IPY-GEOTRACES: Multi-tracer investigation of the effect of climate change on nutrient and carbon cycles in the Arctic Ocean

ArcticNet 0903 – LEG 3a
August 27 – September 12, 2009
Paulatuk - Paulatuk
CCGS *Amundsen*

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Candian International Polar Year - GEOTRACES Program

CONTENT

1. SUMMARY

The Canadian IPY-GEOTRACES sampling program took place from August 27, 2009 through September 12, 2009. It was part of Leg 3a of the 2009 CCGS Amundsen Expedition in the Arctic Ocean (ArcticNet 0903). Sampling started in the Mackenzie River delta and continued into the Beaufort Sea (Shelf, slope and deep Canada Basin). Various measurements (temperature, salinity, nutrients, alkalinity, pH, primary production, bacterial production) and sampling (seawater, marine particles) were conducted at 10 stations (Fig. 1). Underway measurements (temperature, salinity, trace gases) and sampling (marine particles) were also conducted along the cruise track. Sampling tools on stations were the ship's CTD/rosette (ArcticNet), a Trace-Metal CTD/rosette system (UVic / UBC) and large volume in-situ pumps (UBC).

We conducted measurements and collected samples to document a suite of key physical (temperature, salinity, ice cover, light penetration), chemical (nutrients, trace metals, trace gases, radioisotopes, stable isotopes) and biological (phytoplankton and microbial assemblages, primary and microbial productivity, trace metal phytoplankton quotas) parameters in relation to proximity to the Mackenzie River delta, seafloor bathymetry and ice cover to elucidate the processes influencing phytoplankton growth and carbon cycling in the Arctic Ocean. In particular, we collected samples to elucidate the processes which supply and remove trace metals, nutrients and carbon to and from the upper ocean, and conducted ship-board experiments to study how biological productivity is affected by various chemical and physical conditions. Through a combination of on-board measurements, experiments and subsequent laboratory analysis, our research program aims at: (i) documenting the pathways of addition, removal and cycling of key trace elements which act as biological micronutrients or tracers of carbon and nutrient cycles in the Arctic Ocean; (ii) elucidating the potential effects of changing ice cover and river discharge on productivity, carbon sequestration and trace gas emission in the Arctic Ocean; (iii) developing chemical tracers to establish a historical sedimentary record of Arctic Ocean productivity in relation to long term natural climate change.

This research program is a Canadian contribution to the international GEOTRACES program (http://www.geotraces.org/) and the International Polar Year (http://www.api-ipy.gc.ca/). The results will be integrated in:

- the International GEOTRACES database (http://www.bodc.ac.uk/geotraces/)
- the Polar Data Catalogue (http://www.polardata.ca/)

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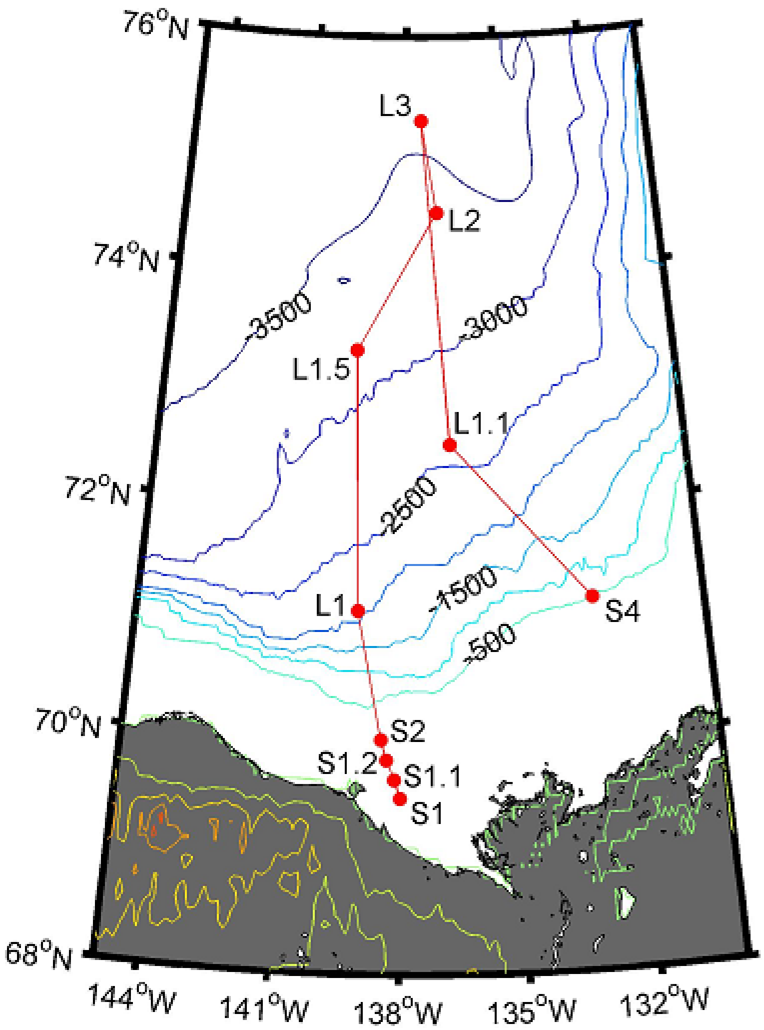
3. OVERVIEW

Sampling has been carried out at 10 stations (Figure 1) chosen to highlight the relative influence of the Mackenzie River and the Pacific Ocean/Chukchi shelf, and to contrast ice-free and ice covered areas. The station depths ranged from 58m on S1 on the shelf to 3485m in the deep ocean basin at L3. A complete list of the stations and casts is given in Table 1. The bridge's science log, which details the timing and exact position of all the activities and reports meteorological and ice conditions is also shown in Appendix 1.

Fig. 1: Sampling locations



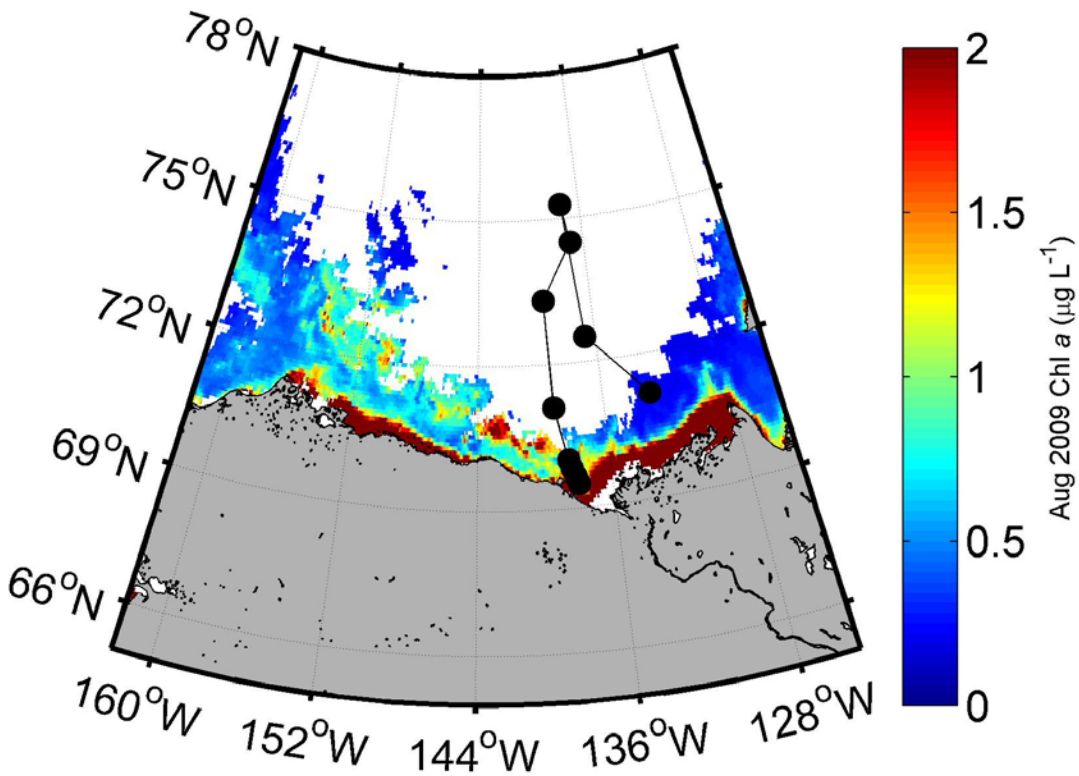

78°N
75°N
72°N
69°N
66°N
160°W
152°W
144°W
136°W
128°W
2
1.5
1
0.5
0
Aug 2009 Chl a (μg L⁻¹)

Table 1: Station List and Cast Log

CASTS LOG - GEOTRACES - LEG 3a (Aug 28 - Sep 12, 2009)					
Event #	Mountain time @ start		Cast type	Cast depth	Remarks
Station S1 (69°30'N; 137°59'W; Depth: 58m)					
1	Aug-29	18:00	Rosette	50m	for surface biology
2		19:48	In-situ pumps	50m	QMA filters + MnO2 cartridges
3		23:37	Rosette	10m	for ^{223}Ra and ^{224}Ra
4	Aug-30	1:07	Rosette	50m	second cast for surface biology & Nd
5		3:06	Rosette	50m	for ^{223}Ra and ^{224}Ra
Station S1.1 (69°40'N; 138°09'W; Depth: 127m)					
6	Aug-30	4:42	Rosette	100m	for ^{223}Ra and ^{224}Ra
7		6:00	Rosette	10m	for ^{223}Ra and ^{224}Ra
Station S1.2 (69°50'N; 138°219'W; Depth: 193m)					
8	Aug-30	8:37	Rosette	100m	for ^{223}Ra and ^{224}Ra
9		9:44	Rosette	10m	for ^{223}Ra and ^{224}Ra
Station S2 (70°00'N; 138°30'W; Depth: 260m)					
10	Aug-30	11:06	Rosette	100m	for surface biology
11		14:22	Rosette	250m	for deep biogeochemistry
12		18:16	Rosette	100m	for ^{223}Ra and ^{224}Ra
13		18:55	In-situ pumps	200m	QMA filters + MnO2 cartridges
14	Aug-31	0:48	Rosette	10m	for ^{223}Ra and ^{224}Ra
15		1:37	Pump on deck		Test pumping from moonpool for trace metals
Station L1 (71°06'N; 139°10'W; Depth: 2000m)					
16	Aug-31	14:18	Rosette	200m	for surface biology
17		16:35	Trace metal rosette	400m	to fill up Go-Flo
18		20:17	Rosette	1700m	for deep biogeochemistry
19		22:25	Pump on deck		from moon pool for trace metals
20	Sep-01	3:11	In-situ pumps	1490m	QMA filters + MnO2 cartridges
21		9:28	Rosette	1700m	for Nd isotopes
22		12:38	In-situ pumps		Supor filters (failed due to winch problem)
23		15:02	Rosette	1700m	for ^{230}Th, ^{231}Pa, and ^{129}I
24		17:57	Trace metal rosette	400m	for trace metals
25		19:10	Rosette	1000m	for microbiology (Rivkin's group)
26		23:10	In-situ pumps	800m	for biogenic silica and silicon isotopes
27	Sep-02	3:20	Rosette	100m	for Ra-228
28		5:12	Trace metal rosette	1750m	for Pb isotopes
29		7:07	Rosette	1700m	for Cr and U isotopes
30		10:30	Trace metal rosette	10m	for micrograzer experiment
31		11:21	Rosette	1500m	for Ra-226
32		13:58	Trace metal rosette	1800m	for trace metals
Station L1.5 (73°19'N; 139°23'W; Depth: 3250m)					
33	Sep-03	8:50	Trace metal rosette	1000m	for trace metals

Station L2 (74°30'N; 137°W; Depth: 3300m)					
34	Sep-03	18:09	Rosette	3390m	for ^{230}Th, ^{231}Pa, and ^{129}I
35		21:05	Trace metal rosette	2950m	for trace metals
36	Sep-04	0:23	Rosette	1000m	for Ra-226/228
37		1:46	In-situ pumps	1200m	Supor filters
38		8:14	Rosette	125m	for surface biology
39		10:16	Trace metal rosette	700m	for trace metals
40		12:35	Rosette	1000m	for microbiology (Rivkin's group)
41		15:26	Rosette	3000m	for Nd isotopes & Th-234 calibration
42		21:37	Rosette	10m	Proteomics
43		22:39	Rosette	10m	Genomics
44		23:24	Rosette	59m	Proteomics
45		23:39	Rosette	59m	Genomics
46	Sep-05	2:48	Rosette	1700m	for deep biogeochemistry
47		6:48	In-situ pumps	3000m	QMA filters + MnO2 cartridges
48		12:27	Trace metal rosette	2750m	for Cr and U isotopes
49		18:20	Trace metal rosette	100m	for micrograzer experiment
50		19:04	In-situ pumps	800m	for biogenic silica and silicon isotopes
51	Sep-06	0:22	Trace metal rosette	1100m	for Pb isotopes
Station L3 (75°17'N; 137°30'W; Depth: 3485m)					
52	Sep-07	8:04	Rosette		for ^{230}Th, ^{231}Pa, and ^{129}I
53		11:15	In-situ pumps	1300m	Supor filters
54		15:25	Rosette		for surface biology
55		16:19	Trace metal rosette	1200m	for trace metals
56		18:19	Rosette		for deep biogeochemistry
Station L1.1 (72°31'N; 136°41'W; Depth: 2530m)					
57	Sep-08		Trace metal rosette	67m	for micrograzer experiment
58			Rosette		for ^{230}Th, ^{231}Pa, and ^{129}I + resp
59			Trace metal rosette	360m	for trace metals
60			In-situ pumps	1000m	Supor filters
61			Rosette		for Ra-226/228
62			Trace metal rosette	400m	for Maite's cell wash
63			Rosette		for surface biology
64			Trace metal rosette	2400m	for Cr and U isotopes
65			In-situ pumps	1000m	QMA filters + MnO2 cartridges
66			Rosette		for deep biogeochemistry
67			Trace metal rosette	2400m	for trace metals
68			Rosette		Proteomics
69			Rosette		Genomics
70			Rosette		Proteomics
71			Rosette		Genomics
72			In-situ pumps	1000m	for biogenic silica and silicon isotopes
73			Rosette		for Nd isotopes
74			In-situ pumps	1500m	Supor filters
75			Rosette	75m	Genomics
76			Rosette	75m	Proteomics
Station S4 (71°11'N; 132°57'W; Depth: 320m)					
78			Trace metal rosette	276m	for trace metals

4. RESEARCH PROGRAMS

The overarching goal of our research program is to constrain the effect of climate change on the productivity, carbon sequestration and trace gas emission in the Arctic Ocean by investigating key trace elements and isotopes which act as micronutrients (Fe, Cu, Zn, Cd) or tracers of sources and processes (Al, Ba, Ga, Mn, isotopes of Nd, Cr, Th, Pa) that impact the carbon and nutrient cycles in the Beaufort Sea.

4.1 Trace metal sample collection and analysis

(K. Orians, J. Cullen, I. Beveridge, J. McAlister, R. Ramirez)

Trace metal sampling was performed using a trace metal clean rosette (12 x 12 L Go Flo's on a powder coated frame, equipped with a CTD and O_2 sensor – modified to use Mg anodes instead of Zn anodes). Samples were filtered directly from the Go Flo bottles, using Pall AcroPak 500 0.2µm capsule filters, into pre-cleaned bottles, which were rinsed 3-4 times with sample before filling. Samples for Fe-II were analyzed on board, using a flow injection system (R. Elena Ramirez and Jay Cullen, UVic) – all other analyses will be performed back in shore-based laboratories, at UVic (for total dissolved Fe, Cu, Cd, Zn) and UBC (for total dissolved Al, Mn, Ga, Pb, and for Pb isotopes). Filtered samples to be stored were acidified with 1ml concentrated SeaStar HCl per 500 ml within 12 hours of collection (~pH = 1.7) with the exception of Fe-II which were preserved with 75 µl of 6M SeaStar HCl per 250 ml bottle (~pH = 6) at the time of collection. Samples (125 ml) were also collected, unfiltered, for Mak Saito (WHOI, Marine Chemistry and Geochemistry) for subsequent Co analyses. These samples were stored in a 4ºC refrigerator. Nutrient samples and salinity samples were also drawn from each GO-Flo (unfiltered) at the end of the sample collection, and analyzed on-board (Salinity by GEOTRACES personnel, nutrients by Johnathan Gagnon (ArcticNet)

The samples collected for analysis at UBC will be concentrated and separated from the seawater matrix using the NOBIAS Chelate-PA1resin (Sohrin et al., 2008) and analyzed by ICP-MS. Pb isotopes will be analyzed on a multi-collector ICP-MS after further purifying the column eluant using an anion exchange resin. Samples will be analyzed at UVic using a combination of methods including multi-element analysis by ICP-MS after preconcentration (Sorhrin et al., 2008), and flow injection analysis with colorimetric and chemiluminescent detection (e.g. Lohan et al., 2008).

A subset of samples were analyzed for Fe(II) immediately (10-15 min) after collection on the ship using chemiluminescent detection with luminol (Hansard and Landing 2009).

Table 2: List of samples collected from trace metal analysis

Date	Time	Stn	Lat	Long	Event	Bottle	Depth	Comments	TM (U Vic)	TM (UBC)	Fe II (U Vic)	Pb Iso (UBC)	Co (MS)	Cr Iso (CH)	Nuts	Sal	CTD pres.	CTD Sal	CTD Temp	CTD O2
UTC	UTC					(position)			(0.2um filt.)	(0.2um filt.)	(0.2um filt.)	(0.2um filt.)	unfiltered	(0.45um filt.)	unfiltered	unfiltered				
02-Sep-09	1:07:17	L1	71 6.373'	139 18.25'	24	1	400.1	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
(TM shallow)			(from event 23)		24	2	250.2	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					24	3	200.4	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					24	4	175.1	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					24	5	150.1	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					24	6	120.1	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					24	7	89.7	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					24	8	70.2	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					24	9	49.5	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					24	10	30.6	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					24	11	14.9	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					24	12	8.5	slow filtering	2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
02-Sep-09	12:56:43	L1	71 6.268'	139 20.623'	28	1	1749.9	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
(Pb full)			(from event 27)		28	2	1400.2	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	3	1099.7	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	4	800.1	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	5	599.2	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	6	400.2	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	7	249.9	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	8	159.8	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	9	90.0	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	10	40.2	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	11	14.6	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
					28	12	8.4	slow filtering				1 x 4 L			--	yes	yes	yes	yes	yes
02-Sep-09	17:33:23	L1			30	1	10.0										yes	yes	yes	yes
(Rivkin cast)					30	2	10.0										yes	yes	yes	yes
					30	3	10.0										yes	yes	yes	yes
					30	4	9.9										yes	yes	yes	yes
					30	5	9.5										yes	yes	yes	yes
					30	6	9.0										yes	yes	yes	yes
					30	7	8.3	Bottle triggered but did not close									yes	yes	yes	yes
					30	8	10.0										yes	yes	yes	yes
					30	9	10.0										yes	yes	yes	yes
					30	10	10.0										yes	yes	yes	yes
					30	11	10.0										yes	yes	yes	yes
					30	12	10.0										yes	yes	yes	yes
02-Sep-09	21:38:19	L1	71 6.218'	139 15.839'	32	1	1799.8		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
(TM deep)			(from event 31)		32	2	1698.5	for Cr	--	--	yes		1 x 60ml	5 L	yes	yes	yes	yes	yes	yes
					32	3	1499.8		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	4	1249.8		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	5	999.8		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	6	749.0		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	7	599.9		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	8	500.0		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	9	399.9		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	10	349.7		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	11	299.9		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					32	12	9.6	for Cr	--	--	yes		1 x 60ml	11 L	yes	yes	yes	yes	yes	yes
03-Sep-09	16:17:17	L1.5	73 19.254'	139 23.562'	33	1	1001.2		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
(TM shallow)			(from event 33)		33	2	800.4		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	3	600.2		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	4	450.2		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	5	380.3		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	6	280.3		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	7	190.2		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes

					33	8	139.8		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	9	90.1		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	10	40.0		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	11	18.6		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					33	12	9.8		2 x 0.5 L	3 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
04-Sep-09	4:52:32	L2	74 39.755'	137 20.998'	35	1	2949.5		2 x 0.5 L, 250m	4 x 0.5 L	yes	1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
(TM deep)			(from event 34)		35	2	2700.5		2 x 0.5 L, 250m	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					35	3	2500.5		2 x 0.5 L, 250m	4 x 0.5 L	yes	1 x 4 L	1 x 60ml		yes	yes	yes	yes	yes	yes
	Rosette came up through ice!				35	4	2300.2		2 x 0.5 L, 250m	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					35	5	2100.2		2 x 0.5 L, 250m	4 x 0.5 L	yes	1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
					35	6	1900.4		2 x 0.5 L, 250m	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					35	7	1700.4		2 x 0.5 L, 250m	4 x 0.5 L	yes	1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
					35	8	1500.4		2 x 0.5 L, 250m	4 x 0.5 L	yes	1 x 4 L	1 x 60ml		yes	yes	yes	yes	yes	yes
					35	9	1300.0		2 x 0.5 L, 250m	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					35	10	1094.0	Bottle leaked?	2 x 0.5 L, 250m	4 x 0.5 L	yes	1 x 4 L	1 x 60ml		yes	yes	yes	yes	yes	yes
					35	11	899.2		2 x 0.5 L, 250m	4 x 0.5 L	yes	2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
					35	12	799.6		2 x 0.5 L, 250m	4 x 0.5 L	yes	--	1 x 60ml		yes	yes	yes	yes	yes	yes
04-Sep-09	17:35:47	L2	74 35.62'	137 7.338'	39	1	700.3		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
(TM shallow)			(from event 38)		39	2	550.5		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	3	440.2		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	4	400.2		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	5	360.2		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	6	270.1		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	7	180.5		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	8	120.1		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	9	80.3		2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	10	40.3	Bottle leaked?	2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	yes	yes	yes	yes	yes
					39	11	19.9	Leftover to MN	2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	--	yes	yes	yes	yes
					39	12	7.9	Leftover to MN	2 x 0.5 L, 250m	4 x 0.5 L	yes		--		yes	--	yes	yes	yes	yes
05-Sep-09	20:32:17	L2			48	1	2751.3							11 L	--	yes	yes	yes	yes	yes
(Cr)					48	2	2500.5							11 L	--	yes	yes	yes	yes	yes
					48	3	2000.1							11 L	--	yes	yes	yes	yes	yes
					48	4	1499.5							11 L	--	yes	yes	yes	yes	yes
					48	5	999.8							11 L	--	yes	yes	yes	yes	yes
					48	6	600.5							11 L	--	yes	yes	yes	yes	yes
					48	7	350.2							11 L	--	yes	yes	yes	yes	yes
					48	8	201.1							11 L	--	yes	yes	yes	yes	yes
					48	9	201.1							11 L	--	yes	yes	yes	yes	yes
					48	10	120.3	Looks good!						11 L	--	yes	yes	yes	yes	yes
					48	11	50.5							11 L	--	yes	yes	yes	yes	yes
					48	12	9.9							11 L	--	yes	yes	yes	yes	yes
9/5/2009?	1:24:44	L2			??	1	101.2	Bottle 10 was in position 1 for this cast to check for leaks - looks fine!								yes	yes	yes	yes	yes
(Rivkin cast)						2	55.5										yes	yes	yes	yes
						3	55.1										yes	yes	yes	yes
						4	54.7										yes	yes	yes	yes
						5	54.4										yes	yes	yes	yes
						6	54.0										yes	yes	yes	yes
						7	53.6										yes	yes	yes	yes
						8	53.2										yes	yes	yes	yes
						9	52.8										yes	yes	yes	yes
						10	52.4	Bottle 1 was in position 10 for this cast.									yes	yes	yes	yes
						11	52.0										yes	yes	yes	yes
						12	51.5										yes	yes	yes	yes
06-Sep-09	7:48:12	L2	74 22.9'	136 9.5'	51	1	1100.5	Bottle leaked?		3 x 0.5 L	(2 x 1 L for BG)	1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
(Pb shallow)			(from event 51)		51	2	800.4			3 x 0.5 L		2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					51	3	648.4					1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
					51	4	500.5					2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes

					51	5	420.6					1 x 4 L	1 x 60ml		yes	yes	yes	yes	yes	yes
					51	6	360.4					2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
					51	7	270.6					2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
					51	8	180.5					2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					51	9	120.2					1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
					51	10	55.2	Looks fine!	4 x 250 ml	3 x 0.5 L		2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					51	11	25.5					2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					51	12	7.8					1 x 4 L	2 x 60ml		yes	yes	yes	yes	yes	yes
07-Sep-09	23:41:52	L3	75 19.24'	137 37.9'	55	1	1200.9		2 x 0.5 L	4 x 0.5 L	2 x		1 x 60ml		yes	yes	yes	yes	yes	yes
(TM shallow)			(from event 52)		55	2	1000.2		2 x 0.5 L	4 x 0.5 L	2 x		1 x 60ml		yes	yes	yes	yes	yes	yes
					55	3	800.7		2 x 0.5 L	4 x 0.5 L	2 x		1 x 60ml		yes	yes	yes	yes	yes	yes
					55	4	599.7		2 x 0.5 L	4 x 0.5 L	2 x		1 x 60ml		yes	yes	yes	yes	yes	yes
					55	5	440.4		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	6	349.3		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	7	259.8		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	8	180.4		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	9	139.9		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	10	54.9		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	11	31.7		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
					55	12	10.1		2 x 0.5 L	4 x 0.5 L	2 x		2 x 60ml		yes	yes	yes	yes	yes	yes
09-Sep-09	1:24:20	L 1.1			57	1	66.6													
(Rivkin)					57	2	66.4													
					57	3	66.1													
					57	4	65.9													
					57	5	65.7													
					57	6	65.5													
					57	7	65.3													
					57	8	65.1													
					57	9	64.9													
					57	10	64.7													
					57	11	64.5													
					57	12	10.7													
09-Sep-09	4:41:26	L 1.1	72 30'	136 36'	59	1	360.6		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
(TM shallow)					59	2	270.3		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
Noted "dirty" ice in region of L1.1					59	3	210.7		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
					59	4	169.7		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
					59	5	130.0		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					59	6	110.6		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					59	7	90.2		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					59	8	75.3		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					59	9	60.4		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					59	10	40.1		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					59	11	20.2		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
					59	12	7.6		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
09-Sep-09		L 1.1			64	1	2400.1							11 L		yes	yes	yes	yes	yes
(Cr)					64	2	2000.2							11 L		yes	yes	yes	yes	yes
					64	3	1500.5							11 L		yes	yes	yes	yes	yes
					64	4	1000.2							11 L		yes	yes	yes	yes	yes
					64	5	599.6							11 L		yes	yes	yes	yes	yes
					64	6	400.2							11 L		yes	yes	yes	yes	yes
					64	7	300.1							11 L		yes	yes	yes	yes	yes
					64	8	250.1							11 L		yes	yes	yes	yes	yes
					64	9	200.6							11 L		yes	yes	yes	yes	yes
					64	10	100.1							11 L		yes	yes	yes	yes	yes
					64	11	50.2							11 L		yes	yes	yes	yes	yes
					64	12	10.6							11 L		yes	yes	yes	yes	yes
10-Sep-09	6:??	L 1.1			67	1	2400		2 x 0.5 L	4 x 0.5 L		2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes

(TM deep)					67	2	2250		2 x 0.5 L	4 x 0.5 L			1 x 60ml		yes	yes	yes	yes	yes	yes
					67	3	2000		2 x 0.5 L	4 x 0.5 L		2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
					67	4	1750		2 x 0.5 L	4 x 0.5 L			1 x 60ml		yes	yes	yes	yes	yes	yes
					67	5	1500		2 x 0.5 L	4 x 0.5 L		2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					67	6	1250		2 x 0.5 L	4 x 0.5 L			2 x 60ml		yes	yes	yes	yes	yes	yes
					67	7	1000		2 x 0.5 L	4 x 0.5 L		2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					67	8	800		2 x 0.5 L	4 x 0.5 L			2 x 60ml		yes	yes	yes	yes	yes	yes
					67	9	600		2 x 0.5 L	4 x 0.5 L		2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					67	10	500		2 x 0.5 L	4 x 0.5 L			2 x 60ml		yes	yes	yes	yes	yes	yes
					67	11	425		2 x 0.5 L	4 x 0.5 L		2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
					67	12	400		2 x 0.5 L	4 x 0.5 L			2 x 60ml		yes	yes	yes	yes	yes	yes
11-Sep-09		S3		Cancelled (77)																
(TM shallow)																				
11-Sep-09	18:30?	S4			78	1	275		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
(TM shallow)						2	240		2 x 0.5 L	4 x 0.5 L	yes	1x1L + 2x0.5L	1 x 60ml		yes	yes	yes	yes	yes	yes
						3	200		2 x 0.5 L	4 x 0.5 L	yes		1 x 60ml		yes	yes	yes	yes	yes	yes
						4	150		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	1 x 60ml		yes	yes	yes	yes	yes	yes
						5	120		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
						6	90		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
						7	70		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
						8	50		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
						9	25		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
						10	17		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes
						11	8		2 x 0.5 L	4 x 0.5 L	yes		2 x 60ml		yes	yes	yes	yes	yes	yes
						12	7		2 x 0.5 L	4 x 0.5 L	yes	2 x 1L	2 x 60ml		yes	yes	yes	yes	yes	yes

Table 3: List of samples analyzed for Fe-II??

4.2 Primary Productivity

(D. E. Varela, A. Kobryn)

We performed on-deck experiments for the measurement of net and new (NO_3-driven) primary (phytoplankton) productivity and analyzed the composition of the phytoplankton assemblages with the use of a FlowCam. Triplicate samples were obtained at 4 depths in the euphotic zone, at 50, 10, 1 and 0.1% of incident surface irradiance. Water samples were double-labeled with $^{15}NO_3$ and ^{13}C-bicarbonate. Subsequently, samples were incubated in on-deck acrylic tanks with flowing surface seawater (to maintain samples at surface water temperatures) for 24 h. Samples were filtered (0.7 µm GFF), and filters were dried and stored for further analysis ashore. FlowCam analysis of the particle distribution, which included autotrophic and non-autotrophic microorganisms, was performed at the same 4 depths. We size-fractionated the samples at 50% irradiance to determine the contribution of the < and >5 µm size fraction to primary productivity. We also size-fractionated samples for biogenic silica concentrations at the same depth (50% irradiance).

Table 4: Stations and sampling depth for primary production

S1 – Event #1	S2 – Event #10
Depth (m)	Depth (m)
5	3
15	15
35	45
100	75

L1 – Event # 16	L2 – Event # 38
Depth (m)	Depth (m)
22	10
50	30
85	55
126	100

L3 – Event # 54	L1.1 – Event # 63
Depth (m)	Depth (m)
10	10
32	25
60	70
115	115

4.3 Metal-Biota Interactions

(M. Maldonado, C. Payne, D. Semeniuk, R. Taylor)

1. We established the phytoplankton community composition in the water column at each station [S1 (event #1), S2 (event #10), L1 (event #16), L2 (event #38), L3 (event #54), L1.1 (event # 63)] using a) HPLC pigments & b) phytoplankton microscopic identification, c) flow cytometry phytoplankton & bacteria numbers, and d) total chlorophyll GF/F and size-fractionated chla (5 µm, at the 50% Io).

2. We established a) the photosynthetic efficiency (Fv/Fm) and b) photosynthesis vs. irradiance curves of Arctic plankton communities in the water column (L1, L2, L3, L1.1) using FiRe. These data will be compared with the primary productivity measurements using C13 spikes (Diana Varela).

3. We measured nutrient concentrations (Si, NO_3^-, NO_2^- and PO_4^{3-}) in the water column at each station (S1, S2, L1, L2, L3, L1.1)

4. We determined size-fractionated Fe:Cd:C quotas of plankton using radiotracers in the mixed layer [S2 (seawater collected with in-situ trace metal clean pump, event # 15), L1 (seawater collected with in-situ trace metal clean pump, event # 19), & L2 (seawater collected with trace metal rosette, event # 39, mixed seawater from 8, 25 and 40m)].

5. We collected samples to measure trace metal ratios (using ICPMS) in particles, rinsed with or without oxalate wash, from the water column [4 depths (40, 70, 150 and 250m) at L1.1, event #62)

6. We determine whether plankton communities in the Arctic (L1) are co-limited by Fe light and/or nitrate. We set up a grow-out incubation experiment with three light levels (50, 10, 1% Io), 4 Fe levels (1nM Fe additions, + 3 concentrations of the siderophore DFB). The bottles were also enriched with 10 µM NO_3^-, given that the in-situ NO_3^- concentrations were ~ 0.5 µM. Control bottles had no NO_3^- addition. We sampled on day 0, 2, 4, 6, and 8. The parameters measured were HPLC pigments, Chla GF/F & size-fractionated, flow cytometry bacteria and phytoplankton, nutrients, Fe:Cd:C ratios, Fe uptake rates (FeEDTA & FeDFB), photosynthetic efficiency (Fv/Fm) and photosynthesis vs. irradiance curves. In addition, Rivkin's group measured bacterial productivity on each sampling date.

7. We also took samples (~250 L) for genomics & proteomic analyses from 10 m and 59 m (chla max) at L2 and from 10, 65 (chla max), and 600 m at L1.1. The seawater (pre-filtered through a 200 µm nitex membrane) was filtered, in series, onto Supor -100 membrane filters of 3 and 0.1µm porosities. The plankton composition was characterized by measuring the following parameters: HPLC pigments, Chla GF/F & 5µm, bacteria and phytoplankton flow cytometry, phytoplankton microscopic identification, nutrients, photosynthetic efficiency (Fv/Fm) and photosynthesis vs. irradiance curves. In addition, Rivkin's group measured bacterial productivity on each sampling date. This work is in

collaboration with Richard Rivkin (Memorial University) and Andy Allen (Venter Institute).

Table 5: List of samples taken for metal-biota interactions.

Station S1

Date	Biology cast	Depth	Niskin B#	Io %	Chla max	HPLC pigm	chla GF/F	chla 5um	flow Bact	flow phyto	nutrients	phyto ID	Fv/Fm	PE 0-200 uE m-2 s-1
Aug-29-2009	#1	5	21/19	50	60	X	X	X	X	X	X	X		
18:30		15	15	10		X	X		X	X	X			
		35	9	1		X	X		X	X	X			
		50	3	0.1		X	X		X	X	X			

Station S2

Date	Biology cast	Depth	Niskin B#	Io %	chla max	HPLC	chla GF/F	chla 5um	flow Bact	flow phyto	nutrients	phyto ID	Fv/Fm	PE 0-200 uE m-2 s-1
Aug-30-2009	#10	3	22/23	50	45	X	X	X	X	X	X	X		
noon		15	18/19	10		X	X		X	X	X			
		25	16				X		X	X	X			
		45	14/15	1		X	X		X	X	X			
		50	12				X		X	X	X			
		75	10/11	0.1		X	X		X	X	X			
Aug-31-09	TM pump	29				X	X	X	X	X	X	X	X	X
1:30	Moon-pool													
	first Fe:Cd:C quotas													
	first Fe uptakes													

Station L1

Date	Biology ca	Depth	Niskin B#	Io %	Chla max	HPLC pigm	chla GF/F	chla 5um	flow Bact	flow phyto	nutrients	phyto ID	Fv/Fm	PE 0-200 uE m-2 s-1
Aug-31-2009	#14	22	23/24	50	60 m	X	X	X	X	X	X	X		
16:00		50	18/19	10		X	X		X	X	X			
		85	14/15	1		X	X		X	X	X			
		126	10/11	0.1		X	X		X	X	X			
		150	7			X	X		X	X	X			
		200	3			X	X		X	X	X			
22:30	TM pump	29				X	X	X	X	X	X	X	X	X
	Grow-out													
	Duplicates	Control, no NO3-, 10%Io												
		Control, + 10uM NO3-, 50%Io												
		Control, + 10uM NO3-, 10%Io												
		Control, + 10uM NO3-, 1%Io												
		+Fe, + 10uM NO3-, 50%Io												
		+Fe, + 10uM NO3-, 10%Io												
		+Fe, + 10uM NO3-, 1%Io												
		+ 1 nM DFB, + 10 uM NO3-, 50%Io												
		+ 1 nM DFB, + 10 uM NO3-, 10%Io												
		+ 1 nM DFB, + 10 uM NO3-, 1%Io												
		+ 5 nM DFB, + 10 uM NO3-, 10%Io												
		+ 10 nM DFB, + 10 uM NO3-, 10%Io												

Station L2

Date	Biology cast	Depth	Niskin B#	Io %	Chla max	HPLC	chla GF/F	chla 5um	flow Bact	flow phyto	nutrients	phyto ID	Fv/Fm	PE 0-200 uE m-2 s-1
Sep_4_2009	#24	2.7	23/24		55m	X	X		X	X	X		X	X
8:30		10	18/19	50		X	X	X	X	X	X	X	X	X
		30	14/15	10		X	X		X	X	X		X	X
		55	10/11	1		X	X		X	X	X		X	X
		100	7	0.1		X	X		X	X	X		X	X
		125	3											
	TM shallow													
	quota	40	10	5L	Mixed all	X	X	X	X	X	X	X	X	X
		20	11	5L	bottles									
		8	12	2L										
Sep_4&5_2009	Pgnomics	10	Barrel 1	genomics		X	X	X	X	X	X	X	X	X
22:00-2:00		10	Barrel 2	proteomics		X	X	X	X	X	X	X	X	X
	chla max	59	Barrel 3	genomics		X	X	X	X	X	X	X	X	X
	chla max	59	Barrel 4	proteomics		X	X	X	X	X	X	X	X	X
A	Engine Room													
B	underway sampling													
C	proteomics													
D	~ 400 L													
E														

Station L3

Date	Biology cast	Depth	Niskin B#	Io %	Chla max	HPLC	chla GF/F	chla 5um	flow Bact	flow phyto	nutrients	phyto ID	Fv/Fm	PE 0-200 uE m-2 s-1	
Sep_7_2009		3.1	24		60m	X	X		X	X	X				
16:00		10	17/20	50		X	X	X	X	X	X	X	X	X	
		32	14/15	10		X	X		X	X	X		X	X	
		60	10/11	1		X	X		X	X	X		X	X	
		115	6/7	0.1		X	X		X	X	X				
A	Engine Room														
	underway sampling														
	proteomics														
	~ 400 L														

Station L1.1

Date	Biology cast	Depth	Niskin B#	Io %	Chla max	HPLC	chla GF/F	chla 5um	flow Bact	flow phyto	nutrients	phyto ID	Fv/Fm	PE 0-200 uE m-2 s-1	
Sep_9_2009															
Sep_10_09	TM shallow	40													
	particulate	70													
	metals	90													
	oxalate vs. no	150													
	oxalate wash	200													
		250													
A	Engine Room														
B	underway sampling														
C	proteomics														
D	~ 400 L														
E															

4.4 Microbial meditation of carbon and trace element cycling

(R. Rivkin, M. Hale, A. Hamilton J. Tucker)

The goal of this project was to characterize the microbial community and determine its role in the cycling of carbon and trace elements. Sampling depths were selected to represent light depths (coordination investigations described in 4.2 above) and with major water mass layers.

Five classes of parameter were measured: 1- Biotic stocks (items 1-7), Biodiversity (items 8-11), Rate processes (items 12-16), Dissolved and particulate organic pools (items 17-20) and Natural abundances of stable isotopes in organic materials (items 21-26).

1- Bacterial Abundance by Acridine Orange Direct Count (BA-AO)
2- Bacterial Abundance by Flow Cytometry (BA-FCM)
3- Pico-Phytoplankton Abundance by Flow Cytometry (PICO)
4- Nano-Phytoplankton Abundance by Flow Cytometry (NANO)
5- Phytoplankton Abundance by Flow Cytometry (PHYTO)
6- Heterotrophic Flagellate Abundance by Microscopy (FLAG)
7- Microzooplankton Abundance by Microscopy (MICZ)

8- Bacterial Community Structure by Fluorescence In Situ Hybirdization (FISH)
9- Bacterial Community Structure by Culturing on Media(CULT)
10- Bacterial Community Structure by DNA analysis (DNA)
11- Community Metagenomics by Sequencing (METAGEN)

12- Bacterial Production by Leucine Uptake (BP)
13- Community Respiration by Oxygen Uptake (RESP)
14-Microzooplankton Grazing on Bacteria and Phytoplankton by Dilution Assay ((MICZ-GRAZ)
15- Microzooplankton Mediated Cycling of Fe, Zn, Cu, Cr, Cd, Mn by Modified Dilution Assay (MICZ-CYCL)
16- Effect of Fe, Cu, Zn Enrichment on Growth of Phytoplankton and Bacteria by Dilution Culture (MET-ENRICH)

17- Particulate Organic Carbon by Elemental Analysis (POC)
18- Particulate Organic Nitrogen by Elemental Analysis (PON)
19- Dissolved Organic Carbon by High Temperature Oxidation (DOC)
20- Dissolved Organic Nitrogen by High Temperature Oxidation (DON)

21- Dissolved Organic Carbon-13 by Mass Spectrometry (DOC-13)
22- Dissolved Organic Nitrogen-15 by Mass Spectrometry (DON-15)
23- Particulate Organic Carbon-13 by Mass Spectrometry (POC-13)
24- Particulate Organic Nitrogen 15 by Mass Spectrometry (PON-15)
25- Carbon 13 in Phospho-Lipid Fatty Acids by GC-MS (PLFA)

Measurements for item 13 were made on board and samples for items 9 and 10 were transported back to Memorial University for further study. Items 15 and 16 were returned to the University of Portsmouth for analysis. The remainder of the samples were frozen or preserved and remained on board the Amundsen until it returns to Quebec City in November 2009.

Table 6: List of samples taken for microbial mediation of carbon and trace element cycling.

				PARAMETERS																						
STATION	DEPTH	BA-AO	BA-FCM	PICO	NANO	PHYTO	FLAG	MICZ	FISH	CULT	DNA	METAGEN	BP	RESP	MICZ-GRAZ	MICZ-CYCL	MICZ-ENRICH	POC	PON	DOC	DON	DOC-13	DON-15	POC-13	PON-15	PLFA
S-1	5	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X	X	X	X	X	X
	15	X	X	X	X	X			X				X					X	X	X	X					
	35	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X	X	X	X	X	X
	50	X	X	X	X	X							X					X	X	X	X					
S-2	3	X	X	X	X	X	X	X	X				X					X	X	X	X	X	X	X	X	X
	15	X	X	X	X	X							X					X	X							
	45	X	X	X	X	X	X	X	X				X					X	X	X	X	X	X	X	X	X
	75	X	X	X	X	X							X					X	X							
	100	X	X	X	X	X	X	X	X				X					X	X	X	X					
	125	X	X	X	X	X							X					X	X							
	150	X	X	X	X	X	X	X	X				X					X	X	X	X					
	175	X	X	X	X	X							X					X	X							
	200	X	X	X	X	X	X	X	X				X					X	X	X	X					
L-1	10	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
	22	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	50	X	X	X	X	X							X	X				X	X							
	85	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	100	X	X	X	X	X							X	X						X	X	X	X	X	X	X
	126	X	X	X	X	X							X					X	X							
	150	X	X	X	X	X							X					X	X	X	X					
	200	X	X	X	X	X	X	X	X				X					X	X	X	X					
	250	X	X	X	X	X							X	X				X	X							
	300	X	X	X	X	X							X													
	600	X	X	X	X	X							X	X				X	X	X	X	X	X	X	X	X
	800	X	X	X	X	X							X													
	1000	X	X	X	X	X							X	X				X	X							
	1400	X	X	X	X	X							X													
	1700	X	X	X	X	X							X													
L-2	3	X	X	X	X	X							X					X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X							
	30	X	X	X	X	X							X					X	X	X	X					
	55	X	X	X	X	X	X	X	X	X	X	X	X					X	X							
	60	X	X	X	X	X							X	X	X	X	X					X	X	X	X	X
	100	X	X	X	X	X							X	X				X	X	X	X	X	X	X	X	X
	125	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	250	X	X	X	X	X							X	X				X	X							
	300	X	X	X	X	X	X	X					X							X	X					
	600	X	X	X	X	X	X	X					X	X				X	X	X	X	X	X	X	X	X
	1000	X	X	X	X	X	X	X					X					X	X	X	X					
	1400	X	X	X	X	X							X							X	X					
	1800	X	X	X	X	X							X													
	2250	X	X	X	X	X	X	X					X							X	X					
	3000	X	X	X	X	X							X													
L-3	3	X	X	X	X	X							X					X	X							
NOT	10	X	X	X	X	X	X	X	X				X					X	X	X	X					
COMPLET	32	X	X	X	X	X							X					X	X							
	60	X	X	X	X	X	X	X	X				X					X	X	X	X					
	115	X	X	X	X	X							X					X	X	X	X					
	140	X	X	X	X	X	X	X	X				X					X	X	X	X					
	200	X	X	X	X	X							X							X	X					
	300	X	X	X	X	X	X	X	X				X							X	X					
	600	X	X	X	X	X	X	X	X				X							X	X					
	1000	X	X	X	X	X	X	X	X				X							X	X					
	1400	X	X	X	X	X							X							X	X					
	1800	X	X	X	X	X							X													
	2250	X	X	X	X	X	X	X	X				X							X	X					
	3000	X	X	X	X	X							X													
L-1.1	3	X	X	X	X	X							X													
	10	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X					
	25	X	X	X	X	X							X					X	X							
	70	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X					
	75	X	X	X	X	X							X	X												
	100	X	X	X	X	X							X	X				X	X							
	115	X	X	X	X	X							X							X	X					
	140	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	200	X	X	X	X	X							X							X	X					
	250	X	X	X	X	X							X	X				X	X							
	300	X	X	X	X	X	X	X	X				X							X	X					
	600	X	X	X	X	X	X	X	X			x	X	X						X	X					
	1000	X	X	X	X	X	X	X	X				X	X						X	X					
	1400	X	X	X	X	X							X													
	1800	X	X	X	X	X							X													
	2250	X	X	X	X	X	X	X	X				X							X	X					

4.5 Dissolved inorganic carbon, alkalinity, pH.

(C. Guignard)

The ocean's exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved CO_2 in surface waters. Of the seven relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe inorganic carbon chemistry, overdetermination of the system being beneficial.

pH and alkalinity measurements were performed on each sample of the water column at stations S1, S2, L1, L2, L3 and L1.1 right after sampling. DIC samples were also collected for Dr. Helmuth Thomas from Dalhousie University who was absent from the cruise. They were not analyzed on board, but poisoned with mercuric chloride and stored in the refrigerated container at 5 degrees and then stored in the cold room in the aft labs at the end of the cruise. They will remain stored at 4 degrees until the ship is back in Quebec City. pH was measured by spectrophotometry (HP 8453 spectrophotometer) using phenol red and cresol purple as indicators, and alkalinity was measured using a automatic titrator TIM865 titralab from Radiometer Analytical. The samples were titrated with hydrochloric acid 0.03 N. The list of samples analyzed for alkalinity and pH and sampled for DIC are reported in Table 7

4.6 Water Column δ^{13}C-DIC & Major/Minor Gas Sampling from the Rosette

(K. Brown; E. Asher)

Samples for major and minor dissolved gases (N_2, Ar, O_2, CO_2, N_2O, CH_4) were collected during the biology and geochemistry casts carried out at each station as outlined in Table 1. Samples will be analyzed for dissolved gas concentrations using the GC-MS at UBC.

Samples for analyses of stable carbon isotopes (13C/12C) in dissolved inorganic carbon (DIC) were collected in conjunction with carbonate system parameters (DIC, TALK, pH) at each of the biological casts and geochemistry casts, as outlined in table 1. Samples will be analyzed for stable carbon isotope signatures at the UQAM-Geotop lab in Montreal.

Table 7. Water Column Trace Gas, DIC, alkalinity, pH and 13C-DIC Sampling *(*random duplicates for trace gases)*

Station	Event # Hydrocast #	Bottle	Depth (m)	Gases*	13C-DIC	DIC – Alk - pH
S1	1 - 1	24	4	?	?	
	Biology	23	4			xx
		17	10	?	?	xx
		11	25	?	?	xx
		5	50	?	?	xx
S2	10 - 10	24	2		xx	xx
	Biology	21	3	x	xx	

		20	10		xx	xx
		17	15	x	xx	
		16	25		xx	xx
		13	45	x	xx	
		12	50		xx	xx
		6	75	x		
		5	75		xx	xx
		2	100	x		
		1	100		xx	xx
S2	11 - 11	11	125	x		
	Geochem	9	150	x	xx	xx
		6	175	x		
		4	200	x	xx	xx
L1	16 - 14	21	22	x		
	Biology	20	22		xx	xx
		17	50	x		
		16	50		xx	xx
		13	85	x		
		12	85		xx	xx
		9	126	x		
		8	126		xx	xx
		5	150	x		
		4	150		xx	xx
		3	200		xx	xx
		1	200	x		
L1	18 - 15	24	2		xx	xx
	Geochem	22	10		xx	xx
		21	250	x	xx	xx
		19	300	x	xx	xx
		17	400	x	xx	xx
		15	500	x	xx	xx
		13	600	x	xx	xx
		11	800	x	xx	xx
		9	1000	x	xx	xx
		7	1200		xx	xx
		5	1400	x	xx	xx
		3	1700	x	xx	xx
L2	38 - 24	20	2.7	?	?	xx
	Biology	16	10	?	?	xx
		12	30	?	?	xx
		8	55	?	?	xx

		4	100	?	?	xx
		3	125	?	?	xx
L2	46 - 31	24	150	x	xx	xx
	Geochem	22	200	x	xx	xx
		20	250	x	xx	xx
		19	300	x	xx	xx
		17	400	x	xx	xx
		15	500	x	xx	xx
		14	600	x	xx	xx
		12	800	x	xx	xx
		11	1000	x	xx	xx
		9	1200	x	xx	xx
		8	1400	x	xx	xx
		7	1600	x	xx	xx
		6	1800	x	xx	xx
		5	2000	x	xx	xx
		4	2250	x	xx	xx
		3	2500	x	xx	xx
		2	2750	x	xx	xx
		1	3000	x	xx	xx
L3	54 - 33	24	3.1	x		
	Biology	21	3.1		xx	xx
		20	10	x		
		16	10		xx	xx
		15	32	x		
		12	32		xx	xx
		11	60	x		
		8	60		xx	xx
		7	115	x		
		4	115		xx	xx
		3	140	x	xx	xx
L3	56 - 34	24	150	x	xx	xx
	Geochem	22	200	x	xx	xx
		20	250	x	xx	xx
		19	300	x	xx	xx
		17	400	x	xx	xx
		15	500	x	xx	xx
		14	600	x	xx	xx
		12	800	x	xx	xx
		11	1000	x	xx	xx
		9	1200	x	xx	xx

		8	1400	x	xx	xx
		7	1600	x	xx	xx
		6	1800	x	xx	xx
		5	2000	x	xx	xx
		4	2250	x	xx	xx
		3	2500	x	xx	xx
		2	2750	x	xx	xx
		1	3000	x	xx	xx
L1.1	63 - 37	24	3	x		
	Biology	21	3		xx	xx
		20	10	x		
		16	10		xx	xx
		15	25	x		
		12	25		xx	xx
		11	70	x		
		8	70		xx	xx
		7	115	x		
		4	115		xx	xx
		3	140	x	xx	xx
L1.1	66 - 38	24	175	x	xx	xx
	Geochem	22	200	x	xx	xx
		20	250	x	xx	xx
		19	300	x	xx	xx
		17	350	x	xx	xx
		16	400	x	xx	xx
		14	450	x	xx	xx
		13	500		xx	xx
		12	600	x	xx	xx
		10	800	x	xx	xx
		9	1000	x	xx	xx
		6	1400	x	xx	xx
		5	1600	x	xx	xx
		4	1800	x	xx	xx
		3	2000	x	xx	xx
		2	2250	x	xx	xx
		1	2500	x	xx	xx

4.7 Underway Major & Minor Gas analysis (MIMS)

(K. Brown; E. Asher)

Underway data were collected aboard the Amundsen (Leg 3a) as part of the GEOTRACES program from August 30 to September 11, 2009 between 70°N and 75°N and between 125°W and 139°W. Samples were taken in transit to L1, from L1 to L2 and from L3 to L4. Due to ice breaking between L2 and L3, underway seawater flows dropped to 0 between ~14:50 UTC and 16:25 UTC and between 1:21 UTC and 12:44 UTC on September 6, and underway data was not collected during these times. Dissolved gasses (H_2O, N_2, O_2, Ar, DMS, CO_2) were measured by a membrane inlet mass spectrometer (MIMS). Gas samples were extracted using a sampling cuvette and silicone membrane and then ionized by the quadrupole mass spectrometer. The mass/charge ratio of each gas was measured every 30 seconds during continuous flow analysis. Ion current measurements were calibrated to absolute concentrations for DMS and an atmospheric saturation ratio of $\Delta O_2/Ar$. During surface sea water sampling the vacuum ranged from ~$5e^{-6}$ to ~$8e^{-6}$ torr. CO_2 concentrations will later be calibrated against the underway pCO_2 equilibrator aboard the ship.

4.8 Filtration of particles for alkenones and biomarker analysis

(Underway samples collected by M. T. Hernandez Sanchez for M. Kienast on pre-combusted GFF filters ; Large volume in-situ pump samples collected by M. Soon for M. Kienast on pre-combusted QMA filters)

Alkenones are biosynthesized by algae of the class Haptophyceae/ Prymnesiophyceae, and their degree of unsaturation (number of double bonds) depends on the growth temperature of the organism. Numerous studies in culture, sediment traps and sediment core tops have established a robust and linear relationship between the degree of alkenone unsaturation (the UK37 index) and water temperature in the mixed layer. These global calibrations are robust across all major biogeographic zones and cover a temperature range from -1 – 30 ºC. However, global compilations have shown the relation between UK37 and SST to be somewhat less robust at both ends of the temperature range (<5° and >25°C). This scatter reflects a greater influence of non-thermal factors on alkenone saturation near the limits of the temperature range, and has been linked to the increasing dominance of the tetra unsaturated alkenone in cold water. Fresh water inflow, either from large rivers or sea ice is a common feature among environments in which large abundances of the tetra unsaturated alkenone have been detected. This led to the idea that the biosynthesization of C37:4 is related to salinity.

We have collected samples to analyze alkenone abundance and alkenone unsaturation patterns in suspended matter in the photic zone. The objectives are twofold. First, alkenone unsaturation patterns, which have proven reliable paleo proxies for SST over large parts of the global ocean will be analyzed and compared to surface temperature and salinity measurements in order to confirm or refine the applicability of this proxy at the lower end of the temperature range. Secondly, the tetra unsaturated compound will be examined specifically with respect to sea surface salinity, in order to evaluate its potential as a paleo salinity proxy. The Canadian Arctic, with its large seasonal and spatial salinity gradients, is an ideal site to explore the potential of the tetra unsaturated compound as a paleo salinity tracer and to evaluate the impact of salinity on the established relationship between the UK37 index and SST at the low temperature range of the calibration.

Water was filtered through combusted GFF filters using an underway pump system, which collects water from 7 m water depth. The system typically ran for 3 hours, filtering between 100 and 400 L (Table 8).

Table 8: List of underway samples taken for alkenones and biomarkers analysis

Table 8. List of underway samples taken for alkenones and biomarkers analysis (GFF filters)

SAMPLE ID	DATE	LAT. START	LONG. START	LAT. END	LONG. END	TIME START	TIME END	READING START	READING END	VOL FILTERED	CONTAMINATION
A.1	30/08/2009	69.29N	137.59W	69.50N	138.30W	2:30AM		3000	3076.5	76.5	YES
A.2	30/08/2009	70N	138.30w			10:55AM	1:40PM	3076.5	3102.3	25.8	YES
A.3	31/08/2009	70.43N	138.44W	70.51N	138.41W	7:20AM	08:30AM	3104.5	3136	31.5	YES
A.4	02/09/2009	71.59N	138.48W	72.27N	139.19W	8.14PM	10:50PM	3184.5	3452.6	268.1	NO
A.5	03/09/2009	73.18N	139.23W	73.56N	139.49W	9:10AM	12:30AM	3463.8	3885.6	421.8	NO
A.6	03/09/2009	74.22N	138.28W	74.39N	137.22W	3:35PM	6:35PM	3885.7	4240.5	354.8	NO
A.7	04/09/2009	74.35N	137.07W	74.31N	136.45W	3:20PM	6:35PM	4678.6	4958.6	280	NO
A.8	05/09/2009	74.24N	136.26W	74.27N	136.19W	3:40PM	6:10PM	6037	6375	338	NO
A.9	06/09/2009	74.27N	133.27W	74.26N	133.22W	11PM	2AM	6794.6	7146.5	315.9	NO
A.10	06/09/2009	74.28N	133.06W	74.28N	133.02W	04:20	07:15	7147	7462	315	NO
A.11	06/09/2009	75.16N	137.44W					7462	7768.5	306.5	NO
A.12	07/09/2009	75.12N	137.24W	74.38N	137.06W	9:20PM	12:20PM	8119.5	8429.5	310	NO
A.13	08/09/2009	73.12N	135.28W	72.47N	135.23W	10:20AM	1:20PM	8429.5	8800.6	371.1	NO
A.14	08/08/2009	72.37N	136.50W	72.31N	136.35W			8809.8	9012.5	202.7	NO
A.16	08/09/2009	72.30N	136.35W					9012.5	9350	337.5	NO
A.17	09/09/2009	72.29N	135.45W					9350	9360	280	NO
A.18	10/09/2009	72.29	136.25W	72.27N	136.46W	10PM	1PM	11542.4	12000	457.6	NO
A.19	11/09/2009	72.12N	136.19W	71.51N	135.54W	13:30AM	2:30AM	12000	12339	339	NO
A.20	11/09/2009	71.11N	133.12W	71.06N	131.29W	11:10AM	2:10PM	12339	12728	389	NO

Samples have been taken from 7 m water depth. Note that some of the filters are contaminated

Table 9: List of large volume in-situ pump samples collected for alkenones and biomarkers analysis

Station S1 (69^o30'N; 137^o59'W; Depth: 58m)

Event 2

PUMP #	Depth m	QMA	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	10	x	0	25.78	sudden flow obstruction
3	50	x	47.9	60.4	min flow reached

For alkenones only

Station S2 (70^o00'N; 138^o30'W; Depth: 260m)

Event 13

PUMP #	Depth m	QMA	MnO2 Cart.	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	10	x	x	0	17.64	sudden flow obstruction
2	50	x	x	108.5	495.1	min flow reached
3	100	x	x	166.5	209.98	min flow reached
4	150	x	x	946.2	995.49	
5	200	x	x	352.6	386.22	sudden pressure release

For alkenones and radium isotopes only

Station L1 (71^o06'N; 139^o10'W; Depth: 2000m)

Event 20

PUMP Depth MnO2 Vol. filtered

#	m	QMA	Cart.	Flowmeter (L)	Computer (L)	Analysis/Comments
1	10	x	x	0	11.46	sudden flow obstruction
2	250	x	x	0	87.9	sudden flow obstruction
3	500	x	x	776	857.6	
4	750	x	x	960.5	1026.49	
5	1000	x	x	170.7	183.69	sudden pressure release
6	1500	x	x	53.6	48.84	sudden flow obstruction

Station L2 (74^o30'N; 137^oW; Depth: 3300m)
Event 47

PUMP	Depth	FILTER TYPE	MnO2	Vol. filtered		
#	m	QMA	Cart.	Flowmeter (L)	Computer (L)	Analysis/Comments
1	25	x	x	0	3.71	Sudden flow obstruction
2	250	x	x	863.73	938.58	
3	400	x	x	778.3	862.01	
4	800	x	x	686	800.21	low batteries
6	1200	x	x	0	1.12	Sudden pressure release

Station L1.1 (72^o31'N; 136^o41'W; Depth: 2530m)
Event 65

PUMP	Depth	FILTER TYPE	MnO2	Vol. filtered		
#	m	QMA	Cart.	Flowmeter (L)	Computer (L)	Analysis/Comments
1	Chl max	x	x	531.6	562	min flow reached; filter ripped
2	250	x	x	612.36	901	filter ripped
3	400	x	x	814.6	879	
4	600	x	x	782.8	927	low batteries
5	800	x	x	996.1	1020	filter ripped
6	1000	x	x	0	0	stopped by user

75m = chloro max

4.9 Natural Variations in Silicon Isotopes

(D. E. Varela, M. T. Hernandez Sanchez)

Our knowledge of the biogeochemistry of marine silicon (Si) lags behind that of other nutrients mainly due to inherent limitations of the methods currently used to measure Si production and dissolution. An alternative for studying Si cycling and silica production over broader spatio-temporal scales is to use the variations in the natural abundance of Si isotopes (δ^{30}Si) in surface waters and suspended diatom silica. Surface water variations of δ^{30}Si are due to the biological fractionation of Si isotopes by diatoms, as diatoms discriminate against the heavy ^{30}Si isotope. Thus, δ^{30}Si in dissolved Si and biogenic silica increases as diatom production intensifies in surface waters. Because diatoms are one of the largest contributors to carbon fixation in most marine systems, it is critical to understand their effects on nutrient biogeochemistry in past and present oceans.

During the GEOTRACES cruise, we obtained water samples for the measurement of δ^{30}Si in dissolved Si (δ^{30}DSi) and particulate ($\delta^{30}bSiO_2$) silica. Water samples for dissolved Si were taken at various depths in the water column with the regular rosette, and particulate samples were taken both with large-volume in-situ pumps at selected stations and with an underway continuous pumping system located in the engine room, which recovered water from 7 m depth; typically filtering 100 to 300 L (Fig. 2 & 3). We also obtained samples for biogenic Si ($bSiO_2$) and dissolved Si concentrations at the same depths as those sampled for δ^{30}DSi. Water samples for δ^{30}DSi were filtered (0.6 µm PC) and the filtrate was stored for further analysis ashore. Samples for biogenic Si ($bSiO_2$) concentrations were also filtered (0.6 µm PC) and filters were dried and stored for further analysis ashore. Filters (Supor) from the underwater pumps and underway system were dried and stored for further analysis ashore (Table 11).

Table 10: List of samples taken for the measurement of silicon isotopes in the dissolved fraction (δ^{30}DSi) and biogenic silica concentrations ([$bSiO_2$]) at each station.

Station S1.

Event # 1. Shallow biological rosette

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
5	2	4	21/22
15	2	4	13/14
35	2	4	8
100	2	4	2

Station S2

Event # . Shallow biological rosette

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
3	2	4	22
15	2	4	18
45	2	4	14
75	2	4	10
100	2	4	3

Event # 4. Biogeochemical cast

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
125	2	2	11
150	2	2	9
175	2	2	6
200	2	2	4

Station L1

Event #16. Biology cast

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
22	2	4	22
50	2	4	18
85	2	4	14
126	2	4	10
150	2	4	6
200	2	4	2

Event #18. Biogeochemical cast

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
2	2	4	23
250	2	4	21
300	2	4	19
400	2	4	17
500	2	4	13
800	2	4	11
1000	2	4	9
1200	2	4	7
1399	2	4	5
1699	2	4	3

Event #25

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
10	2	4	21

Station L2

Envent #38. Biology cast

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
2.7	2	4	22
10	2	4	18
30	2	4	14
54.6	2	4	10
100	2	4	6
125	2	4	2

Event# 40

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
10		4	20

Event #42. Biogeochemical cast

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
150	2	2	24
200	2	2	22
250	2	2	20
300	2	2	19

400	2	2	17
500	2	2	15
600	2	2	14
800	2	2	12
1000	2	2	11
1200	2	2	9
1400	2	2	8
1600	2	2	7
1800	2	2	6
2000	2	2	5
2250	2	2	4
2500	2	2	3
2750	2	2	2
3000	2	2	1

Station L3
Event# 52

Depth (m)	$[bSiO_2]$ (L)	δ^{30}DSi (L)	Bottle
3.1	2	4	23
10	2	4	19
32	2	4	14
60	2	4	10
115	2	4	6
140	2	4	2

Event #56

Depth (m)	$[bSiO_2]$ (L)	δ^{30}DSi (L)	Bottle
150	2	4	24
200	2	4	22
300	2	4	20
400	2	4	19
500	2	4	17
600	2	4	15
800	2	4	14
1000	2	4	12
1200	2	4	11
1400	2	4	9
1600	2	4	8
1800	2	4	7
2000	2	4	6
2250	2	4	5
2500	2	4	4
2750	2	4	3
3000	2	4	2
			1

Station L1.1

Event #63

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
3	2	4	23
10	2	4	19
25	2	4	14
70	2	4	10
115	2	4	6
140	2	4	2

Event #65

Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle
175	2	2	24
200	2	2	22
250	2	2	20
300	2	2	19
350	2	2	17
400	2	2	16
450	2	2	14
500	2	2	13
600	2	2	12
800	2	2	10
1000	2	2	9
1200	2	2	7
1400	2	2	6
1600	2	2	5
1800	2	2	4
2000	2	2	3
2250	2	2	2
2500	2	2	1

Table 11. List of underway samples taken for silicon isotopes measurements in the particulate fraction ($\delta^{30}bSiO_2$).

SAMPLE ID	DATE	LAT. START	LONG. START	LAT. END	LONG. END	TIME START	TIME END	READING START	READING END	VOL FILTERED	CONTAMINATION
A1	29/08/2009	69.29N	137.59W					270	300	30	YES
A2	29/08/2009	69.29N	137.59W					300	343	43	YES
A3	29/08/2009	69.5N	138.20W	70N	138.86W	8:50AM	10:30AM	343	380	37	YES
A4	31/08/2009	70.43N	138.44W	70.9N	138.86W	7:45AM	11AM	403	592	189	NO
A5	31/08/2009	71.1N	138.85W	71.04N	139.85W	10AM	11:45AM	592.6	618.5	25.9	YES
A6	31/08/2009	71.04N	139.07W	71.05N	138.96W	11.45AM	1:20PM	318	670	52	YES
A7	02/09/2009	71.07N	139.18W			9:45AM	11:40AM	5594.9	5976.4	381.5	NO
A8	02/09/2009	71.15N	139.11W	71.41N	138.3W	4:20PM	6:40PM	6405	6794.1	389.1	NO
A9	02/09/2009	72.27N	139.19W	72.50N	139.28W	11PM	1.05AM	6815	7026.4	211.4	NO
A10	03/09/2009	73.56N	139.40W	74.22N	138.28W	12:55PM	3:15PM	7062.6	7389	326.4	NO
A11	03/09/2009	74.39N	137.22W			07:05PM	9:10PM	7394.9	7754.4	359.5	NO
A12	04/09/2009	74.35N	137.07W			12:40	03:15	7758.2	8209.5	451.3	NO
A13	05/09/2009	74.24N	136.26W			01:30	03:30	8215.8	8595.2	379.4	NO
A14*	06/09/2009	74.22N	135.59W	74.22N	135.07W	1:45AM	3:20AM	8619	8718.6	99.6	NO
A15	06/09/2009	75.36N	133.22W	74.28N	133W	2:05PM	4:20PM	8724.5	8999.3	274.8	NO
A17*	06/09/2009	74.28N	133.36W	74.30N	134.35W	9:30PM	11:30PM	8999.5	9132	132.5	NO
A18.L3	07/09/2009	75.19N	137.37W					9136.7	9462.2	325.5	NO
A19.L3	07/09/2009	75.16N	137.44W			2:30PM	4:15PM	9462.3	9802.8	360.5	NO
A20	08/09/2009	74.29N	136.59W	74.11N	136.44W			9802.5	10163.2	360.7	NO
A21	08/09/2009	72.47N	135.23W	72.37N	136.50W	1:30PM	3:30PM	10163	10321.2	158.2	NO
A22	08/09/2009	72.30N	136.35W					10321.2	10726	404.8	NO
A23	09/09/2009	71.29N	136.35W					10726.8	11031.5	304.7	NO
A24	09/09/2009	72.80N	136.45W					11031.5	11461.5	430	NO
A25	10/09/2009	72.27N	136.46W	72.12N	136.19W	10:30PM	12:30AM	11462.2	11754.5	292	NO
A26	11/09/2009	71.17N	134.33W	71.11N	133.12W	9AM	11AM	11754	12109	355	NO

*Ice clogged the line while filtered. Therefore the volume filtered is smaller than usual

Fig. 2: Underway filtration unit in the engine room

Underway samples for biomarker analysis (GFF filters)

Underway samples for Si isotopes (Supor filters)
(Photos taken by M.T. Hernandez Sanchez)

4.10 Natural Variations in Nitrogen Isotopes in Nitrate

(Samples collected by J. Gagnon for D. Sigman)

Seawater samples were collected with a syringe and filtered through a GFF filter. These samples were used for nutrient analysis and 60 ml aliquots were stored at -20°C for d15N-nitrate analysis (see appendix for list of nutrient samples)

4.11 Large volume in-situ pumps

(R. Francois, M. Soon, B. De Baere; N. Sutherland)

Six large volume in-situ pumps (McLane) were deployed simultaneously at different depths to obtain samples of suspended marine particles. Two types of filters were used:

- Supor 0.8μm pore size to measure ^{230}Th, ^{231}Pa, ^{234}Th, Ca, Al, Si, P.
- QMA 0.8μm pore size to measure POC, PON, ^{234}Th and alkenones.

Supor: A punch was taken from the filter to measure ^{234}Th by beta counting on board or later at IOS. The remainder was stored frozen and dried a few days later. The other elements and isotopes will be measured at UBC.

QMA: A punch was taken from the filter to measure ^{234}Th by beta counting on board or later at IOS. The remainder was stored frozen at – 80^{o}C to measure alkenones (Markus Kienast, Dalhousie U.)

During the QMA casts, two cartridges of MnO2-impregnated fibers were also mounted in series to measure ^{228}Ra/^{226}Ra (Erika Bousserez; Dalhousie U.).

We also performed Supor casts to collect particle for silicon isotopes measurements (Diana Varela, U. Victoria)

Table 12: List of samples obtained with in-situ large volume pump

Station S1 (69^{o}30'N; 137^{o}59'W; Depth: 58m)

Event 2

PUMP #	Depth m	QMA	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	10	x	0	25.78	sudden flow obstruction
3	50	x	47.9	60.4	min flow reached

For alkenones only

Station S2 (70^{o}00'N; 138^{o}30'W; Depth: 260m)

Event 13

PUMP #	Depth m	QMA	MnO2 Cart.	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	10	x	x	0	17.64	sudden flow obstruction
2	50	x	x	108.5	495.1	min flow reached
3	100	x	x	166.5	209.98	min flow reached
4	150	x	x	946.2	995.49	
5	200	x	x	352.6	386.22	sudden pressure release

For alkenones and radium isotopes only

Station L1 (71^{o}06'N; 139^{o}10'W; Depth: 2000m)

Event 20

PUMP #	Depth m	QMA	MnO2 Cart.	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	10	x	x	0	11.46	sudden flow obstruction
2	250	x	x	0	87.9	sudden flow obstruction
3	500	x	x	776	857.6	
4	750	x	x	960.5	1026.49	
5	1000	x	x	170.7	183.69	sudden pressure release

6	1500	x	x	53.6	48.84	sudden flow obstruction

Event 22

PUMP #	Depth m	SUPOR	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
					cancelled due to winch
1	10	x	0	0	problems
2	250	x	0	0	
3	500	x	0	0	
4	750	x	0	0	
5	1000	x	0	0	
6	1500	x	0	0	

Event 26

PUMP #	Depth m	SUPOR	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	25	x	1187.2	1114.34	
2	100	x	285.3	1089.93	
3	250	x	1021.3	1044.42	
4	400	x	1370.8	1233.52	
6	800	x	78.3	832	sudden flow obstruction

For silicon isotopes

Station L2 (74º30'N; 137ºW; Depth: 3300m)

Event 37

PUMP #	Depth m	FILTER TYPE SUPOR	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	25	x	211.8	223.29	Sudden pressure release
2	250	x	1005.1	1039.71	
3	400	x	1008.3	1036.09	
4	800	x	822.5	923.99	low batteries
6	1200	x	1.6	1.59	Sudden pressure release

Event 47

PUMP #	Depth m	FILTER TYPE QMA	MnO2 Cart.	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	25	x	x	0	3.71	Sudden flow obstruction
2	250	x	x	863.73	938.58	

3	400	x	x	778.3	862.01	
4	800	x	x	686	800.21	low batteries
6	1200	x	x	0	1.12	Sudden pressure release

Event 50

PUMP	Depth	FILTER TYPE	Vol. filtered		
			Flowmeter	Computer	
#	m	SUPOR	(L)	(L)	Analysis/Comments
1	25	x	0	1.42	sudden flow obstruction
2	100	x	41.58	149.01	sudden pressure release
3	250	x	923.6	999	
4	400	x	1030	1098.77	
6	800	x	45.1	44.44	sudden pressure release

For silicon isotopes

Station L3 (75°17'N; 137°30'W; Depth: 3485m)

Event 53

PUMP	Depth	FILTER TYPE	Vol. filtered		
			Flowmeter	Computer	
#	m	SUPOR	(L)	(L)	Analysis/Comments
1	50	x	797.8	751	
2	250	x	720.09	748	
3	400	x	759.4	772	
4	700	x	731.7	774	
5	1000	x	746.5	761	
6	1300	x	0	0	forgot to program pump

Station L1.1 (72°31'N; 136°41'W; Depth: 2530m)

Event 60

PUMP	Depth	FILTER TYPE	Vol. filtered		
			Flowmeter	Computer	
#	m	SUPOR	(L)	(L)	Analysis/Comments
1	75	x	464.4	482	min flow reached
2	250	x	745	770	
3	400	x	767	779	
4	600	x	746.6	785	
5	800	x	25.3	25.1	sudden pressure release
6	1000	x	17.5	23.74	sudden pressure release

75m = chloro max

Event 65

PUMP #	Depth m	FILTER TYPE QMA	MnO2 Cart.	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	Chl max	x	x	531.6	562	min flow reached; filter ripped
2	250	x	x	612.36	901	filter ripped
3	400	x	x	814.6	879	
4	600	x	x	782.8	927	low batteries
5	800	x	x	996.1	1020	filter ripped
6	1000	x	x	0	0	stopped by user

75m = chloro max

Event 73

PUMP #	Depth m	FILTER TYPE SUPOR	Vol. filtered Flowmeter (L)	Computer (L)	Analysis/Comments
1	Chl max (75)	x	558.4	569	
2	100	x	637.7	690	
3	250	x	720.8	749	
4	400	x	732.4	773	
5	800	x	782.1	776	
6	1000	x	1.1	1.1	sudden flow obstruction

75m = chloro max

For Si isotopes

4.12 Seawater sample collection for Cr isotopes measurements

(M. Amini)

Reduction of soluble Cr(VI) to insoluble Cr(III) is associated with mass-dependent isotopic fractionation with the preferential reduction of the lighter isotopes. This might enable isotopic studies to better understand the processes behind Cr redox changes, to improve our understanding of the oceanic Cr cycle and to develop Cr isotopes as an ocean paleo-redox proxy.

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During the cruise, a profile from the shelf region to deep open ocean water as well a depth profiles at each station were taken. The samples were taken either from the CTD/rosette or the TM rosette, drawn through 0.45µm Supor-Filters in precleaned 20L-cubitainers after having rinsed them with the sample itself. The samples were then kept frozen at natural pH (-10°C) until processed in the homelab. For each sample, salinity had been determined on board using standard method. Sample amount, location and depth are listed in Table 12).

Table 12: Sample list for Cr isotope analyses. Station and Cast# as referred in Fig. 1, ‘Ship’ refers to the ship’s rosette and TM to the Trace metal rosette.

	Station	Event#	Amount [L]	Depth [m]	Rosette
1	**S1**	3	10	10	Ship
2		5	10	50	Ship
3	**S1.1**	6	10	100	Ship
4		7	10	10	Ship
5	**S1.2**	8	10	100	Ship
6		9	10	10	Ship
7	**S2**	12	10	100	Ship
8		14	10	10	Ship
9	**L1**	29	20	10	Ship
10			20	50	Ship
11			20	100	Ship
12			20	200	Ship
13			20	250	Ship
14			20	300	Ship
15			20	400	Ship
16			20	600	Ship
17			20	800	Ship
18			20	1000	Ship
19			20	1500	Ship
20			20	1700	Ship
21			5	1698.5	TM
22			11	9.6	TM
23	**L2**	48	11	9.9	TM
24			11	50.5	TM
25			11	120.3	TM
226			11	201.1	TM
27			11	350.2	TM
28			11	600.5	TM
29			11	999.8	TM
30			11	1499.5	TM
31			11	2000.1	TM
32			11	2500.5	TM
33			11	2751.3	TM
34	**L1.1**	64	11	10.6	TM
35			11	50.2	TM
36			11	100.1	TM
37			11	200.6	TM
38			11	250.1	TM

39			11	300.1	TM
40			11	400.2	TM
41			11	599.6	TM
42			11	1000.2	TM
43			11	1500.5	TM
44			11	2000.2	TM
45			11	2400.1	TM

4.13 Sampling for Nd Isotope analyses

(M. Amini, R. Francois)

The Nd isotope signature of ocean water appears to reflect continental sources without being altered by biological fractionation. If true, Nd isotopic compositions of ocean waters could thus provide a powerful tool as tracer for water masses and ocean circulation. However, to date the application of Nd isotopes as a circulation tracer and paleocirculation proxy has been hindered by a poor understanding of the processes whereby seawater acquires it Nd isotopic composition. Because Pacific and Atlantic seawater have very different Nd isotopic composition, following the Nd isotopic composition of Pacific waters as they transit trough the Arctic could reveal these processes. Water samples were taken by the ship's rosette at 3 stations along the transect at various depths (Tab. 13). About 20L (where available) were drained and filtered through an Acropak cartridge (0.45μm) into either cubitainers or jerrycans that were prerinsed by the sample and acidified with HCl (6N or conc.) to pH2.

Table 13: Sample list for Nd isotope analyses.

	Station	**Event#**	**Depth [m]**	**Amount [L]**
1	**L1**	21	10	20
2			50	20
3			100	20
4			200	20
5			250	20
6			300	20
7			400	20
8			600	20
9			800	20
10			1000	20
11			1500	20
12			1700	20
13	**L2**	41	10	21
14			50	23
15			100	23
16			180	21
17			250	23
18			350	23

19			600	21
20			1000	23
21			1500	21
22			2000	11.5
23			2500	23
24			3000	11.5
25	**L1.1**	73	10	23
26			50	23
27			100	23
28			200	23
29			250	23
30			300	23
31			400	23
32			600	23
33			800	11.5
34			1000	23
35			1500	23
36			2000	23

4.14 Dissolved ^{230}Th and ^{231}Pa & ^{129}I

(R. Francois, M. Soon, B. De Baere)

Dissolved ^{230}Th and ^{231}Pa were measured over the entire water column to document recent changes in deep water circulation and particle scavenging. Samples for measuring ^{129}I (John N. Smith; BIO) were taken simultaneously to confirm the changes in circulation deduced from dissolved ^{230}Th and ^{231}Pa.

For dissolved ^{231}Pa and ^{230}Th, 20L samples were collected by closing two bottles per depth. Seawater was quickly drained from the rosette and brought to the laboratory for filtration through an Acropak cartridge (0.45 μm) using a peristaltic pump and for storage in a disposable cubitainer. The samples were then acidified to pH 2 with concentrated HCl and spiked with pre-weighed quantities of ^{233}Pa, ^{229}Th and $FeCl_3$ [aliquots of standard solutions precipitated with Fe hydroxide]. Acidified samples were left to equilibrate for 12 to 24 hours and their pH adjusted to 8-9 to precipitate Fe hydroxide and scavenge ^{231}Pa, ^{233}Pa, ^{230}Th and ^{229}Th. The precipitates were let to settle to the bottom of the cubitainer over 12 to 24 hours and recovered by suction with a peristaltic pump into a 1L plastic beaker for final settling and centrifugation into a 50 ml centrifuge tube for transport to UBC.

Table 14: Sample list for dissolved ^{230}Th, ^{231}Pa, and ^{129}I

Station L1 (71^{o}06'N; 139^{o}10'W; Depth: 2000m)

Z	salinity	I-129	Pa/Th
m		L	L

25	0.5	1	10
25	0.5		10
100	0.5	1	10
100	0.5		10
250	0.5	1	10
250	0.5		10
350	0.5	1	10
350	0.5		10
500	0.5	1	10
500	0.5		10
600	0.5	1	10
600	0.5		10
750	0.5	1	10
750	0.5		10
900	0.5	1	10
900	0.5		10
1000	0.5	1	10
1000	0.5		10
1200	0.5	1	10
1200	0.5		10
1500	0.5	1	10
1500	0.5		10
1700	0.5	1	10
1700	0.5		10

Station L2 (74°30'N; 137°W; Depth: 3300m)

Z	salinity	I-129	Pa/Th
m		L	L
50	0.5	1	10
50	0.5		10
250	0.5	1	10
250	0.5		10
400	0.5	1	10
400	0.5		10
700	0.5	1	10
700	0.5		10

1000	0.5	1	10
1000	0.5		10
1300	0.5	1	10
1300	0.5		10
1600	0.5	1	10
1600	0.5		10
1900	0.5	1	10
1900	0.5		10
2200	0.5	1	10
2200	0.5		10
2500	0.5	1	10
2500	0.5		10
3000	0.5	1	10
3000	0.5		10
3390	0.5	1	10
3390	0.5		10

Station L3 (75°17'N; 137°30'W; Depth: 3485m)

Z	salinity	I-129	Pa/Th
m		L	L
50	0.5	1	10
50	0.5		10
250	0.5	1	10
250	0.5		10
400	0.5	1	10
400	0.5		10
700	0.5	1	10
700	0.5		10
1000	0.5	1	10
1000	0.5		10
1300	0.5	1	10
1300	0.5		10
1600	0.5	1	10
1600	0.5		7.5
1900	0.5	1	10
1900	0.5		10

2200	0.5	1	10
2200	0.5		7.5
2500	0.5	1	10
2500	0.5		10
3000	0.5	1	10
3000	0.5		7.5
3400	0.5	1	10
3400	0.5		10

Station L1.1 (72°31'N; 136°408'W; Depth: 2530m)

Z	salinity	I-129	Pa/Th
m		L	L
Chl max	0.5	1	10
Chl max	0.5		10
250	0.5	1	10
250	0.5		10
400	0.5	1	10
400	0.5		10
600	0.5	1	10
600	0.5		10
800	0.5	1	10
800	0.5		10
1000	0.5	1	10
1000	0.5		10
1300	0.5	1	10
1300	0.5		10
1600	0.5	1	10
1600	0.5		10
2000	0.5	1	10
2000	0.5		10

4.15 Dissolved and particulate ^{234}Th

(N. Sutherland)

Dissolved and particulate ^{234}Th were measured at 4 stations to quantify the export flux of organic carbon from surface to deep water. ^{234}Th was also measured on punches of filters (QMA and Supor) obtained with the large volume in-situ pumps. Combining ^{234}Th and ^{230}Th data provides constraints on particle dynamics in the water column. Comparing

234Th data obtained with different filter types also provide a means of quantifying their relative filtration efficiency

General Comments on the Thorium Program

Sampling went well, although there was some delay in accessing the rosettes while gas sampling was done. Processing samples was generally smooth, although sometimes samples took a long time to filter. A few samples were filtered after hours of delay due to the extreme ship vibration and motion in the container on the foredeck, when icebreaking was underway – with anymore than ~25mL in the towers, the water would often jump out. A few lead bricks around the beta counter also had to be pushed back into place during these conditions. A major potential problem was averted when Sylvain Blondeau most capably created a 5mm lift slide out of Plexiglas for the beta counter, replacing the IOS one that was lost with the missing baggage. Also many thanks to all who helped out with pipettes and gloves etc. to replace my missing gear.

At the end of the cruise, the beta counter was packed for shipping back to Monaco, samples packaged for return to IOS via carry-on baggage, and equipment cleaned and placed into the container for eventual shipment to IOS.

Pump Punch Sample Method:

Pump filters, whether Supor or QMA, were sampled by punching a 25mm hole randomly, except avoiding any torn spots, through the filters. The filters were then placed on filter holders, and with the vacuum on, very gently rinsed with ~20mL DmQ to wash off salts. The filter towers were not used, as the filters did not extend completely to the edges. Once rinsed the filters were placed in a 53°C oven to dry, before mounting and beta counting.

Water Samples Method:

Water for particulate and total thorium samples were collected from Niskin bottles – generally emptying the designated Niskin into a collapsible carboy, about 8-10L per Niskin. This water was then kept cold and dark until separated into particulate and total aliquots.

Particulate Thorium

Four to six litres of water, well shaken, measured by graduated cylinder, one litre at a time, were filtered through a pre-combusted 25mm Tissue Quartz filter, using a vacuum pump with max 5psi suction. At the end, the grad cylinder and filter tower were rinsed with ~50-60mL DmQ water, to wash any stray particles down the sides, and rinse out salts. The filters were then placed in a 53°C oven to dry, before mounting and beta counting.

Total Thorium

Two litres of water, well shaken and measured by grad cylinder, were placed into a clean, pre-rinsed 2L bottle for treatment. Each sample was acidified with 10mL of 1:1 (6M) HCl, environmental grade, then shaken, and a pre-weighed Thorium230 spike (1g of 10dpm) added and allowed to sit for ~12 hours. Room temperature during this time varied from about 8-20°C. At the end of this time the samples were neutralized to pH 8.1-8.3 (using pH paper) by the addition of ~ 5.6mL of conc NH4OH. 125uL of $KMnO_4$, 3g/L, was added, mixed, then 125uL of $MnCl_2$, 8g/L, added and the bottle well shaken. The bottles were then placed in an 80°C water bath for two hours, a maximum of 5 at a time. Afterwards the sample were allowed to come to room temperature, about 4-6 hours, then were filtered through 25mm pre-combusted TQ filters, again max 5psi suction. The bottles and filter towers were rinsed with ~50-60mL DmQ water. The filters were then placed in a 53°C oven to dry, before mounting and beta counting.

Beta Counting

The Malina group graciously left their Riso counter on board, set up in the forward starboard control container, with gases on, and a background already running but without any slides in position. As soon as Sylvain could make up a 5mm lift slide for me, I started a new background with this and the Malina sample holder slide in place, and ran it for about 76 hours before samples came on line. Samples were read to a moderate error level, <5% or <±0.03 cpm, in order to speed them along. About 40% were read onboard, with the rest transferred to the IOS counter as soon as possible.

At one point the gas line to the beta counter was crimped, which resulted in the program shutting down. Gas flow was restored and the system purged, all ran smoothly again afterwards.

Table 15: Sample list for dissolved and particulate ^{234}Th (to convert sample ID into water depth, see ArcticNet rosette log files)

List of Thorium 234 Samples Taken

Note: A&B refer to replicates from one bottle or pump filter

Station	Event#	Sample Type	Source	Sample ID - if Rosette, ID=Niskin#, if Pump, ID=Pump#						Comments
L1	16	Total	Niskin	20	16	12	8	4	2	
		Particulate	Niskin	20	16	12	8	4	2	
	18	Total	Niskin	23	22	20	16	12		
		Particulate	Niskin	23	22	20	16	12A,12D		12A&D are doubled up, one to give blank
										(see under filter blanks below)
	20	QMA punch	Pump	2	3A,3B	4	5	6		#1 not sampled, as no pump flow
L2	38	Total	Niskin	20	16	12	8	4	3	
		Particulate	Niskin	20	16	12	8	4	3	
	41	Total	Niskin	5A,5B	6A,6B					1500m calibration cast for Th:U ratio
		Particulate	Niskin	5	6	5&6				5&6 is combination of leftover water
	42	Total	Niskin	23A,23B	21	18	16	13		
		Particulate	Niskin	23	21	18	16	13		
	37	Supor punch	Pump	1	2	3	4	6		#6 is filter blank, as no pump flow
	47	QMA punch	Pump	1A,1B	2	3	4	6		#1&#6 are filter blanks, as no pump flow
L3	54	Total	Niskin	21	16	12	8	4	3	
		Particulate	Niskin	21	16	12	8	4	3	
	56	Total	Niskin	23	21	18	16	13		
		Particulate	Niskin	23	21	18	16	13		
	53	Supor punch	Pump	1	2	3	4	5	6	#6 is filter blank, as no pump flow
L1.1	63	Total	Niskin	21	16	12	8	4	3	
		Particulate	Niskin	21	16	12	8	4	3	
	65	Total	Niskin	23	21	18	15A,15B	11		
		Particulate	Niskin	23	21	18	15	11		
	60	Supor punch	Pump	1	2	3	4			#5&6 not sample, no pump flow
	64	QMA punch	Pump	1	2	3	4	5	6	#6 is filter blank, as no pump flow
	74	Supor punch	Pump	1	2	4	5	6		#6 is filter blank, as no pump flow
Blanks		Filter Blanks:	d original 25mm TQ filters:							
			060909	FB1	FB2					
			120909	-1						
		Filter Blanks:	from a large TQ filter, as ran out of precut ones:							
			120909	FB cut 1	FB cut 2	FB cut 3	FB cut 4			
		Particulate Filter Blanks, aka dip blanks: Filters soaked overnight in filtered 1500m SW, then rinsed with DmQ as per usual								
				PFB41-1	PFB41-2	PFB41-3	PFB41-4			
		Particulate Filter Blanks, aka double blanks: Filters doubled on filter tower, however, particulates on upper filter not evenly dispersed, and so only the one blank done.								
				P1812D						
		Total Filter Blanks: used 2L DmQ per blank and followed complete total Thorium method.								
			100909	TB A	TB B	TB C	TB D			
		Supor and QMA punches: See notes above for individual casts. For numerous pumps, there was no flow rate, so these filters were often sampled to use as blanks.								

4.16 Dissolved ^{223}Ra, ^{224}Ra, ^{226}Ra and ^{228}Ra

(E. Sternberg-Bousserez)

Helmuth Thomas's group (Dalhousie U.) is interested in carbon exchange between the shelf and the open ocean. In the GEOTRACES program, its aim is to use the radium isotopes to quantify this exchange in the Beaufort Sea. Seawater samples were collected using in-situ pumps and the ship's rosette during the GEOTRACES cruise (leg 3a). The seawater collected with the rosette was filtered onboard the ship on an acrylic fiber coated with MnO_2 and the same fiber was used with the in situ pumps. The fibers will be analyzed in the lab for the long-lived Ra isotopes (^{226}Ra and ^{228}Ra) using gamma spectrometry, and when possible for the short-lived Ra isotopes (^{223}Ra and ^{224}Ra) using an alpha counter (see table). Alpha counting of the short-lived isotopes was started during the cruise.

- Samples collected with the rosette

station	S1	S1.1	S1.2	S2	L1	L2	L1.1
depth (m)	10	10	10	10	10	10	10
	50	100	100	100	100	50	75
				150	250	100	100
				200	500	250	250
					750	400	400
					1000	700	600
					1500	1000	800
							1000

In red: cubitainer leaked, sample lost
In green: samples to be analyzed for ^{223}Ra, ^{224}Ra, ^{226}Ra and ^{228}Ra (~ 270 L sampled per depth). A first count with the alpha counter was performed onboard for these samples.
In blue: samples to be analyzed for ^{226}Ra and ^{228}Ra (100-140 L sampled per depth)
In black: samples to be analyzed for ^{226}Ra (10-12 L sampled per depth)

- Samples collected using the in-situ pumps

station	S2	L1	L2	L1.1
depth (m)	10	10	25	75
	50	250	250	250
	100	500	400	400
	150	750	800	600
	200	1000	1200	800
		1500		1000

In red: pumps did not work
In blue: less than 180L pumped, probably not enough to get a signal

4.17 Sea ice sampling for chemical parameters

(K. Brown))

Sampling for inorganic and organic carbon parameters from sea ice was conducted opportunistically as part of a joint Geotraces & ArcticNet effort. When possible, cores of multi-year and 1st year ice were obtained and sectioned for the analyses of chemical tracer concentrations (DIC/TALK, 13C-DIC, 13C-POC, 18O, 13C-TOC, Salinity, & NH4) as per Table 18. Once cores were removed from the ice floe they were cut with a hand saw into 2x10cm sections and placed in gas tight tedlar bags. Once bags were sealed the head space was carefully removed using a Nalgene hand pump. Core sections were left to melt in the dark at room temperature in the Paleolab (~24hrs) and were then sampled through the use of a drawing tube off the side of the tedlar bag.

In addition to the bulk sea ice property samples, a small 230 volt Quiet One 800 aquarium pump was used to draw sea water from the core hole at a depth of 150cm. This water was collected in a clean (3x rinsed) 10L cubetainer and sampled for various chemical parameters once back on the ship (DIC/TALK, 13C-DIC, 13C-POC, 18O, 13C-TOC, Salinity, & NH4) as per table 18. Stations for chemical analyses within multi-year and 1st year ice were occupied adjacent to L1, L2, & L1.1.

Ikaite ($CaCO_3 \cdot 6H_2O$) Precipitation in Multi-Year Sea Ice: The temperature core from L1 (Sept 1st) was saved in the -10deg cooler to sample for the presence of Ikaite mineral precipitates ($CaCO_3 \cdot 6H_2O$) in the multi-year pack ice. Looking at the temp/salinity profile from the core it was expected that the ice was too warm to have retained enough brine or even maintain a stable precipitate; however the core was processed anyway to practice the method. Since the core was so warm, it was thought that any dissolved $CaCO_3 \cdot 6H_2O$ still in the brine (if any brine was left) might re-crystallize at low temperature. The core was therefore left in the -10degC lab for 2.5 days before processing. Seven 10cm sections of the core with highest salinity were chosen and cut from Core 3 in the -10deg cold room and placed in clean (new) 1L plastic beakers and covered in parafilm for melting. The seven selected sections were then taken to the 4degC container on the heli deck (actual temp maintained between 6.5-8 deg) and slowly melted in an open Coleman cooler. After 11 hours of melting, samples were checked for melt progress every 5 hours and then more frequently once melt had progressed to ~90%; temperature in the container and in the cooler were both recorded on each check of melt progress. Once samples were virtually completely melted, they were taken down to the filtration set up in the aft labs and evaluated for the presence of ikaite crystals following Dieckmann et al 2008. Although no Ikaite crystals are presumed to have been successfully isolated, samples of the collected particulates from the melts were saved on pre-weighted pre-combusted GF/F filters (ethanol washed) or preserved in 75% ethanol in cryovials in the -80deg freezer for possible analysis (or method tests) later in the lab.

Table 18: Sea Ice Core & In Situ Pumping Samples

Station	Lat	Lon	Date	Time	Sample	Depth of Sample	13C-POC	DIC/TALK	13C-DIC	13C-TOC	18O	salinity	NH4
L1	71.019	139.00458	31-Aug-09	14:00	T & S Cores	Full Cores						x	
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 1	37-59cm		x	xx	x	x	x	x
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 2	115-135cm		x	xx	x	x	x	xx
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 3	172-192cm		x	xx	x	x	x	xx
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 4	240-260cm		x	xx	x	x	x	x
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 5	337-357cm		x	xx	x	x	x	x
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 6	403-423cm		x	xx	x	x	x	xx
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 7	bottom 20		x	xx	x	x	x	x
L1	71.019	139.00458	31-Aug-09	14:00	PUMP 1	130cm	x	xx	xx		xx	xx	
L1	71.019	139.00458	31-Aug-09	14:00	PUMP 2	130cm	xx	xx	xx		xx	xx	
L1	71.12749	139.20603	01-Sep-09	7:45	PUMP 3	150cm	xx	xx	xx		xx	xx	
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface		x	xx	xx	x	x	xx
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface		x	xx	xx	x	x	xx
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface	x						
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface	x						
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 1	20-40cm		x	xx	xx		x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 2	40-60cm		x	xx	xx	x	x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 3	60-80cm		x	xx	x		x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 4	80-97cm		x	xx	xx		x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 5	100-120cm		x	xx	xx	x	x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 6	bottom 15cm		x	xx	x	x	x	x
L2	74 31.6	135 45.5	04-Sep-09	18:30	Core Section 1	bottom 60cm	x				x		
L2	74 31.6	135 45.5	04-Sep-09	18:30	PUMP 1	105cm	x	x	xx	xx	x	x	xx
L11			10-Sep-09		Core Bottom	bottom 60cm	x				x		
L11			10-Sep-09		PUMP 3	150cm	x	x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 1	20-40cm		x	xx	xx	x	x	x
L11			10-Sep-09		Core Section 2	51-71cm		x	xx	xx	x	x	x
L11			10-Sep-09		Core Section 3	96-116cm		x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 4	138-158cm		x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 5	172-192cm		x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 6	bottom 20		x	xx	xx	x	x	x
L11			10-Sep-09		PUMP 2	150cm	x	xx	xx		xx	x	x
L11			10-Sep-09		Core Bottom	bottom 60cm	x				x		

5. Acknowledgements

We would like to thank Captain Julien and his crew for their professional support and exceptionally hard work during the cruise, which contributed much to the success of the expedition.

5. Appendices

Appendix 1: Science log from the bridge (with associated GEOTRACES event numbers)

JOURNAL DES ACTIVITÉS SCIENTIFIQUES

EVENT #	DATE (Local)	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT		T° AIR	T° EAU	P° BARO	HUM	GLACES
	28/08	2100	70° 41,6'N	126° 01,8'W	315	Ballon Météo	190	25	095	7.2	6.2	1022.7	97	/
						Station S1								
1	29-08	1300	69°30,05N	137°59,82W	288	Rosette ↓	60	11	342	1,5	3,5	1008,6	96	Ø
	29-08	1832	69°29,95N	137°59,57W	255	Rosette ↑	58,4	11	341	1,8	3,9	1008,6	96	Ø
	29-08	1900	69°29,90N	137°59,06W	241	mobs buoy ↓	56	10	340	2,1	3,9	1008,5	94	Ø
2	29-08	1948	69° 30,0'N	137°58,9'W	321	Foredeck Pump ↓	55,4	9	340	1,9	4,0	1010,9	90	/
	29-08	1955	69° 30,0'N	137° 58,8'W	311	Foredeck Pump ↓ 2e	55,0	10	355	1,9	4,0	1010,8	90	/
	29-08	2228	69° 29,9'N	137° 57,2'W	077	Foredeck Pumps ↑	50	4	170	1,4	3,8	1009,2	90	/
	29-08	2310	69° 30,0'N	137° 58,0'W	280	mobs buoy ↑	52	8	140	1,9	3,8	1008,5	91	/
3	29-08	1137	69°29,9'N	137° 59,6'W	135	Rosette #2 ↓	58,7	11	140	2,2	3,7	1008,0	91	/
	29-08	1147	69°29,9'N	137° 59,6'W	134	Rosette #2 ↑	58,5	12	140	2,2	3,7	1007,8	92	/
4	30/08	0107	69°29,9'N	137°59,4'W	125	Rosette CTD #3 ↓	58	17	140	3.7	3.6	1006.2	91	/
	30/08	0123	69°29,9'N	137°59,0'W	083	Rosette CTD #3 ↑	56	17	155	3.9	3.7	1006.1	91	/
						~~STATION S1.1~~								
5	30/08	0306	69°29,9'N	137°58,9'W	082	Rosette CTD #4 ↓ (ajoutée à STN "S1")	56	19	130	4.8	3.6	1004.1	89	/
	30/08	0318	69°30,1'N	137°58,9'W	034	Rosette CTD #4 ↑	56	20	135	5.1	3.6	1003.7	88	/
						Station S1.1								
6	30-08	0442	69°40.17N	138°09,13W	101	Rosette ↓	126	16	097	4,4	3,9	1002,1	94	Ø
	30-08	0456	69°40.16N	138°09,01W	098	Rosette ↑	126	16	096	4,5	4,2	1001,8	93	Ø

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Station S1,2

	Date	Heure	Latitude	Longitude	CAP	Activités	Prof (m)	Vent		T° air	T° eau	P° Baro	Hum	Glaces
7	30-08	0600	69°40,45N	138°09,69w	080°	Rosette ↓	128	14	080°	4,4	4,2	1000,6	94	Ø
	30-08	0614	69°40,52N	138°09,73w	076°	Rosette ↑	130	16	083°	4,4	4,2	1000,4	94	Ø
	30-08	0727	69°49,89N	138°19,57	068	Rosette ↓ #1	189°	12	067	3,1	3,6	1002,5	96	Ø
	30-08	0752	69° 49,8	138° 20,1'W	053	Rosette ↑ #1	190	8	056	2,8	3,3	1003,6	97	Ø
8	30-08	0837	69° 50,0'N	138° 20,5'W	057	Rosette ↓ #2	191	7	050	2,6	3,1	1003,6	98	1/10
	30-08	0849	69° 50,0'N	138° 20,6'W	045	Rosette ↑ #2	191	6	040	2,5	3,1	1003,6	98	1/10
9	30-08	0944	69° 50,3'N	138° 21,1'W	036	Rosette ↓ #3	195	10	040	2,4	3,0	1003,7	99	Ø
	30-08	0951	69° 50,3'N	138° 21,1'W	048	Rosette ↑ #3	194	11	043	2,2	3,0	1003,7	99	/
						Station S2								
10	30-08	1106	70° 00,0'N	138° 30,2'W	050	Rosette Biology ↓	259	12	062	0,8	2,2	1003,9	99	/
	30-08	1144	70° 00,2'N	138° 30,8'W	066	Rosette Biology ↑	260	10	060	0,5	2,1	1004,2	99	1/10
11	30/08	1422	70°00,52'N	138°30,34'W	112	Rosette biogeochem ↓	260	8	000	0.5	1.8	1005.6	99	1/10
	30/08	1445	70°00,5'N	138°30,2'W	109	Ballon Météo déployé	261	11	340	0.3	1.8	1005.9	99	1/10
	30/08	1452	70°00,5'N	138°30,2'W	094	Rosette biogeochem ↑	260	11	335	0.3	1.8	1006.2	99	1/10
	30/08	1519	70°00,5'N	138°29,6'W	067	mobs buoy ↓	260	16	335	0.3	1.8	1006.9	99	1/10
12	30-08	1816	69°59,68'N	138°29,74W	311	Rosette ↓	256	22	319	-0,3	1,6	1008,3	93	N
	30-08	1833	69°59,70N	138°30,07W	316	Rosette ↑	256	18	327	-0,6	1,6	1008,6	93	N
13	30-08	1855	69°59,41N	138°30,32W	344	début déployement des pump foredeck	257	23	319	-0,5	1,5	1009,	93	N
	30-08	1916	69°59,34N	138°30,36W	341	Fin déployment foredeck pump	257	20	318	-0,5	1,5	1009	93	N
	30-08	2308	69 58,6'N	138°32,3'W	355	Foredecks Pumps ↑	~~35?~~ 258	22	310	-1,0	1,5	1014,3	94	1/10

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STN "S2" (suite)

	DATE	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT		T° AIR	T° EAU	P° BARO	HUM	GLACES
	30/08	2355	69°54.20'N	138°34.71'W	046°	Récuperation of MOBS Bouée	221	22	320	-0,6	1,4	1014,5	78	1/10
14	31/08	0048	70°01,41'N	138°32,86'W	024°	Rosette #3 ↓	271	19	305	-1.4	1.2	1014.7	79	~
	31/08	0108	70°01,50'N	138°33,05'W	033°	Rosette #3 ↑	271	16	305	-1.6	1.2	1014.8	78	~
15	31/08	0137	70°01,37'N	138°32,31'W	032°	Moonpool Pump ↓	268	15	295	-1.9	1.1	1014.9	86	~
	31/08	0308	70°01,99'N	138°32,27'W	350°	Moonpool Pump ↑	269	16	300	-2.0	0.98	1014.6	81	~
						Station L1								
	31/08	1418	71°05,55'N	139°00,59'W	352	Ballon météo déployé	1911	7	110	0.5	0.11	1009.9	78	7/10
16	31/08	1418	71°05,55'N	139°00,59'W	352	Rosette #1 biology cast ↓	1911	7	110	0.5	0.11	1009.9	78	7/10
	31/08	1422	71°05,56'N	139°00,65'W	352	Ice Team déployée	1909	7	105	0.5	0.11	1009.9	78	7/10
	31/08	1500	71°05,69'N	139°01,16'W	353	Hélicoptère déployé (EM team)	1912	9	100	1.4	0.12	1009.8	74	7/10
	31-08	1548	71°05,83N	139°01,41W	356	Rosette ↑ #1	1913	8	109°	1,2°	0,12	1006,9	75	8/10
	31-08	1617	71°05,95N	139°01,49W	357	Arriver de l'hélicopter.	1911	13	107	0,7	0,13	1006,3	82	8/10
17	31-08	1655	71°06,04N	139°01,52W	357	Rosette ↓ 9N	1911	12	104	0,2	0,13	1006,	81	8/10
	31-08	1747	71°06,32 N	139° 01,49W	356	Rosette ↑ out	1912	10	104	0,2	0,13	1008,1	82	8/10
	31-08	1844	71° 06,4'N	139° 01,4'W	356	Départ EM scan Heli	1912	10-15	113	0,2	0,13	1007,1	85	8/10
[illegible]	31-08	1859	71° 06,4 N	139° 01,4'W	355	Arrivée EM scan Helico	1942	17	100	-1,6	0,1	1006,5	88	8/10
[illegible]	31-08	2005	71° 06,4'N	139° 01,4' W	355	Rosette ↓	1942	17	100	-1,6	0,1	1006,5	88	8/10
[illegible]	31-08	2010	71°06,4'N	139° 01,4'W	355	Rosette ↑	1942	16	100	-1,5	0,1	1006,5	89	8/10
18	31-08	2017	71°06,3'N	139° 01,5'W	353	Rosette ↓	1913	18	100	-1,5	0,1	1006,5	89	8/10
	31-08	2141	71° 06,0'N	139° 02,5'W	352	Rosette ↑	1918	22	093	-1,8	0,1	1005,6	91	8/10

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STN "L1" (suite)

	Date	Heure	Latitude	Longitude	CAP	Activités	Prof (m)	Vent		T° air	T° eau	P° Baro	Hum	Glaces
19	31-08	2225	71° 05,9' N	139° 03,4' W	351	MoonPool Pump ↓	1926	22	097	-1,6	0,1	1005,1	91	8/10
	01/09	0133	71° 05,94' N	139° 08,87' W	354	MoonPool Pump ↑	1981	21	090	-1.4	0.1	1004.6	95	8/10
20	01/09	0311	71° 06,41' N	139° 11,37' W	354	LV Pump MoonPool ↓	1982	22	090	-1.1	0.1	1004.1	94	8/10
	01-09	0835	71° 07,64 N	139° 12,40 W	352	LV pump moon pool ↑	1982	18	101	-0,4	0,08	1002,2	94	7/10
	01-09	0905	71° 07,4' N	139° 11,9' W	350	Deploy helicopter ↑	1982	16	097	0	0,1	1004,7	93	7/10
	01-09	0912	71° 07,4' N	139° 11,9' W	350	ICE Team deploy ↑	1982	17	099	0,1	0,1	1004,7	93	7/10
21	01-09	0928	71° 07,4' N	139° 11,9' W	350	Rosette Nd ↓	1990	15	095	0,1	0,1	1004,8	93	7/10
	01-09	1102	71° 06.7' N	139° 12.5' W	350	Rosette Nd ↑	1986	16	094	0.5	0	1002.75	97	7/10
	01-09	1047	71° 06,8' N	139° 12,5' W	350	Recover helicopter ↓	1987	18	095	0,5	0,1	1005,1	92	7/10
	01/09	1157	71° 06,54' N	139° 13,53' W	350	Scan Start (Kerri-Ann)	1989	16	100	0.7	0.1	1005.2	92	7/10
	01/09	1214	71° 06,46' N	139° 13,92' W	350	Scan terminé (Kerri-Ann)	N/A	18	100	0.9	0.1	1005.1	92	7/10
22	01/09	1238	71° 06,36' N	139° 14,63' W	350	LV pump MoonPool ↓	1997	17	100	0.9	0.1	1005.1	92	7/10
	01/09	1306	71° 06,29' N	139° 15,26' W	350	Ice Team à bord	1999	16	105	1.1	0.1	1005.2	91	7/10
	01/09	1446	71° 06,34' N	139° 17,93' W	353	LV Pump MoonPool ↑ (opération annulée)	2015	13	110	1.3	0.1	1005.8	91	7/10
	01/09	1454	71° 06,37' N	139° 18,12' W	353	Photogrammetry début	2015	13	110	1.4	0.1	1005.8	91	7/10
23	01/09	1502	71° 06,39' N	139° 18,26' W	354	Rosette Th/Pa ↓	2016	14	110	1.4	0.1	1005.9	91	7/10
	01-09	1547	71° 06,58 N	139° 19,07 W	357	Photogrammetry fini - Kerri Klaus	2021	16	112°	1,7	0,1	1006	92	7/10
	01-09	1648	71° 06,91 N	139° 19,84 W	000	Rosette ↑ Th/PA	2026	16	116°	1,4	0,1	1006,1	94	7/10
24	01-09	1757	71° 07,30 N	139° 20,19 W	003°	Rosette ↓ Atm	2032	15	114°	1,5	0,1	1006,02	96	7/10
	01-09	1819	71° 07,04 N	139° 20,02 W	005°	Rosette ↑ Atm	2030	15	115°	1,5	0,1	1006,03	97	7/10

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StN ("L1" suite)

	Date	Heure	Latitude	Longitude	CAP	Activités	Prof (m)	Vent		T° air	T° eau	P° Baro	Hum	Glaces
25	01-09	1910	71°07,63N	139°19,96W	007	Rosette ↓ (Rivkin)	2028	13	113	1,3	0	1006,3	98	7/10
	01-09	2006	71°07,7'N	139° 19,4'W	008	Scatromètre	2029	10	114	1,4	0,1	1006,8	98	7/10
	01-09	2020	71°07,7'N	139° 19,2'W	009	Rosette ↑ (Rivkin)	2030	11	117	1,2	0,1	1006,8	99	7/10
26	01-09	2310	71°07,0'N	139° 17,7'W	016	LV PUMP ↓	2043	13	126	1,3	0	1007,2	95	7/10
	02/09	0300	71°06,28'N	139°20,38'W	025	LV Pump cast Si ↑	2044	11	140	1.3	0.0	1008 2	96	7/10
27	02/09	0320	71°06,28'N	139°20,64'W	026	Rosette RA-228 ↓	2048	11	145	1.4	0.0	1008.1	96	7/10
	02-09	0433	71°06,40N	139°21,33W	030	Rosette He RA-228 ↑	2050	10	148	1.2	0.0	1008,4	97	7/10
28	02-09	0512	71°06,52N	139°21,49W	031	Rosette ↓ (Cullen)	2053	11	149	1,3	0.0	1008.5	97	7/10
	02-09	0639	71°06,76N	139°21,18W	033	Rosette ↑ (Cullen)	2052	11	137	1,1	0	1008,9	98	7/10
29	02-09	0707	71°06,81N	139°20,89W	034	Rosette cast Cr/U ↓	2051	10	141	1,3	0	1009,06	97	7/10
	02-09	~~2016~~ 0810	71°06,8'N	139°20,1'W	033	Scateromètre Début (10 mins)	2048	11	138	1,4	0	1009,3	96	6/10
	02-09	~~2020~~ 0820	71°06,8'N	139° 19,8'W	034	Scateromètre Fin	2046	11	144	1.5	0	1009,3	96	6/10
	02-09	0840	71°06,8'N	139° 19,5'W	034	Rosette cast Cr/U ↑	2044	9	139	1.6	0	1009,6	96	6/10
	02-09	0847	71°06,8'N	139° 19,3'W	035	Deploy on ice Team ↑	2044	10	142	1,7	0	1009,6	95	6/10
	02-09	1012	71°06,5'N	139° 18,2'W	036	Deploy helicopter (EM Team)	2038	14	141	1.9	0	1009,5	95	6/10
30	02-09	1030	71°06,5'N	139° 18,1'W	037	~~Rosette Ra-226~~ TM cast Pb ↓ 8V	2038	14	139	2,2	0	1009,4	94	6/10
	02-09	1038	71°06,4'N	139° 18,0'W	037	~~Rosette Ra-226~~ TM cast Pb ↑ 8V	2037	13	140	2,3	0	1009,5	94	6/10
	02-09	1048	71°06,4'N	139° 17,9'W	037	Retrieve on ice team ↓	2035	11	143	2,3	0	1009,5	94	6/10
31	02-09	1121	71°06,2'N	139° 17,8'W	037	Rosette RA-226 ↓	2034	10	133	3,2	0	1009,8	90	6/10
	02-09	12 15	71°05.83'N	139° 17.65'W	038	Retrieve Helicopter	2031	4	240	2.1	0.0	1010.5	92	6/10

STN L1 (suite)

	Date	Heure	Latitude	Longitude	CAP	Activités	Prof (m)	Vent		T° air	T° eau	P° baro	Hum	Glaces
	02/09	1242	71°05,64'N	139°17,66'W	039	Rosette R1-226 ↑	2025	5	165	2.9	0.01	1010.6	88	6/10
	02/09	1304	71°05,49'N	139°17,71'W	040	Équipe sur la glace (Trevor + Matthew) remplacement beacon	2023	5	150	3.2	0.01	1010.6	91	7/10
	02/09	1314	71°05,43'N	139°17,75'W	040	Équipe à bord (Trevor + Matthew) beacon remplacé	2022	3	130	3.2	0.01	1010.6	91	7/10
32	02/09	1358	71°05,14'N	139°18,09'W	042	Rosette TM ~~microgazers~~ Rg deep ↓	2021	6	130	2.2	-0.01	1010.7	95	7/10
	02/09	1523	71°04,76'N	139°19,22'W	045	Rosette TM ~~microgazers~~ Rg deep ↑	2024	9	105	1.9	-0.01	1010.7	95	7/10
	02/09	1551	71°06.59'N	139°17.99'W	006	Weather Balloon (matthew)	2037	12	123°	2.6	0.00	1010.5	95	7/10
						L1.5								
33	03/09	0850	73° 19,0'N	139° 23,1'W	215	Rosette ↓	3251	9	310	0,3	-0,2	1009,6	99	7/10
	03/09	0945	73° 18,8'N	139° 22,8'W	195	Rosette ↑	3247	10	280	0,4	-0,2	1009,9	99	7/10
						Station "L2"								~~8/10~~
34	03-09	1809	74°39,15N	137°22,92W	133	Rosette ↓ Pa/th	3370	15	215	0,5	-0,5	1005,1	99	8/10
	03-09	1907	74° 38,90'N	137° 21,50'W	138	Cage Sampling début	3367	15	226	0,5	-0,5	1004,3	99	8/10
	03-09	1920	74° 38,85'N	137° 21,32'W	142	Cage Sampling Fin	3366	16	222	0,5	-0,5	1004,03	99	8/10
	03-09	2030	74°38,6'N	137° 20,5'W	155	Rosette Pa/th ↑	3365	14	221	0,0	-0,4	1003	99	8/10
35	03-09	2105	74°38,6'N	137° 20,2'W	161	Rosette TM cast ↓	3366	14	223	0,1	-0,4	1002,9	99	8/10
	03-09	2216	74° 38,5'N	137° 19,2'W	158	Ballon Météo	3373	15	230	0	-0,4	1002,3	99	9/10
	03-09	2305	74° 38,5'N	137° 18,4'W	157	Rosette TM cast ↑	3369	14	232	-0,2	-0,4	1001,8	99	9/10
36	04/09	0023	74°38,65'N	137°17,00'W	156	Rosette R1 ↓	3367	11	235	-0.2	-0.4	1001.1	99	9/10
	04/09	0027	74°38,65'N	137°16,89'W	156	Ballon météo déployé	3367	12	230	-0.2	-0.4	1000.9	99	9/10
	04/09	0107	74°38,65'N	137°15,99'W	157	Rosette R1 ↑	3369	13	240	-0.2	-0.36	1000.7	99	9/10

STN L2 (suite)

	DATE	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT		T° AIR	T° EAU	P° BARO	HUM	GLACES
37	04/09	0146	74°38.62' N	137°14.99' W	158	Pump Supor Moonpool ↓	3374	13	245	-0.2	-0.36	1000.5	99	9/10
	04-09	0546	74°37,09 N	137°08,83 W	163	Début déploiement Pump Supor Moonpool ↑	3339	15	285	-0,4	-0.33	1001,09	99	8/10
	04-09	0724	74°36,13 N	137°07,65 W	156	Fin Deploiement Pump Supor ↑	3336	15	282	-1,4	-0,35	1001,76	90	8/10
	04-09	0812	74° 35,6' N	137° 07,3' W	168	Ballon Météo	3334	19	275	-1.1	-0,4	1001.8	94	9/10
38	04-09	0814	74° 35,6' N	137° 07,3' W	168	Rosette biology ↓	3331	18	273	-1.1	-0,4	1001.8	94	9/10
	04-09	0846	74° 35,3' N	137° 07,1' W	167	Rosette biology ↑	3338	20	267	-1.1	-0,4	1001.8	93	9/10
39	04-09	1016	74° 34,9' N	137° 06,6' W	160	Rosette TM cast ↓	3331	24	269	-0,6	-0,4	1001.6	93	9/10
	04-09	1100	74° 34.9' N	137° 05.8' W	158	Rosette TM cast ↑	3330	24	260	-0.4	-0.4	999.2	94	9/10
	04/09	1114	74°34,87' N	137°04,88' W	158	Équipe sur la glace (Kerri-Ann + Monica)	1329	22	265	0.4	-0.4	1001.5	93	9/10
40	04/09	1235	74°34.85' N	137°03.36' W	158	Rosette rivkin ↓	3329	27	264	-0.3	-0.4	1001.34	93	9/10
	04/09	12 43	74°34.85' N	137°03.36' W	158	Équipe de glace à bord du navire (Kerri-ann + Monica)	3329	27	264	-0.3	-0.4	1001.34	93	9/10
	04/09	13 21	74°34.80' N	137°01.47' W	158	Rosette Rivkin ↑	3327	26	263	-0.3	-0.38	1001.25	94	9/10
41	04/09	1526	74°34,16' N	136°54,80' W	172	Rosette ~~biogeochem~~ Nd/Th234 ↓	3319	30	270	0.2	-0.42	1000.9	93	9/10
	04-09	1750	74°32,47 N	136°47,41 W	170	Rosette biogeochem ↑	3303	26	284	-0.1	-0,42	1002,1	89	9/10
	04/09	1849	74°31.6' N	136° 45.6' W	190	Rosette à l'eau ↓	3295	26	280	-0.1	-0.42	1002.5	91	9/10
	04/09	1849	74°31.6' N	136° 45.5' W	190	Équipe de glace sur la glace Monica + Kristina	3295	26	280	-0.1	-0.42	1002.5	91	9/10
	04/09	1840	74°31.6' N	136° 45.5' W	190	Scatterometer Scan Kerri-ann	3295	26	280	-0.1	-0.42	1002.5	91	9/10
	04/09	1905	74°31.24' N	136°44.88' W	195	Équipe de glace à bord	3294	31	283	0.0	-0.42	1002.6	87	9/10
	04/09	1921	74°30,98' N	136°44,46' W	194	Rosette cast ↑	3296	31	285	0,0	-0,4	1003,1	87	9/10
	04/09	1930	74°30,75' N	136° 44,19' W	195	Équipe de glace déployée	3293	31	296	0,0	-0,42	1003,1	87	9/10

STN L2 (suite)

	Date	Heure	Latitude	Longitude	CAP	Activités	Prof (m)	Vent	(Vent)	T° air	T° eau	P° Baro	Hum	Glaces
41	04/09	1955	74° 30,44'N	136° 43,82'	190	Équipe Cage ice de retour	3290	290	25	-0,3	-0,4	1003,5	89	8/10
42	04/09	2137	74° 26,5'N	136° 28,0'W	205	Rosette Pgomics ↓	3242	300	19	-0,4	-0,5	1005,1	87	8/10
	04/09	2152	74° 26,3'N	136° 28,2'W	182	Rosette Pgomics ↑	3241	300	22	-0,8	-0,5	1005,5	96	8/10
43	04/09	2239	74° 25,9'N	136° 28,8'W	182	Rosette Pgomics ↓	3240	300	24	-0,6	-0,5	1006,1	88	8/10
	04/09	2249	74° 25,8'N	136° 28,9'W	182	Rosette Pgomics ↑	3240	303	25	-0,6	-0,5	1006,2	88	8/10
44	04/09	2324	74° 25,6'N	136° 29,3'W	215	Rosette Pgomics ↓	3240	320	22	-0,8	-0,5	1006,7	90	8/10
	04/09	2329	74° 25,5'N	136° 29,4'W	209	Rosette Pgomics ↑	3240	311	20	-0,8	-0,5	1006,7	90	8/10
45	04/09	2339	74° 25,4'N	136° 29,5'W	200	Rosette Pgomics ↓	3241	309	23	-0,7	-0,5	1006,8	88	8/10
	04/09	2348	74° 25,4N	136° 29,6'W	189	Rosette Pgomics ↑	3241	305	21	-0,8	-0,5	1007	88	8/10
	05/09	0030	74° 25.15'N	136° 30.03'W	207	Rosette Pgomics ↓	3241	306	22	-0.9	-0.5	1007.6	91	8/10
	05/09	0047	74° 25.08'N	136° 30.13'W	213	Rosette Pgomics ↑	3242	302	20	-1.1	-0.5	1007.9	86	8/10
	05/09	0025	74° 25.09'N	136° 30.01'W	213	Do over Rosette Pgomics ↓	3241	307	18	-1.0	-0.5	1008.12	84	8/10
	05/09	01 36	74° 25.04'N	136° 29.92'W	213	Rosette Pgomics ↑	3241	297°	21	-1.0	-0.5	1008.26	86	8/10
46	05/09	02 48	74° 25.91'N	136° 30.06'W	209	Rosette Biogeochem ↓	3242	301°	16	-1.1	-0.5	1008.2	91	7/10
	05/09	0518	74° 24,88N	136° 24,88'W	800	Rosette out ↑	3228	289°	10	-1,3	-0,6	1010,3	86	7/10
47	05-09	0648	74° 25,20N	136° 26,43W	290	Pump-puit de lancement ↓	3233	236	11	-1,8	-0,5	1010,4	89	7/10
	05-09	0944	74° 24,2'N	136° 26,0'W	200	Deploy Ice Team ↓	3288	203	10	-1,3	-0,6	1008,2	95	7/10
	05-09	0950	74° 24,0'N	136° 25,'W	198	De By Mobs buoy ↓	3228	198	10	-1,3	-0,6	1009,1	96	7/10
	05-09	1007	74° 24,1'N	136° 25,4'W	187	Profileur CTD ↓	3228	192	9	-1,4	-0,6	1008,9	96	7/10
	05-09	1106	74° 24,1'N	136° 26,1'W	144	Mobs buoy ↑	3228	187	14	-1,1	-0,6	1007,7	97	7/10

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STN L2 (suite)

DATE	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT DIR	VENT VIT	T° AIR	T° EAU	P° BARO	HUM	GLACES
05/09	1113	74° 24,2' N	136° 25,9'W	115	Retrieve and Mobi buoy?! Ice Team ↑	3228	185	14	-1,0	-0,6	1007,5	97	7/10
48 05/09	1227	74°25,06'N	136°26,13'W	083	Rosette TM Cr/U ↓	3231	160	17	-0.5	-0.6	1005.1	95	8/10
05/09	1313	74°25,58'N	136°26,69'W	089	Ballon météo déployé	3236	155	21	-0.5	-0.6	1003.9	93	8/10
05/09	1440	74°25,63'N	136°25,06'W	080	Rosette TM Cr/U ↑	3236	180	23	0.1	-0.6	1001.7	94	8/10
49 05/09	1820	74°27,26'N	136° 19,71'W	245	Rosette TM ↓ in	3240	262	23	0,8	-0,7	999.98	99	8/10
xxx	xxx	xxx	x xx		~~Rosette TM ↑ out~~	xxx	xxx	xx	xxx	xxx	xxx	xxx	xxx
05/09	1824	74°27,24'N	136° 19,47'W	245	lancement ballon	3240	260	22	0,8	-0,7	999.98	99	8/10
05/09	1828	74° 27,23'N	136° 19,08'W	200	Rosette ↑ out	3240	260	22	0,8	-0,7	999,98	99	8/10
50 05-09	1904	74°26,81 N	136°14,32W	280	~~Rosette~~ deploy pump ↓	3234	285	27	0,7	-0,7	1000,6	99	8/10
05-09	1946	74°26,67'N	136° 14,18	280	pump deployment ↑	3234	285	25	0,7	-0,7	1000,4	98	8/10
05-09	2330	74°23,3'N	136° 09,3'W	176	Pump recovery ↑	3213	288	23	0,3	-0,7	1004,8	84	8/10
51 06/09	0022	74°22,92'N	136°09,51'W	197	Rosette TM Pb ↓	3212	280	18	0.3	-0.7	1005.1	84	8/10
06/09	0108	74°22,71'N	136°10,05'W	166	Rosette TM Pb ↑	3212	265	16	0.6	-0.7	1005.6	83	8/10
06/09	0942	74° 25,3'N	133°54,3'W	027	Deploy ICE Team ↓	3236	215	10	-0,9	-0,8	1006,3	95	9+/10 / 8/10
06/09	1002	74°25,2'N	133° 53,6'W	027	Deploy helicopter	3109	212	10	-0,6	-0,8	1006,1	94	9+/10
06/09	1010	74°25,1'N	133° 53,4'W	027	Retrieve ICETEAM ↑	3113	212	12	-0,8	-0,8	1006,3	95	9+/10
06/09	1130	74°26,4'N	133°21,0'W	300	Recover helicopter	3045	204	14	-0,8	-0,9	1005,6	96	9/10
~~06/09~~	~~1217~~	~~74°26,35'N~~	~~133°21,24'W~~	~~295~~	~~Deploy helicopter~~	~~3047~~	~~215~~	~~13~~	~~-0.7~~	~~-0.9~~	~~1005.7~~	~~96~~	~~9/10~~
~~06/09~~	~~1223~~	~~74°26,35'N~~	~~133°21,22'W~~	~~316~~	~~Recover helicopter~~	~~3047~~	~~220~~	~~14~~	~~-0.7~~	~~-0.9~~	~~1005.7~~	~~96~~	~~9/10~~
~~06/09~~													

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	DATE	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT		T° AIR	T° EAU	P° BARO	HUM	GLACES
						Station L3								
	06/09	1432	74°26,25'N	133°22,94'W	077	Ice Team sur la glace (Ryan Galley, Yves, Sébastien V.)	3051	210	15	0.2	-0.85	1005.4	94	9/10
	06/09	1435	74°26,25'N	133°22,99'W	078	Ice team à bord opérations annulées	3051	200	14	0.2	-0.85	1005.4	94	9/10
	06/09	1435	74°26,25'N	133°23,00'W	078	EM Scan début (Kerri-Ann)	3051	200	14	0.2	-0.85	1005.4	94	9/10
	06/09	1444	74°26,26'N	133°23,13'W	077	Ice team sur la glace déployement beacon	3052	210	13	0.2	-0.85	1005.2	94	9/10
	06/09	1450	74°26,27'N	133°23,18'W	077	Beacon installé	3051	205	14	0.2	-0.85	1005.1	94	9/10
	07/09	0015	74°37.83'N	134°53.9'W	315	Weather Balloon launched (Matteo)	2464	253	29	-0.5	-1.0	1001.77	82	9/10
52	07/09	0804	75° 19,5'N	137° 39,6'W	280	Rosette PATh ~~Biology~~ ↓	3490	284	21	-0,9	-0,9	1006,3	83	7/10
	07/09	1040	75° 16,9'N	137° 35,0'W	280	Rosette PATh ↑	3490	278	19	-1,0	-0,9	1008,9	87	7/10
53	07/09	1115	75° 16,9'N	137° 35,2'W	300	Pump Supor ↓	3482	282	20	-1,0	-0,9	1008,9	87	7/10
	07/09	1254	75°16,99'N	137°35,59'W	313	Hélicoptère déployé (EM Scan)	3483	270	18	-0.9	-0.9	1009.4	86	7/10
	07/09	1322	75°16,98'N	137°35,69'W	340	Hélicoptère à bord (EM Scan terminé)	3483	290	17	-1.2	-0.9	1009.5	93	7/10
	07/09	1437	75°17,38'N	137°35,92'W	350	Ballon météo déployé	3484	280	16	-1.2	-0.9	1010.9	90	7/10
	07/09	1502	75°17,39'N	137°35,87'W	010	Pump Supor ↑	3483	275	13	-1.2	-0.9	1010.9	90	7/10
54	07/09	1525	75°16,79'N	137°33,88'W	321	Rosette Biology ↓	3482	285	15	-1.0	-0.9	1011.1	92	7/10
	07/09	1548	75°16,75'N	137°33,90'W	208	Rosette Biology ↑	3482	290	14	-0.9	-0.9	1011.1	90	7/10
55	07-09	1619	75°16,63N	137°33,44W	296	Rosette tm ↓ in	3481	294	17	-1	-0,8	1011,5	87	7/10
	07/09	1707	75°16,64'N	137°33,29'W	269	Rosette tm ↑ out	3481	280	15	-1.0	-0.8	1011.9	88	7/10
56	07-09	1819	75°16,89N	137°28,75W	278	Rosette ↓ in Biogeo	3474	287	12	-1,1	-0,8	1012,5	92	7/10
		2049	75° 16,4'N	137°26,7'W	276	Rosette ↑ Biogeo	3470	276	15	-2,1	-0,8	1013,4	94	7/10

	DATE	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT		T° AIR	T° EAU	P° BARO	HUM	GLACES
	08/09	0929	73° 16,6'N	135° 34,8'W	165	Deploy helicopter (Eric Scan)	3527	000	6	-2,1	-0,9	1018,5	87	9/10
	08/09	1505	72°40.9'N	136°02.6'W	225	Deploy hélico (Matthew + Simon)	2458	221	9	-1.1	-0.9	1018.78	84	9/10
	08/09	1706	72°30,52'N	136° 34,82'W	VAR.	retreive Helico	2530	033	6	-1,6	-0.9	1016,05	87	9/10
	08/09	1710	72°30,58'N	136°35,13'W	304	Scaterometre début	2527	065	7	-0.2	-0.9	1018.6	80	8/10
	08/09	1725	72°30,58'N	136°35,13'W	304	Scaterometre fin	2527	065	7	-0.2	-0.9	1018.6	80	8/10
						~~ice team~~ STN L1-1	—	—	—	—	—	—	—	—
	08-09	1749	72°30,63 N	136°35,49 W	329	ice team "deploy" ↓	2530	037	6	-1,7	-0,9	1018,6	86	8/10
	08-09	1810	72°30,70 N	136°35,68W	303	ice team IN ↑	2532	037	7	-1,2	-0,8	1018,5	83	8/10
57	08-09	1818	72°30,73 N	136°35,75W	318	Rosette tm ↓	2533	037	9	-1,2	-0,8	1018,5	83	8/10
	08-09	1828	72°30,76 N	136°35,86W	305	Rosette tm ↑	2531	030	7	-2,0	-0,8	1018,5	87	8/10
58	08-09	1903	72°30,82 N	136°35,95W	258	Rosette PA/TH ↓ à l'eau	2531	018	8	-1,7	-0,8	1018,5	88	8/10
	08-09	2059	72°30,6'N	136°35,5'W	306	Rosette PA/TH ↑	2528	058	9	-2,2	-0,8	1018,5	90	8/10
59	08-09	2132	72° 30,3'N	136° 35,2'W	297	Rosette Tm ↓	2525	051	11	-2,3	-0,8	1018,5	90	8/10
	08-09	2155	72° 30,1'N	136° 35,1'W	297	Rosette Tm ↑	2525	061	9	-2,3	-0,8	1018,5	90	8/10
60	08/09	2335	72°29,5'N	136° 35,0'W	020	Pumping Supor ↓	2516	093	10	-4,1	-0,7	1018,7	97	8/10
	09/09	0316	72°29,16'N	136°40,55'W	072	Moon Pool Pump Supor ↑	2517	060	7	-5.4	-0.7	1018.4	96	8/10
61	09-09	0414	72°29,50 N	136°43,34 W	058	Rosette out ↓ Ra	2525	063	8	-5,3	-0,7	1018,3	96	8/10
	09-09	0521	72°29,89N	136°44,83 W	084	Rosette IN ↑ Ra	2529	058	8	-5,3	-0,7	1018,3	96	8/10
62	09-09	0611	72°30,06N	136°45,88 W	074	Rosette Tm ↓	2528	061	9	-5,3	-0,7	1018,4	96	8/10
	09-09	0640	72°30,25W	136°46,45W	031	Rosette Tm ↑	2547	083	8	-5,5	-0,7	1018,5	96	8/10

STN "L1-1" (suite)

	DATE	HEURE	LATITUDE	LONGITUDE	CAP	ACTIVITÉS	PROF (M)	VENT		T° AIR	T° EAU	P° BARO	HUM	GLACES
63	09/09	0832	72° 30,9' N	136° 47,4' W	295	Rosette Biology ↓	2543	063	8	-4,6	-0,7	1018,3	96	9/10
	09/09	0853	72° 30,9' N	136° 47,5' W	351	Rosette Biology ↑	2542	065	7	-4,7	-0,7	1018,4	96	9/10
	09/09	0930	72° 31,1' N	136° 47,9' W	340	Deploy helicopter (EM Team)	2554	064	7	-4,7	-0,7	1018,3	95	9/10
	09/09	0935	72° 31' N	136° 47,7' W	272	Deploy zodiac ↓ (ICE Team)	2533	062	10	-4,0	-0,7	1018,4	96	9/10
	09/09	1024	72° 30,7' N	136° 47,0' W	146	Recover zodiac ↑	2535	058	13	-4,2	-0,7	1018,3	95	9/10
	09/09	1050	72° 30,8' N	136° 44,3' W	065	Deploy ICE Team + Helicopter	2536	071	17	-4,8	-0,7	1018,3	95	9/10
	09/09	1130	72° 30,7' N	136° 45,0' W	350	Recover helicopter (EM Team)	2534	073	15	-3,9	-0,7	1018,2	96	9/10
64	09/09	1225	72° 30,7' N	136° 46,4' W	353	Rosette TM ↓	2534	080	15	-4.2	-0.7	1018.1	96	9/10
	09/09	1420	72° 30,7' N	136° 50,4' W	002	Ballon météo déployé	2540	080	17	-3.2	-0.7	1017.9	90	9/10
	09/09	1426	72° 30,7' N	136° 50,4' W	002	Rosette TM ↑	2540	080	17	-3.2	-0.7	1017.9	90	9/10
	09/09	1513	72° 30.1' N	136° 50.6' W	259	Recover Ice Team	2533	080	15	-2.8	-0.67	1017.96	88	9/10
65	09/09	1530	72° 29.6' N	136° 55.5' W	047	Deploy pump in moonpool	2554	085	17	-2.9	-0.67	1018.0	88	9/10
	09-09	1605	72° 29,86 N	136° 56,29 W	067	Fin déploiement des pumps ↓	2535	085	15	-2,75	-0,67	1017,9	87	9/10
	09-09	1639	72° 30,00 N	136° 56,00 W	077	Récupérer Bouée Mukesh	2537	085	15	-2,4	-0,67	1017,9	88	9/10
	09-09	1829	72° 30,91 N	136° 59,03 W	080	Hélico de retour	2543	088	17	-2,9	-0,6	1017,9	93	9/10
	09-09	1942	72° 31,51 N	136° 59,65 W	072	Début récupération des pump	2547	084	18	-3,3	-0,6	1017,7	97	9/10
	09-09	2012	72° 31,6' N	136° 59,6' W	085	Fin récupération des pump	2549	076	20	-3,3	-0,6	1017,7	97	9/10
66	09-09	2051	72° 32,2' N	136° 58,8' W	083	Rosette Biogeochem ↓	2552	080	16	-3,4	-0,6	1017,6	97	9/10
	09-09	2238	72° 32,4' N	136° 55,5' W	080	Rosette Biogeochem ↑	2553	080	17	-3,7	-0,6	1017,7	97	9/10
67	09-09	2300	72° 32,4' N	136° 55,4' W	080	Rosette TM ↓	2551	080	18	-3,7	-0,6	1017,7	97	9/10

STN L1-1 (suite)

	Date	Heure	Latitude	Longitude	CAP	Activités	Prof (M)	Vent		T° Air	T° Eau	P° Baro	Hum	Glaces
	10/09	0031	72°32,4'N	136°55,3'W	082	Rosette TM ↑	2563	075	16	-3.4	-0.6	1017.5	98	9/10
68	10/09	0200	72°32,6'N	136°59,2'W	068	Rosette proteomics 600m ↓	2555	080	18	-3.2	-0.5	1017.4	98	9/10
	10/09	0226	72°32,7'N	136°59,3'W	069	Rosette proteomics 600m ↑	2557	085	15	-3.2	-0.5	1017.4	98	9/10
69	10/09	0316	72°32,5'N	137°03,2'W	079	Rosette genomics 600m ↓	2558	085	22	-3.0	-0.5	1016.9	98	9/10
	10/09	0339	72°32,7'N	137°03,4'W	076	Rosette genomics 600m ↑	2559	085	18	-2.8	-0.5	1016.8	98	9/10
70	10-09	0411	72°32,91N	137°04,07W	088	Rosette surface ↓	2560	085	20	-2,8	-0,5	1016,8	98	9/10
	10-09	0419	72°32,97N	137°04,42W	079	Rosette surface ↑	2562	084	18	-2,8	-0,5	1016,8	98	9/10
71	10-09	0456	72°33,26N	137°05,53W	076	Rosette (Maldonado) ↓	2567	086	21	-2,7	-0,5	1016,5	97	9/10
	10-09	0504	72°33,34N	137°05,63W	081	Rosette (maldonado) ↑	2566	078	21	-2,6	-0,5	1016,4	97	9/10
72	10-09	0535	72°33,55N	137°07,09W	080	Pump Si moonpool ↓	2570	083	22	-2,5	-0,5	1016,1	96	9/10
	10-09	0608	72°33,73N	137°06,99W	093	Fin descendre pump ↓	2573	080	22	-2,5	-0,5	1016,1	95	9/10
	10-09	0914	72°34,9'N	137°09,0'W	080	Pump Si ↑	2587	083	21	-2.0	-0,4	1015,2	92	9/10
73	10-09	1013	72°35,2'N	137°08,6'W	086	Rosette Nd ↓	2590	087	20	-1,7	-0,4	1014,9	91	9/10
	10/09	1200	72°35,6'N	137°09,6'W	087	Rosette Nd ↑	2594	095	23	-1.9	-0.4	1014.5	97	9/10
74	10/09	1240	72°35,9'N	137°10,6'W	087	Moonpool Pump deep Supor ↓	2600	095	24	-1.7	-0.4	1014.3	99	9/10
	10/09	1450	72°36,3'N	137°13,1'W	099	Ballon météo déployé	2606	095	20	-0.1	-0.4	1013.5	99	9/10
	10/09	1600	72°36,7N	137°14,5W	104	(Début opérations) Moonpool Pump Deep Supor ↑	2612	101	22	0.4	-0.3	1012.9	99	9/10
	10/09	1657	72°37,1'N	137°15,6'W	100	Moonpool Pump Deep Supor (Récupération terminée)	2615	100	25	0.2	-0.3	1012.2	99	9/10
75	10/09	1717	72°37,3'N	137°19,6'W	115	Rosette geonomics ↓	2626	105	24	0.2	-0.3	1012.2	99	9/10
	10/09	1730	72°39,4N	137°19,7W	106	Rosette geonomics ↑	2628	104	23	0.3	-0.3	1012.5	99	9/10

Last page for event 76 & 78 missing [14]

Appendix 2: Log from ArcticNet CTD-rosette

Cruise ID 0903
Cruise NAME Geotraces

Cast	Station	Date début UTC	Heure UTC	Lat. (N)	Long. (W)	Fond (m)	Prof. cast (m)	Commentaires	Type	Init
001	S1	30 / 08 / 09	00 : 09	69 ° 30.050	137 ° 59.786	60	54	First cast	Biology	DB
002	S1	30 / 08 / 09	05 : 34	69 ° 29.952	137 ° 59.702	59	54	Everything worked well !	Radium	DB
003	S1	30 / 08 / 09	07 : 08	69 ° 29.942	137 ° 59.484	58	56	Remake of cast 001	Biology	DB
004	S1	30 / 08 / 09	09 : 06	69 ° 29.980	137 ° 58.969	56	54	First cast by Veronique	Radium	VD
005	S1.1	30 / 08 / 09	10 : 40	69 ° 40.172	138 ° 9.168	126	120	No comments	Radium	DB
006	S1.1	30 / 08 / 09	11 : 57	69 ° 40.441	138 ° 9.720	128	123	Water mixed by ship	Radium	DB
007	S1.2	30 / 08 / 09	13 : 25	69 ° 49.888	138 ° 19.628	189	181	Mauvaise station	Biogeochem	DB
008	S1.2	30 / 08 / 09	14 : 35	69 ° 50.058	138 ° 20.616	191	100	Profil incomplet. 24 didn't work	Radium	DB
009	S1.2	30 / 08 / 09	15 : 42	69 ° 50.312	138 ° 21.150	194	10	Profil incomplet. 24 didn't work	Radium	DB
010	S2	30 / 08 / 09	17 : 05	70 ° 0.077	138 ° 30.310	242	247	No comments	Biology	VD
011	S2	30 / 08 / 09	20 : 23	70 ° 0.520	138 ° 30.400	260	252	Bouteille 24 ouverte	Biogeochem	VD
012	S2	31 / 08 / 09	00 : 13	69 ° 59.681	138 ° 29.533	256	248	Bouteille 24 ouverte	Radium	VD
013	S2	31 / 08 / 09	06 : 48	69 ° 59.688	138 ° 32.870	271	261	Bouteille 24 ferme	Radium	VD
014	L1	31 / 08 / 09	20 : 17	71 ° 5.531	139 ° 0.541	1914	1900	Pas de nitrates. Altimeter not working. Engines running.	Biology	DB
015	L1	01 / 09 / 09	02 : 13	71 ° 6.352	139 ° 1.529	1913	1906	No nitrates. No PAR.	geochem + O2	DB
016	L1	01 / 09 / 09	15 : 26	71 ° 7.154	139 ° 11.898	1988	1978	No nitrates. No PAR.	Nd	VD
017	L1	01 / 09 / 09	21 : 03	71 ° 6.373	139 ° 18.250	2015	2066	Stopped for ice. Altimeter working.	Th Pa	VD
018	L1	02 / 09 / 09	01 : 08	71 ° 7.603	139 ° 19.723	2030	2077	No comments	Rivkin team	DB
019	L1	02 / 09 / 09	09 : 19	71 ° 6.268	139 ° 20.623	2045	2073	No comments	Ra 228	DB
020	L1	02 / 09 / 09	13 : 04	71 ° 6.802	139 ° 20.960	2049	2086	No comments	Cr & U	VD
021	L1	02 / 09 / 09	14 : 39	71 ° 6.218	139 ° 15.839	2034	2059	No comments	Ra 228-226	VD
022	L2	04 / 09 / 09	00 : 08	74 ° 38.740	137 ° 20.890	3000	3000	Stopped for cable problems	Th Pa	VD
023	L2	04 / 09 / 09	06 : 23	74 ° 38.670	137 ° 17.068	3000	1000	No comments	Ra 228-226	VD
024	L2	04 / 09 / 09	14 : 12	74 ° 35.620	137 ° 7.338	3000	500	No comments	Biology	DB
025	L2	04 / 09 / 09	18 : 31	74 ° 34.872	137 ° 3.553	3000	1000	No comments	Rivkin team	DB
026	L2	04 / 09 / 09	21 : 30	74 ° 34.174	136 ° 54.806	3000	3000	No comments	Nd & O2	DB
027	L2	05 / 09 / 09	03 : 35	74 ° 26.464	136 ° 28.141	3000	100	No comments	Pgnomics	VD
028	L2	05 / 09 / 09	04 : 37	74 ° 25.958	136 ° 28.804	3000	39	No comments	Pgnomics	VD
029	L2	05 / 09 / 09	05 : 36	74 ° 25.468	136 ° 29.587	3000	99	Rosette remontée et repartie	Pgnomics	VD
030	L2	05 / 09 / 09	07 : 24	74 ° 25.057	136 ° 29.983	3000	59	Voir Operator verbo	Pgnomics	VD
031	L2	05 / 09 / 09	08 : 49	74 ° 25.924	136 ° 30.034	3000	3000	No comments	Biogeochem	VD
032	L3	07 / 09 / 09	14 : 02	75 ° 19.540	137 ° 39.638	3000	3000	Ship moving during upcast	Th Pa	DB
033	L3	07 / 09 / 09	21 : 26	75 ° 16.776	137 ° 33.851	3000	200	No comments	Biology	DB
034	L3	08 / 09 / 09	00 : 17	75 ° 16.892	137 ° 28.592	3000	3000	No comments	Biogeochem	VD
035	L1.1	09 / 09 / 09	01 : 00	72 ° 30.827	136 ° 35.912	2530	2534	Winch problems	Th Pa	VD
036	L1.1	09 / 09 / 09	10 : 22	72 ° 29.539	136 ° 43.603	2527	1000	Stop to cool winch	Ra	DB
037	L1.1	09 / 09 / 09	14 : 29	72 ° 30.950	136 ° 47.402	2533	200	No comments	Biology	DB
038	L1.1	10 / 09 / 09	02 : 48	72 ° 32.207	136 ° 56.005	2551	2556	Bottle 7 didn't close	Biogeochem	VD
039	L1.1	10 / 09 / 09	07 : 59	72 ° 32.594	136 ° 59.248	2554	600	No comments	Pgnomics	DB
040	L1.1	10 / 09 / 09	09 : 15	72 ° 32.552	136 ° 3.226	2558	600	Bottle 23 didn't close	Pgnomics	DB
041	L1.1	10 / 09 / 09	10 : 10	72 ° 32.920	136 ° 4.136	2560	10	No comments	Pgnomics	DB
042	L1.1	10 / 09 / 09	10 : 56	72 ° 33.266	137 ° 5.598	2560	10	No comments	Pgnomics	DB
043	L1.1	10 / 09 / 09	16 : 11	72 ° 35.268	136 ° 8.716	2590	2594	Bottle 7 didn't close	Nd	VD
044	L1.1	10 / 09 / 09	23 : 17	72 ° 37.316	137 ° 19.655	2626	100	No comments	Pgnomics	VD
045	L1.1	10 / 09 / 09	23 : 52	72 ° 37.646	137 ° 19.984	2630	80	Last Geotraces	Pgnomics	DB

Appendix 3: Preliminary nutrient analysis

		NO2	NO3+NO2high	NO3+NO2low	Si raw	PO4 raw	NO3
stS1 cast1							
Event 1							
b1		0.208	0.361	1.194	6.944	0.799	0.986
b7		0.196	-0.36	0.491	4.345	0.706	0.295
b13		0.185	-0.464	0.351	4.451	0.513	0.166
b19		0.173	-0.492	0.328	5.913	0.422	0.155
S1. SHALLOW BIOLOGY ROSETTE.							
S1 ct1 50m Maite H. 4	50m				10.6	1.015	
3	35m				3.737	0.549	
2	15m				3.453	0.515	
1	5m				6.205	0.401	
stS2 cast10							
Event 10							
b1		0.232	7.097		17.157	1.399	6.865
b5		0.237	5.523		14.229	1.338	5.286
b12		0.254	3.782		11.445	1.216	3.528
b15		0.25	2.011		8.718	1.042	1.761
b16		0.196	-0.797	0.463	3.398	0.741	0.267
b19		0.225	-0.842	0.438	3.17	0.629	0.213
b24		0.202	-0.915	0.416	4.323	0.46	0.214
S2. SHALLOW BIOLOGY ROSETTE							
100m Maite H.	100m				17.472	2.022	
75m	75m				14.128	1.328	
45m	45m				8.946	1.093	
15m	15m				3.217	0.89	
3m	3m				4.513	0.461	
stS2 cast 11							
Event 11							
b4		0.22	15.098		32.435	1.79	14.878
b6		0.253	12.48		28.729	1.781	12.227
b9		0.242	9.843		23.58	1.623	9.601
b11		0.294	7.158		18.259	1.464	6.864
S2. DEEP CAST. BIOGEOCHEM							
200m Maite H.	200m				32.905	1.81	
175m	175m				28.959	1.786	
150m	150m				24.252	1.647	
125m	125m				18.403	1.484	
St L1 ct 14							
Event 16							
b1 200m		0.1	13.592		21.164	1.265	13.492
b7 150m		0.109	16.797		37.823	2.025	16.688
b11 125m		0.097	15.017		31.551	1.951	14.92
b15 85m		0.108	5.905		12.348	1.279	5.797
b19 50m		0.09	-0.026	0.164	2.674	0.759	0.074
b24 22m		0.092	0.065	0.134	1.858	0.653	0.042
L1. SHALLOW BIOLOGY CAST							
L1 ct14 Maite H 200	200m				17.373	1.193	
150m	150m				33.088	1.892	
126m	126m				29.29	1.908	
85m	85m				11.996	1.259	
50m	50m				2.583	0.718	
22m	22m				1.986	0.634	
st L1 cast 15							
Event 18							
b3		0.176	14.756		10.862	1.029	14.58
b5		0.174	14.048		8.831	0.975	13.874
b7		0.178	13.762		7.944	0.954	13.584
b9		0.176	13.421		7.275	0.943	13.245
b11		0.184	13.447		7.141	0.927	13.263
b13		0.181	13.575		7.274	0.92	13.394

b15		0.218	13.651		7.359	0.92	13.433	
b17		0.214	13.527		7.578	0.923	13.313	
b19		0.204	13.738		10.313	1.001	13.534	
b21		0.19	12.592		10.493	0.963	12.402	
L1. DEEP CAST. BIOGEOCHEM								
L1 ct15 Maite 1700m	1700m				10.757	1.032		
1400m	1400m				8.799	0.957		
1200m	1200m				7.821	0.92		
1000m	1000m				7.222	0.901		
800m	800m				7.004	0.885		
600m	600m				7.139	1.55		
500m	500m				7.142	0.874		
400m	400m				7.332	0.885		
300m	300m				10.068	0.954		
250m	250m				10.283	0.923		
2m	2m				2.064	0.528		
Event 19								
L1 nut I1 Maldonado		0.195	-0.075	0.375	1.879	0.675	0.18	
L1 nut I2 Maldonado		0.187	0.043	0.405	2.294	0.738	0.218	
L1 nut I3 Maldonado		0.206	0.019	0.502	1.86	0.651	0.296	
Event 24								
L1 10m shallow 25		0.103	-0.456	0.291	2.69	0.601	0.188	
amd09 TM L1								
Event 24								
b1		0.103	13.158		7.165	0.915	13.055	
b2		0.091	12.442		10.735	1.046	12.351	
b3		0.096	13.849		21.479	1.366	13.753	
b4		0.111	16.106		33.206	1.866	15.995	
b5		0.106	16.263		34.126	2.044	16.157	
b6		0.118	13.549		27.758	1.899	13.431	
b7		0.12	7.723		15.583	1.454	7.603	
b8		0.163	1.468		5.404	0.968	1.305	
b9		0.114	-0.493	0.219	2.438	0.787	0.105	
b10		0.099	-0.55	0.127	1.647	0.653	0.028	
b11		0.1	-0.528	0.137	1.766	0.605	0.037	
b12		0.101	-0.556	0.166	1.704	0.552	0.065	
TM L1								
Event 32								
	1	0.149	15.038		11.1	1.059	14.889	
	2	0.146	14.653		10.227	1.032	14.507	
	3	0.134	14.171		9.098	0.996	14.037	
	4	0.144	13.736		7.589	0.964	13.592	
	5	0.131	13.425		6.912	0.936	13.294	
	6	0.147	13.43		6.485	0.915	13.283	
	7	0.159	13.67		6.703	0.91	13.511	
	8	0.163	13.562		6.704	0.914	13.399	
	9	0.158	13.445		6.759	0.916	13.287	
	10	0.137	13.524		7.07	0.914	13.387	
	11	0.148	13.601		9.598	0.982	13.453	
	12	0.146	-0.296	0.3	1.453	0.579	0.154	
TM L1.5								
Event 33								
	1	0.16	13.289		6.644	0.922	13.129	
	2	0.139	13.353		6.379	0.912	13.214	
	3	0.142	13.311		6.311	0.902	13.169	
	4	0.146	13.293		5.887	0.898	13.147	
	5	0.128	12.904		6.136	0.89	12.776	
	6	0.151	12.34		8.581	0.928	12.189	
	7	0.147	16.549		35.703	1.966	16.402	
	8	0.153	13.493		26.37	1.812	13.34	
	9	0.163	3.859		8.477	1.072	3.696	
	10	0.138	-0.302	0.277	1.062	0.663	0.139	

11	0.116	-0.314	0.255	2.196	0.566	0.139
12	0.123	-0.334	0.232	1.927	0.504	0.109
TM L2						
Event 35						
1	0.172	15.142		12.795	1.043	14.97
2	0.196	16.003		12.954	1.043	15.807
3	0.168	15.502		0	1.043	15.334
4	0.184	15.392		11.324	1.027	15.208
5	0.228	15.208		10.532	1.029	14.98
6	0.166	14.849		9.757	1.002	14.683
7	0.174	14.036		8.707	0.976	13.862
8	0.212	14.195		8.064	0.955	13.983
9	0.214	13.778		7.176	0.936	13.564
10	0.2	13.34		6.64	0.908	13.14
11	0.202	13.575		6.358	0.899	13.373
12	0.186	13.486		6.143	0.89	13.3
stn L2 cast 24						
Event 38						
b1	0.141	13.87		27.381	1.845	13.729
b7	0.156	9.989		18.925	1.529	9.833
b11	0.177	0.077	0.638	2.652	0.804	0.461
b15	0.14	-0.282	0.311	1.363	0.634	0.171
b19	0.157	-0.311	0.302	1.433	0.561	0.145
b24	0.139	-0.331	0.284	1.498	0.546	0.145
Day 2 incubation						
Maldonado day2 1	0.133	-0.316	0.251	1.393	0.663	0.118
2	0.158	-0.297	0.336	1.337	0.661	0.178
3	0.166	7.419		1.145	0.652	7.253
4	0.134	7.394		1.085	0.704	7.26
5	0.162	9.516		1.058	0.646	9.354
6	0.138	10.747		1.032	0.644	10.609
7	0.146	10.256		0.944	0.639	10.11
8	0.171	9.267		0.953	0.64	9.096
9	0.149	7.913		1.11	0.644	7.764
10	0.171	7.445		0.509	0.646	7.274
11	0.147	7.835		1.144	0.643	7.688
12	0.172	7.69		1.109	0.644	7.518
13	0.129	6.793		1.325	0.652	6.664
14	0.157	7.053		1.373	0.65	6.896
15	0.18	9.398		1.085	0.633	9.218
16	0.156	10.572		1.116	0.695	10.416
17	0.183	9.673		1.132	0.624	9.49
18	0.15	9.991		1.131	0.634	9.841
19	0.178	9.14		1.099	0.634	8.962
20	0.191	9.362		1.103	0.637	9.171
21	0.162	8.638		1.146	0.634	8.476
22	0.198	9.397		1.158	0.638	9.199
23	0.165	9.649		1.2	0.639	9.484
24	0.168	10.094		1.181	0.632	9.926
st L2 cast 31						
Event 46						
b1	0.127	15.955		13.523	1.085	15.828
2	0.128	15.693		13.501	1.09	15.565
3	0.141	15.633		12.434	1.091	15.492
4	0.143	15.638		11.806	1.089	15.495
5	0.131	15.198		10.818	1.056	15.067
6	0.135	14.82		9.905	1.034	14.685
7	0.15	14.488		8.842	1.005	14.338
8	0.14	14.163		7.903	0.984	14.023
9	0.136	14.056		7.374	0.965	13.92
11	0.166	14.02		6.942	0.941	13.854
12	0.147	13.926		6.888	0.935	13.779
14	0.164	13.704		6.692	0.923	13.54
15	0.167	13.891		6.374	0.904	13.724

17		0.143	13.495		6.546	0.901	13.352
19		0.166	12.921		7.485	0.895	12.755
20		0.133	11.612		8.407	0.875	11.479
22		0.156	12.962		18.42	1.387	12.806
24		0.137	16.292		34.594	2.203	16.155
L2. DEEP CAST. BIOGEOCHEM							
st L2 ct31 Her 3000	3000	0.161	15.771		13.295	1.253	15.61
2750m	2750	0.181	16.282		13.581	1.25	16.101
2500m	2500	0.139	15.668		12.514	1.246	15.529
2250m	2250	0.153	15.709		11.965	1.278	15.556
2000m	2000	0.146	15.345		10.845	1.222	15.199
1800m	1800	0.143	15.015		9.787	1.188	14.872
1600m	1600	0.151	14.699		8.918	1.165	14.548
1400m	1400	0.155	14.537		7.96	1.139	14.382
1200m	1200	0.139	14.035		7.361	1.118	13.896
1000m	1000	0.173	14.043		6.877	1.148	13.87
800m	800	0.161	13.99		6.871	1.475	13.829
600m	600	0.181	14.04		8.661	1.196	13.859
500m	500	0.145	13.698		6.263	1.093	13.553
400m	400	0.163	13.502		6.517	1.085	13.339
300m	300	0.177	12.853		7.425	1.085	12.676
250m	250	0.167	14.078		8.454	1.026	13.911
150m	150	0.171	15.539		29.741	2.021	15.368
TM L2							
Event 39							
b1		0.156	13.984		6.701	1.11	13.828
b2		0.155	13.523		6.221	1.097	13.368
b3		0.153	13.495		6.305	1.089	13.342
b4		0.16	13.425		6.322	0.877	13.265
b5		0.164	13.336		6.635	0.874	13.172
b6		0.167	12.37		8.001	0.862	12.203
b7		0.15	17.199		37.469	1.991	17.049
b8		0.157	13.201		25.759	1.774	13.044
b9		0.2	4.181		8.86	1.065	3.981
b10		0.145	0.004	0.274	1.782	0.692	0.129
b11		0.168	-0.013	0.333	1.856	0.634	0.165
b12		0.147	-0.03	0.267	2.033	0.541	0.12
Event 39	Mix various bottles from surface						
L2 quot Maldonado		0.153	-0.017	0.247	1.774	0.634	0.094
EVENT #38		L2. SHALLOW BIOLOGY CAST					
st L2 Hern E1	2.7m	0.159	-0.002	0.272	1.945	0.539	0.113
E2	10m	0.189	0.011	0.358	1.916	0.552	0.169
E3	30m	0.169	0.043	0.324	1.766	0.626	0.155
E4+25	100m	0.175	11.077		20.958	1.58	10.902
E4+50	125m	0.217	14.184		27.999	1.848	13.967
Day 4 incubation							
INCUB Maldonado day 4 1		0.203	-0.294	0.461	1.986	0.671	0.258
2		0.214	-0.167	0.345	1.871	0.676	0.131
3		0.158	7.512		1.618	0.663	7.354
4		0.165	7.336		1.551	0.663	7.171
5		0.159	9.377		1.541	0.653	9.218
6		0.166	10.658		1.576	0.656	10.492
7		0.151	9.961		1.369	0.652	9.81
8		0.184	9.286		1.354	0.651	9.102
9		0.169	7.788		1.569	0.662	7.619
10		0.182	7.364		1.517	0.653	7.182
11		0.153	7.519		1.569	0.658	7.366
12		0.161	7.703		1.509	0.652	7.542
13		0.158	6.696		1.779	0.667	6.538
14		0.151	6.63		1.72	0.663	6.479
15		0.167	9.098		1.505	0.648	8.931
16		0.257	10.534		1.505	0.696	10.277
17		0.187	9.409		1.486	0.648	9.222

18		0.219	9.697		1.441	0.646	9.478
19		0.209	9.103		1.419	0.645	8.894
20		0.183	8.968		1.462	0.647	8.785
21		0.178	8.35		1.567	0.655	8.172
22		0.235	9.268		1.509	0.654	9.033
23		0.266	9.307		1.486	0.647	9.041
24		0.2	9.937		1.455	0.648	9.737
TM L2							
event 51							
1		0.223	13.281		6.819	0.932	13.058
2		0.204	13.391		6.416	0.904	13.187
3		0.239	13.44		6.251	0.904	13.201
4		0.266	18.052		5.961	0.884	17.786
5		0.248	13.027		5.94	0.876	12.779
6		0.26	12.988		6.376	0.878	12.728
7		0.208	11.74		7.743	0.877	11.532
8		0.221	14.88		30.865	1.721	14.659
9		0.244	13.189		26.265	1.86	12.945
10		0.242	-0.103	0.543	2.36	0.767	0.301
11		0.221	-0.145	0.322	1.544	0.646	0.101
12		0.268	-0.091	0.474	1.629	0.561	0.206
st L3 cast 33							
Event 54							
b1		0.215	14.098		29.027	1.881	13.883
b7		0.195	11.097		21.468	1.629	10.902
b11		0.229	0.865	1.037	3.53	0.805	0.808
b15		0.21	0.153	0.304	1.678	0.611	0.094
b17		0.204	0.165	0.252	2.388	0.506	0.048
b24		0.201	0.19	0.257	2.356	0.502	0.056
L3. SHALLOW BIOLOGY CAST							
Maite ev.54 140m	140	0.22	13.934		28.319	1.854	13.714
115m	115	0.229	11.219		21.128	1.606	10.99
60m	60	0.26	0.747	0.95	3.295	0.802	0.69
32m	32	0.223	0.178	0.294	1.688	0.621	0.071
10m	10	0.213	0.171	0.294	2.348	0.501	0.081
3.1m	3.1	0.213	0.196	0.307	2.309	0.587	0.094
proteom L2 10m ba.1		0.277	0.005	0.44	1.627	0.552	0.163
proteom L2 ba.2		0.269	-0.139	0.457	1.575	0.55	0.188
proteom L2 ba.3		0.288	0.356	0.848	2.57	0.771	0.56
proteom L2 ba.4		0.302	0.055	0.778	2.475	0.771	0.476
TM L3							
Event 55							
1		0.114	13.073		7.229	0.918	12.959
2		0.148	12.811		6.838	0.922	12.663
3		0.114	12.994		6.503	0.897	12.88
4		0.145	12.689		6.222	0.89	12.544
5		0.119	12.41		6.123	0.841	12.291
6		0.126	12.463		6.25	0.874	12.337
7		0.135	11.201		7.989	0.849	11.066
8		0.147	15.968		36.129	1.941	15.821
9		0.156	13.845		28.953	1.918	13.689
10		0.197	0.224	0.46	2.883	0.782	0.263
11		0.125	0.134	0.149	1.76	0.651	0.024
12		0.124	0.149	0.172	2.483	0.53	0.048
st L3 cast 34							
Event 56							
1		0.14	14.627		12.976	1.054	14.487
2		0.121	14.756		13.086	1.058	14.635
3		0.131	14.512		11.735	1.054	14.381
4		0.13	14.47		11.13	1.036	14.34
5		0.14	14.23		10.21	1.012	14.09
7		0.132	13.61		8.231	0.971	13.478
8		0.158	13.528		7.512	0.946	13.37

9		0.16	12.923		6.998	0.929	12.763
11		0.13	13.162		6.543	0.912	13.032
12		0.14	12.909		6.297	0.906	12.769
14		0.165	12.951		6.322	0.887	12.786
15		0.135	12.615		5.673	0.856	12.48
17		0.146	12.729		5.856	0.86	12.583
19		0.14	12.11		6.989	0.859	11.97
20		0.137	10.946		8.639	0.853	10.809
22		0.153	13.396		24.281	1.402	13.243
24		0.148	14.729		31.12	1.932	14.581
L3. DEEP CAST. BIOGEOCHEM							
Maite ev.56 3000m	3000	0.177	14.568		12.87	1.064	14.391
2500m	2750	0.156	14.72		11.854	1.048	14.564
2750m	2500	0.18	15.514		13.105	1.056	15.334
2250m	2250	0.169	14.996		11.29	1.039	14.827
2000m	2000	0.137	14.397		10.201	1.012	14.26
ev 56 1800m	1800	0.157	14.232		9.353	0.99	14.075
1600m	1600	0.147	13.621		8.292	0.958	13.474
1400m	1400	0.177	13.496		7.465	0.933	13.319
1200m	1200	0.151	13.333		6.932	0.904	13.182
1000m	1000	0.155	13.156		6.49	0.907	13.001
800m	800	0.15	12.887		6.225	0.889	12.737
600m	600	0.18	12.854		6.06	0.851	12.674
500m	500	0.181	12.687		5.746	0.861	12.506
400m	400	0.2	12.652		5.887	0.874	12.452
300m	300	0.173	11.964		6.995	0.864	11.791
250m	250	0.175	11.191		8.529	0.853	11.016
200m	200	0.192	13.405		25.153	1.46	13.213
150m	150	0.184	14.615		31.348	1.955	14.431
Day 6 incubation							
incub Maldon day6 1		0.142	0.171	0.112	1.563	0.645	-0.03
2		0.159	0.142	0.169	1.67	0.643	0.01
3		0.167	7.37		1.439	0.622	7.203
4		0.16	7.202		1.332	0.628	7.042
5		0.18	9.351		1.248	0.628	9.171
6		0.176	10.348		1.239	0.619	10.172
7		0.223	10.191		1.127	0.618	9.968
8		0.187	9.012		1.169	0.604	8.825
9		0.149	7.625		1.326	0.611	7.476
10		0.183	7.237		1.309	0.623	7.054
11		0.152	7.698		1.324	0.613	7.546
12		0.2	7.642		1.349	0.627	7.442
13		0.191	6.865		1.52	0.632	6.674
14		0.15	6.933		1.511	0.617	6.783
15		0.198	9.193		1.276	0.609	8.995
16		0.174	10.247		1.302	0.593	10.073
17		0.162	9.4		1.334	0.625	9.238
18		0.201	9.697		1.348	0.623	9.496
19		0.164	9.024		1.356	0.618	8.86
20		0.186	9.073		1.348	0.621	8.887
21		0.179	8.293		1.341	0.621	8.114
22		0.201	9.214		1.368	0.622	9.013
23		0.162	8.932		1.347	0.615	8.77
24		0.189	9.934		1.351	0.612	9.745
TM L1.1							
event 59							
1		0.174	12.786		6.553	0.861	12.612
2		0.179	11.752		7.943	0.851	11.573
3		0.129	12.496		18.467	1.195	12.367
4		0.152	16.421		36.433	2.049	16.269
5		0.136	13.13		26.725	1.814	12.994
6		0.155	9.34		18.342	1.522	9.185
7		0.161	2.928		7.56	1.01	2.767
8		0.202	0.115	0.802	3.525	0.8	0.6
9		0.161	-0.143	0.515	2.101	0.717	0.354

10		0.141	-0.35	0.111	1.443	0.664	-0.03	0
11		0.136	-0.385	0.102	2.126	0.566	-0.034	0
12		0.153	-0.364	0.146	1.964	0.495	-0.007	0
st L1.1 ct 37								
Event 63								
b1		0.121	14.762		30.036	1.9	14.641	
7		0.142	11.158		22.179	1.685	11.016	
11		0.217	-0.258	0.641	3.123	0.792	0.424	
15		0.119	-0.282	0.054	2.265	0.577	-0.065	0
17		0.132	-0.38	0.098	2.011	0.48	-0.034	0
24		0.132	-0.382	0.081	2.03	0.489	-0.051	0
L1.1. SHALLOW BIOLOGY CAST								
ev 63 L1.1 3m. HERNAN	3	0.13	-0.38	0.068	2.016	0.491	-0.062	
10m	10	0.143	-0.376	0.15	2.046	0.492	0.007	
25m	25	0.155	-0.38	0.155	2.084	0.57	0	
70m	70	0.217	-0.261	0.591	2.92	0.769	0.374	
140m	140	0.169	14.029		29.292	1.866	13.86	
st L1.1 ct 38								
Event 66								
b1		0.12	14.848		14.096	1.08	14.728	
2		0.119	14.914		12.852	1.087	14.795	
3		0.121	14.563		11.871	1.076	14.442	
4		0.121	14.578		11.014	1.046	14.457	
5		0.128	14.006		9.737	1.036	13.878	
6		0.14	13.834		8.303	0.967	13.694	
9		0.118	13.199		6.934	0.918	13.081	
10		0.135	13.16		6.799	0.92	13.025	
12		0.138	13.268		6.809	0.907	13.13	
13		0.145	13.125		6.43	0.9	12.98	
14		0.142	13.239		6.7	0.892	13.097	
16		0.133	13.115		6.728	0.897	12.982	
17		0.116	12.989		6.778	0.89	12.873	
19		0.128	12.816		8.058	0.912	12.688	
20		0.124	11.674		8.909	0.894	11.55	
22		0.127	15.312		28.834	1.621	15.185	
24		0.12	16.809		36.102	1.997	16.689	
L1.1. DEEP CAST. BIOGEOCHEM								
ev 66 L1.1 2500m. HERN	2500	0.125	15.389		14.177	1.086	15.264	
2250m	2250	0.143	15.238		12.896	1.077	15.095	
2000m	2000	0.156	15.022		12.007	1.07	14.866	
1800m	1800	0.131	14.782		11.308	1.037	14.651	
1600m	1600	0.139	14.477		9.911	1.01	14.338	
1400m	1400	0.134	13.73		8.347	0.957	13.596	
1000m	1000	0.123	13.465		6.956	0.924	13.342	
800m	800	0.146	13.045		6.735	0.949	12.899	
600m	600	0.149	13.323		6.756	0.895	13.174	
500m	500	0.152	13.118		6.357	0.89	12.966	
450m	450	0.129	13.258		6.701	0.881	13.129	
400m	400	0.156	13.069		6.673	0.881	12.913	
350m	350	0.169	13.075		6.804	0.879	12.906	
300m	300	0.146	12.616		7.967	0.894	12.47	
250m	250	0.152	11.605		8.903	0.877	11.453	
200m	200	0.163	15.149		28.979	1.624	14.986	
175m	175	0.159	16.579		36.129	2.024	16.42	
TM L1.1								
event 67								
1		0.27	14.984		13.868	1.123	14.714	
2		0.182	14.764		13.081	1.095	14.582	
3		0.233	14.78		12.317	1.105	14.547	
4		0.245	14.663		10.875	1.076	14.418	
5		0.225	13.921		9.303	1.027	13.696	
6		0.221	13.414		8.156	0.987	13.193	
7		0.157	13.025		7.169	0.958	12.868	
8		0.213	13.143		6.932	0.943	12.93	

9		0.205	13.173		7.221	0.939	12.968	
10		0.28	12.915		6.664	0.925	12.635	
11		0.219	12.854		6.572	0.928	12.635	
12		0.287	13.022		7.051	0.93	12.735	
Kristina Brown 1		0.154	-0.378	0.164	1.967	0.479	0.01	
Kristina Brown 2		0.154	-0.37	0.183	1.959	0.473	0.029	
Kristina Brown 3		0.15	-0.371	0.165	1.929	0.465	0.015	
Kristina Brown 4		0.167	-0.368	0.226	1.925	0.466	0.059	
Day 8 incubation								
incu Maldo. day8 1		0.181	-0.361	0.248	1.86	0.641	0.067	
2		0.152	-0.376	0.168	1.886	0.643	0.016	
3		0.176	9.653		1.59	0.595	9.477	
4		0.191	9.59		1.579	0.596	9.399	
5		0.196	8.989		1.588	0.614	8.793	
6		0.204	9.62		1.606	0.602	9.416	
7		0.191	9.247		1.463	0.614	9.056	
8		0.181	10.562		1.5	0.651	10.381	
9		0.219	10.511		1.617	0.607	10.292	
10		0.176	9.688		1.595	0.599	9.512	
11		0.205	8.177		1.697	0.608	7.972	
12		0.182	6.733		1.679	0.594	6.551	
13		0.174	7.631		1.919	0.619	7.457	
14		0.195	8.657		1.887	0.621	8.462	
15		0.254	7.664		1.631	0.62	7.41	
16		0.217	10.616		1.649	0.628	10.399	
17		0.178	7.619		1.749	0.612	7.441	
18		0.198	9.321		1.667	0.618	9.123	
19		0.183	7.641		1.694	0.624	7.458	
20		0.145	8.022		1.719	0.629	7.877	
21		0.154	7.362		1.727	0.61	7.208	
22		0.155	7.193		1.268	0.625	7.038	
23		0.185	7.512		1.73	0.628	7.327	
24		0.194	7.536		1.792	0.626	7.342	
TM S4								
event 78								
1		0.243	13.451		11.049	1.067	13.208	
2		0.209	12.803		12.27	1.068	12.594	
3		0.193	13.606		20.34	1.339	13.413	
4		0.187	15.6		33.24	1.938	15.413	
5		0.26	14.995		31.859	1.98	14.735	
6		0.22	12.73		26.672	1.848	12.51	
7		0.266	8.56		18.489	1.54	8.294	
8		0.255	0.776	1.262	5.011	0.93	1.007	
9		0.265	-0.09	0.262	2.942	0.813	-0.003	0
10		0.277	-0.103	0.228	2.872	0.766	-0.049	0
11		0.225	-0.109	0.145	2.808	0.7	-0.08	0
12		0.209	-0.126	0.195	2.805	0.651	-0.014	0
K Brown 3-ice		0.181	-0.1	0.143	-0.338	-0.034	-0.038	0
K Brown 7-ice		0.207	-0.095	0.198	-0.214	-0.012	-0.009	0
K Brown 9-ice		0.1	-0.105	0.19	-0.492	-0.036	0.09	
K Brown 10-ice		0.152	-0.107	0.134	-0.43	-0.042	-0.018	0
K Brown 12-ice		0.148	-0.058	0.368	-0.801	-0.083	0.22	
K Brown 13-ice		0.162	-0.084	0.219	-0.672	-0.063	0.057	
Event 75-76								
Proteom 100909 ba 9		0.311	0.535	0.948	3.66	0.846	0.637	
proteom 100909 ba10		0.338	0.569	0.983	3.807	0.902	0.645	
Event 68-71								
L11 proteo ba 1		0.343	13.171		7.285	0.964	12.828	
L11 proteo ba 2		0.208	13.138		7.213	0.94	12.93	
L11 proteo ba 3		0.192	-0.054	0.378	2.263	0.531	0.186	
L11 proteo ba 4		0.317	0.05	0.514	2.331	0.544	0.197	

Event 62									
Part TM cast 40m		0.241	-0.065	0.325	1.766	0.712		0.084	
part TM cast 70m		0.345	1.795		5.639	0.959		1.45	
Part TM cast 90m		0.25	4.046		9.264	1.137		3.796	
part TM cast 150m		0.241	15.037		31.8	2.056		14.796	
part TM cast 200m		0.262	14.186		26.989	1.585		13.924	
part TM cast 250m		0.304	11.73		9.879	0.944		11.426	