Atlantic Water through the North Cape Current (NCC) and the West Spitsbergen Current (WSC) (Laurantin 2004). This influx is linked to large-scale atmospheric circulation (North Atlantic Oscillation and Arctic Oscillation), which has implications for sea-ice distribution, ocean temperatures and precipitation and thus glaciation in the Barents region. These predictions will be tested in paleoclimate-records reflecting the WSC and NC during the late glacial-Holocene.

In order to investigate natural rapid ocean changes on longer time scales it is crucial to obtain reliable quantitative proxy data. Earlier reconstructions of sea surface temperatures (SST) below 5°C are hampered by incomplete training sets, sample quality and unsuitable sample preparation techniques (e.g. Pflaumann *et al.* 2006). We aim to improve modern analogue data on planktonic and benthic foraminifera, coccoliths, diatoms, dinocysts, foraminiferal Ca/Mg-ratios and oxygen and carbon isotopes. Undisturbed sediment samples will be taken by multi corer and CTD measurements in the polar North Atlantic covering the widest possible oceanographic range in the area. The goal is to extend the marine polar data set to include more sites from Arctic seas to improve the transfer functions, to increase the range of environmental variables (e.g. salinity, seasonality, sea-ice cover) in the transfer functions.

Cruise narrative

Thursday (April 26): The participants embarked in Tromsø in the evening. The coring equipment was taken onboard and installed during the evening and night. The ship left the harbour and set course for the Bjørnøya Through in the Barents Sea.

Friday (April 27): The weather was bad at the coast (strong gale), and the introduction lectures in the morning were postponed till the afternoon, where the weather had improved. The stations in the Bjørnøya Through was reached late in the evening, and sampled with gravity cores (Fig. 1A). The ship then set the course for the western Svalbard margin.

Saturday (April 28): Transport to western Svalbard margin. The weather was still favourable (fresh breeze), and the sea was relatively calm.

Sunday (April 29): In the morning a seismic survey with the sub-bottom profiler was carried out across the sampling site, before a final site was chosen (Fig. 1B). Here CTD measurements were carried out, in addition to sampling with the gravity corer and piston corer during the day. In the evening the first surface sampling station in the west-east transect was reached, and again sub-bottom profiling was carried out before choosing a sampling site. The first attempt with multi corer was futile, but the next was successful.

Monday (April 30):

At the next surface sampling station the multi corer hit the ship when it was taken onboard, and one of the releases was bent. The rest of the surface samples were sampled with a large box corer. Sub-bottom profiling was carried out at each station before

sampling. CTD measurements were carried out at each station, until the CTD probe malfunctioned. Three stations were sampled while it was attempted to repair the CTD probe. The latter was not succeeded. The course was set for Forlandssundet, and a seismic profile was carried out in the evening and night.

Tuesday (May 1):
The most advantageous site was chosen for sampling and both a gravity and piston core were taken. The CTD probe was then repaired and CTD measurements were obtained. The course was set for Longyearbyen, and the labs were cleaned. The weather was the best possible with calm sea and sun.

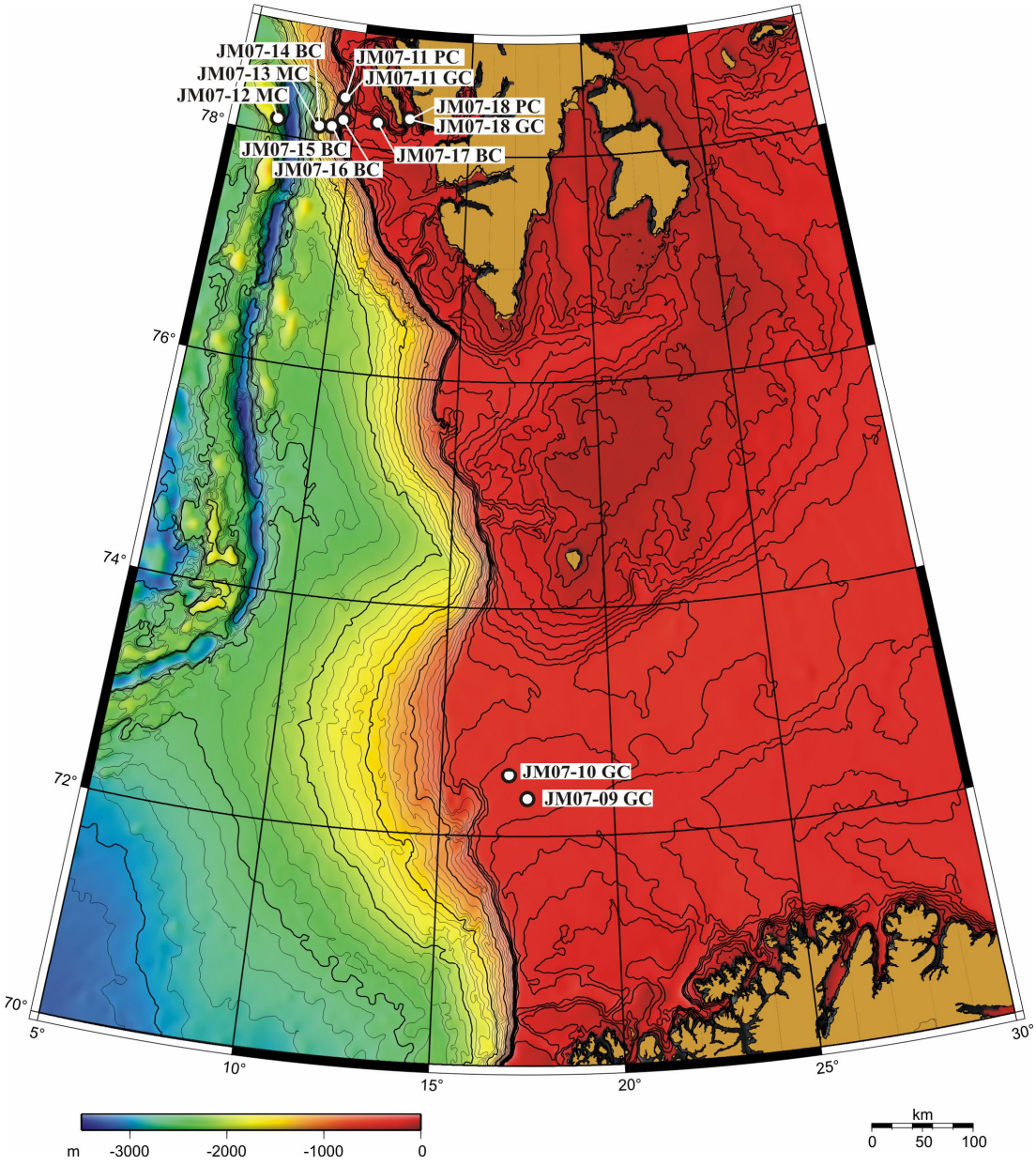

Fig. 1A. Location map showing all the stations which were sampled during the cruise.

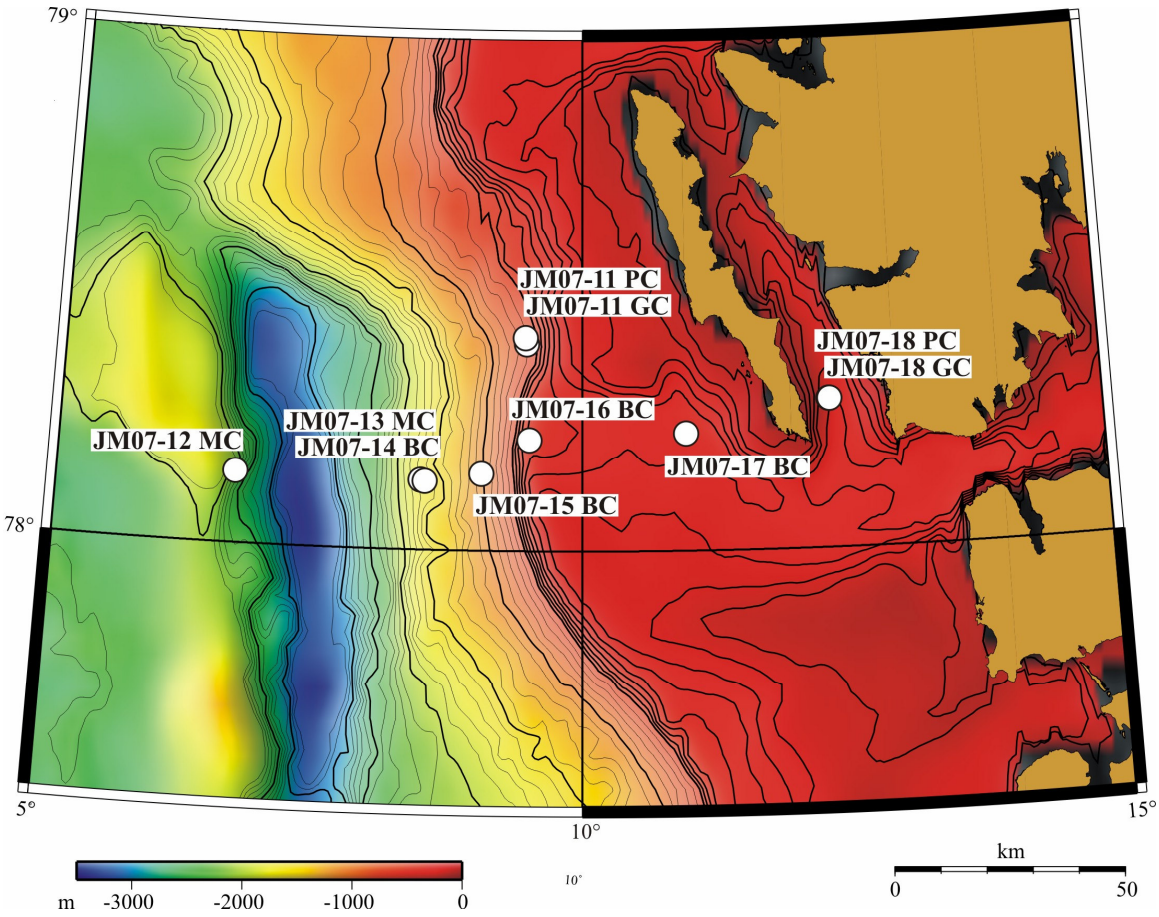

Fig. 1B. Location map showing the stations sampled at the West Svalbard margin.

Methods

The positions of the sediment cores were identified with sub-bottom profiler (3.5 kHz penetration echo sounder placed in the keel of the ship) (Appendix 2). The longer sediment cores were sampled with gravity corer (max core length 6 m) and/or piston corer (max core length 12 m). The surface samples were sampled with box corer (50 x 50 x 50 cm) or multi corer (6 core liners, outer diameter 110mm, length 0.8m). CTD measurements were obtained in order to measure salinity, temperature, conductivity and turbidity through the water column. CTD measurements are carried out with a Seabird 911 CTD with an attached turbidimeter (Appendix 2).

Subsampling of box corer and multi corer

The multi corer automatically gives 6 cores, which then were sampled. The box corer was sampled with short core tubes using a vacuum pump. Subsampling was carried out immediately so compaction of the unconsolidated surface sediments was avoided. Five different subsamples were taken for the proxies; 0-1 cm for the planktonic and benthic foraminifera, 0-15 cm (every cm) for dinocysts, coccoliths and ^{210}Pb, 0-1 cm diatoms, 0-1 cm foraminiferal Ca/Mg-ratios, and 0-1 cm foraminiferal oxygen and carbon isotopes. In case of scarce material in the box corer the samples were split in halves or quarters. One core was subsampled for every cm full length or 25 cm and the samples were kept as

reference samples. The sediment samples were stored at 5° C. The foraminiferal samples were additionally preserved with ethanol and Rosa Bengal stain.

Subsampling of gravity corer and piston corer
The cores were cut into shorter pieces of 1 m, capped, labelled and transported back to Tromsø. The cores are stored at 5° C at the Kræmer Kaia cool storage in Tromsø.

Preliminary results
A total of 6 stations were sampled for surface sediments with either multi corer or box corer. One station was sampled unsuccessfully (JM07–12 MC) (Appendix 3). Additionally 4 gravity cores and 2 piston cores were also collected (Fig. 1A, Fig. 1B, Appendix 4). Sub-bottom profiling (3.5 kHz) was done at every station and supplementary survey was carried out in selected areas. Unfortunately, the navigation file system failed and no navigation were saved. CTD measurements were not performed at all stations as the CTD probe malfunctioned during some of the cruise. CTD measurements were only obtained at the following 3 stations: JM07–11 GC/PC, JM07-13 MC, and JM07-18 GC/PC.

Public outreach
The 4 high school teachers (Jane Braute, Peter Hobeke, Arne Liaklev, Audun Raen) all gave a positive evaluation of their participation, and stated that they learned many things which could be put into their teaching immediately. They wrote a short report which was published on the homepage of SciencePub:
http://www.ngu.no/sciencepub/norsk/PAGES/nyheter_gudmund3.html

Maja Sojtaric (journalist) from the University of Tromsø wrote articles, which were published on the internet at "Tromsøflaket", and "forskning.no":
http://uit.no/nyheter/tromsoflaket/4357?From=0
http://uit.no/nyheter/tromsoflaket/4367?From=0
http://www.forskning.no/Artikler/2007/mai/1179231319.81
http://www.forskning.no/Artikler/2007/mai/1179735759.68

Stian Arnesen and Ole-Petter Klepp from NRK produced a short feature which was shown on the news from the national television on Saturday May 5, 2007:
http://www1.nrk.no/nett-tv/indeks/95209
Additional recordings from the cruise may be used later in the autumn 2007 at NRK.

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APPENDICES

1. Participants
2. Equipment
3. Ship log
4. Sample log

APPENDIX 1

In addition to the crew of RV "Jan Mayen" led by Captain Jon Almestad, the participants were:

	Name	Affiliation
1	Steffen Aagaard Sørensen (PhD student)	IG UiT
2	Stian Arnesen (Journalist)	NRK, Norwegian Broadcasting Corporation
3	Jane Braute (Teacher)	High school
4	Matthias Forwick (Postdoc)	UNIS/IG UiT
5	Karl Magnus Fossan (Engineer)	IG UiT
6	Peter Hobeke (Teacher)	High school
7	Katrine Husum (Scientific cruise leader)	IG UiT
8	Ole-Petter Klepp (Photographer)	NRK, Norwegian Broadcasting Corporation
9	Arne Liaklev (Teacher)	High school
19	Kyrre Lydersen (Engineer)	NFH UiT
11	Audun Raen (Teacher)	High school
12	Tine Rasmussen (Professor)	IG UiT
13	Kari Skirbekk (Master student)	IG UiT
14	Maja Sojtaric (Journalist)	UiT

IG: Department of Geology, NFH: Norwegian College of Fishery Sciences, UNIS: The University Studies of Svalbard, UiT: University of Tromsø, Norway.

Shift A (08-14, 20-02):
Katrine Husum
Steffen Aagaard Sørensen
Kyrre Lydersen
Jane Braute
Peter Hobeke

Shift B (02-08, 14-20):
Tine Rasmussen
Kari Skirbekk
Karl Magnus Fossan
Arne Liaklev
Audun Raen

APPENDIX 2

Equipment

Acoustic equipment
Geoacoustic/Ferranti O.R.E. 3.5 kHz penetration echo sounder, 10kW, 2 pulses;
Transmittet: Geopulse 5430 A; Reciever: Geopulse 5210 A
EPC 9800 thermo recorder, 2 channel
Digital recorder: PC with Delph 2 channel; log format: ELICS; Store formats: CD-rom
Echo sounder, Simrad EK 500, 38 kHz

Coring equipment
Large box corer (0.5m x 0.5m x 0.5m)
Multi-corer, KC model 72.000 (6 liners, outer diameter 110 mm, length 0.8m)
Gravity corer (core length max 6 m, outer diameter of liners 110 mm)
Piston corer (core length max 12 m outer diameter of liners 110 mm)

Water properties
CTD (Seabird 911 Plus) with compact rosette
Turbidimeter attached to CTD (gain: 1x, 5x, 20x, 100x, light source wavelength: 880nm, sensing distance from window: < 5cm approx.). Store formats: CD.

Appendix 3

Date	Time	Subject	Weather	Area
26/4	15:00	Loading equipment at Kræmerkaia in Tromsø and installing coring equipment (piston, gravity, box, multi)	calm, rainy	Tromsø
26/4	19:00	The participants arrived.	calm, rainy	Tromsø
26/4	20:00	Safety instructions and demonstration of emergency exits and survival suits on RV Jan Mayen	calm, rainy	Tromsø
27/4	03:00	Departure Tromsø	windy, rainy	Tromsø
27/4	21:30	Starting sampling site #1 in Bjørnøya Through	calm, overcast	Bjørnøya Through
27/4	23:30	Starting sampling site #2 in Bjørnøya Through	calm, overcast	Bjørnøya Through
28/4	01:00	Transport to the sampling site west of Prins Karls Forland, W. Svalbard margin	calm, overcast	West Svalbard Margin
29/4	08:00	Sub-bottom profiling core sites	calm, overcast	West Svalbard Margin
29/4	09:00	Setting up the piston core	calm, overcast	West Svalbard Margin
29/4	12:05	Sampling of gravity core west of Prins Karls Forland, W. Svalbard margin	calm, overcast	West Svalbard Margin
29/4	14:16	Sampling of piston core west of Prins Karls Forland, W. Svalbard margin	calm, snowing	West Svalbard Margin
29/4	20:00	Surface sample transect sub-bottom profiling began	calm, overcast	West Svalbard Margin
29/4	19:46	Multi corer sampling and CTD measurement	calm, overcast	West Svalbard Margin
30/4	02:36	Failed multi corer sampling	calm, overcast	West Svalbard Margin
30/4	04:50	Sampling surface samples with box corer	calm, overcast	West Svalbard Margin
30/4	07:52	CTD malfunction, repair started	calm, overcast	West Svalbard Margin
30/4	18:20	Box corer sampling finished, CTD still under repair	calm, overcast	West Svalbard Margin
30/4	22:45	Sub-bottom profiling in Forlandssundet	calm, overcast	Forlandssundet
1/5	09:16	PC sampling	calm, sunny	Forlandssundet
1/5	11:09	GC sampling, CTD measurements	calm, sunny	Forlandssundet
1/5	12:00	Departure for Longyearbyen and cleaning labs	calm, sunny	Forlandssundet
1/5	15:00	Arrival Longyearbyen	calm, sunny	Isfjorden

Appendix 4 A

Station Number	Date	Water depth (m)	Latitude	Longitude	Corer type	Core recovery	Core length	No. of core	Area
JM07-09 GC	27.4.2007	378	N 72 19,673	E 017 30,715	GC	5	2,83	3	Bjørnøya Through
JM07-10 GC	27.4.2007	385	N 72 32,010	E 016 58,087	GC	5,5	2,35	3	Bjørnøya Through
JM07-11 GC	29.4.2007	601	N 78 24,333	E 09 27,904	GC	6	4,02	4	West Spitsbergen Margin
JM07-11 PC	29.4.2007	590	N 78 25,055	E 09 27,098	PC	9,5	7,03	7	West Spitsbergen Margin
JM07-12 MC	29.4.2007	2000	N 78 08,427	E 06 42, 020	MC	0,2	0,00	0	West Spitsbergen Margin
JM07-13 MC	30.4.2007	1766	N 78 08,203	E 08 27,778	MC	0,4	0,17	2	West Spitsbergen Margin
JM07-14 BC	30.4.2007	1744	N 78 08,074	E 08 30,219	BC		0,25	2	West Spitsbergen Margin
JM07-15 BC	30.4.2007	1036	N 78 09,022	E 09 02,528	BC		0,30	2	West Spitsbergen Margin
JM07-16 BC	30.4.2007	334	N 78 13,080	E 09 29,774	BC		0,19	2	West Spitsbergen Margin
JM07-17 BC	30.4.2007	364	N 78 13,816	E 10 59,638	BC		0,21	2	West Spitsbergen Margin
JM07-18 PC	1.5.2007	258	N 78 17,509	E 12 22,380	PC	9	5,40	6	Forlandssundet
JM07-18 GC	1.5.2007	258	N 78 17,539	E 12 22,653	GC	> 6	4,05	4	Forlandssundet

Appendix 4 B

Station Number	Subcoring labelling	Comments
JM07-09 GC	JM07-09 GC, zero from the top, #34 on bridge	3 samples: core catcher, core cutter and rock from core cutter
JM07-10 GC	JM07-10 GC, zero from the top, sample from lowermost core cutter labelled "under core cutter", #35 on bridge	3 samples: core catcher, core cutter and sample from lowermost part of core cutter
JM07-11 GC	JM07-11 GC, zero from the top, #36 on bridge	2 samples: core catcher, rock from core top
JM07-11 PC	JM07-11 PC, zero from the top, #37 on bridge	2 samples: core catcher and core cutter
JM07-12 MC	none	Test sample of lost sediment on deck, stained with rosa bengal, sieved later, not stored.
JM07-13 MC	MC A (subsamp. 0-1 cm: 1/4 sample for diatoms, dinocysts/coccoliths, isotopes, Mg/Ca and 1-15 every cm for dinocysts/coccoliths), MC B (0-1 cm for forams, subsamp. every cm 1-17 cm for reference). #0006 on bridge.	First attempt failed and 3 tubes lost. Multi corer hit the side of the ship and one tube holder was slightly bent. Second attempt relatively successful, all had released and no tubes were lost, but it moved too much coming up and 3 tubes of sediment were lost. 2 tubes were rescued.
JM07-14 BC	MC A (subsamp. 0-1 cm: 1/4 sample for diatoms, dinocysts/coccoliths, isotopes, Mg/Ca), MC B (0-1 cm for forams, subsamp. every cm 1-25 cm for reference). NB labelled MC instead of BC on samples. #38 on bridge. No CTD.	
JM07-15 BC	MC A (subsamp. 0-1 cm: 1/4 sample for diatoms, dinocysts/coccoliths, isotopes, Mg/Ca and 1-15 every cm for dinocysts/coccoliths), MC B (0-1 cm for forams, subsamp. every cm 1-18 cm for reference). #39 on bridge. No CTD.	
JM07-16 BC	MC A (subsamp. 0-1 cm: 1/4 sample for diatoms, dinocysts/coccoliths, isotopes, Mg/Ca), MC B (0-2 cm for forams, subsamp. every cm 2-11 cm for reference). #40 on bridge. No CTD.	
JM07-17 BC	MC A (subsamp. 0-1 cm: 1/4 sample for diatoms, dinocysts/coccoliths, isotopes, Mg/Ca and 1-15 every cm for dinocysts/coccoliths), MC B (0-1 cm for forams, subsamp. every cm 1-21 cm for reference). #41 on bridge. No CTD.	
JM07-18 PC	JM07-18 PC, zero from the top, #42 on bridge	2 samples: core catcher and core cutter. Upper tube empty, imploded.
JM07-18 GC	JM07-18 GC, zero from the top, sample from lowermost core cutter labelled "under core cutter", #43 on bridge	3 samples: core catcher, core cutter and sample from lowermost part of core cutter