CRUISE REPORT: GEOVIDE

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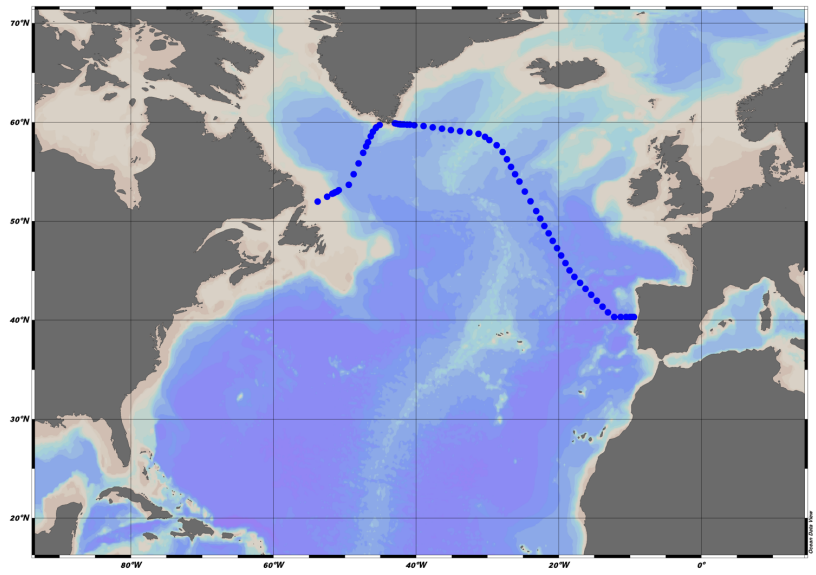

Highlights

Cruise Summary Information

Section Designation	GEOVIDE
Expedition Designation (ExpoCode)	**35PK20140515**
Chief Scientist	**Geraldine Sarthou, Pascale Lherminier**
Dates	15 May – 30 June 2014
Ship	R/V *Pourquoi Pas?*
Ports of Call	Lisbon, Portugal to St. John's, Canada
Geographic Boundaries	59° 9"N 53° 82"W 9° 46"W 40° 33"N
Stations	78
Floats and Drifters Deployed	17 floats 8 ARVOR, 2 ARVOR – deep, 1 ARVOR double DO 2 PROVOR-DO 2 PROVBIO 2 APEX
Moorings Deployed and Recovered	0

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GEOVIDE

An international GEOTRACES study along the OVIDE section in the North Atlantic and Labrador Sea

CRUISE REPORT
15 May - 30 June 2014
On board R/V Pourquoi Pas?

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I. Cruise participants

The international GEOVIDE cruise brought on board R/V Pourquoi Pas? 40 scientists with 9 different citizenships. 16 laboratories from 7 countries were involved in the cruise. Within the framework of the GEOVIDE project, 18 laboratories from 9 different countries are involved.

Nom	Prénom	Spécialité (géologie, physique, chimie, biologie, mécanique, électronique, informatique, etc.)	Responsabilité et rôle à bord (données, analyses …)	Laboratory	email
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II. The Cruise

II.1. Cruise objectives

Trace elements and their isotopes (TEIs) play a key role in the ocean and can be used as tracers of past and present oceanic processes. Studying their cycle, together with the oceanic circulation, has direct implications in diverse research areas such as carbon cycling, climate change, ocean ecosystems and environmental contamination.
The North Atlantic is a key region for Earth climate. Indeed, the most important heat exchanges between the Tropics and the Arctic occur in this region, as well as the so-called Meridional Overturning Circulation (MOC), driven by the deep water formation. Moreover, the TEIs have very contrasted sources in this area and their cycles are poorly known. The GEOVIDE project is strongly linked to the OVIDE[1] project, which aims at studying the characteristics and variability of the MOC. GEOVIDE is the French contribution of the GEOTRACES[2] programme in the North Atlantic.

The scientific objectives are:
1- Better know and quantify the MOC and the carbon cycle in a decadal variability context, adding new key tracers
2- Map the TEI distribution with their physical and chemical speciation along a full-depth high resolution ocean section
3- Investigate the link between the TEIs, and the production, export and remineralisation of particulate organic matter
4- Identify the TEI sources and sinks and quantify their fluxes at the ocean boundaries
5- Better understand and quantify the paleoproxies $^{231}Pa/^{230}Th$, □Nd, and □^{30}Si.

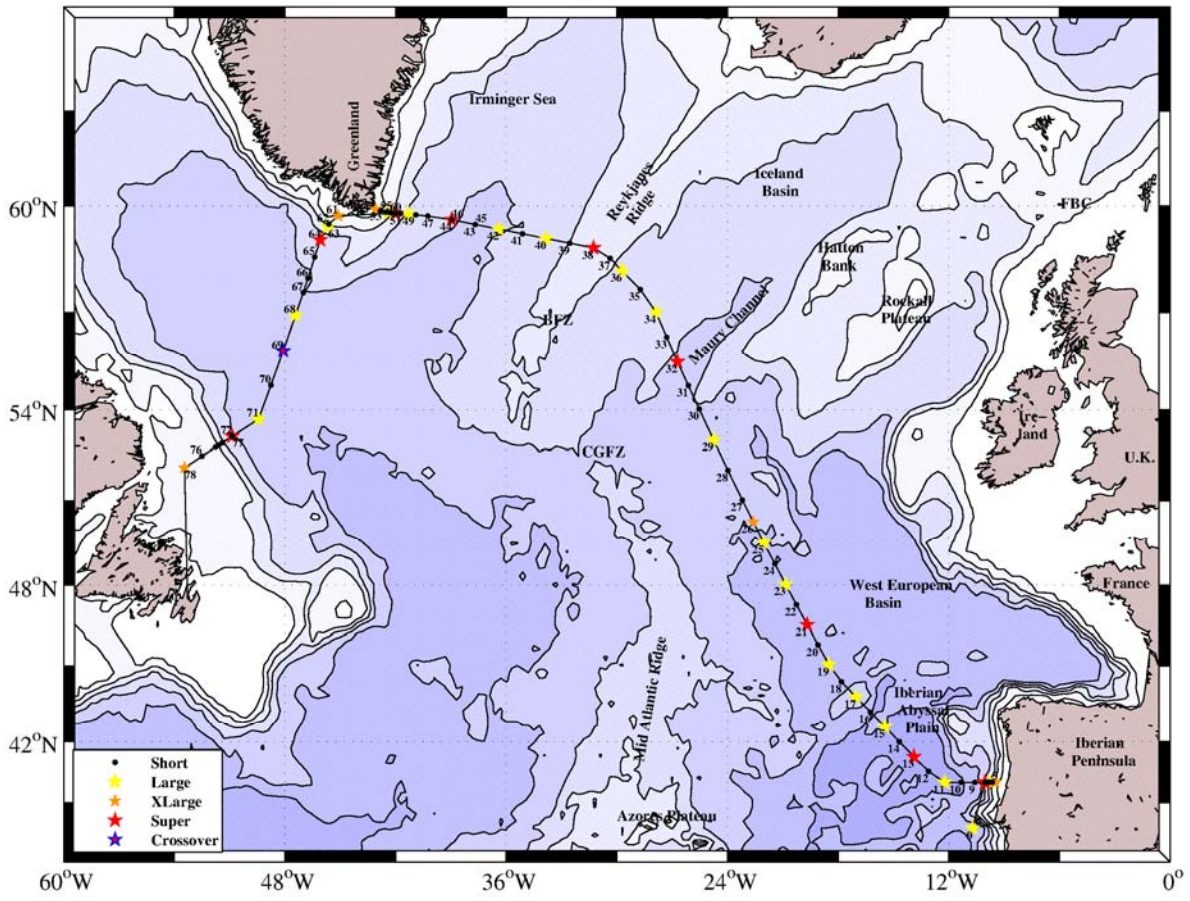
To achieve these objectives, a 47-day multidisciplinary cruise was carried out on board R/V Pourquoi Pas? (15 May - 30 June 2014).

[1] http://wwz.ifremer.fr/lpo/La-recherche/Projets-en-cours/OVIDE
[2] http://www.geotraces.org/

II.2. Cruise track and station location

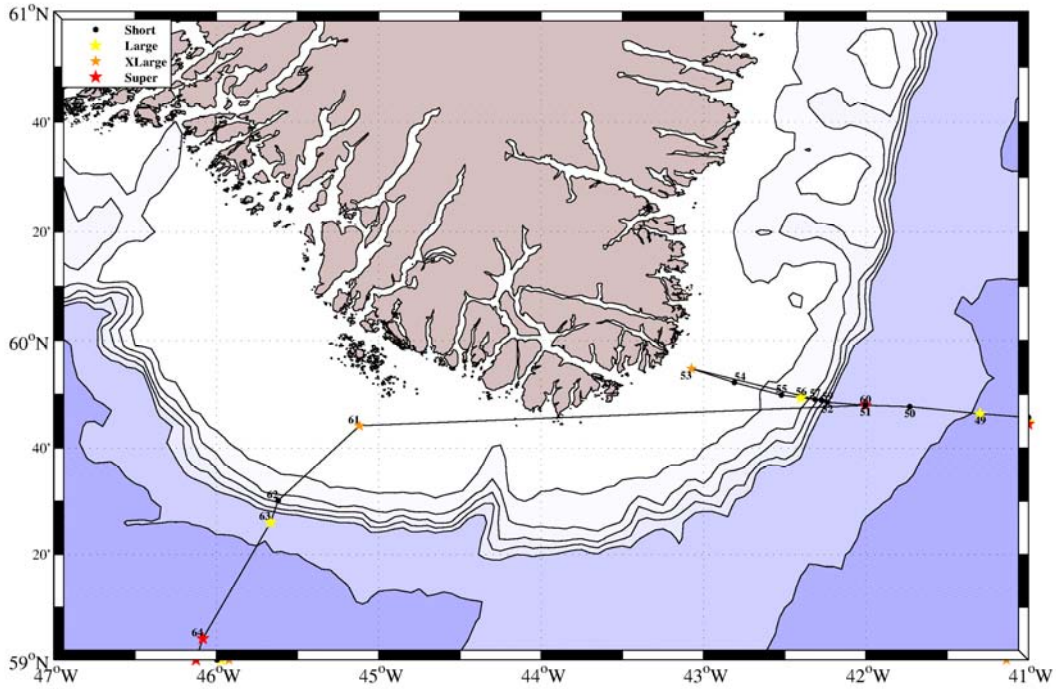
The cruise track crossed significant regional gradients in TEI sources (continental margins, atmospheric inputs, hydrothermal inputs) as well as in biological productivity, (Iberian upwelling region, oligotrophic subtropical gyre and subpolar gyre). In order to take into account these North Atlantic specificities, the GEOVIDE section fitted the OVIDE section from the Iberian upwelling system to the subpolar North Atlantic region, with an additional transect in the Labrador Sea that follows the OSNAP[3] recommendation in order to better constrain the deep water export.

The final cruise track and station location are reported on Figure 1 below.

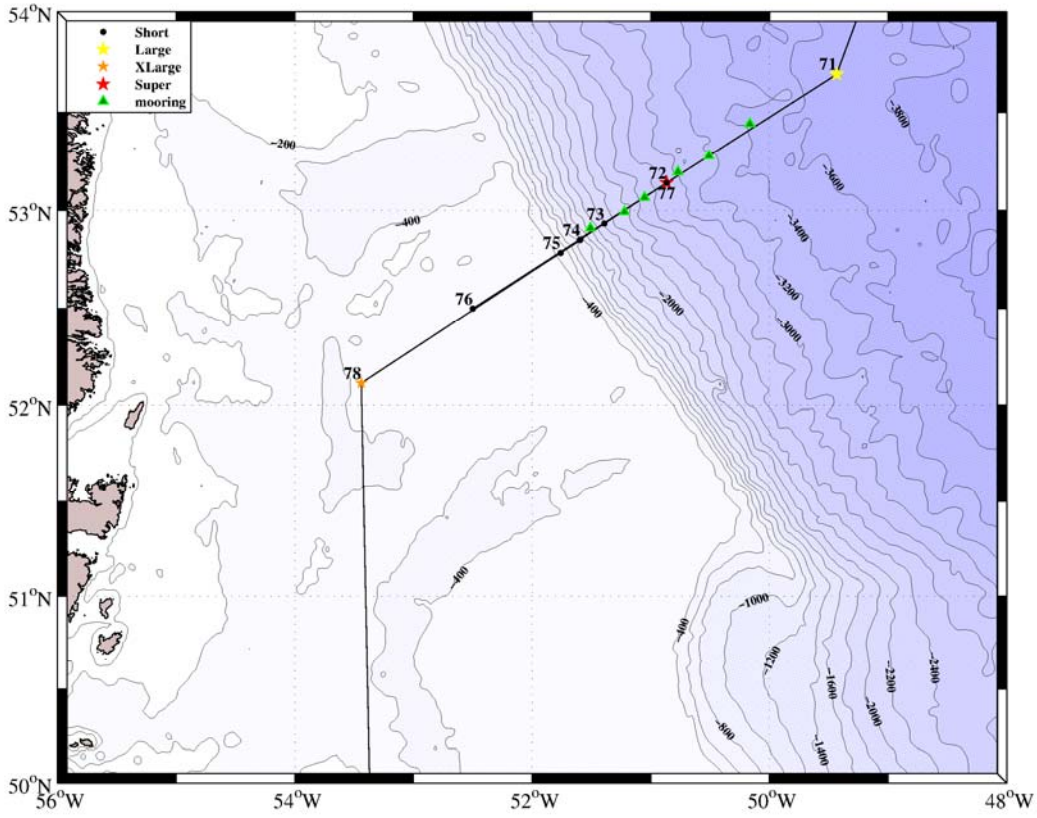


(a)

[3] http://www.noc.soton.ac.uk/nmf/mfp/upload/d5/p588/UK-OSNAP-concept-note_9.pdf?PHPSESSID=fb4c43b4e10f650d91250bfdc34948d0



(b)



(c)

Fig. 1: GEOVIDE cruise track (a), with a focus on the Greenland margin (b), and Canadian margin (c).

In total, 78 stations were realized (plus the test station), including 46 short stations, 17 Large ones, 5 Xlarge ones and 10 Super ones. 341 on-deck operations were carried out.

Station #	Latitude		Longitude		Depth	Type of station
	Deg.	Min.	Deg.	Min.	m	
Port Lisbonne	38	42.78	-9	7.32		
0	38	25.98	-10	42.00	4500	Large_Test
1	40	19.98	-10	2.16	3570	Super
2	40	19.98	-9	27.56	152	XLarge
3	40	19.98	-9	38.59	382	Short
4	40	19.98	-9	46.04	807	Large
5	40	19.98	-9	48.13	1335	Short
6	40	19.98	-9	52.60	2385	Short
7	40	19.98	-9	56.65	3371	Short
8	40	19.98	-10	2.16	3570	Short
9	40	19.98	-10	34.65	4388	Short
10	40	19.98	-11	20.41	5100	Short
11	40	19.98	-12	13.17	5261	Large
12	40	47.23	-13	5.99	5341	Short
13	41	22.98	-13	53.26	5350	Super
14	41	58.95	-14	40.35	5340	Short
15	42	34.88	-15	27.68	5000	Large
16	43	10.89	-16	14.72	5142	Short
17	43	46.76	-17	1.87	4035	Large
18	44	22.60	-17	49.01	4948	Short
19	45	3.04	-18	30.29	4670	Large
20	45	47.60	-19	5.44	4546	Short
21	46	32.65	-19	40.32	4544	Super
22	47	17.39	-20	15.71	4550	Short
23	48	2.33	-20	50.83	4495	Large
24	48	47.13	-21	25.94	4113	Short
25	49	31.84	-22	1.04	4225	Large
26	50	16.67	-22	36.28	4131	XLarge
27	51	1.78	-23	11.43	3945	Short
28	52	1.50	-23	58.32	3804	Short
29	53	1.20	-24	45.12	3552	Large
30	54	0.90	-25	31.99	3382	Short
31	54	45.65	-26	7.33	3100	Short
32	55	30.34	-26	42.63	3234	Super
33	56	15.13	-27	17.55	2740	Short
34	57	0.23	-27	52.71	2755	Large
35	57	40.49	-28	43.80	2457	Short
36	58	12.46	-29	43.49	2222	Large
37	58	33.00	-30	21.71	1591	Short
38	58	50.56	-31	15.95	1452	Super
39	58	58.39	-32	33.33	1865	Short
40	59	6.13	-33	49.67	2280	Large
41	59	14.07	-35	7.27	2985	Short
42	59	21.78	-36	23.79	3093	Large
43	59	29.48	-37	40.83	3111	Short
44	59	37.42	-38	57.46	2925	Super
45	59	29.48	-37	40.83	3111	Short
46	59	37.42	-38	57.46	2925	Short
47	59	43.38	-40	15.16	2657	Short
48	59	45.48	-40	54.24	2273	Short
49	59	46.39	-41	17.78	2039	Large
50	59	47.70	-41	43.80	1845	Short
51	59	47.95	-42	0.17	1722	Short (with ISP)
52	59	48.54	-42	14.22	1199	Short
53	59	54.77	-43	4.42	169	XLarge
54	59	52.20	-42	48.60	227	Short
55	59	49.86	-42	31.20	308	Short
56	59	49.36	-42	23.93	308	Large
57	59	49.08	-42	18.78	574	Short
58	59	48.96	-42	16.50	891	Short
59	59	48.54	-42	14.22	1199	Short
60	59	47.95	-42	0.17	1722	Super
61	59	44.16	-45	7.08	139	XLarge
62	59	30.12	-45	37.17	506	Short
63	59	26.05	-45	39.95	1589	Large
64	59	4.04	-46	4.97	2114	Super
65	58	34.98	-46	23.10	2515	Short
66	57	59.53	-46	45.18	2475	Short
67	57	34.68	-47	0.66	2900	Short
68	56	55.02	-47	25.38	3585	Large
69	55	50.51	-48	5.59	3578	Super_Overcross
70	54	46.01	-48	45.79	3729	Short
71	53	41.50	-49	26.00	3704	Large
72	53	8.50	-50	52.00	2870	Short
73	52	56.00	-51	23.51	2000	Short
74	52	51.10	-51	35.80	1250	Short
75	52	47.16	-51	45.63	492	Short
76	52	30.00	-52	30.00	260	Short
77	53	0.00	-51	6.00	2500	Super
78	52	6.84	-53	26.40	228	XLarge
Port St-John's	47	30.00	-53	17.28		

Typical schedules of Short, Large, XLarge and Super stations were as follow:

1- Short Station (example of station #39):

Station #39 (Short station, 58°58.39'N; 32°33.33'W) Depth = ~ 1860 m

Operations	Local time	Durations (h)	Cast number
Station localization	**11/6/14, 22:20**	00: 10	
CTD-Hydro	**11/6/14, 22:30**	01: 50	01
SVP-SAL + APEX-DO	**12/6/14, 0:20**	00: 10	
End of Station	**12/6/14, 0:30**		

2- Large station (example of station #42)

Station #42 (Large station, 59°21.78'N; 36°23.79'W) **Depth = ~ 3000 m**

Operations	Local time	Durations (h)	Cast number
Station localization	**12/6/14, 19:45**	00: 10	
CTD-Hydro	**12/6/14, 19:55**	02: 30	01
TMR-stock	**12/6/14, 22:25**	02: 30	02
CTD-Hydro-Biogeo-Shallow	**13/6/14, 0:55**	00: 50	03
End of Station	**13/6/14, 1:45**		

3- XLarge station (example of station #26)

Station #26 (XLarge station, 50°16.67'N; 22°36.28'W) **Depth = ~ 4100 m**

Operations	Local time	Durations (h)	Cast number
Station localization	**4/6/14, 4:15**	00: 20	
CTD-Hydro	**4/6/14, 4:35**	03: 00	01
TMR-stock	**4/6/14, 6:45**	03: 00	02
CTD-Ra+REE+Th+Ba	**4/6/14, 9:45**	03: 00	03
ISP	**4/6/14, 12:45**	07: 10	04
CTD-Pa/Th/Pb/Po/Be/art radion.	**4/6/14, 19:55**	01: 20	05
TMR-Fe-isotopes	**4/6/14, 21:15**	03: 00	06
CTD-Biogeo-Shallow	**5/6/14, 0:15**	00: 50	07
ARVOR deployment	**5/6/14, 1:05**	00: 10	
End of Station	**5/6/14, 1:15**		

4- Super station (example of station #44)

Station #44 (Super station,59°37.42'N, 38°57.46'W) **Depth = ~ 2900 m**

Operations	Local time	Durations (h)	Cast number
Station localization	**13/6/14, 12:15**	00: 20	
CTD-Hydro	**13/6/14, 12:35**	02: 20	01
TMR-stock	**13/6/14, 14:55**	02: 20	02
CTD-Biogeo-Shallow	**13/6/14, 17:15**	00: 40	03
ISP-Shallow	**13/6/14, 17:55**	04: 30	04
CTD-Pa/Th/Pb/Po	**13/6/14, 22:25**	02: 20	05
TMR-Fe-isotopes	**14/6/14, 0:45**	02: 20	06
CTD-Ra+REEs	**14/6/14, 3:05**	02: 20	07
ISP-Deep	**14/6/14, 5:25**	07: 30	08
CTD-Biogeo-Remin+REEs	**14/6/14, 12:55**	01: 20	09
TMR-particulate	**14/6/14, 14:15**	02: 20	10
CTD-Be	**14/6/14, 16:35**	00: 20	11
Plankton net	**14/6/14, 16:55**	00: 45	12
CTD-Radionuclides	**14/6/14, 17:40**	02: 20	13
PROVBIO-2	**14/6/14, 20:00**	00: 10	
End of Station	**14/6/14, 20:10**		

We have deployed:

- 163 times the classical rosette on the bathysonde winch, except at station 14, 15, 16, 17, and 59, where the classical rosette was deployed on the clean winch
- 53 times the clean rosette on the clean winch

- 25 times the in-situ pumps on the hydro winch
- 11 times the mono-corer on the hydro winch, with or without the in-situ pumps clamped on the cable.
- 9 times the plankton net.

We also collected:

- 140 sea-surface samples using a fish towed from the ship's starboard side and deployed at 1–2m below the surface
- 18 aerosol samples
- 10 rainwater samples
- 9 times the plankton net.

Finally, we dropped:

- 60 XBTs
- 8 ARVOR, 2 ARVOR-deep, 2 PROVOR-DO, 2 PROVBIO, 1 ARVOR double DO, 2 APEX
- 12 weather buoys

The parameters that were measured during the cruise or will be at the on-land laboratories are reported on Table 1.

Table 1: list of parameters measured during the GEOVIDE cruise.

GEOVIDE Parameters	Methods	Laboratories	Persons in charge
Physical parameters			
Temperature	CTD	LPO, DT-INSU	P. Lherminier
Salinity	CTD, salinometer	LPO, DT-INSU	P. Lherminier
Fluorescence	CTD, *in-situ* sensors	LPO, DT-INSU	P. Lherminier
Dissolved O_2	*In-situ* sensors, Winkler titration	LPO, DT-INSU	P. Lherminier
Current velocity	SADCP/LADCP/altimetry	LPO	P. Lherminier
PAR		DT-INSU	
Transmissiometry		DT-INSU	
Carbonic system			
pH	Spectrophotometry colorimetry	CSIC-IIM	A.F. Ríos A.F./F.F. Pérez
Total alkalinity	Potentiometric titration	CSIC-IIM	A.F. Ríos A.F./F.F. Pérez/N. Metzl
DIC	SOMMA/AIRICA	CSIC-IIM	A.F. Ríos A.F./F.F. Pérez/N. Metzl
pCO2	Spectrophotometric detection	CSIC-IIM	A.F. Ríos A.F./F.F. Pérez
Ancillary measurements			
Macro-nutrients	Colorimetry, fluorimetry	UBO	P. Tréguer
Chla	Fluorimetry	LEMAR	R. Corvaisier
POC/PON	CHN	LEMAR	R. Corvaisier
BSi	Colorimetry	LEMAR	R. Corvaisier
Pigments	HPLC	LOV	H. Claustre
Biogeotraces		Univ. Dalhousie	R. Barkhouse/J. Laroche
C- and N (NO_3^- and NH_4^+)-uptake	Mass spectrometry	VUB	F. Dehairs
Bacterial counts	Flow cytometry	LEMAR	C. Lambert
Pico-nanoplankton	Flow cytometry	LEMAR	C. Lambert
TEIs			
Fe speciation	FIA-chemiluminescence	LEMAR	G. Sarthou/H. Planquette
Trace metals	SF-ICP-MS	LEMAR	G. Sarthou/H. Planquette
Fe and Cu organic speciation	Voltammetry	LEMAR	G. Sarthou/E. Bucciarelli
Al/Ag	FIA-fluorimetry	NOC	E. Achterberg
$\delta^{15}N/\delta^{18}O$ (nitrate)	IRMS	VUB	F. Dehairs
$\delta^{13}C/\delta^{18}O$	Mass spectrometry	LOCEAN	C. Pierre/G. Reverdin/N. Metzl
$^{231}Pa/^{230}Th$	MC-ICP-MS	Univ. Oxford	G. Henderson
Pb isotopes	MC-ICP-MS	MIT	E. Boyle
Nd isotopes	Mass spectrometry	LEGOS	C. Jeandel
Particulate TEIs	SF-ICP-MS	LEMAR, LEGOS	H. Planquette/F. Lacan
Aerosol trace metals	ICP-MS	LEMAR	R. Shelley/G. Sarthou
Fe isotopes	MC-ICP-MS	LEGOS	F. Lacan
REEs	SF-ICP-MS	LEGOS	C. Jeandel
Ra isotopes / Ac	Gamma counting	LEGOS	P. Van Beek
$^{234}Th/Ba_{xs}$	Beta counting	LEMAR, VUB	F. Planchon/F. Dehairs
$^{210}Pb/^{210}Po$	Alpha detection	Univ. Barcelona	M. Castrillejo/P. Masque
Radionuclides	Beta/gamma detection, ICP-MS	Univ. Barcelona	M. Castrillejo/P. Masque
Hg speciation	Atomic fluorescence spectroscopy	Ifremer, LTGE	D. Cossa/L.-E. Heimburger
^{14}C	Mass spectrometry	LSCE	N. Tisnerat
$\delta^{30}Si$	MC-ICP-MS	LEMAR	J. Sutton/C. de la Rocha
Cu/Zn isotopes	MC-ICP-MS	ETH Zürich	D. Vance
Cd isotopes	MC-ICP/MS	Univ. Oxford	G. Henderson
$^{227}Ac/^{7}Be$	Gamma counting	LEGOS/Univ. Barcelona	P. Van Beek/P. Masque
^{236}U	Low energy AMS	Univ. Barcelona	P. Masque
^{137}Cs	Gamma spectrometry	Univ. Barcelona	P. Masque
^{90}Sr	Beta counting	Univ. Barcelona	P. Masque
Pu isotopes, ^{237}Np	SF-ICP-MS	Univ. Barcelona	P. Masque

The detailed logbook is reported below.

II.3. Logbook

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
TEST	0	CTD-Hydro	-	17/05/2014	15:31	38.433 °N -10.7001 °E	38° 25.97' S 010° 42.00' W	4 860 m				00° 00.00' S 000° 00.00' W			17/05/2014	16:10	38.433 °N -10.7001 °E	38° 25.97' S 010° 42.01' W	4 858 m	00:38	Problem with the Bathy portic. CTD cancelled
TEST	0	CTD-Hydro	-	17/05/2014	19:04	38.433 °N -10.7001 °E	38° 25.97' S 010° 42.00' W	4 856 m				00° 00.00' S 000° 00.00' W			17/05/2014	20:10	38.433 °N -10.7001 °E	38° 25.98' S 010° 42.00' W	4 855 m	01:06	Problem with CTD. CTD cancelled
TEST	0	CTD-Hydro	-	17/05/2014	21:09	38.433 °N -10.7001 °E	38° 25.98' S 010° 42.00' W	4 856 m				00° 00.00' S 000° 00.00' W			17/05/2014	21:17	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 855 m	00:08	Problem with CTD. CTD cancelled
TEST	0	TMR-Stock	geop_000_01	17/05/2014	22:29	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 854 m	18/05/2014	00:36	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W		02:07	18/05/2014	03:04	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 856 m	04:34	
TEST	0	CTD-Hydro	geoh_000_02	18/05/2014	03:15	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 856 m	18/05/2014	05:00	38.433 °N -10.7000 °E	38° 25.98' S 010° 42.00' W	4 857 m	01:45	18/05/2014	06:33	38.433 °N -10.7000 °E	38° 25.98' S 010° 42.00' W	4 857 m	03:18	
TEST	0	ISP-Deep	geoi_000_03	18/05/2014	07:50	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 856 m	18/05/2014	08:42	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 855 m	00:51	18/05/2014	10:24	38.433 °N -10.7000 °E	38° 25.97' S 010° 42.00' W	4 856 m	02:33	
Sp	1	CTD-Hydro	geoh_001_01	18/05/2014	21:36	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	18/05/2014	22:44	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	4 359 m	01:07	19/05/2014	00:34	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 511 m	02:57	
Sp	1	TMR-stock	geop_001_02	19/05/2014	00:55	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 514 m	19/05/2014	02:27	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	01:31	19/05/2014	04:30	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	03:34	
Sp	1	CTD-Biogeo-Shallow	geoh_001_03	19/05/2014	04:47	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	19/05/2014	05:06	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 516 m	00:18	19/05/2014	05:31	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	00:43	
Sp	1	ISP-Shallow	geoi_001_04	19/05/2014	06:00	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 516 m	19/05/2014	08:42	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 516 m	02:42	19/05/2014	10:55	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 513 m	04:55	
Sp	1	CTD-Pa/Th/Pb/Po	geoh_001_05	19/05/2014	10:59	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 513 m	19/05/2014	12:09	40.333 °N -10.0359 °E	40° 19.99' S 010° 02.16' W	3 514 m	01:10	19/05/2014	13:44	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	02:45	
Sp	1	TMR-Fe-isotopes	geop_001_06	19/05/2014	14:46	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	19/05/2014	16:05	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	3 515 m	01:18	19/05/2014	17:38	40.333 °N -10.0359 °E	40° 19.99' S 010° 02.16' W	3 515 m	02:51	
Sp	1	CTD-Ra+REEs	geoh_001_07	19/05/2014	17:53	40.333 °N -10.0359 °E	40° 19.99' S 010° 02.16' W	3 515 m	19/05/2014	19:00	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 514 m	01:07	19/05/2014	20:18	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.15' W	3 514 m	02:25	
Sp	1	ISP-Deep	geoi_001_08	19/05/2014	22:31	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 515 m							20/05/2014	06:32	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 515 m	08:00	
Sp	1	CTD-Biogeo-Remin+REEs	geoh_001_09	20/05/2014	06:45	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 516 m	20/05/2014	07:19	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.15' W	3 515 m	00:33	20/05/2014	08:08	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 516 m	01:22	
Sp	1	TMR-particulate	geop_001_010	20/05/2014	08:24	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.15' W	3 515 m	20/05/2014	10:12	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.15' W	3 517 m	01:48	20/05/2014	12:10	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 515 m	03:46	
Sp	1	CTD-Be	geoh_001_11	20/05/2014	12:28	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	3 515 m	20/05/2014	12:33	40.333 °N -10.0360 °E	40° 20.00' S 010° 02.16' W	3 516 m	00:05	20/05/2014	12:48	40.334 °N -10.0364 °E	40° 20.02' S 010° 02.19' W	3 509 m	00:20	
Sp	1	Plankton net	geon_001_12	20/05/2014	13:00	40.339 °N -10.0359 °E	40° 20.32' S 010° 02.15' W	3 486 m							20/05/2014	13:30	40.333 °N -10.0413 °E	40° 19.96' S 010° 02.48' W	3 484 m	00:30	
Sp	1	CTD-Radionuclides	geoh_001_13	20/05/2014	14:15	40.333 °N -10.0358 °E	40° 19.99' S 010° 02.15' W	3 519 m	20/05/2014	15:26	40.333 °N -10.0358 °E	40° 19.99' S 010° 02.15' W	3 519 m	01:10	20/05/2014	16:42	40.333 °N -10.0358 °E	40° 19.99' S 010° 02.15' W	3 519 m	02:26	
XL	2	CTD-Hydro++	geoh_002_01	20/05/2014	20:26	40.333 °N -09.4595 °E	40° 19.99' S 009° 27.57' W	153 m	20/05/2014	20:38	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	152 m	00:11	20/05/2014	21:03	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	154 m	00:36	
XL	2	ISP-Bottom	geoi_002_02	20/05/2014	21:15	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	154 m							21/05/2014	01:15	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	152 m	03:59	
XL	2	TMR-stock++	geop_002_03	21/05/2014	01:44	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	152 m	21/05/2014	02:03	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	152 m	00:19	21/05/2014	02:27	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	152 m	00:42	
XL	2	Corer	geosc_002_04	21/05/2014	02:33	40.333 °N -09.4594 °E	40° 19.98' S 009° 27.57' W	152 m							21/05/2014	02:45	40.333 °N -09.4595 °E	40° 19.98' S 009° 27.57' W	152 m	00:12	
S	3	CTD-Hydro	geoh_003_1	21/05/2014	04:20	40.333 °N -09.6432 °E	40° 19.97' S 009° 38.59' W	439 m	21/05/2014	04:37	40.333 °N -09.6432 °E	40° 19.98' S 009° 38.59' W	439 m	00:16	21/05/2014	04:59	40.333 °N -09.6432 °E	40° 19.98' S 009° 38.59' W	440 m	00:38	
L	4	CTD-Hydro	geoh_004_01	21/05/2014	15:50	40.333 °N -09.7664 °E	40° 20.00' S 009° 45.99' W	803 m	21/05/2014	16:21	40.333 °N -09.7668 °E	40° 19.99' S 009° 46.01' W	803 m	00:30	21/05/2014	16:47	40.333 °N -09.7668 °E	40° 19.99' S 009° 46.01' W	803 m	00:57	
L	4	TMR-stock	geop_004_02	21/05/2014	17:12	40.333 °N -09.7668 °E	40° 19.99' S 009° 46.01' W	805 m	21/05/2014	17:44	40.333 °N -09.7669 °E	40° 19.99' S 009° 46.01' W	805 m	00:31	21/05/2014	18:25	40.333 °N -09.7668 °E	40° 19.99' S 009° 46.01' W	805 m	01:12	
S	5	CTD-Hydro	geoh_005_1	21/05/2014	19:07	40.333 °N -09.8020 °E	40° 19.98' S 009° 48.12' W	1 344 m	21/05/2014	19:39	40.333 °N -09.8019 °E	40° 19.98' S 009° 48.11' W		00:32	21/05/2014	20:27	40.333 °N -09.8019 °E	40° 19.98' S 009° 48.12' W	1 333 m	01:19	
S	6	CTD-Hydro	geoh_006_1	21/05/2014	21:49	40.333 °N -09.8762 °E	40° 19.99' S 009° 52.57' W	2 378 m	21/05/2014	22:39	40.333 °N -09.8760 °E	40° 19.96' S 009° 52.56' W		00:50	21/05/2014	23:50	40.333 °N -09.8761 °E	40° 19.95' S 009° 52.56' W	2 354 m	02:00	
S	7	CTD-Hydro	geoh_007_1	22/05/2014	01:29	40.333 °N -09.9441 °E	40° 19.98' S 009° 56.64' W	3 368 m	22/05/2014	02:34	40.333 °N -09.9440 °E	40° 19.98' S 009° 56.64' W	3 395 m	01:05	22/05/2014	04:03	40.333 °N -09.9440 °E	40° 19.98' S 009° 56.64' W	3 394 m	02:34	
S	8	CTD-Hydro	geoh_008_1	22/05/2014	05:29	40.333 °N -10.0358 °E	40° 19.98' S 010° 02.15' W	3 516 m	22/05/2014	06:37	40.333 °N -10.0359 °E	40° 19.98' S 010° 02.15' W	3 515 m	01:08	22/05/2014	08:13	40.333 °N -10.0359 °E	40° 19.98' S 010° 02.15' W	3 515 m	02:44	
S	9	CTD-Hydro	geoh_009_1	22/05/2014	11:12	40.333 °N -10.5773 °E	40° 19.95' S 010° 34.64' W	4 345 m	22/05/2014	12:31	40.333 °N -10.5774 °E	40° 19.97' S 010° 34.64' W	4 346 m	01:19	22/05/2014	14:28	40.333 °N -10.5774 °E	40° 19.97' S 010° 34.64' W	4 346 m	03:16	
	9	Fish		22/05/2014	14:48	40.334 °N -10.5906 °E	40° 20.06' S 010° 35.44' W	4 421 m													Fish remains in the water. No pumping.
		XBT_1		22/05/2014	16:31	40.333 °N -10.9026 °E	40° 19.98' S 010° 54.15' W	4 847 m													
S	10	CTD-Hydro	geoh_010_1	22/05/2014	18:49	40.333 °N -11.3401 °E	40° 19.98' S 011° 20.41' W	5 095 m	22/05/2014	20:23	40.333 °N -11.3401 °E	40° 19.98' S 011° 20.41' W	5 096 m	01:33	22/05/2014	22:14	40.333 °N -11.3401 °E	40° 19.98' S 011° 20.41' W	5 097 m	03:24	
		XBT_2		23/05/2014	00:32	40.333 °N -11.7815 °E	40° 19.97' S 011° 46.89' W	5 214 m													
L	11	CTD-Hydro	geoh_011_1	23/05/2014	02:53	40.332 °N -12.2193 °E	40° 19.93' S 012° 13.16' W	5 257 m	23/05/2014	04:36	40.333 °N -12.2190 °E	40° 19.95' S 012° 13.14' W	5 257 m	01:43	23/05/2014	06:29	40.333 °N -12.2190 °E	40° 19.95' S 012° 13.14' W	5 258 m	03:36	
L	11	TMR-stock	geop_011_2	23/05/2014	06:37	40.333 °N -12.2190 °E	40° 19.96' S 012° 13.14' W	5 258 m	23/05/2014	08:53	40.333 °N -12.2191 °E	40° 19.96' S 012° 13.14' W	5 259 m	02:15	23/05/2014	11:16	40.333 °N -12.2191 °E	40° 19.95' S 012° 13.14' W	5 258 m	04:39	
L	11	CTD-Biogeoch-Surface	geoh_011_3	23/05/2014	11:22	40.333 °N -12.2191 °E	40° 19.96' S 012° 13.14' W	5 258 m	23/05/2014	11:35	40.333 °N -12.2190 °E	40° 19.95' S 012° 13.14' W	5 258 m	00:12	23/05/2014	11:54	40.333 °N -12.2190 °E	40° 19.95' S 012° 13.14' W	5 258 m	00:31	
		ARVOR_1		23/05/2014	12:07	40.334 °N -12.2189 °E	40° 20.05' S 012° 13.13' W	5 258 m													11
		Deep-ARVOR_1		23/05/2014	12:10	40.336 °N -12.2225 °E	40° 20.17' S 012° 13.35' W	5 260 m													11
		XBT_3		23/05/2014	14:39	40.546 °N -12.6399 °E	40° 32.77' S 012° 38.39' W	5 304 m													
S	12	CTD-Hydro	geoh_0012_1	23/05/2014	17:40	40.787 °N -13.0999 °E	40° 47.23' S 013° 05.99' W	5 334 m	23/05/2014	19:20	40.787 °N -13.1000 °E	40° 47.22' S 013° 06.00' W	5 336 m	01:39	23/05/2014	21:20	40.787 °N -13.1000 °E	40° 47.22' S 013° 06.00' W	5 335 m	03:39	

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
		XBT_4		24/05/2014	00:09	41.087 °N -13.4936 °E	41° 05.21' S 013° 29.61' W	5 346 m													
Sp	13	CTD-Hydro	geoh_013_01	24/05/2014	03:05	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 345 m	24/05/2014	04:47	41.383 °N -13.8877 °E	41° 22.98' S 013° 53.26' W	5 345 m	01:41	24/05/2014	06:42	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	03:36	
Sp	13	TMR-stock	geop_013_02	24/05/2014	06:50	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	24/05/2014	09:00	41.383 °N -13.8877 °E	41° 22.98' S 013° 53.26' W	5 346 m	02:09	24/05/2014	11:21	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 347 m	04:30	
Sp	13	CTD-Biogeo-Shallow	geoh_013_03	24/05/2014	11:28	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	5 347 m	24/05/2014	11:38	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	5 346 m	00:10	24/05/2014	12:06	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	5 347 m	00:38	
Sp	13	ISP-Shallow	geoi_013_04	24/05/2014	12:30	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	5 347 m	24/05/2014	13:05	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W		00:34	24/05/2014	17:31	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 345 m	05:00	
Sp	13	CTD-Pa/Th/Pb/Po	geoh_013_05	24/05/2014	17:45	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 345 m	24/05/2014	19:21	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	5 345 m	01:36	24/05/2014	21:18	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 346 m	03:33	
Sp	13	TMR-Fe-isotopes	geop_013_06	24/05/2014	22:21	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	5 346 m	25/05/2014	00:23	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 347 m	02:01	25/05/2014	02:33	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 346 m	04:12	
Sp	13	CTD-Ra+REEs	geoh_013_07	25/05/2014	02:47	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 346 m	25/05/2014	04:27	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	01:40	25/05/2014	06:18	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	03:31	
Sp	13	ISP-Deep + corer	geoi_013_08	25/05/2014	06:35	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m							25/05/2014	15:30	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 346 m	08:54	
Sp	13	CTD-Biogeo-Remin+REEs	geoh_013_09	25/05/2014	15:46	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	25/05/2014	16:24	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 345 m	00:38	25/05/2014	17:07	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 346 m	01:21	
Sp	13	TMR-particulate	geop_013_010	25/05/2014	17:17	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	25/05/2014	19:18	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 345 m	02:01	25/05/2014	21:53	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 346 m	04:35	
Sp	13	CTD-Be	geoh_013_11	25/05/2014	22:00	41.383 °N -13.8876 °E	41° 22.97' S 013° 53.26' W	5 346 m	26/05/2014	00:59	41.383 °N -13.8875 °E	41° 22.97' S 013° 53.25' W	5 347 m	02:58	25/05/2014	22:24	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 346 m	00:23	
Sp	13	Plankton net	geon_013_12	25/05/2014	22:35	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	5 346 m				00° 00.00' S 000° 00.00' W		01:25	25/05/2014	23:15	41.383 °N -13.8875 °E	41° 22.97' S 013° 53.25' W	5 347 m	00:40	
Sp	13	CTD-Radionuclides	geoh_013_13	25/05/2014	23:21	41.383 °N -13.8875 °E	41° 22.97' S 013° 53.25' W	5 347 m	28/05/2014	00:21	41.983 °N -14.6725 °E	41° 58.96' S 014° 40.35' W	5 331 m	01:00							Big problem with the winch!
		XBT_5		27/05/2014	13:59	41.653 °N -14.2402 °E	41° 39.15' S 014° 14.41' W	5 342 m													
S	14	CTD-Hydro	geoh_014_01	27/05/2014	22:37	41.983 °N -14.6725 °E	41° 58.96' S 014° 40.35' W	5 329 m	28/05/2014	09:53	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 969 m	11:15	28/05/2014	02:41	41.983 °N -14.6725 °E	41° 58.96' S 014° 40.35' W	5 331 m	04:03	
		XBT_6		28/05/2014	05:37	42.292 °N -15.0780 °E	42° 17.54' S 015° 04.68' W	5 306 m													
L	15	CTD-Hydro	geoh_015_01	28/05/2014	08:29	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 969 m	28/05/2014	13:57	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 971 m	05:28	28/05/2014	11:55	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	5 046 m	03:26	
L	15	TMR-stock	geop_015_02	28/05/2014	12:25	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 970 m	28/05/2014	13:57	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 971 m	01:32	28/05/2014	15:44	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 970 m	03:19	
L	15	CTD-Biogeoch-Surface	geoh_015_03	28/05/2014	16:08	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 970 m	28/05/2014	16:20	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 970 m	00:12	28/05/2014	16:38	42.581 °N -15.4611 °E	42° 34.87' S 015° 27.67' W	4 970 m	00:30	
		ARVOR_2		28/05/2014	16:46	42.581 °N -15.4636 °E	42° 34.88' S 015° 27.82' W							07:13							15
		XBT_7		28/05/2014	19:31	42.878 °N -15.8463 °E	42° 52.66' S 015° 50.78' W							04:28							
S	16	CTD-Hydro	geoh_016_01	28/05/2014	23:50	43.181 °N -16.2453 °E	43° 10.89' S 016° 14.72' W	5 130 m	29/05/2014	01:20	43.181 °N -16.2454 °E	43° 10.89' S 016° 14.72' W	5 131 m	01:29	29/05/2014	03:20	43.181 °N -16.2454 °E	43° 10.89' S 016° 14.72' W	4 821 m	03:30	
		XBT_8		29/05/2014	06:15	43.486 °N -16.6444 °E	43° 29.15' S 016° 38.66' W							17:44							
L	17	CTD-Hydro	geoh_017_01	29/05/2014	08:45	43.780 °N -17.0322 °E	43° 46.80' S 017° 01.93' W	4 013 m	29/05/2014	09:55	43.780 °N -17.0318 °E	43° 46.79' S 017° 01.91' W	4 012 m	01:10	29/05/2014	11:43	43.780 °N -17.0315 °E	43° 46.79' S 017° 01.89' W	4 013 m	02:58	
L	17	TMR-stock	geop_017_02	29/05/2014	12:04	43.780 °N -17.0314 °E	43° 46.79' S 017° 01.88' W	4 013 m	29/05/2014	13:21	43.780 °N -17.0314 °E	43° 46.79' S 017° 01.88' W	4 014 m	01:17	29/05/2014	14:51	43.780 °N -17.0314 °E	43° 46.79' S 017° 01.88' W	4 014 m	02:47	
L	17	CTD-Biogeoch-Surface	geoh_017_03	29/05/2014	15:10	43.780 °N -17.0314 °E	43° 46.79' S 017° 01.88' W	4 014 m	29/05/2014	15:22	43.780 °N -17.0314 °E	43° 46.79' S 017° 01.88' W	4 014 m	00:12	29/05/2014	15:41	43.780 °N -17.0314 °E	43° 46.79' S 017° 01.88' W	4 014 m	00:31	
		XBT_9		29/05/2014	21:15	44.080 °N -17.4246 °E	44° 04.82' S 017° 25.48' W	3 779 m						02:44							
S	18	CTD-Hydro	geoh_018_01	30/05/2014	03:15	44.377 °N -17.8168 °E	44° 22.60' S 017° 49.01' W	4 832 m	30/05/2014	04:44	44.377 °N -17.8169 °E	44° 22.60' S 017° 49.01' W	4 872 m	01:29	30/05/2014	06:47	44.377 °N -17.8169 °E	44° 22.60' S 017° 49.01' W	4 821 m	03:32	
		XBT_10		30/05/2014	09:15	44.706 °N -18.1554 °E	44° 42.35' S 018° 09.32' W	4 904 m													
L	19	CTD-Hydro	geoh_019_01	30/05/2014	11:55	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 525 m	30/05/2014	13:20	45.050 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 541 m	01:25	30/05/2014	15:06	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 527 m	03:11	
L	19	TMR-stock	geop_019_02	30/05/2014	15:16	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 527 m	30/05/2014	16:48	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 536 m	01:31	30/05/2014	18:29	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 534 m	03:12	
L	19	CTD-Biogeoch-Surface	geoh_019_03	30/05/2014	18:34	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 536 m	30/05/2014	18:45	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 535 m	00:10	30/05/2014	19:10	45.051 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	4 526 m	00:35	
		XBT_11		30/05/2014	21:42	45.423 °N -18.7966 °E	45° 25.38' S 018° 47.80' W	4 580 m						02:17							
S	20	CTD-Hydro	geoh_020_01	31/05/2014	00:22	45.794 °N -19.0914 °E	45° 47.63' S 019° 05.49' W	4 525 m	31/05/2014	01:44	45.794 °N -19.0914 °E	45° 47.63' S 019° 05.49' W	4 525 m	01:22	31/05/2014	03:29	45.794 °N -19.0915 °E	45° 47.63' S 019° 05.49' W		03:06	
		XBT_12		31/05/2014	05:53	46.181 °N -19.3898 °E	46° 10.88' S 019° 23.39' W														
		ARVOR_3		31/05/2014	07:56	46.512 °N -19.6470 °E	46° 30.70' S 019° 38.82' W	4 763 m													avant 21
		Deep-ARVOR_2		31/05/2014	08:02	46.517 °N -19.6517 °E	46° 31.05' S 019° 39.10' W	4 703 m													avant 21
Sp	21	CTD-Hydro	geoh_021_01	31/05/2014	08:40	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 484 m	31/05/2014	10:02	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 603 m	01:22	31/05/2014	11:56	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 634 m	03:16	
Sp	21	TMR-stock	geop_021_02	31/05/2014	12:02	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 658 m	31/05/2014	13:21	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 518 m	01:19	31/05/2014	14:58	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 549 m	02:56	
Sp	21	CTD-Biogeo-Shallow	geoh_021_03	31/05/2014	15:01	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 610 m	31/05/2014	15:10	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 544 m	00:08	31/05/2014	15:34	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 611 m	00:32	
Sp	21	ISP-Shallow	geoh_021_04	31/05/2014	15:52	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 660 m	31/05/2014	16:40	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 610 m	00:47	31/05/2014	20:15	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 476 m	04:22	
Sp	21	TMR-Hg-isotopes	geop_021_05	31/05/2014	20:22	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 476 m	31/05/2014	21:28	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 478 m	01:05	31/05/2014	22:35	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 475 m	02:13	

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
Sp	21	CTD-Pa/Th/Pb/Po	geoh_021_06	31/05/2014	22:40	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 475 m	01/06/2014	00:02	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 475 m	01:22	01/06/2014	01:48	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W		03:08	
Sp	21	TMR-Fe-isotopes	geop_021_07	01/06/2014	01:56	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 477 m	01/06/2014	03:23	46.544 °N -19.6720 °E	46° 32.65' S 019° 40.32' W	4 477 m	01:27	01/06/2014	05:01	46.544 °N -19.6719 °E	46° 32.64' S 019° 40.32' W	4 479 m	03:04	
Sp	21	CTD-Ra+REEs	geoh_021_08	01/06/2014	05:12	46.544 °N -19.6719 °E	46° 32.64' S 019° 40.32' W	4 473 m	01/06/2014	06:36	46.544 °N -19.6719 °E	46° 32.64' S 019° 40.32' W	4 472 m	01:24	01/06/2014	08:24	46.544 °N -19.6720 °E	46° 32.64' S 019° 40.32' W	4 479 m	03:12	
Sp	21	ISP-Deep + corer	geoh_021_09	01/06/2014	08:32	46.544 °N -19.6719 °E	46° 32.64' S 019° 40.32' W	4 473 m	01/06/2014	10:56	46.544 °N -19.6719 °E	46° 32.64' S 019° 40.32' W		02:23	01/06/2014	17:13	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 467 m	08:41	
Sp	21	CTD-Biogeo-Remin+REEs	geoh_021_10	01/06/2014	17:28	46.544 °N -19.6724 °E	46° 32.67' S 019° 40.35' W	4 468 m	01/06/2014	17:56	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 467 m	00:28	01/06/2014	18:47	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 467 m	01:19	
Sp	21	TMR-particulate	geop_021_11	01/06/2014	18:51	46.544 °N -19.6724 °E	46° 32.67' S 019° 40.35' W	4 467 m	01/06/2014	20:23	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 358 m	01:31	01/06/2014	22:12	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 466 m	03:20	
Sp	21	CTD-Be	geoh_021_12	01/06/2014	22:15	46.545 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 466 m	01/06/2014	22:22	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 467 m	00:06	01/06/2014	22:35	46.544 °N -19.6725 °E	46° 32.67' S 019° 40.35' W	4 466 m	00:19	
Sp	21	Plankton net	geon_021_13	01/06/2014	22:48	46.547 °N -19.6723 °E	46° 32.80' S 019° 40.34' W	4 458 m							01/06/2014	23:15	46.544 °N -19.6732 °E	46° 32.66' S 019° 40.39' W	4 469 m	00:27	The collector broke
Sp	21	CTD-Radionuclides	geoh_021_14	01/06/2014	23:33	46.544 °N -19.6721 °E	46° 32.65' S 019° 40.33' W	4 467 m	02/06/2014	00:57	46.544 °N -19.6722 °E	46° 32.65' S 019° 40.33' W	4 467 m	01:23	02/06/2014	02:34	46.544 °N -19.6722 °E	46° 32.65' S 019° 40.33' W	4 468 m	03:00	
		XBT_13		02/06/2014	05:25	46.924 °N -19.9709 °E	46° 55.41' S 019° 58.25' W														Problems with the profile. Negative temperature peaks
S	22	CTD-Hydro	geoh_022_01	02/06/2014	08:16	47.290 °N -20.2619 °E	47° 17.39' S 020° 15.71' W	4 513 m	02/06/2014	09:38	47.290 °N -20.2619 °E	47° 17.39' S 020° 15.71' W	4 513 m	01:22	02/06/2014	11:25	47.290 °N -20.2619 °E	47° 17.39' S 020° 15.71' W		03:08	
		XBT_14		02/06/2014	14:05	47.669 °N -20.5563 °E	47° 40.13' S 020° 33.38' W														
L	23	CTD-Hydro	geoh_023_01	02/06/2014	16:43	48.039 °N -20.8474 °E	48° 02.35' S 020° 50.84' W	4 456 m	02/06/2014	18:07	48.039 °N -20.8476 °E	48° 02.34' S 020° 50.86' W	4 456 m	01:23	02/06/2014	20:00	48.039 °N -20.8476 °E	48° 02.34' S 020° 50.86' W	4 456 m	03:16	
L	23	TMR-stock	geop_023_02	02/06/2014	20:05	48.039 °N -20.8476 °E	48° 02.34' S 020° 50.85' W	4 456 m	02/06/2014	21:28	48.039 °N -20.8476 °E	48° 02.34' S 020° 50.85' W	4 455 m	01:23	02/06/2014	23:08	48.039 °N -20.8475 °E	48° 02.34' S 020° 50.85' W	4 455 m	03:03	
L	23	CTD-Biogeoch-Surface	geoh_023_03	02/06/2014	23:11	48.039 °N -20.8476 °E	48° 02.34' S 020° 50.85' W	4 455 m	02/06/2014	23:21	48.039 °N -20.8475 °E	48° 02.34' S 020° 50.85' W	4 455 m	00:09	02/06/2014	23:41	48.039 °N -20.8476 °E	48° 02.34' S 020° 50.85' W	4 455 m	00:30	
L	23	Plankton net	geon_023_03	02/06/2014	23:50	48.042 °N -20.8471 °E	48° 02.50' S 020° 50.83' W	4 456 m							03/06/2014	00:20	48.054 °N -20.8848 °E	48° 03.21' S 020° 53.09' W	4 427 m	00:30	
		ARVOR_4		02/06/2014	23:52	48.042 °N -20.8493 °E	48° 02.53' S 020° 50.96' W	4 455 m													23
		XBT_15		03/06/2014	02:48	48.415 °N -21.1409 °E	48° 24.90' S 021° 08.45' W	4 345 m													
S	24	CTD-Hydro	geoh_024_01	03/06/2014	05:44	48.785 °N -21.4323 °E	48° 47.13' S 021° 25.94' W	4 075 m	03/06/2014	07:01	48.785 °N -21.4322 °E	48° 47.13' S 021° 25.93' W	4 074 m	01:16	03/06/2014	08:43	48.785 °N -21.4323 °E	48° 47.13' S 021° 25.94' W	4 077 m	02:58	
		XBT_16		03/06/2014	11:54	49.156 °N -21.7234 °E	49° 09.37' S 021° 43.40' W	4 343 m													
L	25	CTD-Hydro	geoh_024_01	03/06/2014	15:18	49.529 °N -22.0173 °E	49° 31.75' S 022° 01.04' W	4 164 m	03/06/2014	16:37	49.529 °N -22.0173 °E	49° 31.75' S 022° 01.04' W	4 165 m	01:18	03/06/2014	18:17	49.529 °N -22.0172 °E	49° 31.75' S 022° 01.03' W	4 224 m	02:58	
L	25	TMR-stock	geop_024_02	03/06/2014	18:22	49.529 °N -22.0172 °E	49° 31.75' S 022° 01.03' W	4 167 m	03/06/2014	19:48	49.529 °N -22.0173 °E	49° 31.75' S 022° 01.04' W	4 164 m	01:26	03/06/2014	21:27	49.529 °N -22.0172 °E	49° 31.74' S 022° 01.03' W	4 166 m	03:04	
L	25	CTD-Biogeoch-Shallow	geoh_024_03	03/06/2014	21:30	49.529 °N -22.0172 °E	49° 31.74' S 022° 01.03' W	4 163 m	03/06/2014	21:47	49.529 °N -22.0172 °E	49° 31.74' S 022° 01.03' W	4 163 m	00:17	03/06/2014	21:57	49.529 °N -22.0172 °E	49° 31.74' S 022° 01.03' W	4 167 m	00:27	
		XBT_17		04/06/2014	00:53	49.897 °N -22.3039 °E	49° 53.85' S 022° 18.24' W	4 002 m													
XL	26	CTD-Hydro	geoh_026_01	04/06/2014	03:48	50.278 °N -22.6022 °E	50° 16.65' S 022° 36.13' W	4 142 m	04/06/2014	05:03	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 142 m	01:15	04/06/2014	06:42	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 144 m	02:54	
XL	26	TMR-stock	geop_026_02	04/06/2014	06:47	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 143 m	04/06/2014	08:07	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 143 m	01:19	04/06/2014	09:42	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 142 m	02:55	
XL	26	CTD-Pa/Th/Pb/Po/Be/Art. Radio	geoh_026_03	04/06/2014	09:46	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 142 m	04/06/2014	11:04	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 143 m	01:17	04/06/2014	12:40	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	4 142 m	02:53	
XL	26	ISP	geoh_026_04	04/06/2014	13:00	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.27' W	4 108 m	04/06/2014	14:40	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W		01:39	04/06/2014	21:07	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.29' W		08:06	
XL	26	CTD-Ra+REEs+Th+Ba	geoh_026_05	04/06/2014	21:13	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.29' W	4 143 m	04/06/2014	21:38	50.278 °N -22.6048 °E	50° 16.67' S 022° 36.29' W	4 143 m	00:24	04/06/2014	22:16	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.29' W	4 143 m	01:02	
XL	26	TMR-Fe-isotopes	geop_026_06	04/06/2014	22:19	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.29' W	4 143 m	04/06/2014	23:29	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.29' W	4 143 m	01:10	05/06/2014	01:02	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.30' W	4 142 m	02:43	
XL	26	CTD-Biogeoch-Shallow	geoh_026_07	05/06/2014	01:07	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.30' W	4 142 m	05/06/2014	01:19	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.30' W	4 142 m	00:11	05/06/2014	01:35	50.278 °N -22.6049 °E	50° 16.67' S 022° 36.30' W	4 142 m	00:27	
		ARVOR_5		05/06/2014	01:43	50.279 °N -22.5994 °E	50° 16.75' S 022° 35.96' W	4 141 m													26
		XBT_18		05/06/2014	04:06	50.648 °N -22.9037 °E	50° 38.90' S 022° 54.22' W	3 751 m													
S	27	CTD-Hydro	geoh_027_01	05/06/2014	07:06	51.030 °N -23.1907 °E	51° 01.78' S 023° 11.44' W	3 943 m	05/06/2014	08:24	51.030 °N -23.1907 °E	51° 01.78' S 023° 11.44' W	3 943 m	01:17	05/06/2014	10:01	51.030 °N -23.1907 °E	51° 01.78' S 023° 11.44' W		02:54	
		XBT_19		05/06/2014	13:29	51.530 °N -23.5835 °E	51° 31.78' S 023° 35.01' W	3 662 m													
S	28	CTD-Hydro	geoh_028_01	05/06/2014	16:56	52.025 °N -23.9731 °E	52° 01.48' S 023° 58.39' W	3 881 m	05/06/2014	13:32	51.534 °N -23.5870 °E	51° 32.03' S 023° 35.22' W	3 680 m	20:35	05/06/2014	19:45	52.025 °N -23.9723 °E	52° 01.49' S 023° 58.34' W		02:49	
		XBT_20		05/06/2014	23:20	52.527 °N -24.3666 °E	52° 31.63' S 024° 21.99' W	3 626 m													
L	29	CTD-Hydro	geoh_029_01	06/06/2014	02:54	53.019 °N -24.7517 °E	53° 01.12' S 024° 45.10' W	3 556 m	06/06/2014	04:00	53.020 °N -24.7520 °E	53° 01.20' S 024° 45.12' W	3 555 m	01:05	06/06/2014	05:29	53.020 °N -24.7520 °E	53° 01.20' S 024° 45.12' W	3 555 m	02:34	
L	29	TMR-stock	geop_029_02	06/06/2014	05:36	53.020 °N -24.7520 °E	53° 01.20' S 024° 45.12' W	3 556 m	06/06/2014	06:44	53.020 °N -24.7520 °E	53° 01.20' S 024° 45.12' W	3 556 m	01:08	06/06/2014	07:57	53.020 °N -24.7521 °E	53° 01.20' S 024° 45.12' W		02:21	
L	29	CTD-Biogeoch-Shallow	geoh_029_03	06/06/2014	08:05	53.020 °N -24.7521 °E	53° 01.20' S 024° 45.12' W	3 556 m	06/06/2014	08:15	53.020 °N -24.7521 °E	53° 01.20' S 024° 45.12' W	3 557 m	00:09	06/06/2014	08:35	53.020 °N -24.7521 °E	53° 01.20' S 024° 45.13' W		00:29	
		PROVOR-DO_1		06/06/2014	08:40	53.023 °N -24.7518 °E	53° 01.38' S 024° 45.11' W	3 559 m													29
		SVP_1		06/06/2014	08:42	53.025 °N -24.7528 °E	53° 01.50' S 024° 45.17' W	3 557 m													29/3
		XBT_21		06/06/2014	12:27	53.511 °N -25.1429 °E	53° 30.68' S 025° 08.57' W	3 587 m													

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
S	30	CTD-Hydro	geoh_030_01	06/06/2014	16:32	54.015 °N -25.5329 °E	54° 00.88' S 025° 31.97' W	3 068 m	06/06/2014	17:33	54.015 °N -25.5329 °E	54° 00.88' S 025° 31.97' W	3 068 m	01:01	06/06/2014	18:49	54.015 °N -25.5329 °E	54° 00.88' S 025° 31.97' W		02:17	
		ARVOR_6		06/06/2014	18:55	54.017 °N -25.5282 °E	54° 01.02' S 025° 31.69' W														30
		XBT_22		06/06/2014	22:24	54.382 °N -25.8360 °E	54° 22.90' S 025° 50.16' W														
S	31	CTD-Hydro	geoh_031_01	07/06/2014	04:31	54.761 °N -26.1222 °E	54° 45.65' S 026° 07.33' W	3 621 m	07/06/2014	05:41	54.761 °N -26.1221 °E	54° 45.65' S 026° 07.32' W	3 608 m	01:10	07/06/2014	07:12	54.761 °N -26.1221 °E	54° 45.65' S 026° 07.33' W	3 607 m	02:41	
		XBT_23		07/06/2014	10:31	55.146 °N -26.4246 °E	55° 08.79' S 026° 25.48' W														
Sp	32	CTD-Hydro	geoh_032_01	07/06/2014	13:41	55.505 °N -26.7106 °E	55° 30.32' S 026° 42.64' W	3 236 m	07/06/2014	14:42	55.506 °N -26.7102 °E	55° 30.34' S 026° 42.61' W	3 431 m	01:01	07/06/2014	16:03	55.506 °N -26.7102 °E	55° 30.34' S 026° 42.61' W	3 235 m	02:22	
Sp	32	TMR-stock	geop_032_02	07/06/2014	16:11	55.506 °N -26.7103 °E	55° 30.33' S 026° 42.62' W	3 235 m	07/06/2014	17:17	55.506 °N -26.7102 °E	55° 30.34' S 026° 42.61' W	3 235 m	01:05	07/06/2014	18:24	55.506 °N -26.7102 °E	55° 30.33' S 026° 42.61' W	3 235 m	02:12	
Sp	32	CTD-Radionuclides	geoh_032_03	07/06/2014	18:32	55.506 °N -26.7102 °E	55° 30.33' S 026° 42.61' W	3 235 m	07/06/2014	19:37	55.506 °N -26.7102 °E	55° 30.34' S 026° 42.61' W	3 235 m	01:04	07/06/2014	20:48	55.506 °N -26.7102 °E	55° 30.33' S 026° 42.61' W	3 235 m	02:16	
Sp	32	ISP-Shallow	geoh_032_04	07/06/2014	20:57	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	07/06/2014	21:42	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	00:44	08/06/2014	01:48	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	04:50	
Sp	32	CTD-Pa/Th/Pb/Po	geoh_032_05	08/06/2014	01:57	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	08/06/2014	02:59	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	01:01	08/06/2014	04:23	55.506 °N -26.7104 °E	55° 30.34' S 026° 42.62' W	3 235 m	02:26	
Sp	32	TMR-Fe-isotopes	geop_032_06	08/06/2014	04:32	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	08/06/2014	05:37	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	01:05	08/06/2014	06:43	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	02:11	
Sp	32	CTD-Ra+REEs	geoh_032_07	08/06/2014	06:49	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	08/06/2014	07:54	55.506 °N -26.7103 °E	55° 30.34' S 026° 42.62' W	3 235 m	01:04	08/06/2014	09:11	55.506 °N -26.7104 °E	55° 30.34' S 026° 42.62' W	3 235 m	02:21	
Sp	32	ISP-Deep	geoh_032_08	08/06/2014	09:25	55.506 °N -26.7104 °E	55° 30.34' S 026° 42.62' W	3 289 m	08/06/2014	10:55	55.506 °N -26.7104 °E	55° 30.34' S 026° 42.62' W	4 216 m	01:29	08/06/2014	16:26	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.17' W	3 234 m	07:00	
Sp	32	CTD-Ac-Bottom	geoh_032_09	08/06/2014	16:34	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.18' W	3 234 m	08/06/2014	17:36	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.17' W	3 234 m	01:02	08/06/2014	18:39	55.515 °N -26.7030 °E	55° 30.90' S 026° 42.18' W	3 234 m	02:05	
Sp	32	CTD-Biogeo-Remin+REEs	geoh_032_10	08/06/2014	19:23	55.515 °N -26.7030 °E	55° 30.90' S 026° 42.18' W	3 234 m	08/06/2014	19:50	55.515 °N -26.7030 °E	55° 30.90' S 026° 42.18' W	3 234 m	00:26	08/06/2014	20:29	55.515 °N -26.7030 °E	55° 30.90' S 026° 42.18' W	3 234 m	01:05	
Sp	32	TMR-particulate	geop_032_11	08/06/2014	20:32	55.515 °N -26.7030 °E	55° 30.90' S 026° 42.18' W	3 234 m	08/06/2014	21:30	55.515 °N -26.7030 °E	55° 30.90' S 026° 42.18' W	3 234 m	00:58	08/06/2014	22:40	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.18' W	3 234 m	02:08	
Sp	32	CTD-Be	geoh_032_12	08/06/2014	22:42	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.17' W	3 234 m	08/06/2014	22:50	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.18' W	3 234 m	00:07	08/06/2014	23:05	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.18' W	3 234 m	00:22	
Sp	32	Plankton net	geoh_032_13	08/06/2014	23:04	55.515 °N -26.7029 °E	55° 30.90' S 026° 42.18' W	3 234 m							08/06/2014	23:45	55.515 °N -26.7036 °E	55° 30.88' S 026° 42.22' W	3 234 m	00:41	
Sp	32	CTD-Ac-Bottom-200/400m	geoh_032_14	08/06/2014	23:53	55.515 °N -26.7037 °E	55° 30.89' S 026° 42.22' W	3 234 m	09/06/2014	00:55	55.515 °N -26.7036 °E	55° 30.89' S 026° 42.22' W	3 235 m	01:02	09/06/2014	01:57	55.515 °N -26.7036 °E	55° 30.89' S 026° 42.22' W	3 234 m	02:04	
Sp	32	CTD-Biogeo-Shallow	geoh_032_15	09/06/2014	02:32	55.515 °N -26.7036 °E	55° 30.89' S 026° 42.21' W	3 234 m	09/06/2014	02:42	55.515 °N -26.7036 °E	55° 30.89' S 026° 42.22' W	3 235 m	00:09	09/06/2014	03:05	55.515 °N -26.7036 °E	55° 30.89' S 026° 42.22' W	3 234 m	00:32	
		SVP_2		09/06/2014	03:10	55.516 °N -26.7050 °E	55° 30.95' S 026° 42.30' W	3 235 m													32-15
		PROVBIO_1		09/06/2014	03:15	55.522 °N -26.7101 °E	55° 31.30' S 026° 42.61' W	3 218 m													32
		XBT_24		09/06/2014	05:36	55.885 °N -27.0024 °E	55° 53.08' S 027° 00.14' W	2 877 m													
S	33	CTD-Hydro	geoh_033_01	09/06/2014	08:09	56.252 °N -27.2925 °E	56° 15.12' S 027° 17.55' W	2 740 m	09/06/2014	03:05	55.515 °N -26.7036 °E	55° 30.88' S 026° 42.22' W	3 235 m	18:56	09/06/2014	10:26	56.252 °N -27.2924 °E	56° 15.13' S 027° 17.54' W	2 741 m	02:16	
		PROVOR-DO		09/06/2014	10:31	56.255 °N -27.2943 °E	56° 15.29' S 027° 17.66' W	2 741 m													33
		XBT_25		09/06/2014	12:48	56.619 °N -27.5752 °E	56° 37.15' S 027° 34.51' W	2 727 m													
L	34	CTD-Hydro	geoh_034_01	09/06/2014	15:18	57.004 °N -27.8785 °E	57° 00.23' S 027° 52.71' W	2 779 m	09/06/2014	16:11	57.004 °N -27.8785 °E	57° 00.23' S 027° 52.71' W	2 751 m	00:53	09/06/2014	17:23	57.004 °N -27.8785 °E	57° 00.23' S 027° 52.71' W	2 751 m	02:04	
L	34	TMR-stock	geop_034_02	09/06/2014	17:27	57.004 °N -27.8785 °E	57° 00.23' S 027° 52.71' W	2 751 m	09/06/2014	18:25	57.004 °N -27.8785 °E	57° 00.23' S 027° 52.71' W	2 751 m	00:57	09/06/2014	19:28	57.004 °N -27.8786 °E	57° 00.23' S 027° 52.71' W	2 751 m	02:01	
L	34	CTD-Biogeoch-Surface	geoh_034_03	09/06/2014	19:32	57.004 °N -27.8786 °E	57° 00.23' S 027° 52.71' W	2 751 m	09/06/2014	19:45	57.004 °N -27.8786 °E	57° 00.23' S 027° 52.71' W	2 750 m	00:12	09/06/2014	20:05	57.004 °N -27.8786 °E	57° 00.23' S 027° 52.71' W	2 750 m	00:32	
		SVP_3		09/06/2014	20:08	57.005 °N -27.8779 °E	57° 00.29' S 027° 52.67' W	2 752 m													34-03
		ARVOR_7		09/06/2014	20:10	57.008 °N -27.8786 °E	57° 00.45' S 027° 52.72' W	2 757 m													34
		XBT_26		09/06/2014	22:47	57.376 °N -28.3506 °E	57° 22.57' S 028° 21.03' W	2 578 m													
S	35	CTD-Hydro	geoh_035_01	10/06/2014	01:01	57.675 °N -28.7299 °E	57° 40.49' S 028° 43.79' W		10/06/2014	01:50	57.675 °N -28.7300 °E	57° 40.49' S 028° 43.80' W	2 370 m	00:49	10/06/2014	02:55	57.675 °N -28.7301 °E	57° 40.49' S 028° 43.81' W	2 468 m	01:54	
		XBT_27					00° 00.00' S 000° 00.00' W														
L	36	CTD-Hydro	geoh_036_01	10/06/2014	07:30	58.207 °N -29.7247 °E	58° 12.43' S 029° 43.48' W	2 224 m	10/06/2014	08:15	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	2 224 m	00:44	10/06/2014	09:24	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W		01:54	
L	36	TMR-stock	geop_036_02	10/06/2014	09:28	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	2 224 m	10/06/2014	10:02	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	2 223 m	00:33	10/06/2014	10:51	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	2 223 m	01:22	
L	36	CTD-Biogeoch-Shallow	geoh_036_03	10/06/2014	10:53	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	2 224 m	10/06/2014	11:02	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	2 223 m	00:09	10/06/2014	11:21	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W		00:27	
		ARVOR E-AIMS double DO 1		10/06/2014	11:30	58.212 °N -29.7298 °E	58° 12.69' S 029° 43.79' W	2 324 m													36
		XBT_28		10/06/2014	13:06	58.406 °N -30.0948 °E	58° 24.34' S 030° 05.69' W	2 155 m													
S	37	CTD-Hydro	geoh_037_01	10/06/2014	13:06	58.406 °N -30.0948 °E	58° 24.34' S 030° 05.69' W	2 155 m	10/06/2014	15:05	58.550 °N -30.3620 °E	58° 33.00' S 030° 21.72' W		01:58	10/06/2014	15:56	58.550 °N -30.3620 °E	58° 33.00' S 030° 21.72' W		02:49	
		SVP_4		10/06/2014	16:02	58.551 °N -30.3611 °E	58° 33.05' S 030° 21.67' W														37-01
		XBT_29		10/06/2014	17:31	58.684 °N -30.7656 °E	58° 41.04' S 030° 45.94' W														

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
Sp	38	CTD-Hydro	geoh_038_01	10/06/2014	19:24	58.843 °N -31.2688 °E	58° 50.56' S 031° 16.13' W		10/06/2014	19:57	58.843 °N -31.2665 °E	58° 50.56' S 031° 15.99' W		00:32	10/06/2014	20:45	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W		01:21	
Sp	38	TMR-stock+particulate	geop_038_02	10/06/2014	20:48	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	1 341 m	10/06/2014	21:14	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	1 341 m	00:25	10/06/2014	21:57	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	1 341 m	01:08	
Sp	38	CTD-Radionuclides+REEs	geoh_038_03	10/06/2014	22:00	58.843 °N -31.2659 °E	58° 50.56' S 031° 15.96' W	1 341 m	10/06/2014	22:29	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W		00:28	10/06/2014	23:05	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	1 341 m	01:04	
Sp	38	ISP	geoh_038_04	10/06/2014	23:06	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	1 341 m	11/06/2014	00:17	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	2 341 m	01:11	11/06/2014	06:00	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.96' W	1 341 m	06:54	
Sp	38	CTD-Pa/Th/Pb/Po+Ac	geoh_038_05	11/06/2014	06:10	58.843 °N -31.2660 °E	58° 50.56' S 031° 15.96' W	1 341 m	11/06/2014	06:43	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.96' W	1 342 m	00:32	11/06/2014	07:30	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.96' W	1 341 m	01:19	
Sp	38	TMR-Hg-isotopes	geop_038_06	11/06/2014	07:35	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.96' W	1 341 m	11/06/2014	08:07	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.97' W	1 341 m	00:31	11/06/2014	08:39	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.97' W	1 341 m	01:03	
Sp	38	CTD-Ac-Bottom_1	geoh_038_07	11/06/2014	08:49	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.97' W		11/06/2014	09:18	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	00:29	11/06/2014	09:50	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W		01:00	
Sp	38	CTD-Ac-Bottom_2	geoh_038_08	11/06/2014	10:21	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	11/06/2014	10:50	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	00:28	11/06/2014	11:21	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	01:00	
Sp	38	CTD-Ra+Ac	geoh_038_09	11/06/2014	11:48	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	11/06/2014	12:15	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	00:27	11/06/2014	12:53	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 341 m	01:05	
Sp	38	Corer	geosc_038_10	11/06/2014	13:09	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W								11/06/2014	14:08	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W		00:58	
Sp	38	CTD-Biogeo-Remin+REEs	geoh_038_11	11/06/2014	14:11	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	11/06/2014	14:34	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 341 m	00:22	11/06/2014	15:15	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 340 m	01:03	
Sp	38	TMR-Fe-isotopes	geop_038_12	11/06/2014	15:22	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.97' W	1 340 m	11/06/2014	15:54	58.843 °N -31.2661 °E	58° 50.56' S 031° 15.97' W	1 341 m	00:32	11/06/2014	16:33	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 341 m	01:11	
Sp	38	CTD-Be	geoh_038_13	11/06/2014	16:43	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 341 m	11/06/2014	16:53	58.843 °N -31.2662 °E	58° 50.57' S 031° 15.97' W	1 342 m	00:09	11/06/2014	17:07	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 342 m	00:23	
Sp	38	Plankton net	geon_038_14	11/06/2014	17:15	58.843 °N -31.2661 °E	58° 50.57' S 031° 15.97' W	1 341 m							11/06/2014	17:50	58.858 °N -31.2685 °E	58° 51.51' S 031° 16.11' W		00:35	
Sp	38	CTD-Biogeo-Shallow	geoh_038_15	11/06/2014	18:05	58.860 °N -31.2726 °E	58° 51.60' S 031° 16.36' W		11/06/2014	18:16	58.860 °N -31.2726 °E	58° 51.60' S 031° 16.36' W	1 306 m	00:11	11/06/2014	18:35	58.860 °N -31.2726 °E	58° 51.60' S 031° 16.36' W		00:30	
		XBT_30		11/06/2014	20:20	58.905 °N -31.8416 °E	58° 54.31' S 031° 50.50' W														
S	39	CTD-Hydro	geoh_039_01	11/06/2014	22:47	58.975 °N -32.5593 °E	58° 58.49' S 032° 33.56' W	1 968 m	11/06/2014	23:28	58.974 °N -32.5571 °E	58° 58.43' S 032° 33.42' W	2 329 m	00:40	12/06/2014	00:29	58.973 °N -32.5556 °E	58° 58.40' S 032° 33.33' W	1 843 m	01:42	
		SVP_SAL		12/06/2014	00:33	58.973 °N -32.5555 °E	58° 58.40' S 032° 33.33' W	1 851 m													39-01
		APEX_1		12/06/2014	00:45	58.983 °N -32.5553 °E	58° 59.01' S 032° 33.32' W														39
		XBT_31		12/06/2014	02:34	59.043 °N -33.1928 °E	59° 02.57' S 033° 11.57' W	2 282 m													
L	40	CTD-Hydro	geoh_040_01	12/06/2014	04:53	59.102 °N -33.8280 °E	59° 06.12' S 033° 49.68' W	2 281 m	12/06/2014	05:40	59.102 °N -33.8279 °E	59° 06.13' S 033° 49.68' W	2 282 m	00:46	12/06/2014	06:51	59.102 °N -33.8279 °E	59° 06.13' S 033° 49.67' W	2 281 m	01:57	
L	40	TMR-stock	geop_040_02	12/06/2014	07:04	59.102 °N -33.8280 °E	59° 06.13' S 033° 49.68' W	2 282 m	12/06/2014	07:58	59.102 °N -33.8282 °E	59° 06.12' S 033° 49.69' W	2 282 m	00:54	12/06/2014	08:55	59.102 °N -33.8286 °E	59° 06.11' S 033° 49.72' W	2 283 m	01:51	
L	40	CTD-Biogeoch-Surface	geoh_040_03	12/06/2014	09:00	59.102 °N -33.8289 °E	59° 06.11' S 033° 49.73' W	2 283 m	12/06/2014	09:09	59.102 °N -33.8291 °E	59° 06.10' S 033° 49.74' W	2 283 m	00:08	12/06/2014	09:28	59.102 °N -33.8288 °E	59° 06.11' S 033° 49.73' W	2 283 m	00:27	
		APEX-DO		12/06/2014	09:33	59.102 °N -33.8304 °E	59° 06.15' S 033° 49.82' W	2 284 m													40
		XBT_32		12/06/2014	11:43	59.171 °N -34.4906 °E	59° 10.24' S 034° 29.44' W	2 608 m													
S	41	CTD-Hydro	geoh_041_1	12/06/2014	14:03	59.234 °N -35.1232 °E	59° 14.05' S 035° 07.39' W		12/06/2014	15:01	59.234 °N -35.1212 °E	59° 14.07' S 035° 07.27' W		00:57	12/06/2014	16:22	59.235 °N -35.1208 °E	59° 14.08' S 035° 07.25' W	3 436 m	02:19	
		XBT_33		12/06/2014	18:26	59.302 °N -35.7837 °E	59° 18.14' S 035° 47.02' W					00° 00.00' S 000° 00.00' W		05:33							
L	42	CTD-Hydro	geoh_042_1	12/06/2014	20:24	59.363 °N -36.3987 °E	59° 21.77' S 036° 23.92' W	3 095 m	12/06/2014	21:22	59.363 °N -36.3962 °E	59° 21.79' S 036° 23.77' W	3 094 m	00:58	12/06/2014	22:51	59.363 °N -36.3964 °E	59° 21.79' S 036° 23.78' W		02:27	
L	42	TMR-stock	geop_042_2	12/06/2014	22:58	59.363 °N -36.3964 °E	59° 21.79' S 036° 23.78' W		12/06/2014	23:53	59.363 °N -36.3963 °E	59° 21.79' S 036° 23.78' W	3 093 m	00:55	13/06/2014	01:12	59.363 °N -36.3963 °E	59° 21.79' S 036° 23.78' W		02:14	
L	42	CTD-Biogeoch-Surface	geoh_042_3	13/06/2014	01:17	59.363 °N -36.3963 °E	59° 21.79' S 036° 23.78' W	3 093 m	13/06/2014	01:25	59.363 °N -36.3963 °E	59° 21.79' S 036° 23.78' W	3 093 m	00:08	13/06/2014	01:41	59.363 °N -36.3963 °E	59° 21.79' S 036° 23.78' W	3 093 m	00:24	
		XBT_34		13/06/2014	03:45	59.430 °N -37.0416 °E	59° 25.79' S 037° 02.49' W	3 116 m													
S	43	CTD-Hydro	geoh_0043_1	13/06/2014	06:02	59.491 °N -37.6805 °E	59° 29.48' S 037° 40.83' W	3 111 m	13/06/2014	07:05	59.491 °N -37.6806 °E	59° 29.47' S 037° 40.84' W	3 111 m		13/06/2014	08:30	59.491 °N -37.6806 °E	59° 29.47' S 037° 40.83' W		02:27	
		SVP_5		13/06/2014	08:39	59.493 °N -37.6848 °E	59° 29.59' S 037° 41.09' W	4 510 m													43-01
		XBT_35		13/06/2014	10:38	59.557 °N -38.3122 °E	59° 33.39' S 038° 18.73' W	3 042 m													
Sp	44	CTD-Hydro	geoh_044_01	13/06/2014	13:08	59.623 °N -38.9539 °E	59° 37.38' S 038° 57.23' W	2 928 m	13/06/2014	14:04	59.623 °N -38.9540 °E	59° 37.39' S 038° 57.24' W	2 928 m	00:56	13/06/2014	15:22	59.623 °N -38.9540 °E	59° 37.38' S 038° 57.24' W	2 928 m	02:14	
Sp	44	TMR-stock	geop_044_02	13/06/2014	15:35	59.623 °N -38.9541 °E	59° 37.38' S 038° 57.24' W	2 928 m	13/06/2014	16:45	59.623 °N -38.9540 °E	59° 37.38' S 038° 57.24' W	2 929 m	01:09	13/06/2014	17:50	59.623 °N -38.9540 °E	59° 37.38' S 038° 57.24' W	2 930 m	02:15	
Sp	44	CTD-Biogeo-Shallow	geoh_044_03	13/06/2014	17:57	59.623 °N -38.9537 °E	59° 37.36' S 038° 57.22' W	2 930 m	13/06/2014	18:10	59.623 °N -38.9538 °E	59° 37.36' S 038° 57.23' W	2 930 m	00:13	13/06/2014	18:31	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.23' W	2 930 m	00:33	
Sp	44	ISP-Shallow	geoi_044_04	13/06/2014	18:50	59.623 °N -38.9538 °E	59° 37.36' S 038° 57.23' W	3 058 m	13/06/2014	19:28	59.623 °N -38.9538 °E	59° 37.36' S 038° 57.23' W	2 930 m	00:37	13/06/2014	23:32	59.623 °N -38.9539 °E	59° 37.37' S 038° 57.24' W	2 929 m	04:42	
Sp	44	CTD-Pa/Th/Pb/Po	geoh_044_05	13/06/2014	23:39	59.623 °N -38.9539 °E	59° 37.37' S 038° 57.23' W	2 929 m	14/06/2014	00:36	59.623 °N -38.9539 °E	59° 37.37' S 038° 57.23' W	2 928 m	00:56	14/06/2014	01:52	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.23' W	2 928 m	02:12	
Sp	44	TMR-Fe-isotopes	geop_044_06	14/06/2014	02:00	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.23' W	2 929 m	14/06/2014	03:01	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.24' W	2 928 m	01:00	14/06/2014	03:58	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.23' W		01:57	
Sp	44	CTD-Ra+REEs	geoh_044_07	14/06/2014	04:07	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.23' W	2 929 m	14/06/2014	05:06	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 929 m	00:59	14/06/2014	06:24	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W		02:17	
Sp	44	ISP-Deep + corer	geoi_044_08	14/06/2014	06:30	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 930 m	14/06/2014	08:06	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.24' W	2 944 m	01:36	14/06/2014	13:09	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 944 m	06:39	
Sp	44	CTD-Biogeo-Remin+REEs	geoh_044_09	14/06/2014	13:23	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 928 m	14/06/2014	13:53	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 928 m	00:29	14/06/2014	14:39	59.623 °N -38.9541 °E	59° 37.36' S 038° 57.24' W	2 928 m	01:16	
Sp	44	TMR-particulate	geop_044_010	14/06/2014	14:44	59.623 °N -38.9541 °E	59° 37.36' S 038° 57.24' W	2 928 m	14/06/2014	15:40	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 928 m	00:55	14/06/2014	16:40	59.623 °N -38.9539 °E	59° 37.36' S 038° 57.24' W	2 929 m	01:55	
Sp	44	CTD-Be	geoh_044_11	14/06/2014	17:02	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 929 m	14/06/2014	17:12	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 929 m	00:10	14/06/2014	17:25	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	2 929 m	00:23	
Sp	44	Plankton net	geon_044_12	14/06/2014	17:40	59.625 °N -38.9586 °E	59° 37.53' S 038° 57.52' W								14/06/2014	18:10	59.635 °N -38.9800 °E	59° 38.12' S 038° 58.80' W		00:30	
Sp	44	CTD-Radionuclides	geoh_044_13	14/06/2014	18:24	59.637 °N -38.9828 °E	59° 38.20' S 038° 58.97' W	2 921 m	14/06/2014	19:24	59.637 °N -38.9829 °E	59° 38.20' S 038° 58.97' W	2 921 m	00:59	14/06/2014	20:31	59.637 °N -38.9829 °E	59° 38.20' S 038° 58.97' W	2 921 m	02:06	

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
S	45	CTD-Hydro	geoh_045_1	15/06/2014	01:05	59.491 °N -37.6818 °E	59° 29.46' S 037° 40.91' W	3 110 m	15/06/2014	02:04	59.491 °N -37.6806 °E	59° 29.48' S 037° 40.84' W		00:58	15/06/2014	03:24	59.491 °N -37.6806 °E	59° 29.48' S 037° 40.84' W		02:18	
S	46	CTD-Hydro	geoh_046_1	15/06/2014	07:40	59.624 °N -38.9577 °E	59° 37.41' S 038° 57.46' W	2 929 m	15/06/2014	08:42	59.624 °N -38.9577 °E	59° 37.41' S 038° 57.46' W	2 929 m	01:02	15/06/2014	10:06	59.624 °N -38.9577 °E	59° 37.41' S 038° 57.46' W	2 929 m	02:25	
		PROVBIO_2		15/06/2014	10:13	59.626 °N -38.9587 °E	59° 37.54' S 038° 57.52' W	2 928 m													44
		XBT_36		15/06/2014	12:15	59.674 °N -39.5902 °E	59° 40.46' S 039° 35.41' W														
S	47	CTD-Hydro	geoh_047_1	15/06/2014	14:28	59.722 °N -40.2529 °E	59° 43.34' S 040° 15.17' W	2 659 m	15/06/2014	15:21	59.722 °N -40.2529 °E	59° 43.34' S 040° 15.18' W	2 659 m	00:52	15/06/2014	16:36	59.722 °N -40.2529 °E	59° 43.34' S 040° 15.17' W	2 660 m	02:07	
S	48	CTD-Hydro	geoh_048_1	15/06/2014	18:43	59.758 °N -40.9054 °E	59° 45.46' S 040° 54.33' W	2 274 m	15/06/2014	19:33	59.758 °N -40.9055 °E	59° 45.46' S 040° 54.33' W	2 273 m	00:49	15/06/2014	20:45	59.758 °N -40.9056 °E	59° 45.46' S 040° 54.33' W	2 273 m	02:01	
L	49	CTD-Hydro	geoh_049_1	15/06/2014	22:14	59.773 °N -41.2969 °E	59° 46.36' S 041° 17.81' W	2 039 m	15/06/2014	22:59	59.773 °N -41.2968 °E	59° 46.36' S 041° 17.81' W	2 039 m	00:44	16/06/2014	00:00	59.773 °N -41.2969 °E	59° 46.36' S 041° 17.81' W	2 038 m	01:46	
L	49	TMR-stock	geop_049_2	16/06/2014	00:07	59.773 °N -41.2969 °E	59° 46.37' S 041° 17.81' W	2 039 m	16/06/2014	00:49	59.773 °N -41.2969 °E	59° 46.37' S 041° 17.81' W	2 038 m	00:42	16/06/2014	01:44	59.773 °N -41.2969 °E	59° 46.37' S 041° 17.82' W	2 037 m	01:37	
L	49	CTD-Biogeoch-Surface	geoh_049_3	16/06/2014	01:48	59.773 °N -41.2969 °E	59° 46.37' S 041° 17.82' W	2 037 m	16/06/2014	01:58	59.773 °N -41.2969 °E	59° 46.37' S 041° 17.82' W	2 037 m	00:09	16/06/2014	02:18	59.773 °N -41.2969 °E	59° 46.37' S 041° 17.82' W	2 037 m	00:29	
S	50	CTD-Hydro	geoh_050_1	16/06/2014	03:56	59.795 °N -41.7303 °E	59° 47.67' S 041° 43.82' W	1 844 m	16/06/2014	04:34	59.795 °N -41.7300 °E	59° 47.70' S 041° 43.80' W	1 844 m	00:38	16/06/2014	05:31	59.795 °N -41.7299 °E	59° 47.70' S 041° 43.80' W	1 845 m	01:35	
S	51	CTD-Hydro	geoh_051_1	16/06/2014	06:43	59.799 °N -42.0029 °E	59° 47.94' S 042° 00.18' W	1 722 m	16/06/2014	07:22	59.799 °N -42.0028 °E	59° 47.94' S 042° 00.17' W	1 723 m	00:39	16/06/2014	08:17	59.799 °N -42.0028 °E	59° 47.94' S 042° 00.17' W	1 722 m	01:34	
S	51	ISP-Bottom	geoh_051_2	16/06/2014	08:24	59.799 °N -42.0028 °E	59° 47.94' S 042° 00.17' W	1 722 m	16/06/2014	09:24	59.799 °N -42.0029 °E	59° 47.94' S 042° 00.17' W		01:00	16/06/2014	13:46	59.798 °N -42.0049 °E	59° 47.90' S 042° 00.30' W	1 722 m	05:22	
S	52	CTD-Hydro	geoh_052_1	16/06/2014	14:44	59.808 °N -42.2379 °E	59° 48.50' S 042° 14.28' W		16/06/2014	15:12	59.808 °N -42.2380 °E	59° 48.51' S 042° 14.28' W	1 180 m	00:27	16/06/2014	15:53	59.808 °N -42.2381 °E	59° 48.51' S 042° 14.28' W	1 183 m	01:09	
XL	53	CTD-Hydro++	geoh_053_01	16/06/2014	19:22	59.902 °N -43.0151 °E	59° 54.09' S 043° 00.91' W	170 m	16/06/2014	19:34	59.902 °N -43.0151 °E	59° 54.10' S 043° 00.91' W	171 m	00:12	16/06/2014	19:56	59.902 °N -43.0151 °E	59° 54.10' S 043° 00.91' W	171 m	00:34	
XL	53	ISP-Bottom	geoh_053_02	16/06/2014	20:15	59.901 °N -43.0056 °E	59° 54.06' S 043° 00.34' W	174 m						03:44	17/06/2014	00:25	59.900 °N -43.0021 °E	59° 53.98' S 043° 00.12' W	178 m	04:10	
XL	53	TMR-stock++	geop_053_03	17/06/2014	00:34	59.899 °N -43.0029 °E	59° 53.95' S 043° 00.17' W	179 m	17/06/2014	00:43	59.897 °N -43.0062 °E	59° 53.84' S 043° 00.37' W	174 m	00:08	17/06/2014	00:54	59.895 °N -43.0098 °E	59° 53.71' S 043° 00.59' W	176 m	00:20	
XL	53	Corer	geosc_053_04	17/06/2014	00:59	59.895 °N -43.0102 °E	59° 53.70' S 043° 00.61' W	175 m							17/06/2014	01:13	59.893 °N -43.0127 °E	59° 53.61' S 043° 00.76' W	180 m	00:14	
XL	53	CTD-isotopes	geoh_053_05	17/06/2014	01:35	59.892 °N -42.9974 °E	59° 53.49' S 042° 59.84' W	191 m	17/06/2014	01:44	59.891 °N -42.9991 °E	59° 53.45' S 042° 59.94' W	195 m	00:09	17/06/2014	02:03	59.890 °N -43.0017 °E	59° 53.38' S 043° 00.10' W		00:27	
S	54	CTD-Hydro	geoh_054_1	17/06/2014	03:04	59.871 °N -42.8135 °E	59° 52.28' S 042° 48.81' W	191 m	17/06/2014	03:14	59.869 °N -42.8165 °E	59° 52.12' S 042° 48.99' W	186 m	00:10	17/06/2014	03:26	59.865 °N -42.8208 °E	59° 51.90' S 042° 49.25' W	187 m	00:22	
S	55	CTD-Hydro	geoh_055_1	17/06/2014	04:40	59.831 °N -42.5198 °E	59° 49.85' S 042° 31.19' W	227 m	17/06/2014	04:52	59.831 °N -42.5200 °E	59° 49.85' S 042° 31.20' W	228 m	00:12	17/06/2014	05:10	59.831 °N -42.5201 °E	59° 49.85' S 042° 31.20' W	228 m	00:29	
L	56	CTD-Hydro	geoh_056_1	17/06/2014	05:55	59.823 °N -42.3989 °E	59° 49.35' S 042° 23.94' W	305 m	17/06/2014	06:09	59.823 °N -42.3990 °E	59° 49.35' S 042° 23.94' W	305 m	00:13	17/06/2014	06:35	59.823 °N -42.3990 °E	59° 49.36' S 042° 23.94' W	306 m	00:39	
L	56	TMR-stock	geop_056_2	17/06/2014	06:46	59.823 °N -42.3990 °E	59° 49.35' S 042° 23.94' W	306 m	17/06/2014	07:00	59.823 °N -42.3989 °E	59° 49.35' S 042° 23.94' W	306 m	00:13	17/06/2014	07:15	59.823 °N -42.3989 °E	59° 49.35' S 042° 23.94' W	306 m	00:29	
L	56	Corer	geosc_056_3	17/06/2014	07:31	59.823 °N -42.3989 °E	59° 49.35' S 042° 23.94' W	306 m							17/06/2014	07:58	59.823 °N -42.3989 °E	59° 49.35' S 042° 23.93' W	306 m	00:27	
S	57	CTD-Hydro	geoh_057_1	17/06/2014	08:35	59.818 °N -42.3135 °E	59° 49.05' S 042° 18.81' W	528 m	17/06/2014	08:50	59.818 °N -42.3134 °E	59° 49.06' S 042° 18.81' W	528 m	00:15	17/06/2014	09:16	59.818 °N -42.3134 °E	59° 49.06' S 042° 18.80' W		00:41	
S	58	CTD-Hydro	geoh_058_1	17/06/2014	10:00	59.816 °N -42.2760 °E	59° 48.93' S 042° 16.56' W		17/06/2014	10:22	59.816 °N -42.2760 °E	59° 48.94' S 042° 16.56' W		00:21	17/06/2014	11:15	59.816 °N -42.2766 °E	59° 48.94' S 042° 16.60' W		01:14	Problems with the classic CTD
S	59	CTD-Hydro/TMR	geop_059_1	17/06/2014	18:15	59.809 °N -42.2372 °E	59° 48.54' S 042° 14.23' W	1 180 m	17/06/2014	18:42	59.808 °N -42.2372 °E	59° 48.49' S 042° 14.23' W	1 196 m	00:26	17/06/2014	19:10	59.806 °N -42.2372 °E	59° 48.34' S 042° 14.23' W	1 211 m	00:55	The CTD profile was done with the TMR
		SVP_SAL_2		17/06/2014	19:18	59.803 °N -42.2326 °E	59° 48.21' S 042° 13.96' W														59-01
Sp	60	Corer	geosc_060_01	17/06/2014	20:48	59.799 °N -42.0030 °E	59° 47.96' S 042° 00.18' W	1 722 m							17/06/2014	22:03	59.799 °N -42.0030 °E	59° 47.96' S 042° 00.18' W		01:15	
Sp	60	TMR-stock+particulate	geop_060_02	17/06/2014	22:11	59.799 °N -42.0030 °E	59° 47.95' S 042° 00.18' W	1 723 m	17/06/2014	22:44	59.799 °N -42.0037 °E	59° 47.95' S 042° 00.22' W	1 723 m	00:33	17/06/2014	23:45	59.799 °N -42.0132 °E	59° 47.96' S 042° 00.79' W	1 723 m	01:34	
Sp	60	CTD-Hydro+Ra	geoh_060_03	17/06/2014	23:53	59.799 °N -42.0138 °E	59° 47.96' S 042° 00.83' W	1 723 m	18/06/2014	00:33	59.799 °N -42.0138 °E	59° 47.96' S 042° 00.83' W	1 723 m	00:40	18/06/2014	01:29	59.799 °N -42.0138 °E	59° 47.96' S 042° 00.83' W	1 723 m	01:35	
Sp	60	ISP-shallow	geoi_060_04	18/06/2014	01:30	59.799 °N -42.0134 °E	59° 47.96' S 042° 00.80' W	1 723 m	18/06/2014	01:39	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.78' W	1 723 m	00:08	18/06/2014	03:47	59.799 °N -42.0130 °E	59° 47.96' S 042° 00.78' W	1 722 m	02:17	
Sp	60	CTD-Biogeo-shallow	geoh_060_05	18/06/2014	03:54	59.799 °N -42.0130 °E	59° 47.96' S 042° 00.78' W	1 722 m	18/06/2014	04:04	59.799 °N -42.0130 °E	59° 47.96' S 042° 00.78' W	1 722 m	00:09	18/06/2014	04:24	59.799 °N -42.0130 °E	59° 47.96' S 042° 00.78' W	1 722 m	00:29	
Sp	60	CTD-Pa/Th/Pb/Po+Ra+REEs	geop_060_06	18/06/2014	05:25	59.799 °N -42.0130 °E	59° 47.96' S 042° 00.78' W	1 721 m	18/06/2014	06:02	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.78' W	1 721 m	00:36	18/06/2014	06:57	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.78' W	1 721 m	01:32	
Sp	60	CTD-Biogeo-Remin+REEs	geoi_060_08	18/06/2014	08:17	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.78' W	1 722 m	18/06/2014	08:37	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.78' W	1 723 m	00:20	18/06/2014	09:18	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.79' W	1 722 m	01:00	
Sp	60	TMR-Fe-isotopes	geop_060_09	18/06/2014	09:24	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.79' W	1 722 m	18/06/2014	09:57	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.79' W	1 724 m	00:33	18/06/2014	10:40	59.799 °N -42.0181 °E	59° 47.95' S 042° 01.09' W	1 723 m	01:15	
Sp	60	CTD-Be	geop_060_010	18/06/2014	10:43	59.799 °N -42.0182 °E	59° 47.95' S 042° 01.09' W	1 722 m	18/06/2014	10:52	59.799 °N -42.0182 °E	59° 47.95' S 042° 01.09' W	1 722 m	00:09	18/06/2014	11:02	59.799 °N -42.0182 °E	59° 47.95' S 042° 01.09' W	1 722 m	00:19	
Sp	60	Plankton net	geon_060_11	18/06/2014	11:15	59.799 °N -42.0182 °E	59° 47.95' S 042° 01.09' W	1 722 m							18/06/2014	12:00	59.799 °N -41.9834 °E	59° 47.95' S 041° 59.00' W	1 724 m	00:45	
Sp	60	CTD-Radionuclides+REEs	geon_060_12	18/06/2014	12:07	59.799 °N -41.9826 °E	59° 47.95' S 041° 58.95' W	1 725 m	18/06/2014	12:44	59.799 °N -41.9825 °E	59° 47.95' S 041° 58.95' W	1 725 m	00:37	18/06/2014	13:35	59.799 °N -41.9825 °E	59° 47.96' S 041° 58.95' W		01:27	
XL	61	CTD-Hydro++	geoh_061_01	18/06/2014	23:37	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W	148 m	18/06/2014	23:46	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W	148 m	00:08	19/06/2014	00:05	59.753 °N -45.1123 °E	59° 45.21' S 045° 06.74' W	171 m	00:27	
XL	61	ISP-Bottom	geoh_061_02	19/06/2014	00:14	59.753 °N -45.1123 °E	59° 45.21' S 045° 06.74' W	148 m	19/06/2014	00:35	59.753 °N -45.1123 °E	59° 45.21' S 045° 06.74' W	148 m	00:21	19/06/2014	03:26	59.753 °N -45.1123 °E	59° 45.21' S 045° 06.74' W	148 m	03:12	
XL	61	TMR-stock++	geop_061_03	19/06/2014	03:37	59.753 °N -45.1123 °E	59° 45.21' S 045° 06.74' W	148 m							19/06/2014	04:06	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W	148 m	00:28	
XL	61	Corer	geosc_061_04	19/06/2014	04:20	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W								19/06/2014	04:34	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W		00:14	
XL	61	CTD-isotopes	geoh_061_05	19/06/2014	04:43	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W	147 m	19/06/2014	04:53	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W	147 m	00:10	19/06/2014	05:11	59.753 °N -45.1122 °E	59° 45.21' S 045° 06.73' W	147 m	00:28	
		XBT_37		19/06/2014	06:02	59.676 °N -45.2778 °E	59° 40.57' S 045° 16.67' W														
		XBT_38		19/06/2014	07:00	59.562 °N -45.5071 °E	59° 33.71' S 045° 30.42' W														
		XBT_39		19/06/2014	07:28	59.511 °N -45.5994 °E	59° 30.65' S 045° 35.96' W														

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
S	62	CTD-Hydro	geoh_062_1	19/06/2014	07:44	59.502 °N -45.6198 °E	59° 30.12' S 045° 37.19' W	495 m	19/06/2014	08:02	59.502 °N -45.6197 °E	59° 30.12' S 045° 37.18' W	495 m	00:17	19/06/2014	08:28	59.502 °N -45.6198 °E	59° 30.12' S 045° 37.19' W	495 m	00:43	
		XBT_40		19/06/2014	08:52	59.461 °N -45.6468 °E	59° 27.65' S 045° 38.81' W														
L	63	CTD-Hydro	geoh_063_1	19/06/2014	09:25	59.434 °N -45.6665 °E	59° 26.04' S 045° 39.99' W		19/06/2014	10:01	59.434 °N -45.6665 °E	59° 26.06' S 045° 39.99' W		00:35	19/06/2014	10:54	59.434 °N -45.6665 °E	59° 26.06' S 045° 39.99' W	1 621 m	01:28	
L	63	TMR-stock	geop_063_2	19/06/2014	11:03	59.434 °N -45.6665 °E	59° 26.06' S 045° 39.99' W		19/06/2014	11:35	59.434 °N -45.6723 °E	59° 26.05' S 045° 40.34' W	1 562 m	00:31	19/06/2014	12:13	59.434 °N -45.6865 °E	59° 26.06' S 045° 41.19' W		01:09	
L	63	CTD-Biogeoch-Surface	geoh_063_3	19/06/2014	12:20	59.434 °N -45.6880 °E	59° 26.06' S 045° 41.28' W	1 563 m	19/06/2014	12:30	59.434 °N -45.6891 °E	59° 26.06' S 045° 41.35' W	1 562 m	00:09	19/06/2014	12:48	59.434 °N -45.6940 °E	59° 26.07' S 045° 41.64' W		00:27	
		XBT_41		19/06/2014	13:11	59.394 °N -45.7374 °E	59° 23.63' S 045° 44.24' W	1 950 m													
Sp	64	CTD-Hydro	geoh_064_01	19/06/2014	15:41	59.068 °N -46.0831 °E	59° 04.07' S 046° 04.99' W		19/06/2014	16:29	59.068 °N -46.0830 °E	59° 04.07' S 046° 04.98' W		00:47	19/06/2014	17:39	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W		01:58	
Sp	64	Corer	geosc_064_02	19/06/2014	17:52	59.068 °N -46.0830 °E	59° 04.07' S 046° 04.98' W		19/06/2014	18:38	59.068 °N -46.0831 °E	59° 04.07' S 046° 04.99' W		00:46	19/06/2014	19:25	59.068 °N -46.0830 °E	59° 04.06' S 046° 04.98' W		01:32	
Sp	64	CTD-Biogeo-Shallow	geoh_064_03	19/06/2014	19:28	59.068 °N -46.0831 °E	59° 04.07' S 046° 04.98' W	2 475 m	19/06/2014	19:39	59.068 °N -46.0832 °E	59° 04.07' S 046° 04.99' W	2 475 m	00:10	19/06/2014	19:59	59.068 °N -46.0831 °E	59° 04.07' S 046° 04.98' W		00:31	
Sp	64	ISP-Shallow	geoi_064_04	19/06/2014	20:05	59.068 °N -46.0830 °E	59° 04.06' S 046° 04.98' W	2 475 m	19/06/2014	20:51	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.98' W		00:45	20/06/2014	00:52	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W	2 476 m	04:46	
Sp	64	CTD-Pa/Th/Pb/Po	geoh_064_05	20/06/2014	00:59	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W		20/06/2014	01:48	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W		00:48	20/06/2014	02:59	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W	2 476 m	01:59	
Sp	64	TMR-Fe-isotopes	geop_064_06	20/06/2014	03:05	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W		20/06/2014	03:49	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.98' W	2 476 m	00:43	20/06/2014	04:42	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W		01:37	
Sp	64	CTD-Ra+REEs	geoh_064_07	20/06/2014	04:50	59.068 °N -46.0831 °E	59° 04.06' S 046° 04.99' W		20/06/2014	05:40	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W	2 457 m	00:50	20/06/2014	06:47	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W	2 475 m	01:56	
Sp	64	ISP-Deep	geoi_064_08	20/06/2014	06:57	59.068 °N -46.0832 °E	59° 04.07' S 046° 04.99' W		20/06/2014	07:59	59.068 °N -46.083 °W	59° 04.06' S 046° 04.99' W		01:02	20/06/2014	13:10	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W	2 476 m	06:13	
Sp	64	CTD-Biogeo-Remin+REEs	geoh_064_09	20/06/2014	13:20	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W		20/06/2014	13:44	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W		00:23	20/06/2014	14:24	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W		01:03	
Sp	64	TMR-stock+particulate	geop_064_010	20/06/2014	14:30	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W	2 475 m	20/06/2014	15:18	59.068 °N -46.0832 °E	59° 04.06' S 046° 04.99' W	2 475 m	00:48	20/06/2014	16:15	59.072 °N -46.0889 °E	59° 04.34' S 046° 05.34' W		01:45	
Sp	64	CTD-Radionuclides	geoh_064_11	20/06/2014	16:22	59.072 °N -46.0888 °E	59° 04.33' S 046° 05.33' W		20/06/2014	17:13	59.072 °N -46.0888 °E	59° 04.33' S 046° 05.33' W		00:51	20/06/2014	18:13	59.072 °N -46.0888 °E	59° 04.33' S 046° 05.33' W		01:50	
Sp	64	Plankton net	geon_064_12	20/06/2014	18:30	59.077 °N -46.0871 °E	59° 04.62' S 046° 05.23' W	2 471 m							20/06/2014	19:00	59.093 °N -46.0769 °E	59° 04.33' S 046° 05.33' W		00:30	
		XBT_42		20/06/2014	21:08	58.820 °N -46.2354 °E	58° 49.23' S 046° 14.12' W														
S	65	CTD-Hydro	geoh_065_1	20/06/2014	22:46	58.583 °N -46.3860 °E	58° 34.98' S 046° 23.16' W	2 548 m	20/06/2014	23:36	58.583 °N -46.3861 °E	58° 34.98' S 046° 23.17' W		00:50	21/06/2014	00:52	58.583 °N -46.3861 °E	58° 34.98' S 046° 23.16' W	2 548 m	02:05	
		XBT_43		21/06/2014	02:37	58.302 °N -46.5651 °E	58° 18.13' S 046° 33.91' W	2 962 m													
S	66	CTD-Hydro	geoh_066_1	21/06/2014	04:52	57.992 °N -46.7531 °E	57° 59.52' S 046° 45.19' W	3 106 m	21/06/2014	05:55	57.992 °N -46.7531 °E	57° 59.52' S 046° 45.19' W	3 106 m	01:02	21/06/2014	07:16	57.992 °N -46.7531 °E	57° 59.52' S 046° 45.19' W	3 105 m	02:24	
		SVP_6		21/06/2014	07:20	57.992 °N -46.7524 °E	57° 59.51' S 046° 45.14' W	3 105 m													66-01
S	67	CTD-Hydro	geoh_067_1	21/06/2014	09:56	57.577 °N -47.0122 °E	57° 34.63' S 047° 00.73' W	2 897 m	21/06/2014	10:51	57.577 °N -47.0117 °E	57° 34.64' S 047° 00.70' W	2 896 m	00:55	21/06/2014	12:10	57.577 °N -47.0118 °E	57° 34.64' S 047° 00.71' W		02:14	
L	68	CTD-Hydro	geoh_068_1	21/06/2014	16:11	56.917 °N -47.4231 °E	56° 55.02' S 047° 25.38' W	3 587 m	21/06/2014	17:22	56.916 °N -47.4216 °E	56° 54.93' S 047° 25.30' W		01:11	21/06/2014	18:53	56.913 °N -47.4191 °E	56° 54.79' S 047° 25.14' W	3 586 m	02:41	
L	68	TMR-stock	geop_068_2	21/06/2014	18:56	56.913 °N -47.4191 °E	56° 54.79' S 047° 25.14' W	3 586 m	21/06/2014	20:13	56.913 °N -47.4190 °E	56° 54.79' S 047° 25.14' W		01:16	21/06/2014	21:32	56.913 °N -47.4190 °E	56° 54.79' S 047° 25.14' W	3 585 m	02:35	
L	68	CTD-Biogeoch-Surface	geoh_068_3	21/06/2014	21:35	56.913 °N -47.4190 °E	56° 54.79' S 047° 25.14' W	3 585 m	21/06/2014	21:42	56.913 °N -47.4190 °E	56° 54.79' S 047° 25.14' W	3 585 m	00:07	21/06/2014	21:58	56.913 °N -47.4191 °E	56° 54.79' S 047° 25.14' W	3 585 m	00:23	
		XBT_44		22/06/2014	01:14	56.378 °N -47.7631 °E	56° 22.71' S 047° 45.78' W														
Sp	69	CTD-Hydro	geoh_069_01	22/06/2014	04:42	55.842 °N -48.0931 °E	55° 50.51' S 048° 05.59' W	3 692 m	22/06/2014	05:55	55.842 °N -48.0932 °E	55° 50.51' S 048° 05.59' W	3 692 m	01:12	22/06/2014	07:29	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W	3 692 m	02:46	
Sp	69	TMR-stock	geop_069_02	22/06/2014	07:34	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W		22/06/2014	08:52	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W	3 692 m	01:18	22/06/2014	10:27	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W	3 692 m	02:53	
Sp	69	CTD-Biogeo-Shallow	geoh_069_03	22/06/2014	10:27	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W		22/06/2014	10:40	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W		00:12	22/06/2014	10:59	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W		00:31	
Sp	69	ISP-Shallow	geoi_069_04	22/06/2014	11:04	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W	3 692 m	22/06/2014	11:32	55.842 °N -48.0931 °E	55° 50.50' S 048° 05.59' W	3 692 m	00:27	22/06/2014	15:28	55.842 °N -48.0931 °E	55° 50.51' S 048° 05.59' W		04:24	
Sp	69	CTD-Pa/Th/Pb/Po	geoh_069_05	22/06/2014	15:38	55.842 °N -48.0931 °E	55° 50.51' S 048° 05.59' W	3 692 m	22/06/2014	16:47	55.842 °N -48.0932 °E	55° 50.50' S 048° 05.59' W	3 692 m	01:09	22/06/2014	18:21	55.842 °N -48.0933 °E	55° 50.50' S 048° 05.60' W	3 692 m	02:43	
Sp	69	TMR-Fe-isotopes	geop_069_06	22/06/2014	18:37	55.842 °N -48.0933 °E	55° 50.49' S 048° 05.60' W		22/06/2014	20:10	55.841 °N -48.0934 °E	55° 50.48' S 048° 05.60' W	3 692 m	01:32	22/06/2014	21:32	55.841 °N -48.0935 °E	55° 50.48' S 048° 05.61' W	3 691 m	02:54	
Sp	69	CTD-Ra+REEs	geoh_069_07	22/06/2014	21:37	55.841 °N -48.0935 °E	55° 50.47' S 048° 05.61' W		22/06/2014	22:48	55.841 °N -48.0935 °E	55° 50.48' S 048° 05.61' W		01:10	23/06/2014	00:15	55.841 °N -48.0933 °E	55° 50.47' S 048° 05.60' W	3 548 m	02:38	
Sp	69	ISP-Deep+corer	geoi_069_08	23/06/2014	00:20	55.841 °N -48.0934 °E	55° 50.47' S 048° 05.60' W	3 692 m	23/06/2014	01:59	55.841 °N -48.0933 °E	55° 50.47' S 048° 05.60' W	3 692 m	01:39	23/06/2014	08:02	55.841 °N -48.0933 °E	55° 50.47' S 048° 05.60' W	3 693 m	07:42	
Sp	69	CTD-Biogeo-Remin+REEs	geoh_069_09	23/06/2014	08:05	55.841 °N -48.0933 °E	55° 50.47' S 048° 05.60' W	3 692 m	23/06/2014	08:38	55.841 °N -48.0934 °E	55° 50.47' S 048° 05.61' W	3 476 m	00:32	23/06/2014	09:24	55.841 °N -48.0935 °E	55° 50.47' S 048° 05.61' W		01:18	
Sp	69	TMR-particulate	geop_069_010	23/06/2014	09:28	55.841 °N -48.0935 °E	55° 50.47' S 048° 05.61' W	3 692 m	23/06/2014	10:39	55.841 °N -48.0935 °E	55° 50.47' S 048° 05.61' W	3 489 m	01:10	23/06/2014	12:02	55.840 °N -48.0932 °E	55° 50.38' S 048° 05.59' W		02:33	
Sp	69	CTD-Be	geoh_069_11	23/06/2014	12:08	55.840 °N -48.0932 °E	55° 50.38' S 048° 05.59' W	3 687 m	23/06/2014	12:13	55.840 °N -48.0932 °E	55° 50.38' S 048° 05.59' W	3 687 m	00:05	23/06/2014	12:24	55.840 °N -48.0932 °E	55° 50.38' S 048° 05.59' W	3 687 m	00:16	
Sp	69	Plankton net	geon_069_12	23/06/2014	12:30	55.839 °N -48.0931 °E	55° 50.37' S 048° 05.59' W	3 686 m							23/06/2014	13:50	55.841 °N -48.0928 °E	55° 50.48' S 048° 05.57' W		01:20	The net was damaged
Sp	69	CTD-Radionuclides	geon_069_13	23/06/2014	13:51	55.841 °N -48.0928 °E	55° 50.48' S 048° 05.57' W	3 692 m	23/06/2014	15:01	55.841 °N -48.0928 °E	55° 50.48' S 048° 05.57' W	3 692 m	01:10	23/06/2014	16:29	55.841 °N -48.0929 °E	55° 50.48' S 048° 05.57' W	3 692 m	02:38	
Sp	69	CTD-REEs	geon_069_14	23/06/2014	17:10	55.841 °N -48.0929 °E	55° 50.48' S 048° 05.57' W	3 692 m	23/06/2014	18:21	55.841 °N -48.0929 °E	55° 50.48' S 048° 05.57' W	3 692 m	01:11	23/06/2014	19:49	55.841 °N -48.0929 °E	55° 50.48' S 048° 05.57' W	3 692 m	02:39	
		SVP_7		23/06/2014	19:55	55.840 °N -48.0939 °E	55° 50.42' S 048° 05.63' W	3 690 m													69-14
		XBT_45		23/06/2014	22:58	55.301 °N -48.4294 °E	55° 18.08' S 048° 25.77' W														1157012

				Start					Bottom						End						
Station name	Station number	Operation	Code	date	time	position (°)	position (°')	sonde	date	time	position (°)	position (°')	sonde	Duration	date	time	position (°)	position (°')	sonde	Duration	remarks
L	71	CTD-Hydro	geoh_071_1	24/06/2014	11:56	53.692 °N -49.4333 °E	53° 41.52' S 049° 26.00' W	3 700 m	24/06/2014	13:09	53.692 °N -49.4333 °E	53° 41.51' S 049° 26.00' W	3 700 m	01:13	24/06/2014	14:46	53.692 °N -49.4333 °E	53° 41.51' S 049° 26.00' W	3 700 m	02:50	
L	71	TMR-stock	geop_071_2	24/06/2014	14:52	53.692 °N -49.4333 °E	53° 41.51' S 049° 26.00' W	3 700 m	24/06/2014	15:58	53.692 °N -49.4333 °E	53° 41.52' S 049° 26.00' W	3 700 m	01:06	24/06/2014	17:08	53.692 °N -49.4333 °E	53° 41.51' S 049° 26.00' W	3 700 m	02:15	
L	71	CTD-Biogeoch-Surface	geoh_071_3	24/06/2014	17:14	53.692 °N -49.4333 °E	53° 41.52' S 049° 26.00' W	3 700 m	24/06/2014	17:24	53.692 °N -49.4333 °E	53° 41.51' S 049° 26.00' W		00:10	24/06/2014	17:46	53.692 °N -49.4332 °E	53° 41.51' S 049° 25.99' W	3 701 m	00:32	
		ARVOR_8		24/06/2014	17:50	53.692 °N -49.4350 °E	53° 41.52' S 049° 26.10' W	3 701 m													
		XBT_47		24/06/2014	21:00	53.418 °N -50.1488 °E	53° 25.10' S 050° 08.93' W	3 485 m													
S	72	CTD-Hydro	geoh_072_01	25/06/2014	00:34	53.142 °N -50.8623 °E	53° 08.51' S 050° 51.74' W	2 866 m	25/06/2014	01:30	53.141 °N -50.8559 °E	53° 08.45' S 050° 51.35' W	2 881 m	00:55	25/06/2014	02:47	53.138 °N -50.8407 °E	53° 08.30' S 050° 50.44' W	2 902 m	02:13	
		SVP_8		25/06/2014	02:51	53.138 °N -50.8401 °E	53° 08.30' S 050° 50.40' W	2 904 m													72-01
		XBT_48		25/06/2014	04:13	53.035 °N -51.1171 °E	53° 02.08' S 051° 07.02' W	2 530 m													
S	73	CTD-Hydro	geoh_073_01	25/06/2014	05:41	52.933 °N -51.3915 °E	52° 56.00' S 051° 23.49' W	2 055 m	25/06/2014	06:25	52.933 °N -51.3915 °E	52° 56.00' S 051° 23.49' W	2 055 m	00:43	25/06/2014	07:28	52.933 °N -51.3915 °E	52° 56.00' S 051° 23.49' W	2 055 m	01:46	
		XBT_49		25/06/2014	08:01	52.895 °N -51.4911 °E	52° 53.67' S 051° 29.46' W														
S	74	CTD-Hydro	geoh_074_01	25/06/2014	08:42	52.852 °N -51.5960 °E	52° 51.10' S 051° 35.76' W	1 254 m	25/06/2014	09:10	52.852 °N -51.5959 °E	52° 51.10' S 051° 35.75' W	1 253 m	00:27	25/06/2014	09:54	52.852 °N -51.5960 °E	52° 51.10' S 051° 35.76' W	1 254 m	01:11	
		XBT_50		25/06/2014	10:21	52.823 °N -51.6690 °E	52° 49.37' S 051° 40.14' W	930 m													
S	75	CTD-Hydro	geoh_075_01	25/06/2014	11:02	52.786 °N -51.7604 °E	52° 47.16' S 051° 45.63' W	480 m	25/06/2014	11:15	52.786 °N -51.7604 °E	52° 47.15' S 051° 45.63' W	480 m	00:12	25/06/2014	11:39	52.786 °N -51.7604 °E	52° 47.15' S 051° 45.63' W	480 m	00:36	
		XBT_51		25/06/2014	13:17	52.641 °N -52.1407 °E	52° 38.49' S 052° 08.44' W	299 m													
S	76	CTD-Hydro	geoh_076_01	25/06/2014	14:58	52.500 °N -52.5001 °E	52° 30.02' S 052° 30.01' W	264 m	25/06/2014	15:08	52.500 °N -52.5001 °E	52° 30.03' S 052° 30.01' W	264 m	00:10	25/06/2014	15:25	52.500 °N -52.5001 °E	52° 30.03' S 052° 30.01' W	264 m	00:27	
Sp	77	CTD-Hydro	geoh_077_01	25/06/2014	21:22	53.000 °N -51.1000 °E	52° 59.98' S 051° 06.00' W	2 487 m	25/06/2014	22:12	53.000 °N -51.1001 °E	52° 59.98' S 051° 06.01' W	2 487 m	00:50	25/06/2014	23:24	53.000 °N -51.1001 °E	52° 59.98' S 051° 06.00' W	2 487 m	02:02	
Sp	77	TMR-stock+particulate	geop_077_02	25/06/2014	23:27	53.000 °N -51.1001 °E	52° 59.98' S 051° 06.00' W	2 487 m	26/06/2014	00:14	52.996 °N -51.0986 °E	52° 59.78' S 051° 05.91' W	2 493 m	00:47	26/06/2014	01:23	52.989 °N -51.0954 °E	52° 59.35' S 051° 05.72' W	2 532 m	01:56	
Sp	77	CTD-Biogeo-Shallow	geoh_077_03	26/06/2014	01:28	52.989 °N -51.0954 °E	52° 59.35' S 051° 05.72' W	2 532 m	26/06/2014	01:36	52.989 °N -51.0954 °E	52° 59.35' S 051° 05.72' W	2 533 m	00:08	26/06/2014	01:53	52.989 °N -51.0954 °E	52° 59.35' S 051° 05.72' W	2 532 m	00:25	
Sp	77	ISP-Shallow	geoi_077_04	26/06/2014	02:04	52.989 °N -51.0954 °E	52° 59.35' S 051° 05.72' W	2 532 m	26/06/2014	02:36	52.989 °N -51.0953 °E	52° 59.35' S 051° 05.72' W	2 532 m	00:31	26/06/2014	06:35	52.989 °N -51.0953 °E	52° 59.35' S 051° 05.72' W	2 532 m	04:31	
Sp	77	CTD-Pa/Th/Pb/Po	geoh_077_05	26/06/2014	07:08	53.000 °N -51.0998 °E	52° 59.99' S 051° 05.99' W	2 486 m	26/06/2014	07:58	53.000 °N -51.0999 °E	52° 59.99' S 051° 05.99' W	2 487 m	00:50	26/06/2014	09:13	53.000 °N -51.0998 °E	52° 59.99' S 051° 05.99' W	2 486 m	02:05	
Sp	77	TMR-Fe-isotopes	geop_077_06	26/06/2014	09:19	53.000 °N -51.0998 °E	52° 59.99' S 051° 05.99' W	2 487 m	26/06/2014	10:07	52.998 °N -51.0975 °E	52° 59.85' S 051° 05.85' W	2 493 m	00:47	26/06/2014	11:04	52.993 °N -51.0908 °E	52° 59.57' S 051° 05.45' W	2 529 m	01:45	
Sp	77	CTD-Ra+REEs	geoh_077_07	26/06/2014	11:08	52.993 °N -51.0908 °E	52° 59.57' S 051° 05.45' W	2 529 m	26/06/2014	12:01	52.994 °N -51.0943 °E	52° 59.65' S 051° 05.66' W	2 517 m	00:53	26/06/2014	13:14	52.997 °N -51.0978 °E	52° 59.82' S 051° 05.87' W	2 492 m	02:05	
Sp	77	ISP-Deep+corer	geoi_077_08	26/06/2014	13:24	52.997 °N -51.0981 °E	52° 59.84' S 051° 05.88' W	2 491 m	26/06/2014	14:49	52.997 °N -51.0981 °E	52° 59.83' S 051° 05.89' W	2 491 m	01:24	26/06/2014	20:15	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 515 m	06:50	
Sp	77	CTD-Biogeo-Remin+REEs	geoh_077_09	26/06/2014	20:21	52.995 °N -51.0958 °E	52° 59.68' S 051° 05.75' W	2 515 m	26/06/2014	20:44	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 515 m	00:23	26/06/2014	21:26	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 515 m	01:05	
Sp	77	TMR-surface	geoh_077_10	26/06/2014	21:29	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 515 m	26/06/2014	21:32	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 515 m	00:03	26/06/2014	21:40	52.995 °N -51.0958 °E	52° 59.68' S 051° 05.75' W	2 516 m	00:11	
Sp	77	CTD-Be	geoh_077_11	26/06/2014	22:26	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 515 m	26/06/2014	22:33	52.995 °N -51.0958 °E	52° 59.68' S 051° 05.75' W	2 515 m	00:06	26/06/2014	22:44	52.995 °N -51.0958 °E	52° 59.68' S 051° 05.75' W	2 515 m	00:17	
Sp	77	CTD-Radionuclides	geoh_077_12	26/06/2014	23:30	52.995 °N -51.0958 °E	52° 59.68' S 051° 05.75' W	2 514 m	27/06/2014	00:22	52.995 °N -51.0958 °E	52° 59.68' S 051° 05.75' W	2 515 m	00:51	27/06/2014	01:24	52.995 °N -51.0959 °E	52° 59.68' S 051° 05.75' W	2 514 m	01:54	
		SVP_9		27/06/2014	01:30	52.994 °N -51.0968 °E	52° 59.66' S 051° 05.81' W	2 512 m													77-12
XL	78	CTD-Hydro++	geoh_078_01	27/06/2014	14:24	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	382 m	27/06/2014	14:37	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:13	27/06/2014	15:03	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:38	
XL	78	ISP-Bottom	geoh_078_02	27/06/2014	15:12	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	27/06/2014	15:32	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:20	27/06/2014	18:55	51.989 °N -53.8167 °E	51° 59.33' S 053° 49.00' W	383 m	03:43	
XL	78	TMR-stock++	geop_078_03	27/06/2014	19:04	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	27/06/2014	19:20	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:16	27/06/2014	19:46	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:42	
XL	78	Corer	geosc_078_04	27/06/2014	20:05	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	27/06/2014	20:07	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:01	27/06/2014	20:09	51.989 °N -53.8168 °E	51° 59.33' S 053° 49.01' W	383 m	00:03	
XL	78	CTD-isotopes	geoh_078_05	27/06/2014	20:10	51.989 °N -53.8167 °E	51° 59.33' S 053° 49.00' W	383 m	27/06/2014	20:23	51.989 °N -53.8167 °E	51° 59.33' S 053° 49.00' W	383 m	00:12	27/06/2014	20:44	51.989 °N -53.8167 °E	51° 59.33' S 053° 49.00' W	383 m	00:33	
		SVP_10		27/06/2014	20:52	51.988 °N -53.8219 °E	51° 59.30' S 053° 49.32' W	382 m													

II.4. Underway aerosol sampling

		Start				End			
Operation	Code	date	time	position (°)	position (°')	date	time	position (°)	position (°')
Aerosol sampling	geoa_1	19/05/2014	10:00	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	20/05/2014	09:40	40.333 °N -10.0360 °E	40° 20.00' S 010° 02.16' W
Aerosol sampling	geoa_2	23/05/2014	10:40	40.333 °N -12.2190 °E	40° 19.96' S 012° 13.14' W	24/05/2014	08:10	41.383 °N -13.888 °W	41° 22.97' S 013° 53.26' W
Aerosol sampling	geoa_3	24/05/2014	10:45	41.383 °N -13.8876 °E	41° 22.98' S 013° 53.26' W	25/05/2014	09:22	41.383 °N -13.888 °W	41° 22.97' S 013° 53.26' W
Aerosol sampling	geoa_4	25/05/2014	09:29	41.383 °N -13.8877 °E	41° 22.97' S 013° 53.26' W	27/05/2014	11:12	41.382 °N -13.885 °W	41° 22.93' S 013° 53.10' W
Aerosol sampling	geoa_5	27/05/2014	11:16	41.384 °N -13.8873 °E	41° 23.05' S 013° 53.24' W	29/05/2014	09:36	43.780 °N -17.032 °W	43° 46.79' S 017° 01.90' W
Aerosol sampling	geoa_6	30/05/2014	13:20	45.050 °N -18.5053 °E	45° 03.03' S 018° 30.32' W	02/06/2014	10:08	47.290 °N -20.262 °W	47° 17.39' S 020° 15.71' W
Aerosol sampling	geoa_7	02/06/2014	10:13	47.290 °N -20.2619 °E	47° 17.39' S 020° 15.71' W	04/06/2014	10:16	50.278 °N -22.605 °W	50° 16.67' S 022° 36.28' W
Aerosol sampling	geoa_8	04/06/2014	10:20	50.278 °N -22.6046 °E	50° 16.67' S 022° 36.28' W	06/06/2014	11:50	53.433 °N -25.075 °W	53° 25.99' S 025° 04.48' W
Aerosol sampling	geoa_9	06/06/2014	11:55	53.444 °N -25.0843 °E	53° 26.64' S 025° 05.06' W	08/06/2014	09:38	55.506 °N -26.710 °W	55° 30.34' S 026° 42.62' W
Aerosol sampling	geoa_10	08/06/2014	11:32	55.506 °N -26.7104 °E	55° 30.34' S 026° 42.62' W	10/06/2014	11:12	58.207 °N -29.725 °W	58° 12.44' S 029° 43.48' W
Aerosol sampling	geoa_11	10/06/2014	11:18	58.207 °N -29.7247 °E	58° 12.44' S 029° 43.48' W	12/06/2014	12:46	59.202 °N -34.810 °W	59° 12.11' S 034° 48.59' W
Aerosol sampling	geoa_12	12/06/2014	12:52	59.205 °N -34.8423 °E	59° 12.33' S 034° 50.54' W	14/06/2014	12:19	59.623 °N -38.954 °W	59° 37.36' S 038° 57.24' W
Aerosol sampling	geoa_13	14/06/2014	12:24	59.623 °N -38.9540 °E	59° 37.36' S 038° 57.24' W	16/06/2014	12:26	59.799 °N -42.003 °W	59° 47.94' S 042° 00.17' W
Aerosol sampling	geoa_14	16/06/2014	12:33	59.799 °N -42.0029 °E	59° 47.93' S 042° 00.17' W	18/06/2014	11:56	59.799 °N -41.986 °W	59° 47.94' S 041° 59.18' W
Aerosol sampling	geoa_15	18/06/2014	18:02	59.600 °N -43.5022 °E	59° 36.02' S 043° 30.13' W	20/06/2014	16:35	59.072 °N -46.089 °W	59° 04.33' S 046° 05.32' W
Aerosol sampling	geoa_16	21/06/2014	20:55	56.913 °N -47.4190 °E	56° 54.79' S 047° 25.14' W	23/06/2014	20:44	55.702 °N -48.179 °W	55° 42.10' S 048° 10.74' W
Aerosol sampling	geoa_17	23/06/2014	20:49	55.686 °N -48.1885 °E	55° 41.18' S 048° 11.31' W	25/06/2014	20:13	52.943 °N -51.363 °W	52° 56.59' S 051° 21.79' W
Aerosol sampling	geoa_18	25/06/2014	20:18	52.952 °N -51.3433 °E	52° 57.11' S 051° 20.60' W	27/06/2014	21:33	51.986 °N -53.836 °W	51° 59.17' S 053° 50.15' W

II.5. Underway rainwater sampling

		Start				End			
Operation	Code	date	time	position (°)	position (°')	date	time	position (°)	position (°')
Rain sampling	geor_1	19/05/2014	11:15	40.333 °N -10.0360 °E	40° 19.99' S 010° 02.16' W	19/05/2014	14:25	40.333 °N -10.036 °W	40° 19.99' S 010° 02.16' W
Rain sampling	geor_2	19/05/2014	22:00	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	19/05/2014	23:10	40.333 °N -10.036 °W	40° 20.00' S 010° 02.15' W
Rain sampling	geor_3	19/05/2014	23:45	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.16' W	20/05/2014	07:50	40.333 °N -10.036 °W	40° 20.00' S 010° 02.15' W
Rain sampling	geor_4	20/05/2014	11:25	40.333 °N -10.0359 °E	40° 20.00' S 010° 02.15' W	20/05/2014	17:15	40.333 °N -10.035 °W	40° 20.00' S 010° 02.11' W
Rain sampling	geor_5	20/05/2014	18:15	40.314 °N -09.8722 °E	40° 18.83' S 009° 52.33' W	20/05/2014	21:15	40.333 °N -09.459 °W	40° 19.98' S 009° 27.57' W
Rain sampling	geor_6	21/05/2014	17:20	40.333 °N -09.7668 °E	40° 19.99' S 009° 46.01' W	22/05/2014	08:40	40.333 °N -10.101 °W	40° 20.00' S 010° 06.06' W
Rain sampling	geor_7	01/06/2014	10:10	46.544 °N -19.6719 °E	46° 32.64' S 019° 40.32' W	01/06/2014	13:30	46.544 °N -19.672 °W	46° 32.64' S 019° 40.32' W
Rain sampling	geor_8	05/06/2014	21:45	52.304 °N -24.1856 °E	52° 18.27' S 024° 11.14' W	06/06/2014	07:57	53.020 °N -24.752 °W	53° 01.20' S 024° 45.12' W
Rain sampling	geor_9	18/06/2014	02:07	59.799 °N -42.0131 °E	59° 47.96' S 042° 00.78' W	18/06/2014	13:10	59.799 °N -41.982 °W	59° 47.95' S 041° 58.95' W

II.6. Underway fish sampling

		Start				End				Remarks
Operation	Code	date	time	position (°)	position (°')	date	time	position (°)	position (°')	
Fish sampling	geof_1	28/05/2014	17:33	42.665 °N -15.5651 °E	42° 39.88' S 015° 33.90' W	28/05/2014	17:48	42.692 °N -15.601 °W	42° 41.55' S 015° 36.07' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_2	28/05/2014	20:54	43.026 °N -16.0394 °E	43° 01.55' S 016° 02.36' W	28/05/2014	21:02	43.041 °N -16.058 °W	43° 02.43' S 016° 03.51' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_3	29/05/2014	07:36	43.649 °N -16.8584 °E	43° 38.96' S 016° 51.50' W	29/05/2014	07:41	43.662 °N -16.876 °W	43° 39.70' S 016° 52.56' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_4	30/05/2014	07:59	44.532 °N -17.9778 °E	44° 31.90' S 017° 58.67' W	30/05/2014	08:03	44.541 °N -17.988 °W	44° 32.48' S 017° 59.27' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_5	30/05/2014	09:25	44.722 °N -18.1699 °E	44° 43.31' S 018° 10.20' W	30/05/2014	09:27	44.726 °N -18.174 °W	44° 43.58' S 018° 10.43' W	Artificials
Fish sampling	geof_6	30/05/2014	20:16	45.189 °N -18.6210 °E	45° 11.32' S 018° 37.26' W	30/05/2014	20:20	45.200 °N -18.630 °W	45° 11.97' S 018° 37.81' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_7	30/05/2014	23:06	45.627 °N -18.9575 °E	45° 37.60' S 018° 57.45' W	30/05/2014	23:11	45.640 °N -18.968 °W	45° 38.42' S 018° 58.08' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_8	31/05/2014	04:57	46.033 °N -19.2728 °E	46° 01.95' S 019° 16.37' W	31/05/2014	05:03	46.050 °N -19.286 °W	46° 02.99' S 019° 17.17' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_9	02/06/2014	13:23	47.569 °N -20.4791 °E	47° 34.15' S 020° 28.74' W	02/06/2014	13:26	47.577 °N -20.485 °W	47° 34.61' S 020° 29.12' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_10	02/06/2014	16:05	47.980 °N -20.7970 °E	47° 58.81' S 020° 47.82' W	02/06/2014	16:11	47.996 °N -20.809 °W	47° 59.79' S 020° 48.51' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_11	03/06/2014	01:41	48.249 °N -21.0256 °E	48° 14.91' S 021° 01.54' W	03/06/2014	01:46	48.262 °N -21.034 °W	48° 15.71' S 021° 02.06' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_12	03/06/2014	03:53	48.564 °N -21.2563 °E	48° 33.86' S 021° 15.38' W	03/06/2014	03:58	48.576 °N -21.266 °W	48° 34.55' S 021° 15.97' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_13	03/06/2014	09:00	48.805 °N -21.4487 °E	48° 48.29' S 021° 26.92' W	03/06/2014	09:02	48.809 °N -21.452 °W	48° 48.52' S 021° 27.11' W	Artificials
Fish sampling	geof_14	03/06/2014	14:19	49.435 °N -21.9424 °E	49° 26.10' S 021° 56.54' W	03/06/2014	14:24	49.445 °N -21.950 °W	49° 26.68' S 021° 57.02' W	dAl/dAg, TdAl/TdAg, dHg, TdHg
Fish sampling	geof_15	04/06/2014	02:34	50.139 °N -22.4944 °E	50° 08.34' S 022° 29.67' W	04/06/2014	03:37	50.278 °N -22.603 °W	50° 16.69' S 022° 36.16' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_16	05/06/2014	04:19	50.676 °N -22.9262 °E	50° 40.57' S 022° 55.57' W	05/06/2014	04:24	50.690 °N -22.936 °W	50° 41.39' S 022° 56.19' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_17	05/06/2014	20:30	52.122 °N -24.0502 °E	52° 07.31' S 024° 03.01' W	05/06/2014	20:30	52.122 °N -24.050 °W	52° 07.31' S 024° 03.01' W	Artificials
Fish sampling	geof_18	05/06/2014	22:05	52.352 °N -24.228 °W	52° 21.13' S 024° 13.70' W	05/06/2014	22:08	52.359 °N -24.234 °W	52° 21.54' S 024° 14.05' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_19	06/06/2014	02:31	52.993 °N -24.731 °W	52° 59.60' S 024° 43.85' W	06/06/2014	02:35	53.003 °N -24.739 °W	53° 00.16' S 024° 44.35' W	TdAl/TdAg, TdHg, Artificials, Pb
Fish sampling	geof_20	09/06/2014	07:30	56.184 °N -27.234 °W	56° 11.04' S 027° 14.03' W	09/06/2014	07:31	56.187 °N -27.236 °W	56° 11.20' S 027° 14.15' W	TdAl/TdAg, TdHg, Artificials, Pb
Fish sampling	geof_21	09/06/2014	20:44	57.078 °N -27.969 °W	57° 04.66' S 027° 58.14' W	09/06/2014	20:47	57.085 °N -27.979 °W	57° 05.10' S 027° 58.73' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_22	09/06/2014	23:13	57.429 °N -28.415 °W	57° 25.77' S 028° 24.92' W	09/06/2014	23:16	57.437 °N -28.425 °W	57° 26.23' S 028° 25.49' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_23	10/06/2014	04:33	57.880 °N -29.112 °W	57° 52.78' S 029° 06.69' W	10/06/2014	04:37	57.889 °N -29.127 °W	57° 53.33' S 029° 07.65' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_24	10/06/2014	06:36	58.123 °N -29.565 °W	58° 07.36' S 029° 33.88' W	10/06/2014	06:38	58.127 °N -29.573 °W	58° 07.61' S 029° 34.36' W	dAl/dAg, TdAl/TdAg

		Start				End				Remarks
Operation	Code	date	time	position (°)	position (°')	date	time	position (°)	position (°')	
Fish sampling	geof_25	10/06/2014	13:24	58.436 °N -30.148 °W	58° 26.13' S 030° 08.85' W	10/06/2014	13:27	58.442 °N -30.159 °W	58° 26.51' S 030° 09.57' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_26	11/06/2014	19:21	58.877 °N -31.501 °W	58° 52.60' S 031° 30.08' W	11/06/2014	19:26	58.879 °N -31.530 °W	58° 52.73' S 031° 31.83' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_27	11/06/2014	20:44	58.913 °N -31.936 °W	58° 54.78' S 031° 56.18' W	11/06/2014	20:47	58.914 °N -31.950 °W	58° 54.83' S 031° 56.97' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_28	12/06/2014	01:40	59.015 °N -32.885 °W	59° 00.91' S 032° 53.12' W	12/06/2014	01:48	59.020 °N -32.939 °W	59° 01.18' S 032° 56.34' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_29	12/06/2014	03:48	59.082 °N -33.616 °W	59° 04.93' S 033° 36.97' W	12/06/2014	03:51	59.084 °N -33.634 °W	59° 05.04' S 033° 38.04' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_30	12/06/2014	10:05	59.114 °N -33.958 °W	59° 06.83' S 033° 57.46' W	12/06/2014	10:10	59.117 °N -33.986 °W	59° 07.00' S 033° 59.17' W	dAl/dAg, TdAl/TdAg, TdHg, Artificials, Pb
Fish sampling	geof_31	12/06/2014	16:38	59.242 °N -35.176 °W	59° 14.54' S 035° 10.54' W	12/06/2014	16:38	59.242 °N -35.176 °W	59° 14.54' S 035° 10.54' W	Artificials
Fish sampling	geof_32	12/06/2014	17:06	59.257 °N -35.341 °W	59° 15.45' S 035° 20.44' W	12/06/2014	17:10	59.259 °N -35.364 °W	59° 15.56' S 035° 21.86' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_33	12/06/2014	19:50	59.349 °N -36.260 °W	59° 20.96' S 036° 15.59' W	12/06/2014	19:57	59.353 °N -36.299 °W	59° 21.20' S 036° 17.96' W	dAl/dAg, TdAl/TdAg, TdHg, Artificials, Pb
Fish sampling	geof_34	13/06/2014	03:40	59.428 °N -37.019 °W	59° 25.66' S 037° 01.17' W	13/06/2014	03:52	59.433 °N -37.067 °W	59° 25.96' S 037° 03.99' W	dAl/dAg, TdAl/TdAg, TdHg, Artificials, Pb
Fish sampling	geof_35	13/06/2014	10:10	59.543 °N -38.169 °W	59° 32.55' S 038° 10.16' W	13/06/2014	10:21	59.549 °N -38.228 °W	59° 32.91' S 038° 13.69' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_36	16/06/2014	03:02	59.783 °N -41.499 °W	59° 47.00' S 041° 29.96' W	16/06/2014	03:07	59.784 °N -41.529 °W	59° 47.06' S 041° 31.76' W	dAl/dAg, TdAl/TdAg, TdHg, Artificials, Pb
Fish sampling	geof_37	21/06/2014	09:04	57.705 °N -46.934 °W	57° 42.33' S 046° 56.02' W	21/06/2014	09:08	57.693 °N -46.942 °W	57° 41.61' S 046° 56.49' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_38	21/06/2014	14:08	57.246 °N -47.225 °W	57° 14.78' S 047° 13.49' W	21/06/2014	14:11	57.238 °N -47.231 °W	57° 14.27' S 047° 13.85' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_39	22/06/2014	02:01	56.252 °N -47.845 °W	56° 15.09' S 047° 50.69' W	22/06/2014	02:18	56.203 °N -47.874 °W	56° 12.20' S 047° 52.44' W	dAl/dAg, TdAl/TdAg, TdHg, Artificials, Pb, 10L Carboys
Fish sampling	geof_40	23/06/2014	21:40	55.531 °N -48.288 °W	55° 31.86' S 048° 17.28' W	23/06/2014	22:05	55.456 °N -48.335 °W	55° 27.34' S 048° 20.07' W	30-L Carboys LEMAR
Fish sampling	geof_41	23/06/2014	22:07	55.450 °N -48.338 °W	55° 26.99' S 048° 20.29' W	23/06/2014	22:09	55.444 °N -48.342 °W	55° 26.62' S 048° 20.52' W	dAl/dAg, TdAl/TdAg, TdHg
Fish sampling	geof_42	24/06/2014	06:58	54.443 °N -48.965 °W	54° 26.60' S 048° 57.88' W	24/06/2014	07:21	54.379 °N -49.005 °W	54° 22.75' S 049° 00.28' W	dAl/dAg, TdAl/TdAg, TdHg

III. On-board reports

III.1. Physical parameters: pressure, temperature, salinity and oxygen data from CTD rosettes

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Résumé/Abstract:

During the GEOVIDE cruise, 216 CTD-O_2 profiles were acquired over 78 stations. Two 24-bottle rosettes were used: one classical Hydrographic Rosette (HR), deployed at all stations, and one Trace Metal Rosette (TMR), deployed at Large, XLarge and Super stations. The sampling strategy followed what was exposed in the proposals, with adjustments that took into account real-time data, but also technical difficulties and meteorogical forecasts. All the shelves could be sampled, despite the very recent presence of sea ice.
After presenting the hydrographic objectives and context of the cruise, the sampling strategy is explained, the calibration method is briefly exposed and the first striking results on water mass hydrographic properties are commented.

1- Scientific context and objectives

During the GEOVIDE cruise, two hydrological sections were carried out in the North Atlantic. The first one was the 7th repetition of the OVIDE section between the south tip of Greenland and Portugal. The second one was the 1st occurrence of a section across the southern Labrador Sea, between Cape Farewell and Newfoundland.

The program OVIDE started in 2002. One of the objectives was to analyse and understand the interannual to decadal variability of the Meridional Overturning Circulation (MOC) across the section. In this context, the GEOVIDE section contributes to this objective. The MOC quantifies the transformation of warm and saline light water brought by the northward North Atlantic Current (NAC) into colder and fresher dense water exported mainly in the southward Western Boundary Currents. The orientation, position and resolution of the section were chosen to

optimize the estimation of the transport of the main currents composing the MOC. Those transports are deduced from absolute geostrophic velocities. When computed from in-situ observations, the relative geostrophic velocities are deduced from the temperature-salinity data measured at stations by the CTD, adjusted with a least-squares method to the in-situ velocity profiles measured from the ship. This way, each survey provides a snapshot of the circulation across the section. Alternatively, the circulation of the first 2000 meters can also be reconstructed weekly using a combination of satellite altimetry and hydrological data from ARGO profilers (Mercier et al., 2013), although boundary currents, critical for the estimation of the MOC, are not well resolved with this approach. Despite this caveat, the MOC time series reconstructed across the OVIDE section from 1993 was compatible with the 6 first estimates from the OVIDE cruises. It exhibited a decadal variability which reality and origin needs to be assessed by a longer time series of in-situ observations.

The Labrador Sea is known to be subject to deep convection (down to about 2000m), a thus contributes to the transfer of surface water to deep water. However, studies on the MOC in the Labrador Sea show that most of the surface water in the Labrador Sea has already been densified during its journey in the Eastern North Atlantic and already belongs to the lower limb of the MOC, when the latter is computed in the density space (Pickart and Spall, 2007; Sarafanov et al., 2012; Debruyères et al., in prep.). Therefore, the North Atlantic MOC is not expected to be largely impacted by deep convection in the Labrador Sea. The data acquired during the GEOVIDE cruise will be an opportunity to estimate the MOC with the method used since 2002 for the OVIDE section and directly compare the respective contribution of the Eastern and Western North Atlantic circulation to the MOC in 2014.

In the frame of GEOTRACES, a good knowledge of the circulation and water masses is critical to determine the dynamical and hydrological domains sampled by biogeochemists. In return, the transport of biogeotracers across the section that can be calculated within the inverse model is susceptible to provide interesting constrains to improve the model and also help in the interpretation of the large-scale circulation, particularly for deep waters. For example, the conservation of silicates has already been used to compensate for large uncertainties of the velocity field in the deep and bottom Iberian Abyssal Plain (Lherminier et al., 2010).

2- Methodology and sampling strategy

Considering the large number of parameters to be measured and the duration of a typical GEOTRACES station, it was necessary to decrease the total number of stations along the section (as compared to the previous OVIDE cruises). The main challenge was to determine the correct sub-sampling in GEOVIDE so that the OVIDE time-series can be continued. We chose to decrease the resolution by a factor of two in the interior, and to keep the full resolution in the boundary currents. Using the inverse model described in Lherminier et al. (2007), sensitivity experiments on OVIDE 2010 data showed that the sampling proposed above gives consistent results with the full resolution inversion, although errors increased by 10 to 20% on integral quantities and up to 30% locally. Taking into account the in-situ current measurements done by the ship Acoustic Doppler Current Profiler is determinant to obtain such good comparisons (see “Velocity profiles from SADCP” in this report). Super stations were located at the centre of the gyres and in characteristic areas such as margins or ridges. Knowing that the boundary currents have a large short-

term variability, the Super stations located within them were done before or after the corresponding hydrographic segment. Similarly, using real-time operational oceanography products (MERCATOR), a special attention was paid on-site to detect the critical frontal systems and avoid time-consuming stations within them.

Using sampling adaptative strategy was particularly critical to identify the position of the XLarge station that would be representative of the southern main branch of the NAC, which position varies by 200km from year to year. Herlé Mercier processed the daily MERCATOR products ashore, i.e. Sea Surface Height (SSH), Salinity (SSS) and Temperature (SST), by interpolating them along the Ovide line. Knowing that the horizontal gradient of SSH is proportional to the surface water velocity, we could determine the most likely location of the NAC station two days in advance (Figure 1) at station 26 (that was moved a little eastward). This choice was confirmed later by the strong horizontal gradient of properties observed in the CTD data. A little later, stations 27 to 30 had to be spaced to avoid a gale that would have stopped the operations.

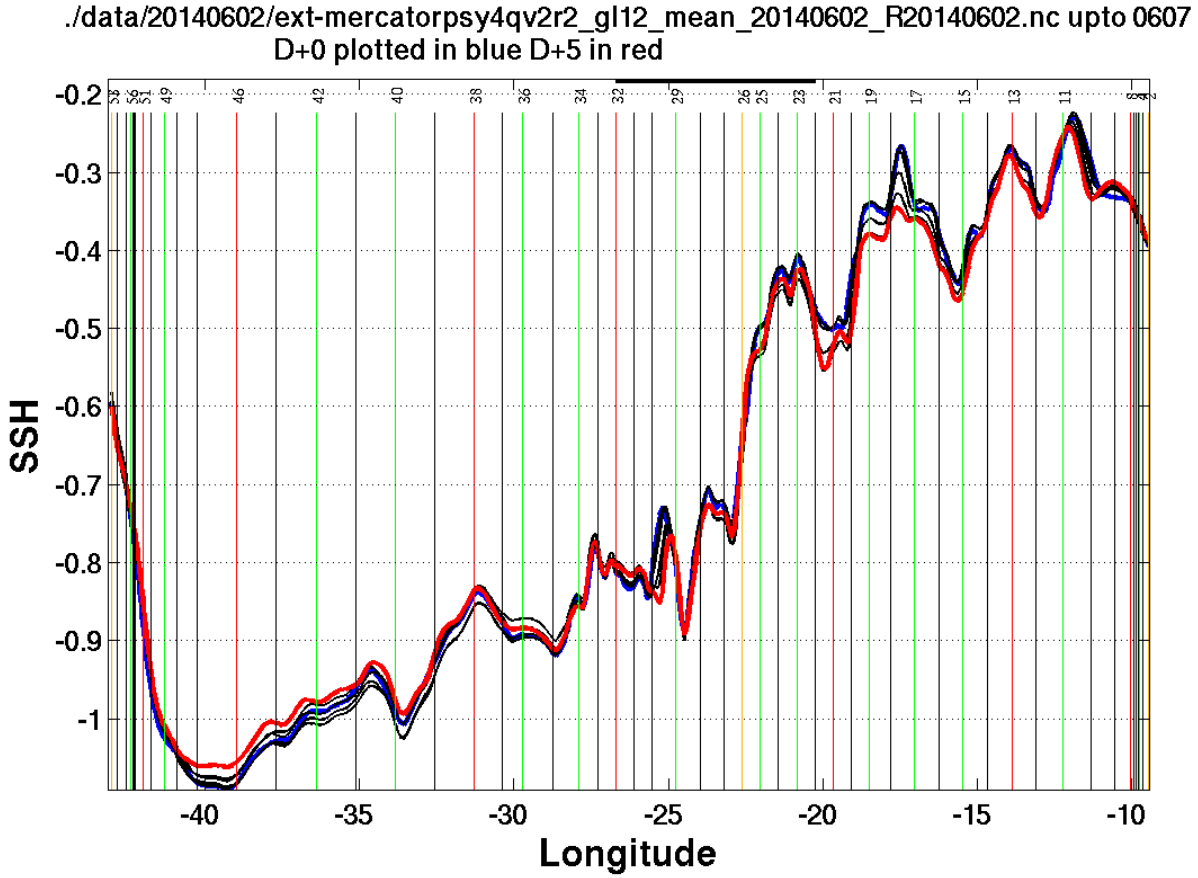

***Figure 1**: MERCATOR Sea Surface Height (SSH) interpolated along the OVIDE section from Greenland to Portugal, from the analysis at day 0 (June 2, 2014, in blue) to the forecast at day 5 (June 7, in red). The position of the ship at those dates is given by the bold line at the top. Vertical lines indicate the station positions and numbers (Super in red, XLarge in orange, Large in green and Short in black). The strong positive slope around 22.5°W indicates a strong northward surface current belonging to the North Atlantic Current.*

Concerning Super and XLarge stations, the sampling strategy on the OVIDE section was adapted based on the analysis of historical data and circulation patterns (Figure 2). Maribel García (Vigo group) provided aboard the result of an Optimal MultiParameter (OMP) approach averaged over the OVIDE cruises of 2002-2004-2006-2008-2010 (Figure 3), although this analysis is not final yet (article in prep.). All the water masses on Figure 3 were sampled during Super Stations. The depths of the samples for all the parameters were decided in real time by studying the first profile of the series to identify the water masses. Sampling strategy for salinity and oxygen was based on the strategy of the previous cruises (i.e. standard levels plus significant extrema of each parameter), but when possible, the sampling was adapted to be compatible with other biogeochemical data, the main constraint being the need to have enough deep samples for the salinity and oxygen calibration.

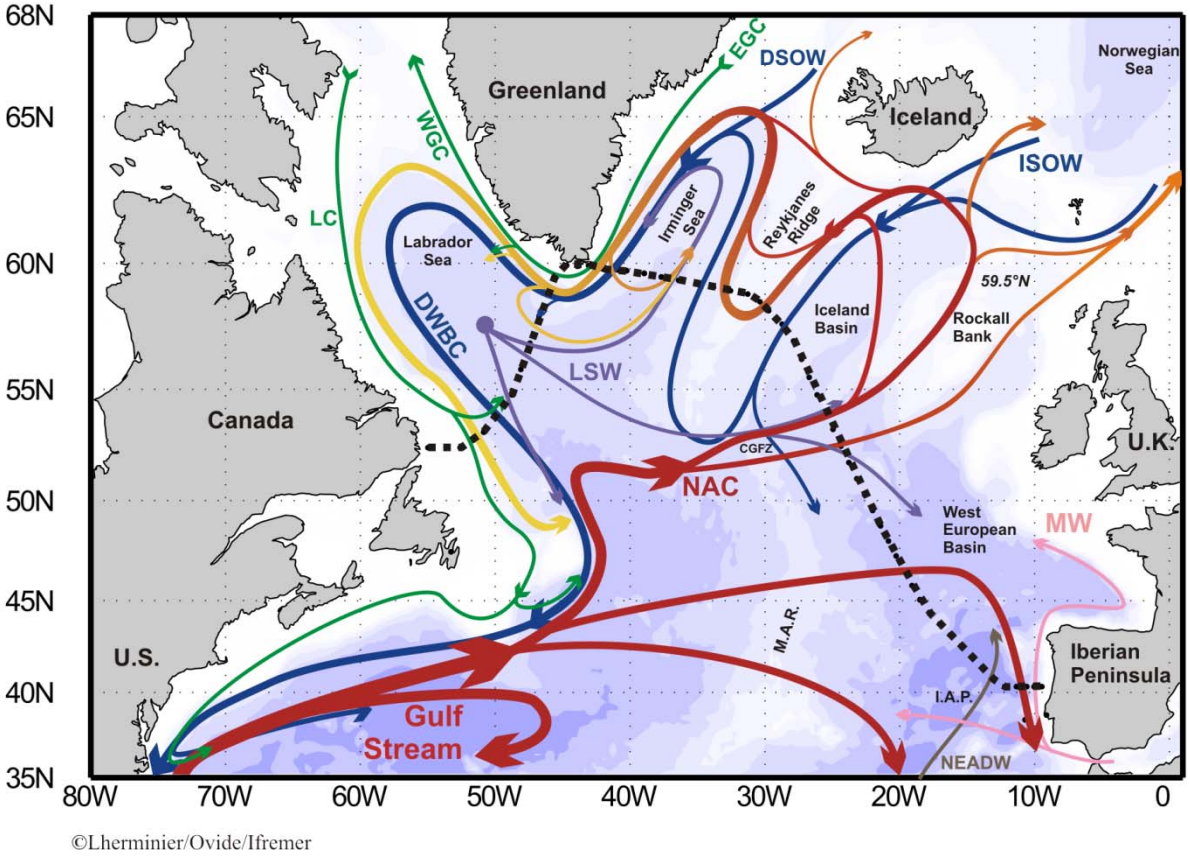

***Figure 2**: Main circulation patterns of the North Atlantic. From surface to bottom: NAC: North Atlantic Current; EGC: East Greenland Current; WGC: West Greenland Current; LC: Labrador Current; MW: Mediterranean Water; LSW: Labrador Sea Water; ISOW: Iceland-Scotland Overflow Water; DSOW: Denmark Strait Overflow Water; NEADW: North-East Atlantic Deep Water; DWBC: Deep Western Boundary Current. Topographic features: Mid-Atlantic Ridge (MAR), Charlie-Gibbs Fracture Zone (CGFZ), Iberian Abyssal Plain (IAP).*

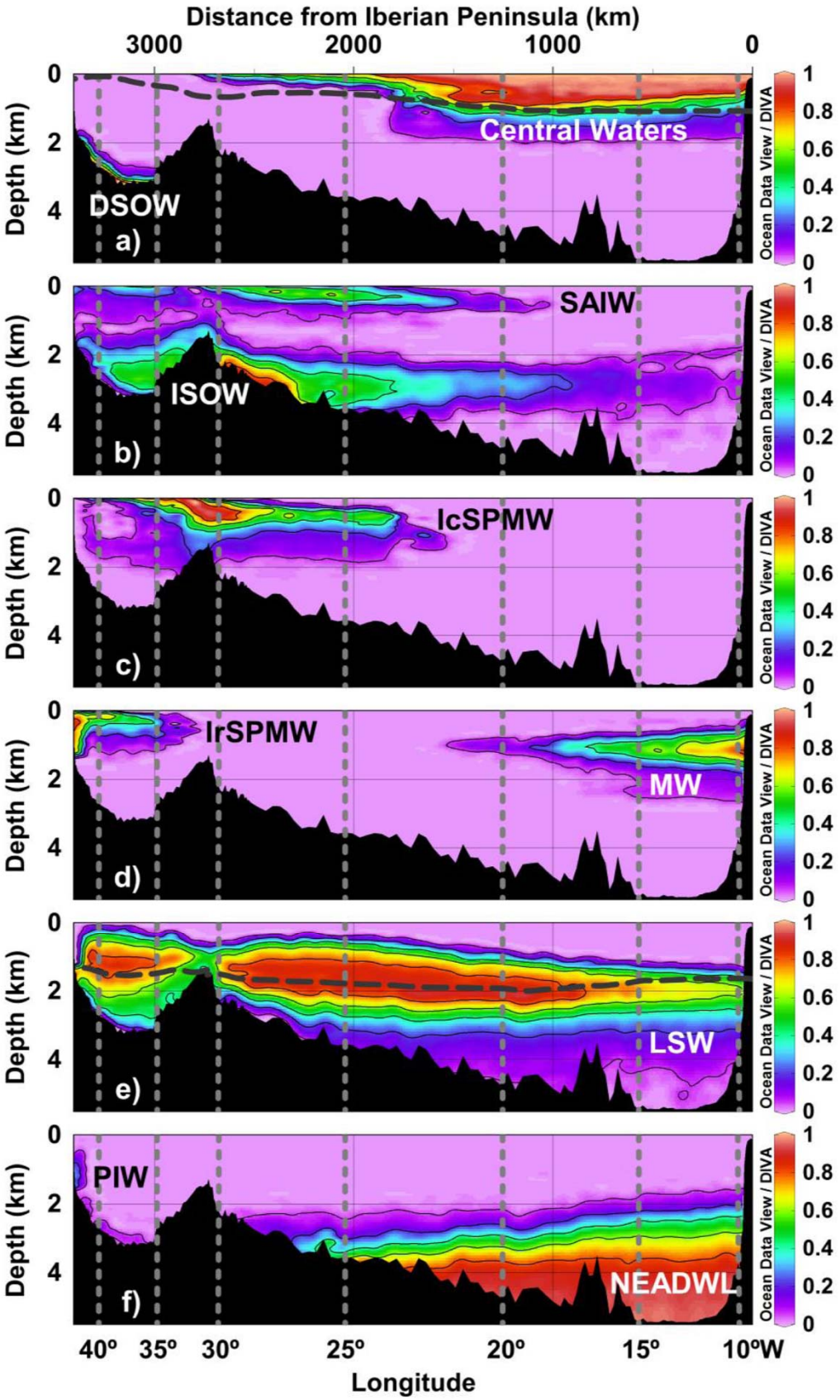

***Figure 3**: Result of an OMP analysis along the OVIDE section from Greenland (left) to Portugal (right), provided by Maribel García (in prep.). The proportion of the main water masses is depicted in color, from 0 (none) to 1 (pure). Only one or two water*

masses geographically distinct are represented on each plot. From top to bottom: Denmark Strait Overflow Water (DSOW), all types of Central Water, Iceland-Scotland Overflow Water (ISOW), SubArctic Intermediate Water (SAIW), Iceland Subpolar Mode Water (IcSPMW), Irminger SPMW (IrSPMW), Mediterranean Water (MW), Labrador Sea Water (LSW), Polar Intermediate Water (PIW) and North East Atlantic Deep Water Lower (NEADWL).

In order to achieve synoptic views of the highly variable Western Boundary Currents, some back and forth movements were done on the sections to adapt for the long duration of the super stations. For this reason, some stations were done at the same position. This is the case for stations 44 (super) and 46 (short), 51 (short) and 60 (super), 72 (short) and 77 (super).

Pre-calibration of the salinity and dissolved oxygen profiles:

Excluding the test stations, 78 stations were visited between Portugal and Newfoundland. At each station, we performed between 1 and 9 casts with the hydrographic rosette (HR hereafter) and between 1 and 4 casts with the Trace Metal (clean) Rosette (TMR hereafter). Each rosette was equipped with 24 bottles for sampling.The first cast of each station was always done down to about 10 meters from the bottom.
The HR was equipped with 2 conductivity sensors, 2 oxygen sensors, an altimeter, a fluorometer, a transmissiometer, an irradiance and a surface irradiance meter. The TMR was equipped with 2 conductivity sensors, 1 oxygen sensor, an altimeter, a transmissiometer and a turbidimeter. In this section, we will concentrate on temperature, salinity and oxygen data. The other sensors were particularly useful to determine the sampling strategy of the biogeotracers.

The test station showed a failure in the SBE9+ #813 of the HR. We switched to the spare SBE911 (#802 and associated sensors) from station 1 to 58, where it broke. Then we used the SBE9+ borrowed from Vigo, but using the same sensors. The SBE911 (#75) and associated sensors on the TMR acquired good data over the whole cruise.

The calibration of the sensors was done by Seabird for all the CTDs, but experience shows that obtaining high precision data requires a further calibration based on chemical analysis of samples, at least for salinity and dissolved oxygen. Those measurements were done on board, in a laboratory container. Then the profiles were pre-calibrated using the CADHYAC software (LPO, version 3.1). The sampling of oxygen on the TMR turned out to be problematic, due to the constraints of clean sampling. So only the salinity was calibrated with chemical samples on the TMR. A specific procedure will be developed onshore to calibrate the oxygen using the HR samples.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units	number of profiles/samples
1. Pressure	CTD (SBE911)	dbar	163
2. Temperature	CTD (SBE911)	degC (T90)	163
3. Salinity	CTD (SBE911)		163
4. Dissolved oxygen	CTD (SBE43)	ml/l or µmol/kg	163
5. Pressure	TMR (SBE911)	dbar	53
6. Temperature	TMR (SBE911)	degC (T90)	53
7. Salinity	TMR (SBE911)		53
8. Dissolved oxygen	TMR (SBE43)	ml/l or µmol/kg	53
9. Salinity	Salinometer		1444 + 614
10. Dissolved oxygen	Titrino	ml/l	1559

* Classic CTD, ISP, TMR, NET, CORER, FISH

3- Preliminary results

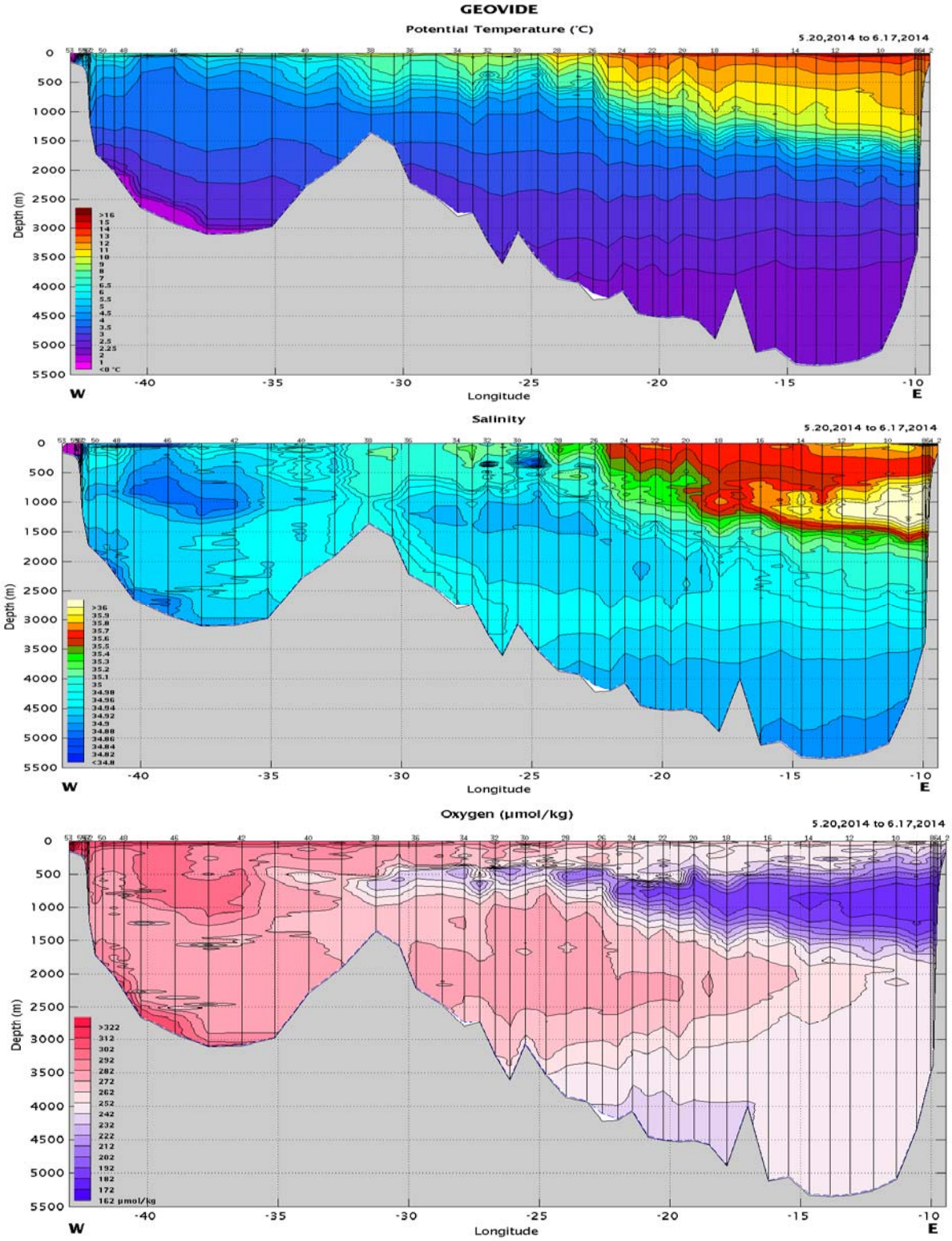

***Figure 4**: Sections of temperature (top, in °C), salinity (middle) and dissolved oxygen (bottom, in µmol/kg) between Greenland (left) and Portugal (right), as a function of longitude. Those sections were done with the pre-calibrated data of the first downcast of each station (hydrological rosette).*

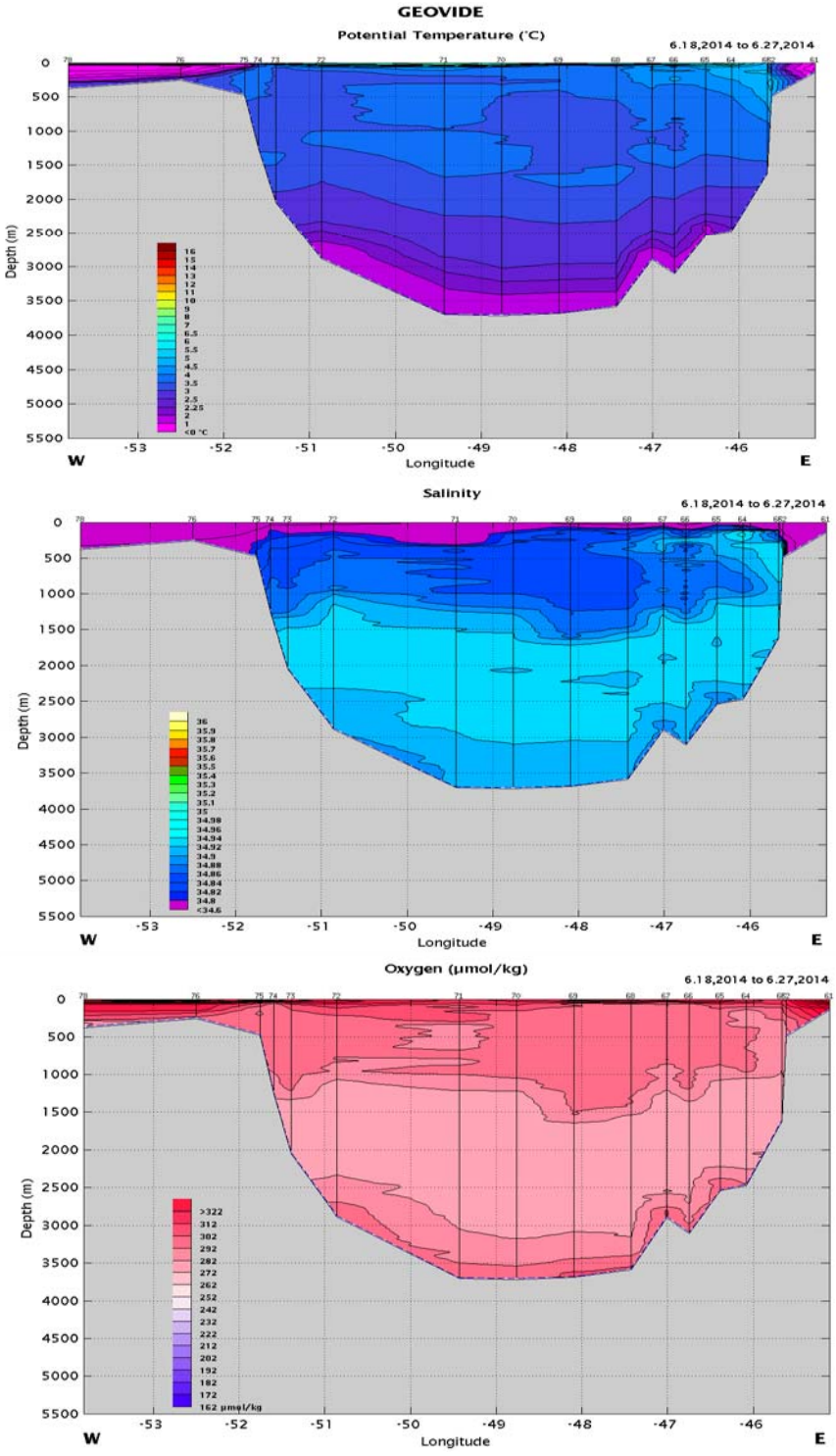

Figure 5*: Sections of temperature (top, in °C), salinity (middle) and dissolved oxygen (bottom, in µmol/kg) between Newfoundland (left) and Greenland (right), as a function of longitude. Those sections were done with the pre-calibrated data of the first downcast of each station (hydrological rosette).*

The pre-calibration of the data gave very good results. The standard deviation of the difference between bottle and CTD salinity (oxygen) was less than 2 psu (0.05 ml/l). So salinity accuracy is already compliant with WOCE international requirements for all the CTDs. However, some spurious small-scale patterns need to be examined

more closely and need to be corrected, particularly in the western Irminger Sea. The results are not yet as good for the dissolved oxygen where the standard deviation amounts to 0.04 ml/l for the HR CTD and the spurious points are obvious in the Irminger Sea, when the CTD #802 was probably beginning to fail intermittently. So a post-cruise correction and calibration is necessary for oxygen.

The striking patterns that emerged from a preliminary analysis of the data are presented hereafter:

- The branches of the NAC seem to be concentrated between stations 18 and 27 (Fig. 1 and 4), with a very sharp front at stations 25-26 that definitely separate the subpolar domain from the inter-gyre domain, i.e. the transition region between the subtropical and the subpolar gyres.This is the first time that the subarctic front is found so much to the south and the branches of the NAC so concentrated geographically.
- The Iceland Basin is marked by a strong presence of SAIW at about 350m depth, linked with meso-scale patterns. It is marked by minima of salinity on Fig. 4, at stations 26, 27, 29, 30 and 32. Analysis on the Mercator SSH maps showed a complex meandering in this area. Note that SAIW is supposed to be formed by a mixing between the Atlantic and polar water in the vicinity of the Labrador Current and then advected into the cyclonic subpolar gyre. Its presence in the Iceland Basin tends to indicate a strong horizontal circulation around the subpolar gyre.
- The central Irminger Sea on Fig. 4 is marked by a recently ventilated water mass down to 1000m, capped by a thin fresh layer.
- The Polar Water of the Greenland Shelf on Fig. 4 extents deep and far offshore, but it is expected at mid-June, since the sea ice cover was just swept away (by a combination of melting and wind and current drift). The same applies in the Labrador Sea (Fig. 5)
- The thickest layer of recent Labrador Sea Water was found at station 69 (the crossover/super station, Fig. 5), down to 1500m depth. The most homogeneous layer was found between 600 and 1300m depth, at θ=3.38°C and S=34.853. These are the same characterisitcs than the 2005 and 2008 vintages of the LSW_{2000} (Yashayaev, 2007, Yashayaev and Loder, 2009). It is probable that this water was ventilated in the winter 2013-2014, although it needs to be proven.

4- Post-cruise sampling analyses and dead-lines, data bases

- Final calibration of CTD datasets (T, S, O_2) and report: april 2015
- Bottle data will be sent to the cruise data center in Villefranche in September, with access restricted to the project partners. CTD pre-calibrated data will be available on demand.
- Calibrated data will be sent to Villefranche and to the SISMER in Brest in June 2015.

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III.2. Velocity profiles from Ship Acoustic Doppler Current Profilers (SADCP)

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Résumé/Abstract:

Two Acoustic Doppler Current Profilers (SADCP) are mounted in the hull of the *Pourquoi Pas?*. They both measure velocity profiles under the ship, but with two different compromises between range and resolution. The SADCP OS38 (OS150) reaches about 700m (400m) with a vertical resolution of 24m (8m). Both SADCPs acquired data all along the cruise. A pre-processing was achieved on board, giving already datasets of good quality, but a post-processing is needed to reach the objective of determining the Meridional Overturning Circulation across the GEOVIDE sections.

1. Scientific context (1/2 page max.)

The scientific context and objective are presented in the CTD section. The SADCPs provide the in situ velocity data necessary to determine the absolute geostrophic velocities across the section. Indeed, while the geostrophic profiles can be determined with the potential density field, it is relative to an arbitrary value at a chosen reference level. The SADCP data averaged between stations provides indirectly the required reference velocities (Lherminier et al., 2007). Ultimately, the transport of the main currents and the Meridional Overturning Circulation will be quantified.

2. Methodology and sampling strategy (2 pages max.)

Both SADCPs are Ocean Surveyors built by RDInstruments (Teledyne). They were configured in a standard water track mode. The Ocean Surveyor at 38kHz (OS38 hereafter) was set in broad band mode, to increase the precision of the data at the expense of the range. By contrast, the OS150 was set in the Narrow Band mode. Both instruments were synchronized using the OSEA system, with a ping every 3s (2.5s) for the OS38 (OS150). OSEA also synchronized 2 other acoustic devices: the EA600 at 12 kHz to get the bottom depth, and occasionally the RESON7150 at 12 kHz for multi-beam ocean floor cartography. This way, no interference was observed on the acoustic signals.

SADCPs were piloted and pre-processed through a RDI software called VmDas (version 1.46.5), that integrates the navigation and attitude parameters to remove the ship movements from the measured velocities. In the chosen configuration, the precision of the OS38 and the OS150 (in mono-ping) are 9 cm/s and 19 cm/s respectively. This is why profiles are immediately averaged over 2 minutes, and then saved in STA files that we use. The accuracy of the velocities is then estimated at 1.5 cm/s and 2.7 cm/s for the OS38 and OS150 respectively. Raw data were also saved so that they can potentially be re-processed in delayed mode with VmDas, but in our case, it will probably be useless.

On board, the STA files were analysed using the CASCADE software made at LPO (Le Bot et al., 2011). It consists in a conversion of all the data in one single netCDF file and a quality control of the data that are flagged good or bad according to criteria adapted to the area. CASCADE also adds an estimate of the barotropic tide (global inverse solution TPXO 7.2, Egbert and Erofeeva, 2002) and of the bottom depth (Etopo1, Amante and Eakins, 2009), CASCADE also estimates some possible biases due to misalignment or incorrect amplitude factor, and plots the data.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1. U, V (zonal and merid. velocities)	Underway ship ADCP OS38	m/s
2. U, V (zonal and merid. velocities)	Underway ship ADCP OS150	m/s

* Classic CTD, ISP, TMR, NET, CORER, FISH

3. Preliminary results (2 pages max.)

According to the pre-processing results (presented here), the quality of the data is good for the OS38 and very good for the OS150. Indeed, some problems occurred with the OS38:

- A strong sensitivity to the bow thrusters strongly affects the range and quality of the data in station,
- spurious high velocities were observed in the first 200m at the beginning of the cruise,
- The data error increased in the surroundings of the zooplankton (that migrates vertically daily),
- We observed poor data quality in the central Labrador Sea for an unknown reason (maybe interferences with the multi-beam echo sounder due to a failure of OSEA).

Despite those problems, the OS38 give very good velocities in the 350-600m depth between stations, and will most likely be used to determine the reference velocities of the geostrophic velocity profiles. Furthermore, the comparison of the OS150 and the OS38 in the 100-350m gave excellent results (that will be quantified in the final data report).

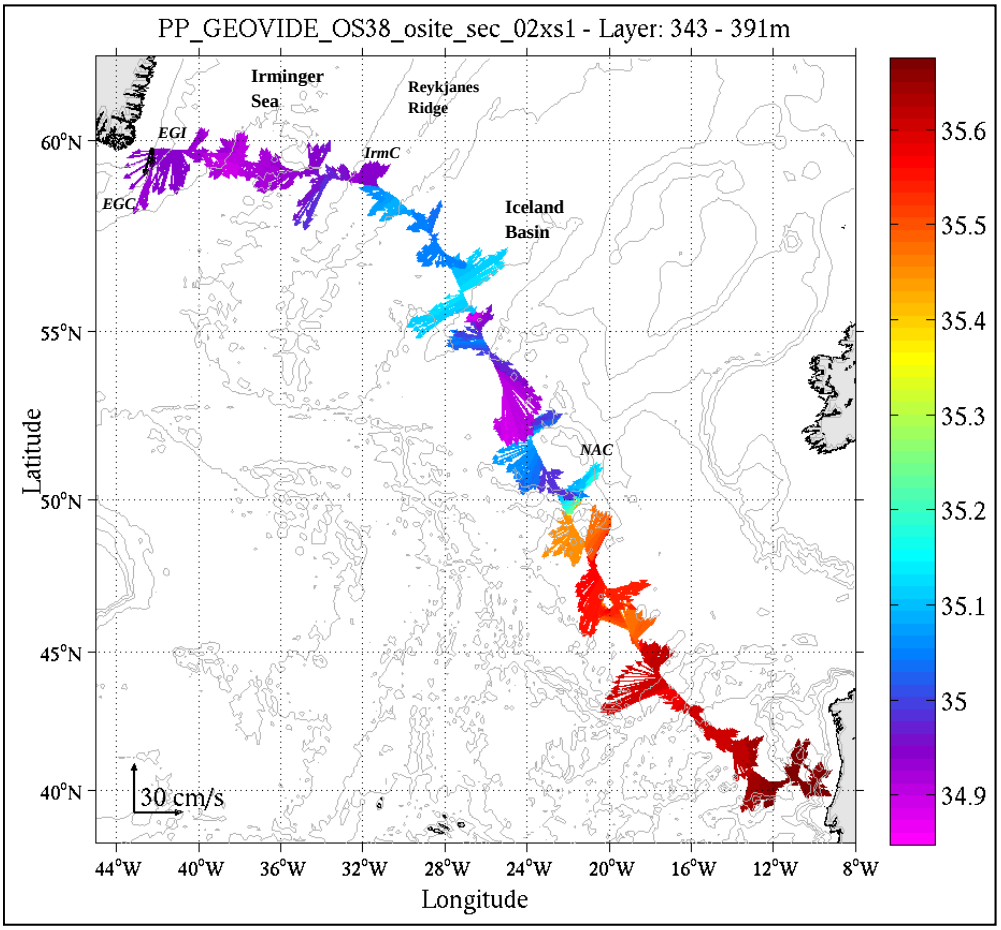
The alignment of both ADCPs was correct, but a small correction in the amplitude factor has to be applied. The use of bottom-track configurations at the very beginning of the cruise will help us to apply the good correction.

To present the results of the SADCP data synthetically, water currents were plotted below in layers of interest. In order to identify the main water masses, the arrows

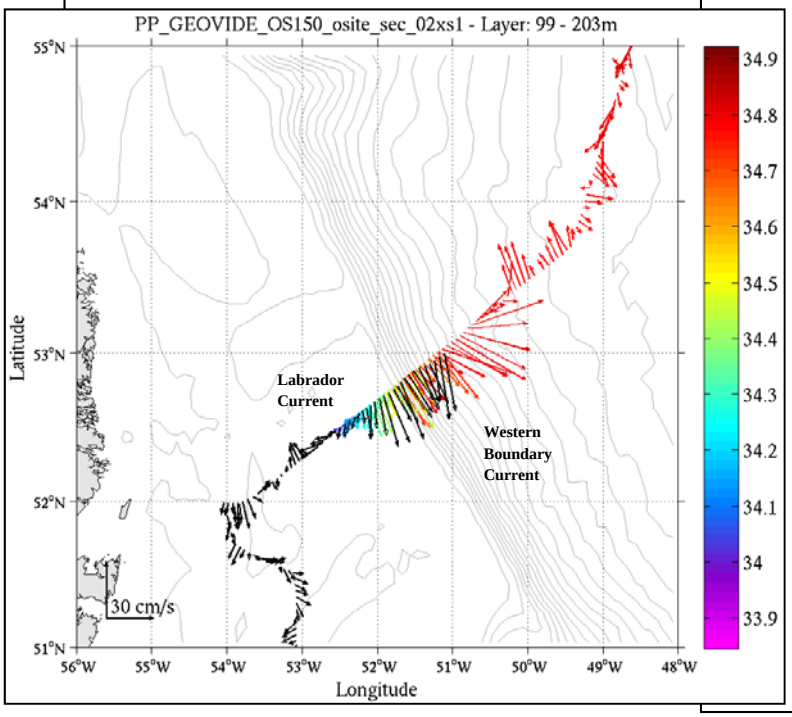
were colored using a horizontal interpolation of the salinity measured by the CTD at stations.

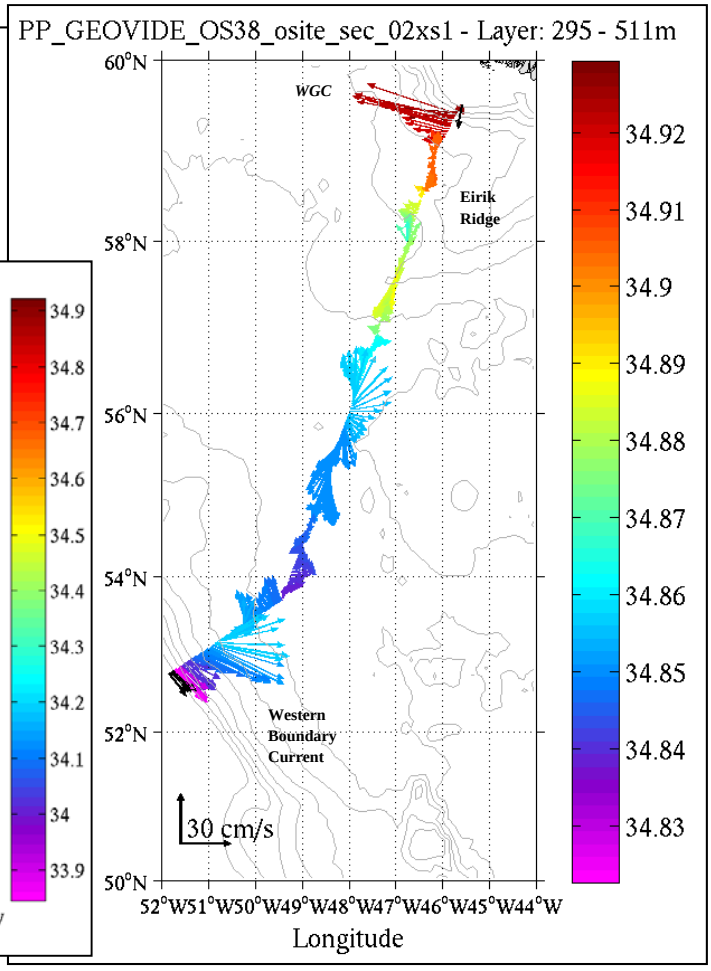
Along the OVIDE section, the 350-400m layer was plotted because it reveals the presence of Subarctic Intermediate Water (SAIW) by salinity minima between 50°N and 56°N, among other interesting observations. Here are some patterns that stand out:

- The velocities emphasize the meso-scale meandering nature of the SAIW northward intrusion in the Iceland Basin (see CTD section).
- The North Atlantic Current is meandering between 45°N and 50°N.
- The position of the main (north) branch of the North Atlantic Current (NAC) at 49°30'N and 22°W, very close to the station 25. Note that at surface, the front was closer to station 26.
- A large anticyclonic eddy also appears at 56°N in the Iceland Basin (stations 33-36).
- The persistent anticyclonic circulation around Reykjanes Ridge is observed (31°W).
- An anticyclonic eddy at 34°W is visible west of the Irminger Current.
- The Irminger Basin is marked by lower salinities in this layer, and very turbulent.
- The East Greenland-Irminger Current (EGIC) and the East Greenland Coastal Current (EGCC) appears east of Greenland, although of moderate amplitude (Daniault et al., 2011).



Water velocities from SADCPs and colored by the salinity interpolated from CTD data in the same layer. Top: the SAIW layer along the OVIDE section. Right: the 300-500m layer along the Labrador section. Bottom: the 100-200m layer on the Labrador slope and shelf (WBC).





In the Labrador Sea, a deeper layer was chosen to better detect Labrador Sea Water, (although not deep enough according to the CTD data analysis). Here again, some circulation patterns are observed, and most of them are already described in the bibliography:

- The West Greenland Current brings modified Atlantic Water northwestward, towards the Labrador Sea
- Complex recirculation patterns are found in the surroundings of Eirik Ridge (Holliday et al., 2009).
- The main pool of Labrador Sea Water is found south of station 69 (56°N) in this layer. Its westward and southwestward transport is consistent with its presumed formation site north of the section. The strong westward velocities at 56°N may mark the position of the current that connects the Labrador Sea with the Irminger Sea at 38°W (Lavender et al., 2000, Våge et al., 2011), but we expect to clarify this point with the transport calculations and the tracer analysis.
- A strong northward current is found around 50°W, consistent with recirculation of the Western Boundary Current shown in Schott et al. (2004) and studied in Fischer et al. (2004).
- Finally, the Deep Labrador Current on the Labrador slope carries North Atlantic Deep Water (NADW) southward and is a key current of the Meridional Overturning Circulation.

4. Post-cruise sampling analyses and dead-lines

- Although not final, the velocity dataset is already available to project partners on demand. It consists in 2 large netcdf files, one for each SADCP, covering the whole cruise. Plots can also be done with CASCADE

- The data will be processed by the end of 2014. A data report will be written (January 2015).

5. Data base organization (general cruise base and/or specific data base(s))

The files will be transferred to the general cruise base and to the SISMER in January 2015.

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III.3. Carbonic system

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Résumé/Abstract: The subpolar gyre of the North Atlantic is a critical zone where the changes of circulation, Meridional Overturning Circulation (MOC), and ventilation of water masses can be examined. The motivation is to better understand the interannual to decadal variability of anthropogenic carbon (C_{ANT}) storage and transport by acquiring a long-term time series of physical and biochemical properties across the MOC between the Iberian Peninsula and Greenland. pH will be quantified in the water masses to follow the acidification that reaches the maximum rates in the subpolar gyre, related with the deep convection. Other greenhouses gases as N_2O and CH_4 will be measured to know the rate of uptake by the ocean circulation.

Parameter	code of operation *	units
1. N_2O/CH_4	452 samples in Classic CTD	pmol/L
2. pH	1392 samples in Classic CTD	no
3. Alkalinity	1009 samples in Classic CTD	Micromole/Kg sw
4. Total inorganic Carbon	40 samples in Classic CTD	Micromole/Kg sw
...		

Scientific context and main objectives

We will further assess the impact of the ocean on Earth's climate and atmospheric chemistry by investigating the carbon dioxide (CO_2), as well as two other important green-house gases: methane (CH_4) and nitrous oxide (N_2O), together accounting for ~20% of enhanced greenhouse forcing. Therefore, the estimation of the natural and anthropogenic entries as well as the knowledge of the formation mechanisms of CO_2, CH_4, and N_2O are essential to understand the past and the future of the Earth's climate. The comparison of CO_2, CH_4, and N_2O distribution in the ocean interior between 2012 (last OVIDE cruise, called CATARINA, led by the CSIC in Vigo -Spain) and 2014 will be very valuable for evaluating differences in the inventories of these three greenhouse gases in the North Atlantic.

The specific questions we want to address are:

1. **How is the rate of acidification in the water masses in the North Atlantic and their relation with the water mass formation?**

2. **What is the evolution of the inventories of CO_2, CH_4 and N_2O gases in the North Atlantic?**
3. **What are the sources of variability of the N_2O in the ocean and its relation with the oxygen minimum layer?**
4. **What is the storage rate of CO_2, CH_4 and N_2O in the main water masses and in the whole column water?**

This study is framed in the IOCCP program, in fact the OVIDE sections have been identified by the GOSHIP project as high-frequency lines (http://www.go-ship.org/RefSecs/GOSHIPMap_April2011.pdf).

Methodology and sampling strategy

pH

Seawater pH samples were taken at 24 levels in all the stations along the cruise section. pH samples were taken directly from the Niskin bottles into special optical glass spectrophotometric cells of 28 mL and 100 mm of path length. These cells were carefully stored in a thermostatic bath at 25.0ºC approximately one hour before the analysis. pH measurements were performed using the spectrophotometric method described in Clayton and Byrne (1993). This method consists in adding 75 µL of m-cresol purple to the seawater sample and measuring its absorbance at 3 wavelengths, i.e., λ_{HI} =434 nm; λ_I =578 nm and $\lambda_{non\text{-}abs}$=730 nm. The reaction of interest for seawater pH is the second dissociation $HI^-_{(aq)}=H^+_{(aq)}+I^{2-}_{(aq)}$ in which I is the indicator. Then, the total hydrogen ion concentration can be determined by $pH=pK_2+\log_{10}[I^{2-}]/[HI^-]$.

Absorbance measurements were performed with a Shimadzu UV-2401PC UV-VIS spectrophotometer. pH values were calculated following the equations described in Dickson *et al*. (2007), who include a correction due to the difference between seawater and the indicator acidity (ΔR).

Total Alkalinity (A_T)

Samples of A_T were taken in all the stations along the cruise section, except in several superstations. Clean borosilicate glass bottles (600 mL) were rinsed and filled from the bottom using a silicon tube, overflowing half a volume. Samples were stored before the on board analyses. Measurements of A_T were done by a one endpoint method using an automatic potentiometric titrator (Dosino 800 Metrohm) with a combined glass electrode (Perez and Fraga, 1987). A Knudsen pipette (~185 mL) was used to transfer the samples into an open Erlenmeyer flask in which the potentiometric titration was carried out with HCl (0.1 M). The final volume of titration was determined by means of two pH reading after the endpoint of 4.42 is reached (Mintrop et al., 2000). These A_T measurements were done in 15 sets of analysis. In order to estimate the accuracy of the A_T method, measurements of certified reference material (CRM) of CO_2 from batch 135 provided by Dr. Andrew Dickson were analysed. In addition, an extra calibration (substandard) was made by using a closed container of 75 L filled with open ocean surface water.

Total Inorganic Carbon (C_T)

Four levels in 10 stations were sampled to check the computed C_T from pH and A_T. Clean borosilicate glass bottles (600 mL) were rinsed and filled from the bottom using a silicon tube, overflowing half a volume. A headspace of 1% of the bottle volume is left. Saturated aqueous solution of mercuric chloride (300 µL) was added to the

sample as a preservative of fouling formation. The bottle was sealed with glass stoppers covered with Apiezon-L grease and stored in the dark.

These samples will be analysed in the laboratories of IIM-CSIC in Vigo (Spain) using a SOMMA (Single-Operator Multiparameter Metabolic Analyzers) system connected to a model CM101_093 coulometer. The analysis consists on acidifying an aliquot of 20 mL with H_3PO_4 in a glass stripping chamber. Then, the resulting CO_2 gas is carried in the equipment by a free-CO_2 gas (N_2) into a coulometric cell, in which the coulometrical titration is performed (Johnson et al., 1993). Certified Reference Material of CO_2 analyses were performed in order to control the accuracy of C_T measurements.

Underway measurements

Continuous sea-surface underway sampling has been performed along the GEOVIDE cruise track to determine the partial pressure of CO_2 (pCO_2, a variable of the carbonic system) and the thermohaline structure. pCO_2 was measured in seawater using a SAMI-pCO_2 (Sunburst Sensors LLC), which also recorded also temperature of the pCO_2 measurement.

In the SAMI-pCO_2, gaseous CO_2 diffuses through a silicone rubber tubular membrane, forming carbonic acid, which changes the pH of a Bromothymol Blue (BTB) indicator solution in acid-base equilibrium ($HI^- \xleftrightarrow{K_a'} I^{2-} + H^+$) where HI^- and I^{2-} are the protonated and unprotonated forms of the diprotic indicator BTB and K_a is the indicator equilibrium constant. The response is calculated from a ratio ($R = A_{620}/A_{434}$) of absorbance measurements at the absorbance maxima of HI^- (434 nm) and I^{2-} (620 nm) forms of BTB, where A_{620} and A_{434} are the measured absorbances. The SAMI-pCO_2 response (R_{CO2}) is calculated as the right side (log) term of the equation:

$$pH = pK_a' + \log\left(\frac{R - e_1}{e_2 - Re_3}\right)$$

The SAMI-pCO_2 response is therefore only dependent upon the indicator solution pH and indicator equilibrium constant for systems with identical wavelength bandpass (e"s are ratios of the HI^- and I^{2-} molar absorptivities). The indicator solution pH is fixed by the solution A_T and CO_2 equilibrated across the gas permeable membrane. Indicator solutions are very stable and, if periodic blank readings are obtained, the SAMI-pCO_2 has excellent long-term stability, i.e. no drift over month-long periods. With its current tubular silicone rubber membrane (165-um wall thickness), the response time is ~5 minutes. To determine the absorbance ratio R, the actual absorbances must be obtained, that is A = –log (I/Io) where Io is the light intensity transmitted with no absorber present (the blank) and I is the light intensity transmitted through the CO_2-equilibrated indicator solution. The measurement of Io requires flushing the cell with a blank solution (de-ionized water) which consumes significant power, time, and indicator. As a compromise to running water blanks between every pCO_2 measurement, we have found that running a blank every 2-3 days is sufficient if reference light intensity corrections are made. A pCO_2 precision of 0.5 to 1 µatm is routinely achieved with the SAMI-pCO_2 using these procedures.

N_2O/CH_4

Discrete samples from the water column were taken every other station. For each water depth, two replicates were taken from the Niskin bottles. Samples were withdrawn immediately after the dissolved oxygen sampling. Samples were taken in 100 mL vials for the simultaneous analysis of N_2O and CH_4. Vials were filled using a silicon tube squeezing air bubbles to assure air bubble free sampling. The silicon tube is placed to

the bottom of the vial, then leave overflow seawater at least 2 volume and finally close vial with a rubber plug under running water. Close attention is paid when closing the vials avoiding air bubbles trapped in the sample. When all samples for one station are collected, the vials are close with an aluminium capsule using a crimping tool. Samples were conserved right after sampling each station using saturated $HgCl_2$.

The N_2O and CH_4 concentration will be determined by gas chromatography in the laboratories of the IIM-CSIC in Vigo (Spain). Gas trace samples can be stored up to 10 month without an effect on the N_2O and CH_4 concentration if stored properly. Samples will be analysed with a static equilibration method: a headspace of 20 mL compressed a secondary standard is added to the sample vial and left to equilibrate with the liquid phase for at least 2 h. Afterwards subsamples are taken from the headspace and injected automatically into the gas chromatographic system. N_2O and CH_4 are determined simultaneously with the electronic capture and flame ionization detectors respectively.

5. Preliminary results (2 pages max.)

The preliminary pH measurements of the OVIDE section were converted to SWS scale and were plotted using ODV (Schlitzer 2011), as it is shown in next figure.

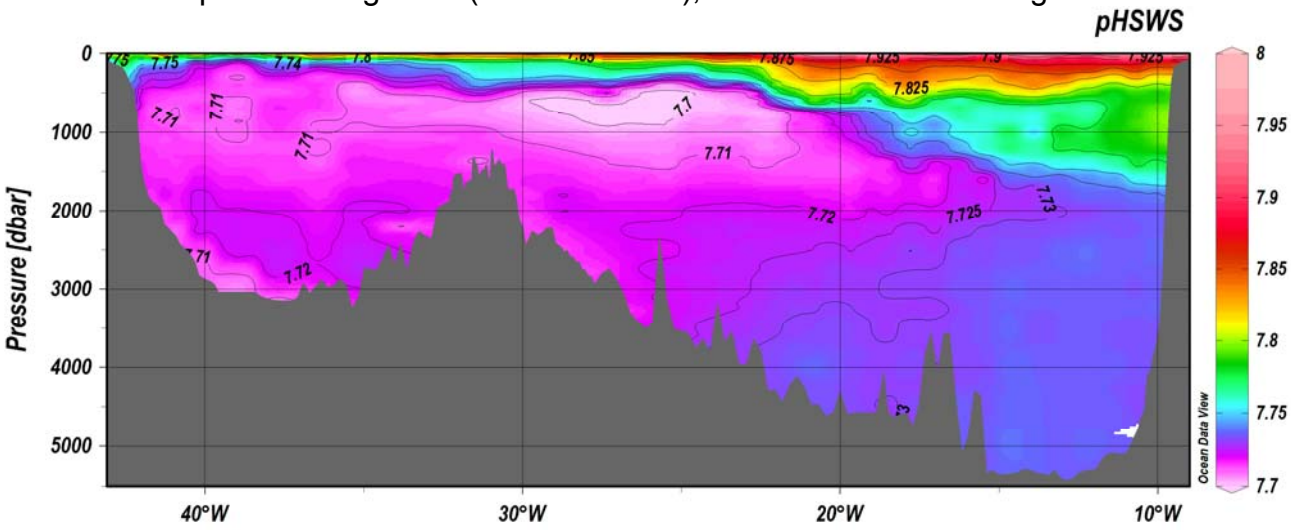

***Figure** : pH_{SWS} distribution along the OVIDE section.*

The minimum of pH SWS is associated to the layer of low oxygen. The upper layer has higher pH because of the biological CO_2 fixation. Also Mediterranean Water (MW) shows a relative pH maximum at 1000 dbar close to Iberian Peninsula. In the Irminger Sea, the low pH of Denmark Strait Overflow Water (DSOW) is associated to the high content of anthropogenic CO_2.

The distribution of A_T concentrations in $\mu mol \cdot kg^{-1}$ of the same section is shown in the following figure. Note that the plot accounts for measured and interpolated data (30%).

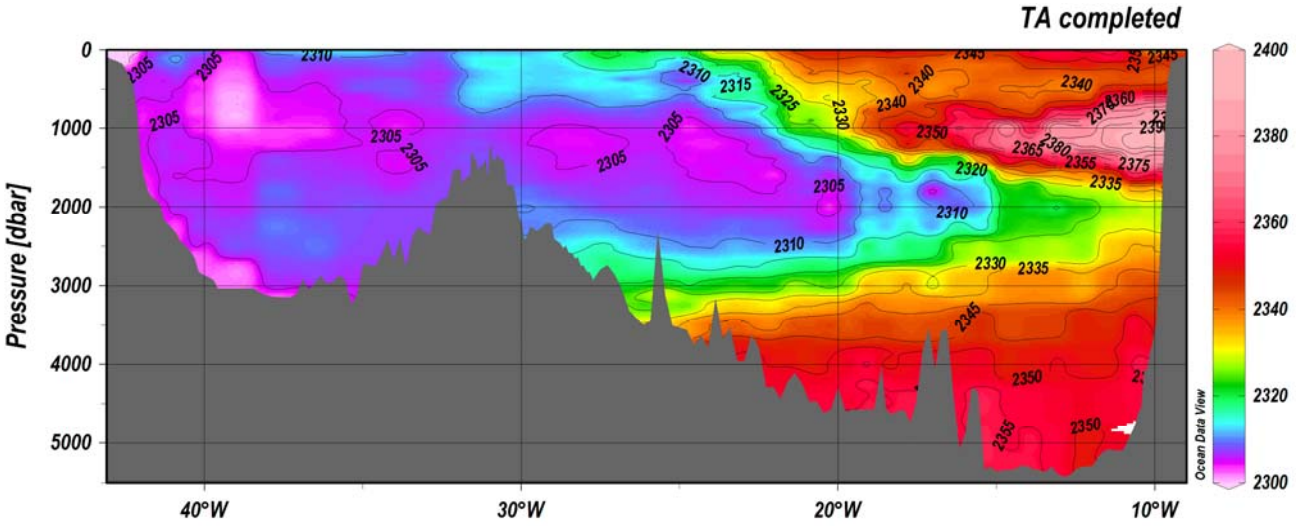

Figure: *A_T distribution along the OVIDE section*

The maximums at the upper layer toward the east and at 1000 close to the Iberian Peninsula are associated to the high saline waters. However the maximum in deep waters is due to the advection of Antarctic waters with high A_T concentrations. The water formed in the subpolar gyre has low and very homogenous A_T concentrations (2310-2315 $\mu mol \cdot kg^{-1}$).

The C_T is computed from pH_{SWS} and A_T using the thermodynamic constants determined by Mehrbach et al. (1973) and fitted to SWS scale by Dickson and Millero (1987). The C_T distribution along the OVIDE section is show in the next figure:

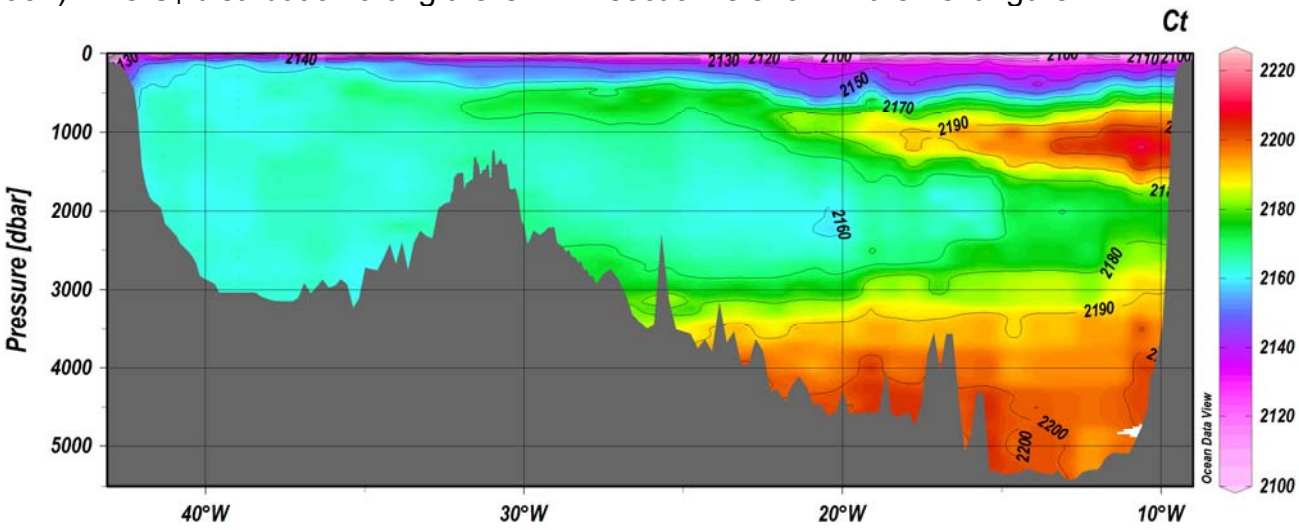

Figure *C_T distribution along the OVIDE section*

C_T followed the same pattern than A_T, except in the upper layer where the biological CO_2 fixation decreases the C_T concentrations.

The first estimation of anthropogenic CO_2 (C_{ANT}) can be done using the preliminary dissolved oxygen data measured by Pierre Branellec. We have used the backcalculation phi-method (Vazquez-Rodríguez et al., 2009, Perez et al. 2008; Rios et al. 2010). C_{ANT} distribution along the main section is shown in the next figure.

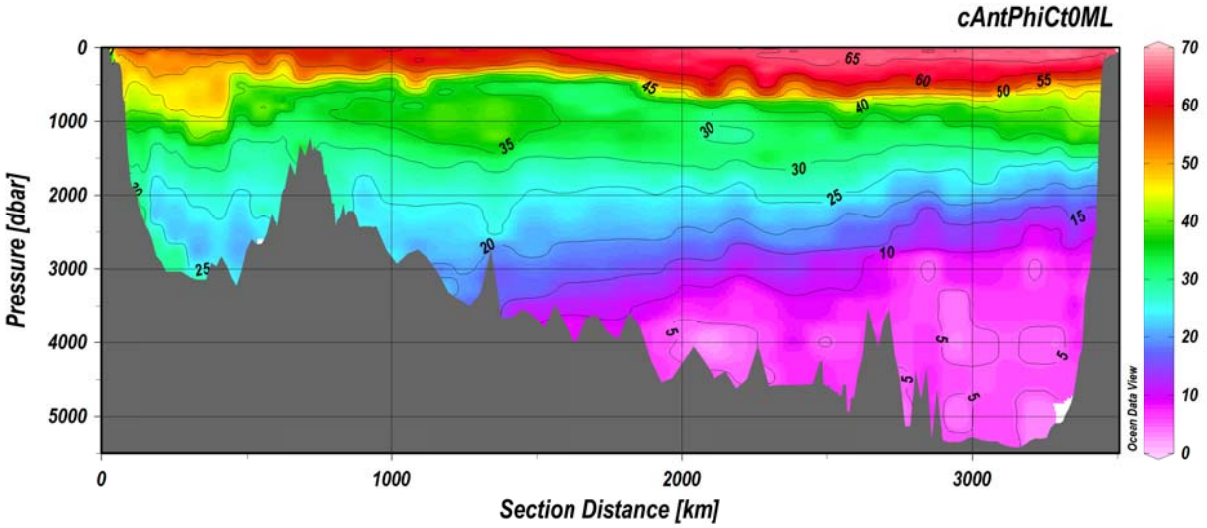

Figure: *C_{ANT} distribution along the OVIDE section.*

High values of C_{ANT} are detected in the thermocline showing a general decrease toward the bottom. Deep waters in the Iberian Basin show very low values. In the Irminger Sea, the thick layer of Labrador Sea Water (LSW) contains high values of C_{ANT}, as well as the thin layer of DSOW just in the bottom.

In addition to the pCO2 measurements, other variables, like ship position data and hydrological information, were gathered via the vessel mounted oceanographic data acquisition system, which includes the surface temperature and salinity measurements of a thermosalinograph (SBE-45-MicroTSG) as well. The preliminary distribution of sea-surface fugacity of CO_2 together with sea surface temperature is presented in the following figure:

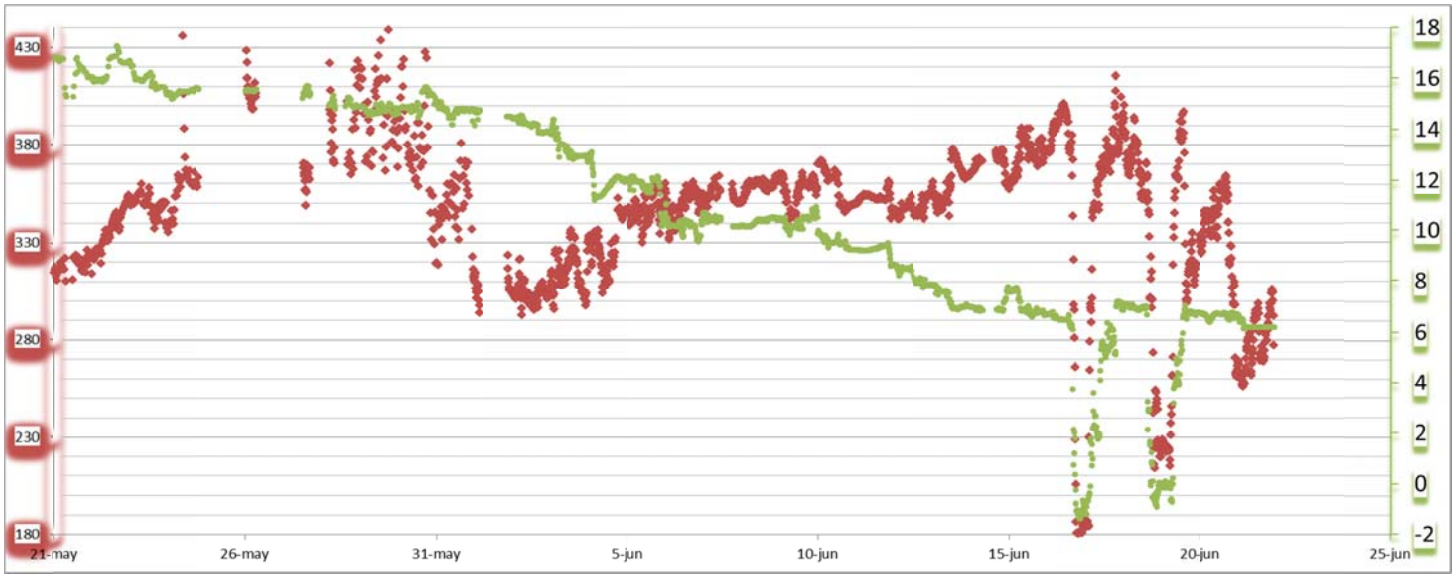

Figure: *Time series record of seawater CO_2 fugacity and SST along the OVIDE section*

6. Post-cruise sampling analyses and dead-lines

Analysis of N_2O/CH_4 will be done next autumn. The Coulometric analysis will be done as soon as possible.

7. Data base organization (general cruise base and/or specific data base(s))

pCO_2 data will be submitted to quality control to SOCAT (http://www.socat.info/) and CO_2 system data to CDIAC (*cdiac.esd.ornl.gov)*.

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III.4. Ancillary parameters

III.4.1. Nutrient distributions during the GEOVIDE cruise

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Résumé/Abstract:
In order to help identifying water masses and to better constrain the biological activity, samples were taken at each station for nitrate, phosphate, silicic acid and ammonium analysis. More than six thousands samples were analysed on board. The other ones will be analysed back to the laboratory within the next 18 months.

1. **Scientific context (1/2 page max.)**

In addition to classical physical tracers such as potential temperature and salinity, nutrients are core-parameters that are used, especially in deep and bottom waters, as tracers of water masses (e.g. Antarctic Intermediate Waters – AAIW, upper Circumpolar Waters – UCPW, Antarctic Bottom Water, AABW).
The low concentrations of nutrients in surface and subsurface waters reflect biological activity (primary production and regeneration). In the North Atlantic, pronounced spring phytoplankton blooms occur in response to upwelling or to water column stratification (Savidge et al., 1995; Bury et al., 2001; ; Henson et al., 2009). Usually, these blooms are initially dominated by diatoms (Lochte et al., 1993; Leblanc et al., 2009). Such diatom blooms are known to trigger substantial export of fast-sinking particles (Lampitt, 1985; Honjo and Manganini, 1993), and represent a major scavenging process of particulate organic carbon, macronutrients, and TEIs to the deep ocean. Trace metal inputs in the North Atlantic seem to be high enough to prevent any limitation. However, Fe limitation or co-limitation (Fe/macronutrients) were observed in the North Atlantic (Martin et al., 1993; Blain et al.,

2004) and the subpolar gyre (Nielsdottir et al., 2009), resulting in the formation of the seasonal high-nutrient, low chlorophyll (HNLC) conditions in this region at the end of the spring bloom (Nielsdottir et al., 2009). Modelling studies have indicated that complete nutrient removal in the high-latitude North Atlantic would potentially lower atmospheric pCO_2 more significantly than either in the HNLC sub-Arctic or equatorial Pacific, and is second only to the Southern Ocean in terms of influence (Marinov et al., 2008; Sarmiento and Orr, 1991). A better assessment of what controls the organic production in the North Atlantic is thus essential. This will be in part constrained by the measurements of nutrient concentrations.

2. Overview of the project and objectives (1/2 page max.)

The objective of this study is to gather a high quality dataset of core-parameters, here nutrient concentrations, essential for the interpretation of the physical and biogeochemical parameters.

3. Methodology and sampling strategy

Seawater samples were collected using the classical rosette at all stations on the CTD-hydro, as well as on the TMR-stock at all Large, XLarge and Super stations. Nitrate, nitrite, and silicate were analysed on board by standard methods with a Bran +Luebbe AA III autoanalyser as described by Tréguer and Le Corre (1975), Gordon & Ross (1993) and Aminot and Kerouel (2007). Phosphate and ammonium will be analysed back in the home laboratory LEMAR by spectrophotometry (Murphy and Riley, 1962; Koroleff and Solorzano, 1969).

Table: **Exhaustive** list of sampled parameters

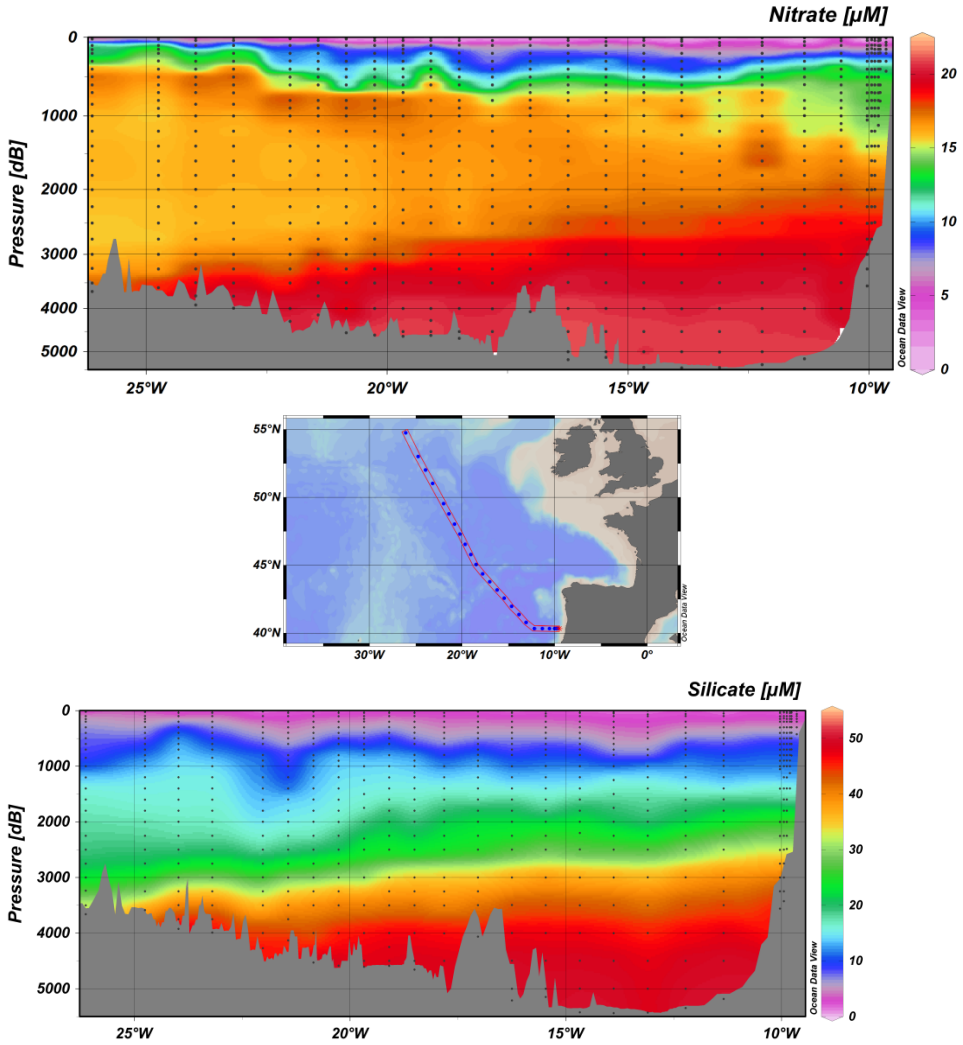
Parameter	code of operation *	units
1. Nitrate	Classic CTD-hydro and TMR-stock	µM
2. Nitrite	Classic CTD-hydro and TMR-stock	µM
3. Silicate	Classic CTD-hydro and TMR-stock	µM
4. Phosphate	Classic CTD-hydro and TMR-stock	µM
5. Ammonium	Classic CTD-hydro and TMR-stock	µM
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

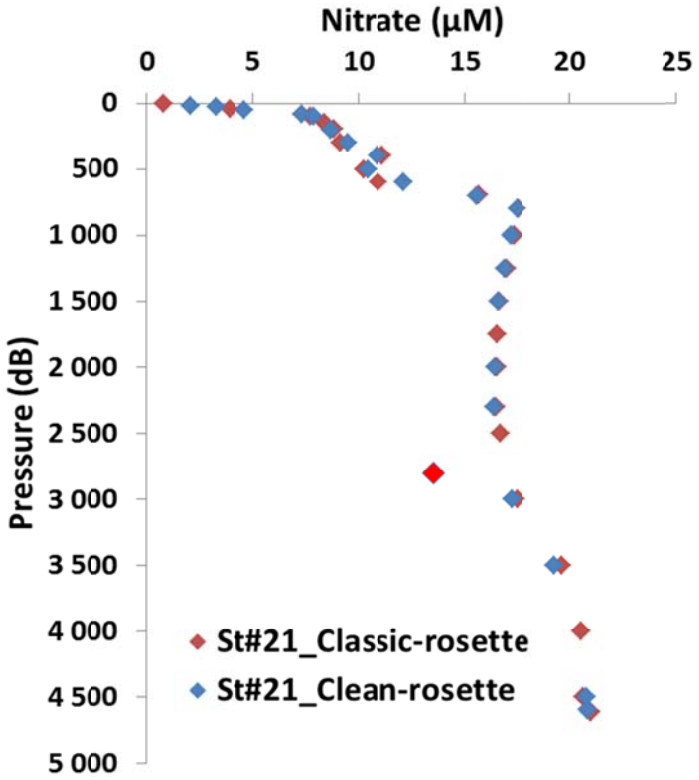
4. Preliminary results (2 pages max.)

A total of 6258 samples were analysed on board.

Below are nitrate and silicate concentrations along the section (stations 1 to 31). High silicic acid concentrations in the bottom water at 40°N reflects some impact of AABW. The lower nitrate concentrations measured in the layer centered at about 1000 m at 40°N, and beyond, is due to the extension of low nutrient high salinity Mediterranean water in the North Atlantic Ocean.



Nitrate measured on the TMR-stock will be used for the interpretation of the trace metal profiles, but also served to check for potential leakage on the Go-Flo bottles. As an example below, at station#21, at 2800 m the Go-Flo#5 was leaking and the measurement will not be considered in the data set.



5. Post-cruise sampling analyses and dead-lines

The analyses of all the parameters should be completed within the next 12 months.

6. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

7. References

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III.4.2. POC/PON, BSi, Pigments, Pico-nano eucaryotes and bacteria

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Résumé/Abstract:
Samples for POC/PON, BSi, and pigment concentrations, as well as pico-nano eucaryotes and bacteria counts were collected at all Large, XLarge and Super Stations to assess the biological activity in this productive region. All samples will be analysed back to the laboratory within the next 18-24 months.

1. Scientific context (1/2 page max.)

Pronounced spring phytoplankton blooms occur in the North Atlantic in response to upwelling or water column stratification (Savidge et al., 1995; Bury et al., 2001; Henson et al., 2009). These blooms are initially dominated by diatoms (Lochte et al., 1993; Leblanc et al., 2009). Such diatom blooms are known to trigger substantial export of fast-sinking particles (Lampitt, 1985; Honjo and Manganini, 1993), and represents a major scavenging process of particulate organic carbon, macronutrients, and TEIs to the deep ocean. Trace metal inputs in the North Atlantic seem to be high enough to prevent any limitation. However, Fe limitation or co-limitation (Fe/macronutrients) were observed in the North Atlantic (Martin et al., 1993; Blain et al., 2004) and the subpolar gyre (Nielsdottir et al., 2009), resulting in the formation of the seasonal high-nutrient, low chlorophyll (HNLC) conditions in this region at the end of the spring bloom (Nielsdottir et al., 2009). Modelling studies have indicated that complete nutrient removal in the high-latitude North Atlantic would potentially lower atmospheric pCO2 more significantly than either in the HNLC sub-Arctic or equatorial Pacific, and is second only to the Southern Ocean in terms of influence (Marinov et al., 2008; Sarmiento and Orr, 1991). A better assessment of what controls the organic production in this area is thus essential. This will be in part constrained by the measurements of particulate organic carbon and nitrogen (POC/PON), as well as biogenic silica (BSi), which represents the diatom biomass. Pigment concentrations will indicate which phytoplankton species was present in the water column.

2. Overview of the project and objectives (1/2 page max.)

The objective of this study is to gather a high quality dataset of ancillary biological parameters, essential for the interpretation of the biogeochemical parameters.

3. Methodology and sampling strategy

Seawater samples were collected using the classical rosette at all Large, XLarge and Super stations.

1- POC/PON: Samples for concentrations of POC and PON were collected on pre-combusted glass fibre filters (GF/F), rinsed with deionized, distilled water to remove salts, and then dried at 60°C. Prior to analysis, dried filters will be fumed with hydrochloric acid to remove inorganic carbon. POC and PON will then be measured using a Flash 1112 series elemental NC analyser ThermoQuest as described in Lorrain et al. (2003).

2- BSi: Samples for biogenic silica and lithogenic silica concentrations (BSi and LSi) were filtered through 0.4 µm polycarbonate filters immediately upon collection. Concentrations of BSi and LSi will be determined by measuring the Si and Al content of two sequential alkaline digestions and a third digestion in hydrofluoric acid of the material collected on the filters (Ragueneau et al., 2005).

3- Pigments: For pigments determination, 2L samples were filtered on 25 mm diameter GF/F Whatman filters. After filtration, samples were quick frozen in liquid nitrogen, then stored at -80°C until analysis. Before analysis, samples will be extracted in methanol and analyzed by HPLC, according to Ras et al. (2007).

4- Nano-, pico-plankton and bacteria counts. For enumeration of heterotrophic bacteria, 3-mL subsamples of raw seawater were fixed with 2% formaldehyde (final concentration), stored in the dark at room temperature for 30min, and quick frozen in liquid nitrogen. Samples were stored at -80°C until analysis. A FACScalibur flow cytometer (Becton Dickinson, San Jose, CA) equipped with a 488-nm, 15-mW Argon laser was used for all flow cytometric analysis (Lebaron et al., 2001a).

Table: **Exhaustive** list of sampled parameters

Parameter	code of operation *	units
1. POC/PON	Classic CTD	µM
2. BSi	Classic CTD	µM
3. Pigments	Classic CTD	µM
4. Pico- et nano-eucaryotes	Classic CTD	Cells/ml
5. Bactéries	Classic CTD	Cells/ml
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

None

5. Post-cruise sampling analyses and dead-lines

The analyses of all the parameters should be completed in the next 18-24 months.

6. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

Acknowledgements

We would like to thank the crew of the R.V. Pourquoi Pas?, for their great help during the Classic CTD operations. We acknowledge the Co-Chief Scientist Pascale Lherminier.
This work was funded by the ANR Blanc (ANR-13-BS06-0014), IFREMER, CNRS-INSU (programme LEFE), and LabEX MER. For the logistics: DT-INSU, IFREMER and GENAVIR.

III.4.3. Primary production & nitrogen cycling

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Résumé/Abstract:
Primary production and uptake rates for different nitrogen substrates (N_2, NO_3^-, NO_2^-, NH_4^+) were measured at 10 superstations and 2 xlarge stations (St. 2 and 57). Seawater was sampled at 3 to 6 depths in the euphotic layer and spiked with heavy isotope enriched (13-C, 15-N) substrates. Nitrification rates were also assessed with isotope dilution experiments to assess the regeneration of nitrate. Samples for nitrate isotopic analyses were also taken as it is a tracer for processes affecting the nitrogen cycle over a longer timescale (months) than one day rate measurements. Nitrite and ammonium concentrations were measured on board, other nutrients will be measured at our home based lab. Our work is in close participation with export measurements using the 234-Thorium method.

1. Scientific context (1/2 page max.)

The biological carbon pump is one of the main pathways for atmospheric carbon to be sequestrated and stored in the deep ocean. The strength of the process depends on (1) the amount of carbon fixed by phytoplankton (primary production) and (2) the efficiency by which particles are exported to the deep sea.
Marine primary production is limited by nitrogen availability over large areas of the world's ocean but especially in tropical and subtropical waters [Moore et al., 2009]. Nitrogen thus plays a critical role in the sequestration of atmospheric carbon into the deep ocean via the biological pump [Sohm et al., 2011].
In marine systems at the end of the spring bloom, primary production can mainly continue on regenerated nitrogen substrates such as ammonium, nitrite and regenerated nitrate. This results in low export of carbon as particles are remineralised before they can reach the deeper layers of the ocean. Assessing the importance of different nitrogen sources and the internal conversion between substrates is essential in understanding the nitrogen cycle and by extend the whole carbon pump.

During the Geovide cruise, different water masses are crossed ranging from subtropical oligotrophic conditions at the Iberian Peninsula to nutrient rich and sea-ice effected water at the Greenland shelf. The North Atlantic is also largely affected by dust deposition from the Sahara desert bringing essential trace elements such as iron to the ocean surface which can boost biological nitrogen fixation. Measuring primary production and looking at the nitrogen cycle in different physico-chemical conditions, allows us to better understand the effect of these external forcing's.

2. Overview of the project and objectives (1/2 page max.)

The aim of this study is to assess the behaviour and variability of biological production over different provinces in the North Atlantic Ocean, with an especial focus on the productivity regime, whether new or regenerated with implications on the carbon sequestration efficiency. At 12 stations, from 40.33 - 59.90°N and 10.04 - 51.01°W, water column samples are used to determine nutrient distributions (ammonium, nitrite, nitrate, phosphate) and natural isotopic composition of nitrate ($\delta^{15}N$ and $\delta^{18}O$) to trace the major biological transformations of the nitrogen pool, including N_2-fixation (Großkopf et al., 2012). Incubation experiments are conducted using stable isotope enrichment techniques ($^{15}N_2$; $^{15}NO_3^-$; $^{15}NO_2^-$; $^{15}NH_4^+$; $H^{13}CO_3^-$), in order to investigate primary production (PP) and contribution of different N-sources, and importance of nitrification over the euphotic layer (surface to 0.5 % PAR depth level)

3. Methodology and sampling strategy (2 pages max.)

Incubation Experiments:
Samples were taken at all Super stations and two XLarge stations (st. 2 and 53) using the CTD-Biogeo-Shallow. Depending on the station, three to six depths were incubated at fixed PAR light percentages (54%, 25%, 13%, 3%, 1% and 0.2%). Depths were chosen based on the PAR profile obtained at a previous cast or from the station before.

Uptake rates for carbon and different nitrogen substrates (N2, NO3-, NH4+, NO2-) and nitrification rates are obtained using the stable isotope toolbox. Substrates enriched in the heavy stable isotope (^{13}C and ^{15}N) were added to the different uptake rate experiments to result in a 5-10% enrichment. Nitrification rates are quantified by adding a $^{15}NO_3^-$ spike resulting in approximately 30% enrichment and measuring the spike dilution after 24h by nitrate coming from nitrification.

For each depth the following enrichment experiments were performed:

- Primary Production + N_2-fixation: $H^{13}CO_3^- + {}^{15}N_2$
- Primary Production + Nitrate: $H^{13}CO_3^- + {}^{15}NO_3^-$
- Primary Production + Ammonium: $H^{13}CO_3^- + {}^{15}NH_4^+$
- Primary Production + Nitrite: $H^{13}CO_3^- + {}^{15}NO_2^-$
- Nitrification : $^{15}NO_3^-$

For each incubation two bottles were made, one was filtrated at 0h, being the initial state of each experiment. Bottles were than incubated for 24h at the appropriate light level using on deck incubation tanks. Temperature was held constant a by continuously flow of surface seawater. Light was adjusted using light filters.

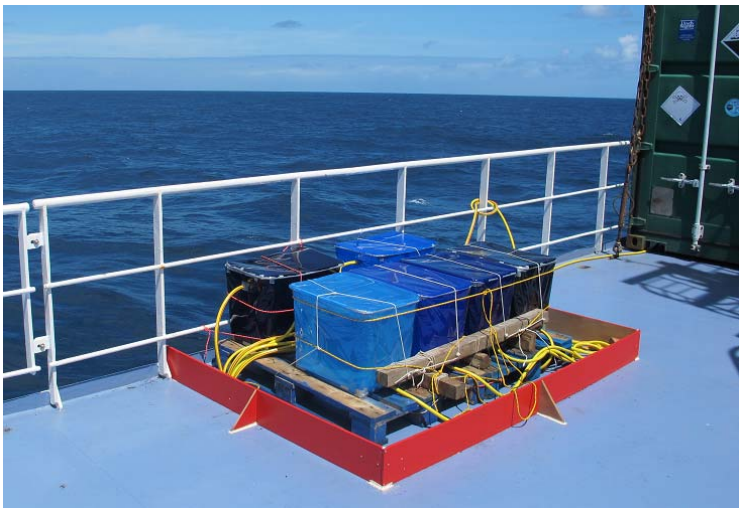

Figure 1. Incubators for the 6 different depths with adjusted light lifters (54%, 25%, 13%, 3%, 1%, 0.2%) as setup during the Geovide cruise

Particulate matter (POC/PN) was collected on glassfiber filters (GFF: 0.7µm) and will be analyzed via Elemental Analyzer – Isotope Ratio Mass Spectrometer (EA-IRMS) for carbon and nitrogen concentration and isotope ratios (VUB, Brussels, Belgium).

Nitrate Isotopic Signatures:
The isotopic signature of nitrate is a tracer for different processes that affect the substrate. Nitrate uptake, N_2-fixation, nitrification, etc result in different small variations of the isotope ratios. By doing dual isotope ($\delta^{15}N$ and $\delta^{18}O$) analyses, these can be identified.

Samples for nitrate isotopic signatures were taken at all stations where we performed the incubation experiments and some additional stations. Sampling was done on the CTD-Hydro (all depths) and CTD-Biogeo-Shallow (incubated depths). For conservation, the sample were filtered over 0.2µm acrodiscs and stored at -20°C for analysis at the VUB.
We apply the denitrifier method elaborated by Sigman et al. (2001) and Casciotti et al. (2002). This method is based on the isotopic analysis of $\delta^{15}N$ and $\delta^{18}O$ of nitrous oxide (N_2O) after the conversion of nitrate by denitrifying bacteria (Pseudomonas aureofaciens) lacking N_2O-reductase activity. As a prerequisite the nitrate concentrations need to be known (nutrients analysis in the home lab; Quaatro, Seal analytic) as this sets sample amount provided to the denitrifier community. The N_2O is purified and preconcentrated using cryogenic focusing and analysed by IRMS (Delta V, Thermo).

Onboard Nutrients:
Ammonium and nitrite are nutrients with a fast overturn and were measured on board using Ocean Optics spectrometers. Ammonium was measured using fluorescence while nitrite was measured using the classical colorimetric method. Measurements were done at all incubation stations. A profile for NH_4^+ and NO_2^- was measured on the CTD-Hydro (not full depth resolution) and on the CTD-Biogeo-Shallow (incubated depths).

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1. Primary Production (HCO_3^-)	Classic CTD	$nmol.L^{-1}.d^{-1}$ & $mg.m^{-2}.d^{-1}$
2. N_2-Fixation (N_2)	Classic CTD	$nmol.L^{-1}.d^{-1}$
3. Nitrate Uptake (NO_3^-)	Classic CTD	$nmol.L^{-1}.d^{-1}$
4. Nitrite Uptake (NO_2^-)	Classic CTD	$nmol.L^{-1}.d^{-1}$

5. Ammonium Uptake (NH_4^+)	Classic CTD	$nmol.L^{-1}.d^{-1}$
6. Nitrification	Classic CTD	$nmol.L^{-1}.d^{-1}$
7. Nitrate concentration [NO_3^-]	Classic CTD	$\mu mol.L^{-1}$
8. Nitrite concentration [NO_2^-]	Classic CTD	$\mu mol.L^{-1}$
9. Ammonium concentration [NH_4^+]	Classic CTD	$\mu mol.L^{-1}$
10. Nitrate isotopy ($\delta^{15,18}$-NO_3^-)	Classic CTD	‰

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

Concentrations for nitrite (NO_2^-) and ammonium (NH_4^+) were analysed on board. Processing of the results is on-going and will be finalised in the weeks after the cruise, the calculations for some stations are finalized. Typically concentrations below 300m are drawn back to zero. At the surface most stations showed a peak for both nutrients. Due to the low depth resolution at the surface of the CTD-Hydro, these peaks are not always visible in the Hydro profile. In most cases the nitrite max was found just below the ammonium max which itself, was found just below the Chlorophyll max. Nitrite concentrations reached approx. 0.7µM whereas ammonium went up to 1.3µM at some stations. Data will be further processed in the coming months.

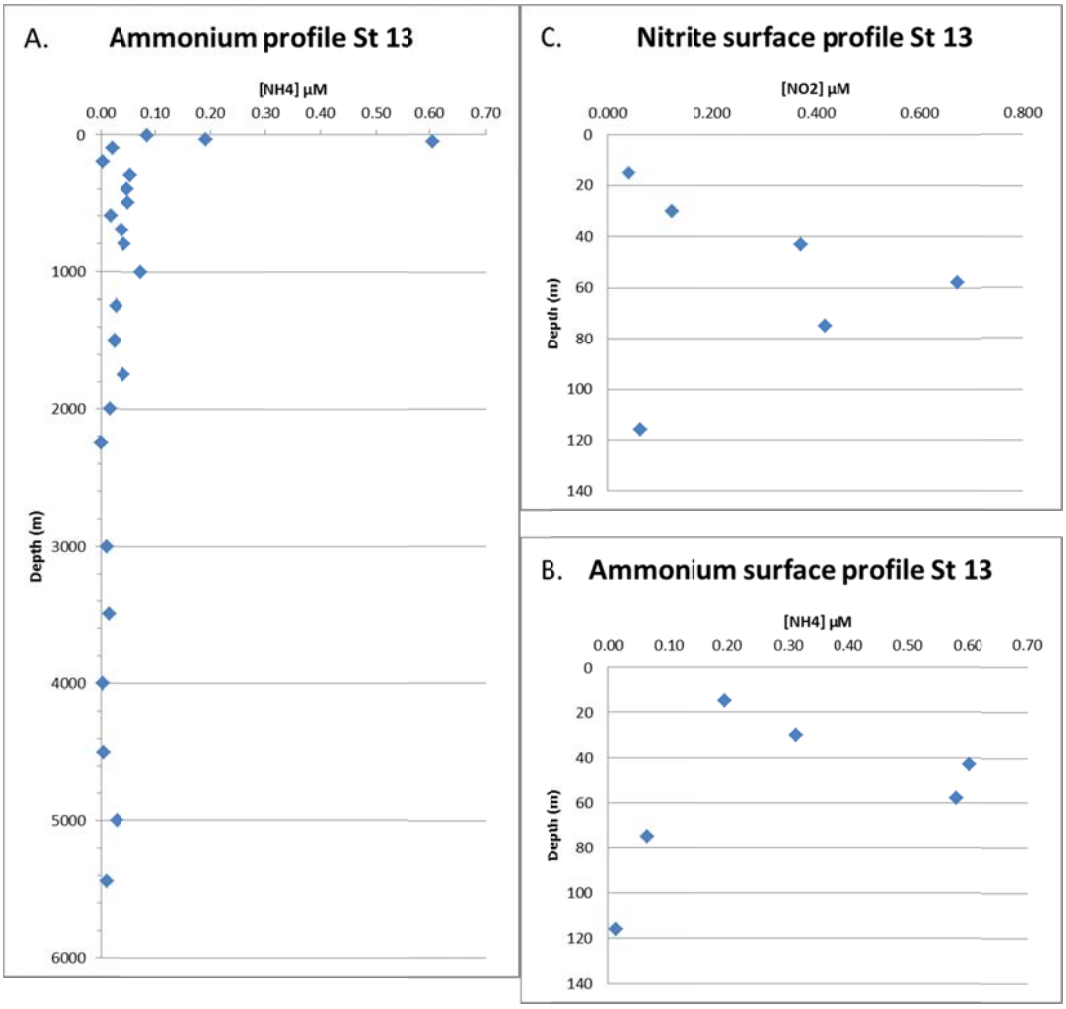

Figure 2. : On board measurements for nitrite and ammonium at station 13. A; Ammonium profile sampled from the CTD-Hydro. B & C; Ammonium and nitrite profile sampled from incubation depths at the CTD-Biogeo-Shallow. A clear maximum is found for both nutrients. The Chlorophyll maximum at station 13 was at 35m. The NH_4^+ max is just below, followed by a NO_2^-.

5. Post-cruise sampling analyses and dead-lines

Processing of the samples collected on the Geovide cruise will start by the end of 2014, as part of the PhD research project of students Arnout Roukaerts and Debany Fonseca Batista. Analysis of the samples, including isotopic signature of dissolved subtrates (N_2 and DIC), nutrients (nitrate) and particulate matter ($PO^{13}C/P^{15}N$), will last approximately one year. Data analysis, interpretation and communication will follow in the year 2015 and finally scientific publications will conclude our work by the end of the summer 2016.

6. Data base organization (general cruise base and/or specific data base(s))

The data acquired will be progressively updated starting from early 2016 within the meta data base of the Geovide cruise, referenced as the "Primary Production and Nitrogen Dynamics" dataset.

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III.4.4. Photic layer distribution of Heme b

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1. Scientific context (1/2 page max.)

Atmospheric CO_2 have been rapidly increasing since the industrial revolution (Falkowski, P. 2000). Phytoplankton, decrease the amount of atmospheric CO_2 during photosynthesis in a process known as primary production (Falkowski, P. et al. 1998). Essential nutrients such Nitrogen and Phosphorous (Tyrrell. 1999), Iron and other trace metals have been shown to be co(limiting) nutrients for this process (Boyd, P.W., 2010; Boyd, P.W. et al., 2007; De Baar, H.J. et al., 2005). Hemes are iron-complexes acting as important functional groups for a wide range of iron proteins. Known as hemoproteins, they are key Fe components of multiple reactions of phytoplankton during primary production (Dupont et al. 2004). Recent studies have suggested that marine phytoplankton might cycle hemes through protein pools in order to boost primary production when iron concentrations are low (Saito et al. 2010; Gledhill M. 2007). The abundance and distribution of hemoproteins in oceanic phytoplankton is badly constrained (Honey, D.J. et al., 2013; Gledhill et al., 2013; Gledhill M., 2007) and more research effort is still needed.

2. Overview of the project and objectives (1/2 page max.)

During this cruise, the main objective is to study the distribution of heme b across the Sub polar North Atlantic Ocean and relate it to chlorophyll concentrations and nitrogen fixation rates measured by other groups.

3. Methodology and sampling strategy (2 pages max.)

All the samples were collected from the classical CTD on HDPE bottles and filtered immediately to reduce contamination and prevent growth or decay of sample organisms. GFF 25mm filters were used and then placed in fissure tubes and stored in a -80 C freezer for analysis back in Kiel.
On each of the stations listed below, 6 depths above 200 m were chosen according to oceanographic features (Chl max, OMZ etc).
A total of 192 samples were taken.

Table : **Exhaustive** list of measured parameters

Type of station	N° of station	Hemes
Super	1	x
XLarge	2	x
Large	4	x
Large	11	x
Super	13	x
Large	15	x
Large	17	x
Large	19	x
Super	21	x
Large	23	x
Large	25	x
XLarge	26	x
Large	29	x
Super	32	x
Large	34	x
Large	36	x
Super	38	x
Large	40	x
Large	42	x
Super	44	x
Large	49	x
XLarge	53	x
Large	56	x
Super	60	x
XLarge	61	x
Large	63	x
Super	64	x
Large	68	x
Super	69	x
Large	71	x
Super	75	x
XLarge	76	x

Parameter	code of operation *	units
1. Heme b	CTD	10^{-12} mol/L
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

Any preliminary results yet.

5. Post-cruise sampling analyses and dead-lines

The analysis will be completed between 12-18 months after the cruise, using a High Performance Liquid Chromatographer attached with diode array spectrophotometry

6. Data base organization (general cruise base and/or specific data base(s))

Data will be loaded onto the GEOVIDE database after analysis.

7. References

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III.4.5. Biogeotraces: Microbial genomics and biogeochemistry

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Résumé/Abstract:
Microbes are crucial to the cycling of elements on earth. In the ocean, microbes are responsible for primary production in the euphotic zone and for recycling of the nutrients. In particular, our group is interested in the N cycle and the environmental factors controlling processes such as inorganic carbon fixation, N2 fixation, and nitrification. Samples for DNA extraction, analytical flow cytometry, single cell sorting and enrichment of diazotophs were collected during the Geovide cruise in order to provide a general characterization of the microbial community throughout the transect. In particular we will analyse the samples for the presence of nifH genes, which encodes for the nitrogenase enzyme carrying out N2 fixation. We will also provide a selected dataset of the 16S rRNA and 18S rRNA diversity using high throughput sequencing and bioinformatics analysis

1. Scientific context (1/2 page max.)

Microbes play an important role in the cycling of macro and micronutrients in the ocean. They also have a very large effect on the dissolved CO2 and O2 concentrations. It is therefore useful to have basic information concerning the composition of the microbial community in order to interpret the biological transformation and cycling of nutrients throughout cross-basin transects. During the cruise samples were collected to extract DNA back in the laboratory. These DNA samples will be sequenced first for the phylogenetic biodiversity. The data will be analysed in the context of trace nutrient and macronutrient distribution. In particular, we have observed during the US Atlantic Geotraces cruises that there is a strong relation between Saharan dust deposition and the relative abundance of nifH genes indicative of the presence of diazotrophs.

2. Overview of the project and objectives (1/2 page max.)

The goal of the project is to obtain a profile of the microbial community composition throughout the Geovide transect and to analyse the variation in community composition in function of the trace metal and macronutrient observations. In additional, we will quantify the copy numbers of certain genes known to play a role in the microbial transformation of nitrogen.

3. Methodology and sampling strategy (2 pages max.)

Seawater samples were collected from a classic rosette (24 x 12 L) and pre-filtered through Tygon tubing with a 149 µm mesh into 4 L LDPE bottles.

Samples for DNA extraction: All samples were filtered through 0.2 µm isopore membrane filters (Merck Millipore) with a 10 cm Hg vacuum. The filters were then frozen immediately (-80 °C).
Samples for analytical flow cytometry: Prior to filtering, 1.8 ml replicates (3) were drawn from the surface, mixed layer, chlorophyll maximum, and oxygen minimum samples and fixed with 126 µl glutaraldehyde (25 % in aqueous solution, VWR Prolab), and frozen (-80 °C). This will provide quantitative analysis of the main picophytoplankton and other prokaryotes.
Samples for microscopy and for single cell sorting: Pre-prepared cryoprotectant (glyTE, Single Cell Genomic Centre at Bigelow) was added to 40 ml seawater samples, collected from the surface and chlorophyll maximum before filtering, and frozen (-80 °C), These will be archived for microscopy, and single cell sorting by flow cytometry, if needed.
Enrichment cultures: Cultures were prepared from surface samples in 25 cm^3 BioLite vented flasks (Thermo Fisher Scientific) with 0.0001 % FeC_{13} (50 µl) and 0.00056 % HPO_4Na_2 (50 µl), and stored under natural light conditions. These samples have been prepared for the enrichment and possible isolation of diazotrophs. They will be analysed for the presence of nifH genes and for their 16S phylogenetic diversity.
The analysis of all samples will be performed at the Marine Microbial Genomics & Biogeochemistry laboratory at Dalhousie University.

Table : **Exhaustive** list of measured parameters

Type of Station	Station Number	Filters for DNA extraction	2 ml Sample for analytical flow cytometry	40 ml Sample for microscopy and single cell sorting	Enrichment Cultures for the isolation of diazotrophs
Super	1	X	X	X	X
XLarge	2	X	X		
Large	4	X	X		
Large	11	X	X		
Super	13	X	X	X	X
Large	15	X	X		
Large	17	X	X		
Large	19	X	X		
Super	21	X	X	X	X
Large	23	X	X		
Large	25	X	X		
XLarge	26	X	X		
Large	29	X	X		
Super	32	X	X	X	X
Large	34	X	X		
Large	36	X	X		
Super	38	X	X	X	X
Large	40	X	X		
Large	42	X	X		
Super	44	X	X	X	X
Large	49	X	X		X
XLarge	53	X	X		X
Large	56	X	X		X
Super	60	X	X	X	X
XLarge	61	X	X		X
Large	63	X	X		X
Super	64	X	X	X	X
Large	68	X	X		X
Super	69	X	X	X	X

Large	71	X	X		X
Super	77	X	X	X	X
XLarge	78	X	X		X

Parameter	code of operation *	units
1.Filters for DNA extraction	Classic CTD	No units
2. Flow cytometry	Classic CTD	Cells /ml
3. 40 ml sample	Classic CTD	No units
4. Culture	Classic CTD	No units
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

There are no preliminary results. All samples will be analysed post cruise in the laboratory of Julie LaRoche

5. Post-cruise sampling analyses and dead-lines

Samples will be analysed within 24 months

6. Data base organization (general cruise base and/or specific data base(s))

Sequence data will be deposited into genbank with reference in the geovide database to the accession numbers in genbank

III.5. Trace elements and their isotopes

III.5.1. Dissolved Trace Metals (Fe, Cu, Mn, Co, Ni, Cd, Al, and Pb) and their isotopes (Pb, Zn, Cu, Cd)

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Résumé/Abstract:
Les métaux traces jouent un rôle majeur dans l'océan. Ils sont soient essentiels au métabolisme cellulaire, soit toxiques, soit les deux en fonction de leur concentrations. Afin de mieux appréhender leur cycle biogéochimique, pendant GEOVIDE, nous étudions les distributions des métaux traces dans la phase dissoute (Fe, Mn, Cu, Co, Ni, Zn, Cd et Pb), leur spéciation organique (Fe, Cu) et leur composition isotopique (Pb, Zn, Cu, Cd).
Les mesures seront réalisées dans les différents laboratoires : LEMAR (Brest, France) pour les distributions des métaux et la spéciation organique (PI G. Sarthou), Massachusetts Institute of Technology (USA) pour les isotopes du Pb (PI Ed. Boyle), l'Université d'Oxford (UK) pour les isotopes du Cd (PI G. Henderson) et ETH Zürich (Suisse) pour les isotopes du Zn et du Cu (PI. D. Vance).

Trace metals play a crucial role in the ocean. They are either essential for the cell metabolism, toxic or both, depending of their concentrations. In order to better understand and quantify their biogeochemical cycle, during GEOVIDE, we study their distributions in the dissolved phase (Fe, Mn, Cu, Co, Ni, Zn, Cd, Al, Ag and Pb), their organic speciation (Fe and Cu), and their isotopic composition (Pb, Zn, Cu, Cd).
Measurements will be carried out back at the home laboratories: LEMAR (Brest, France) for trace metal distributions and organic speciation (PI G. Sarthou), Massachusetts Institute of Technology (USA) for Pb isotopes (PI Ed. Boyle), University of Oxford (UK) for Cd isotopes (PI G. Henderson), ETH Zürich (Switzerland) for Zn and Cu isotopes (PI. D. Vance) and GEOMAR (Germany) for Al and Ag.

1. Scientific context (1/2 page max.)

Trace elements and their isotopes (TEIs) play a crucial role in the ocean. Some of them (e.g., Fe, Cu, Mn, Co, Zn) serve as essential micronutrients, being involved in many metabolic processes of marine organisms (e.g., Sunda, 1994; Morel and Price, 2003; Sarthou et al., 2005). Some of these micro-nutrients are thought to control the structure of ocean ecosystems and their biological productivity (de Baar et al., 2005; Peers and Price, 2006; Boyd et al., 2007; Blain et al., 2007; Pollard et al., 2007; Middag et al., 2011), both of which are key factors regulating the ocean carbon cycle and hence have effects throughout the Earth system, responding to and influencing global change. A better knowledge of the distributions and internal cycling of such important micro-nutrients is thus crucial in the context of global change. Others, like Al can be used to estimate the deposition of atmospheric dust to the surface ocean (Measures and Brown, 1996; Mahowald et al., 2005, Measures et al., 2005). Al is not assimilated by living cells, which makes this element a nearly conservative tracer of dust input.
Some of these elements are also contaminants of the environment. They are either toxic at high concentration but essential at low concentration, or only toxic (eg Pb, Zn, Cu, Cd, Ag). The poor knowledge of their cycles is a major drawback for the understanding of their biogeochemical impact on the food web. For some trace metals, more than 90% of their dissolved fraction is complexed by organic ligands (Rue and Bruland, 1995, Moffett and Dupont, 2007), preventing precipitation and removal by scavenging or regulating their bioavailability. Finally, the interactions between these trace metals and the biosphere often leads to isotopic fractionations [e.g. 5-7], suggesting a role for their isotopic systems in investigating their biogeochemical cycling.

2. Overview of the project and objectives (1/2 page max.)

In this project, our main objective is to study the distributions, sources and internal cycle of dissolved trace metals (mainly Fe, Mn, Cu, Co, Ni, Zn, Cd, Pb, Al and Ag), including their organic speciation (Fe, Cu), and their isotopic composition (Pb, Zn, Cu, Cd).

3. Methodology and sampling strategy

Seawater were collected using a Trace Metal Clean Rosette (TMR, General Oceanics Inc. Model 1018 Intelligent Rosette), attached to a 6 mm Kevlar line. After collection, Go-Flo bottles were transferred into a clean container for sampling, and processed under a laminar flow unit.
On each TMR cast, nutrient and/or salinity samples were taken to check potential leakage of the Go-Flo bottles.

- Underway sampling “Fish”

Underway samples were collected during the transect using an “Achterberg” tow fish deployed with a Kevlar wire off the starboard side of the ship.
Nearsurface seawater (~3 metre depth) was pumped into the sampling container using a Teflon diaphragm pump connected to a clean oil-free compressed air compressor. Samples were collected for a range of parameters (See sampled parameters)every 3 to 4 hours of transit. In addition samples for Hg, artificials (See reports)and large volume of filtered seawater were collected as reference seawater.

- Physical speciation

Total dissolvable Fe samples were collected without any filtration. Dissolved trace metals were filtered on-line through 0.2 µm filter cartridges (SARTOBRAN® 300, Sartorius or a polysulfone filter, Supor®). All samples were acidified within 24 h of collection with ultrapure hydrochloric acid (HCl, Merck, 250 µL, final pH 1.7).
Dissolved and total dissolvable Fe samples will be analysed back to the home laboratory (LEMAR, Brest, France) by flow injection analysis following the method by Obata et al. (1993) modified by Sarthou et al. (2003). Dissolved and total dissolvable Al will be analyzed at GEOMAR (Kiel, Germany) using flow injection analysis developed by Resing and Measures (1994) and subjected to modifications by Brown and Bruland (2008). Dissolved and total dissolvable Ag will be analysed at GEOMAR (Kiel, Germany) by preconcentration on an anion exchange resin via isotope dilution ICP-MS.

Dissolved trace metals (Mn, Co, Ni, Cu, Zn, Cd and Pb) will be analysed using an isotope dilution high resolution magnetic sector inductively coupled mass spectrometry (HR-ICP-MS) method following Quéroué et al. (2014), in the shore-based LEMAR laboratory.

- Organic speciation

Samples for organic speciation of Fe were filtered on-line through 0.2 µm filter cartridges (SARTOBRAN® 300, Sartorius or Pall Supor membrane, Acropak 200) and immediately frozen. They will be analysed in the shore-based laboratory (LEMAR, Brest, France) by cathodic stripping voltammetry (Croot and Johanson, 2000, Leal et al., 1999 for Fe and Cu speciation, respectively).

- Trace metal isotopic composition (IC)

Samples for Zn, Cu, and Cd, IC were filtered on-line through 0.45 µm filter membranes (a polysulfone filter, Supor®), under a 0.5 bar 0.2µm filtered nitrogen flow. Zn and Cu IC will at the ETH Zürich (UK), with a multicollector-inductively coupled plasma mass spectrometer (MC-ICPMS). Cd IC will at the University of Oxford (UK), with a multicollector-inductively coupled plasma mass spectrometer (MC-ICPMS)

Table: **Exhaustive** list of sampled parameters

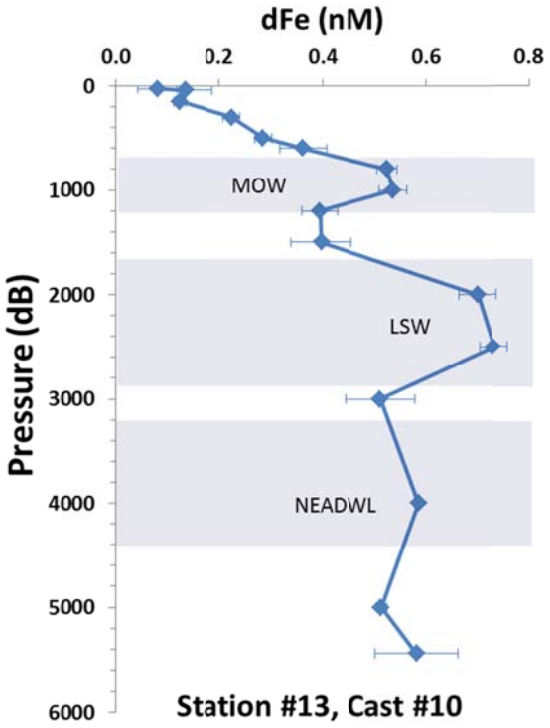
Type of station	Station number	DFe	TdFe	dTM	Fe/Cu organic speciation	Pb IC	Zn/Cu IC	Cd IC	Nutrients	Salinity
Super station	1	x	x	x	x	x			x	
XLarge station	2	x	x	x					x	
Large station	4	x	x	x					x	x
Large station	11	x	x	x		x			x	x
Super station	13	x	x	x	x	x	x		x	
Large station	15	x	x	x		x			x	x
Large station	17	x	x	x		x			x	x
Large station	19	x	x	x					x	x
Super station	21	x	x	x	x	x	x	x	x	
Large station	23	x	x	x					x	x
Large station	25	x	x	x		x			x	x
XLarge station	26	x	x	x		x			x	
Large station	29	x	x	x		x			x	x
Super station	32	x	x	x	x	x	x		x	
Large station	34	x	x	x		x			x	x
Large station	36	x	x	x		x			x	x
Super station	38	x	x	x	x	x	x		x	
Large station	40	x	x	x		x			x	x
Large station	42	x	x	x		x			x	x
Super station	44	x	x	x	x	x	x	x	x	
Large station	49	x	x	x		x			x	x
XLarge station	53	x	x	x					x	
Large station	56	x	x	x					x	x
Super station	60	x	x	x	x	x			x	
XLarge station	61	x	x	x					x	
Large station	63	x	x	x					x	x
Super station	64	x	x	x	x	x			x	
Large station	68	x	x	x		x			x	x
Super station	69	x	x	x	x	x	x	x	x	
Large station	71	x	x	x		x			x	x
Super station	75	x	x	x	x	x			x	
XLarge station	76	x	x	x					x	

Parameter	code of operation *	units
1. dFe concentration	TMR	10^{-9} mol/L
2. TdFe concentration	TMR	10^{-9} mol/L
3. dTM (Mn, Co, Ni, Cu, Zn, Cd and Pb) concentration	TMR	10^{-9} mol/L
4. Pb isotopic composition	TMR+FISH	Per mil
5. Zn and Cu isotopic composition	TMR	Per mil
6. Cd isotopic composition	TMR	Per mil
7. dAl concentration	TMR+FISH	10^{-9} mol/L
8. TdAl concentration	TMR+FISH	10^{-9} mol/L
9. dAg concentration	TMR+FISH	10^{-12} mol/L
10. TdAg concentration	TMR+FISH	10^{-12} mol/L

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results

One dFe profile was analysed on board to check for TMR contamination.



Very low concentrations were observed at sea surface (< 0.1 nM), due to biological uptake. Below, the dFe Fe profile is very well associated with water masses, with Fe maxima in the Mediterranean outflow Waters (MOW) and the Labrador Sea Water (LSW).
All the other analyses will be performed in the shore-based laboratories.

5. Post-cruise sampling analyses and dead-lines

The analyses of all the parameters should be completed in the next 18-24 months.

6. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

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III.5.2. Iron isotopes

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Résumé/Abstract:
Iron is a key metal for oceanic biogeochemical cycles. It plays an important role in primary production but also on the cycles of many other trace element and isotopes (TEIs) which are very efficiently scavenged on iron oxy-hydroxides.
Iron isotopes are a new tool allowing to bring new constraints on the iron cycle. On its sources to the ocean, the processes associated to these sources and the processes controlling the iron cycle in the water column.
We sampled the Super and XLarge stations for both dissolved (<0.4µm) and particulate (>0.4µm) iron isotopic composition determination. Iron concentration will also be produced as a by-product of the isotopic composition measurement. Similarly the concentration of a number of elements will be obtained in the suspended particles, as a by-product of the particle iron isotope measurements.
Data should be delivered not before 3 years after the cruise.

1. Scientific context (1/2 page max.)

Iron is a key metal for oceanic biogeochemical cycles. It plays an important role in primary production but also on the cycles of many other trace element and isotopes (TEIs) which are very efficiently scavenged on iron oxy-hydroxides. Therefore it plays a role in the climate and also potentially in the dispersion of pollutants.
Despite this important role, aspects of its cycle remains poorly known, as for instance its sources to the ocean. Iron isotope emerge as a new very promising tool allowing to better constrain the iron cycle, and more widely oceanic biogeochemical cycles (Lacan et al 2008, Radic et al. 2011, John et al 2012a, 2012b, Labatut et al. 2014, Abadie et al. 2014).

2. Overview of the project and objectives (1/2 page max.)

We will determine a full depth iron isotope section along the OVIDE line and across the Labrador Sea, for both filtered seawater and suspended particles (< and > than 0.4µm). These data will bring new constrain on the Fe cycle and more widely on biogeochemical cycles in this area of the North Atlantic Ocean. They will be interpreted in relation to the other parameters measured during the cruise, the physics, the biology and the biogeochemistry.

3. Methodology and sampling strategy (2 pages max.)

We sampled the Super and XLarge stations for both dissolved (<0.4µm) and particulate (>0.4µm) iron isotopic composition determination. Samples taken from the Trace Metal Clean Rosette, were filtered, within the INSU clean container, through 90 to 47mm, 0.4µm nuclepore membranes, under a 0.5 bar 0.2µm filtered nitrogen suppression. The Fe isotopic compositions will be measured as described in Lacan et al 2008 and 2010. Basically, after iron preconcentration and purification, the Fe isotopic composition will be measured with a multi-collector ICPMS.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1. DFe isotopic composition	TMR	Per mil relative to IRMM-014
2. PFe isotopic composition	TMR	Per mil relative to IRMM-014
3. DFe concentration	TMR	10^{-9} mol/L
4. PFe concentration	TMR	10^{-9} mol/L
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

None.

5. Post-cruise sampling analyses and dead-lines

The analyses should require 2 to 4 years, if salaries are funded to recruit students or postdocs to carry out the analyses.

6. Data base organization (general cruise base and/or specific data base(s))

The data will be put on the general cruise base and also on the GEOTRACES data centre. Data will remain protected until published.

7. References

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III.5.3. Mercury Cycling in the North Atlantic

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Résumé/Abstract:
The GEOVIDE transect in the North-Atlantic Ocean was explored for determining partition, chemical speciation and isotopic ratios of mercury in water. Plankton and sediments were also sampled. 31 stations were occupied with 6 to 24 depths sampled. Measurements for total mercury and dissolved gaseous mercury were performed on board, whereas water samples were stored for further laboratory analyses, including methylmercury determination. Total mercury concentrations determined onboard are in the subpicomolar range with horizontal and vertical distribution patterns consistent with oceanographic parameters.

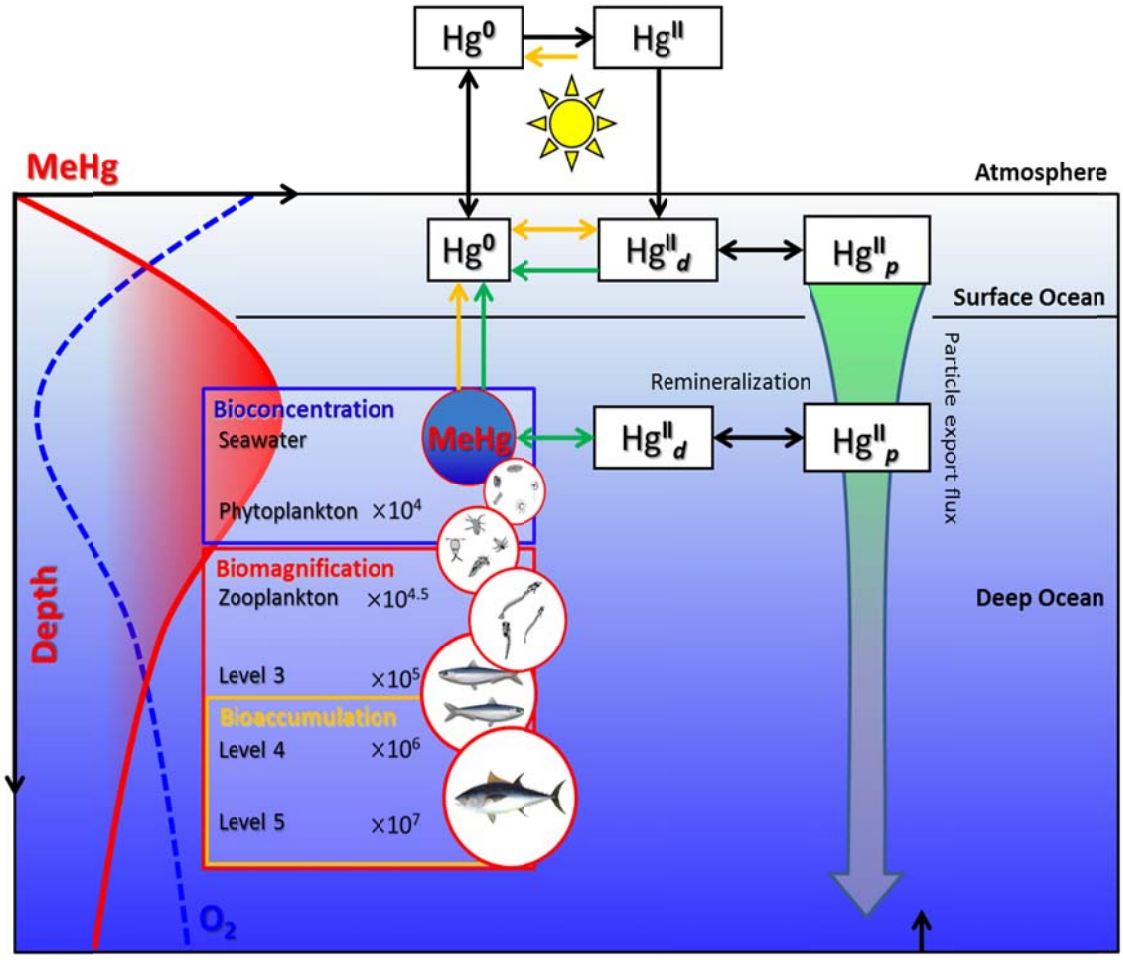
1. Scientific context

Inorganic mercury, whether of natural or anthropogenic origin, can be converted into the neurotoxin methylmercury (MeHg). Presently, this conversion is thought to occur during the bacterial reminerlization of sinking organic matter in the oceanic water column. The North Atlantic Ocean, under the influence of warming climate and anthropogenic emissions, is an excellent study site to investigate in more detail the source of inorganic Hg and processes yielding MeHg.

The marine cycle of mercury is complex and includes sea-air exchange (Hg^0, HgX_2^0), redox changes (Hg^0 / Hg^{II}) and formation of methylated mercury (MeHg, is the sum of monomethylmercury (MMHg) and dimethylmercury (DMHg) (Fig. 1). Distributions of these species in the World Ocean are still poorly described. Recent researches have begun to explore in details the air-sea Hg exchanges in North Atlantic Ocean (Sorensen et al., 2010) and MeHg dynamics in North Pacific, Southern Ocean and the Mediterranean Sea (Sunderland et al., 2009; Cossa et al., 2009; Cossa et al., 2011; Heimbürger et al., 2011). To date there is only two datasets published of Hg speciation for the North Atlantic Ocean (Mason et al. 1998, Cossa et al. 2004). Here we apply, better analytical tools and high resolution vertical profiling that will allow us to studying MeHg distribution and production in the necessary detail. The isotopic signature of Hg can possibly be used to trace its sources and its biogeochemical transformations.

Mercury (Hg) isotopes fractionate in nature dependently and independently from their mass (mass dependent fractionation: MDF and mass independent fractionation: MIF). It is believed that the main process generating MIF is the photo-degradation of Hg species in the surface ocean and the subsequent separation, via evaporation, of the products from the reactants (Bergquist et al. 2007). This should result in two compartments with essentially different MIF fingerprints: the atmosphere showing negative MIF and the Hg remaining in the oceanic pool should therefore depict positive MIF. Several works have confirmed this hypothesis (Sonke, 2011) using atmospheric (lichens, peat) and oceanic integrators (marine sediments, fish, oceanic top predators). Only a few and controversial results on direct atmospheric

measurements have been published (Gratz et al. 2010; Chen et al. 2012), whereas direct measurements of Hg isotopes in the ocean are still lacking. There are multiple interests in studying the isotope signatures of dissolved and particulate Hg. The first is to confirm broad observational and modeling projections that marine Hg has a positive MIF signature. The second will be to calibrate the isotope fractionation factor for Hg sorption to particles, if significant at all. Finally, the continuously produced DGM will outgas to the atmosphere where it mixes with the gaseous elemental mercury pool. Outgassing, a diffusional process, likely favors the lighter Hg isotopes, and we hope to quantify this effect as well.
During GEOVIDE 2014 cruise we explored (i) total mercury (HgT) , reactive Hg (HgR) , dissolved gaseous mercury (DGM) distribution, (ii) methylated Hg distributions (iii) Hg isotopic signatures in the water column in relation with the oceanic circulation.



2. Objectives

- Document the distributions of total mercury (HgT) and its species (MeHg, MMHg, DGM, inorganic Hg) in the different waters masses present on the GEOVIDE transect.
- Explore the methylation/demethylation processes in relation with the PP, oxygen consumption and nutrient regeneration.
- Explore the Hg sources and processes by Hg isotopic fingerprinting in the atmosphere, some selected water masses, surface sediment and plankton.

3. Methodology and sampling strategy

Water for mercury analyses was collected from the ultra-clean sampling device including clean Rosette and Glo-Flo bottles. Specific methods for studying mercury in the GEOTRACES context are described in our paper on mercury on the SR3- GEOTRACES section in seawater

the Southern Ocean (Cossa et al., 2011), complementary details are provided in Lamborg et al. (2012). Methodology for the determination of mercury isotopic ratios is in development.
We sampled 380mL unfiltered seawater at each depth at each station, totaling ~500 samples, for the determination of total methylated mercury (HgT). On selected station we purged off the gaseous dimethylmercury (DMHg), to measure the remaining monomethylmercury only (MMHg).
The two forms of methylated mercury (MMHg/DMHg) will be measured as the sum of both, because the acidification step quantitatively converts DMHg into MMHg. The final measurement will be realized after a derivatization step (propylation) of inorganic and MMHg present in the seawater sample, extraction into hexane, chromatographic separation *via* gas chromatography and detection *via* sector field inductively coupled mass spectrometry. The dataset will cover the whole GEOVIDE transect and be the highest resolution Hg speciation transect to date. We organize a 2nd GEOTRACES international intercalibration exercise for *dissolved total methylated mercury* and *dissolved total mercury* in seawater. Ten partner laboratories will contribute.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1. HgT	TMR	547
2. MeHg	TMR	431
3. DGM	TMR	113
4. Plankton	NET	9
5. Sediment	CORER	9

- Classic CTD, ISP, TMR, NET, CORER, FISH

Annexe table: *Number of samples collected. In brackets filtered samples. HgT, and DGM have been analyzed on board in the Ifremer clean (Class 100) container*

Station	HgT	DGM	MeHgT	Plankton	Sediment
0	19				
1	21 *(21)*	12	21	200µm	
2	7 (7)		12		
4	10 *(10)*				
11	22 *(20)*		12		
13	21	12	21	200µm	X
15	20 *(20)*		12		
17	22 *(22)*		12		
19	22 *(22)*		6		
21	22	12	22	200µm	X
23	21		12		
25	22		12		
26	21		12		
29	21		12		
32	22	12	22	500µm	
34	22		12		
36	11		12		
38	18	12	18	500µm	X
40	8		12		
42	22		12		
44	22	14	22	500µm	X
49	22	13	12	500µm	
53	6		12		X
56					X
58					X

60	22 *(10)*		22		
61	6 *(6)*		12		
63	11 *(6)*		12		
64	13	13	13	500µm	
65					X
68	11 *(11)*		12		
69	21 *(15)*	13	21	500µm	X
71	12	13	12		
77	21 *(15)*	13	21		
78	6		6		

4. Preliminary results

Total mercury concentration (HgT) measured on board were in the subpicomolar range. Geographical variations of HgT are consistent with oceanographic parameters. Concentrations decrease North-Westward. Vertical distributions are consistent with the identified water masses of the OVIDE transect.

5. Post-cruise sampling analyses and dead-lines

HgT and DGM concentrations have been determined onboard. The data will be validated before September 2014. MeHg analyses are planned for October 2014. Hg isotopes measurements in air, seawater, sediment and plankton will be realized within the coming 2 years.

6. Data base organization (general cruise base and/or specific data base(s)

7. References

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III.5.4. Thorium (^{230}Th, ^{232}Th) and Protactinium (^{231}Pa)

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Résumé/Abstract:
The naturally occurring radioisotopes ^{231}Pa and ^{230}Th are both produced in the ocean from the decay of uranium (^{235}U and ^{234}U respectively) and are rapidly removed from the ocean by scavenging onto particle surfaces and settling. The distribution of ^{231}Pa and ^{230}Th in the oceans is therefore governed by the degree of particle affinity for each ^{231}Pa and ^{230}Th, the flux of particles, and the advection of any ^{231}Pa or ^{230}Th remaining in the dissolved, or "non-sinking" fraction. The sedimentary record of ^{231}Pa and ^{230}Th is increasingly used as a tracer of past oceanographic conditions. However, the use of this proxy is currently controversial with many questions still to be resolved. A total of 150 seawater samples of 5 litre were taken during Geovide cruise, from 15th May to 30th June 2014 on board R/V "Pour Quoi pas?". Samples were filtered right from niskin bottles using 0.45 um acropack filter cartridges. Obtaining a section of ^{231}Pa and ^{230}Th concentrations along Geovide in the North Atlantic Ocean will allow the investigation of the nature of particle scavenging across different bio- oceanographic settings, with variations of particle flux and type along the Geovide section. These dataset will also help clarifying some of the unresolved questions regarding the use of these radionuclides as a proxy for paleoceanography.

1. Scientific context.

The naturally occurring radioisotopes ^{231}Pa and ^{230}Th are both produced in the ocean from the decay of uranium (^{235}U and ^{234}U respectively). The high solubility and hence long residence time of U in the oceans leads to a uniform (varying only with salinity) concentration of U and only small variations in the isotopic composition of dissolved U in the open ocean (Andersen et al. 2007). Once produced ^{231}Pa and ^{230}Th are rapidly removed from the ocean by scavenging onto particle surfaces and settling. The distribution of ^{231}Pa and ^{230}Th in the oceans is therefore governed by the degree of particle affinity for each ^{231}Pa and ^{230}Th, the flux of particles, and the advection of any ^{231}Pa or ^{230}Th remaining in the dissolved, or "non-sinking" fraction. The sedimentary record of ^{231}Pa and ^{230}Th is increasingly used as a tracer of past oceanographic conditions. It has been used to infer past rates and modes of ocean circulation (Yu et al. 1996; McManus et al. 2004; Gherardi et al. 2005; Thomas et al. 2007; Gherardi et al. 2009; Negre et al. 2010), and particle fluxes (Kumar et al. 1993; Kumar et al. 1995; Bradtmiller et al. 2007). The use of this proxy is currently controversial with many questions still to be resolved surrounding the transfer of water column ^{231}Pa and ^{230}Th to oceanic sediments.

2. Overview of the project and objectives.

The GEOVIDE project will cover the open ocean, the European and Canadian margins, as well as the Greenland platform. This will allow investigating the nature of particle scavenging across different bio- oceanographic settings, with variations of particle flux and type along the section. This project will also provide the opportunity to study the extent to which enhanced scavenging in these high particle flux regions effects the oceanic ^{231}Pa and ^{230}Th concentrations (Anderson et al. 1983; Anderson et al. 1990), and hence how this might bias paleoceanographic reconstructions.

3. Methodology and sampling strategy (2 pages max.)

A total of 150 seawater samples of 5L were taken obtaining full depth profiles at all super stations. Surface seawater was also collected in between super stations using the stainless rosette. Samples were directly filtered from the Niskin bottles using PVC tubing and Acropak capsules (0,45 µm pore size). Plastic film was used to cover the bottle mouth during sampling to reduce contamination. Prior to use, each Acropak was rinsed with 5L surface water taken with the stainless rosette. Acropaks were replaced upon reduction of the flow rates. To reduce cross-contamination Acropaks were rinsed with ~500 mL of sample before rinsing the sample bottle with a further ~100mL of sample prior to filling. Once filled samples were capped, they were bagged and stored in boxes for transport back to Oxford, where they will be acidified with 1.2mL/L of 10N HCl (quartz distilled). Particulate samples were obtained using in-situ pump filtration units, further details can be found in the In situ pump section.

Table 1: ^{431}Pa/^{430}Th seawater samples taken during Geovide cruise.

Parameter	Code of operation	Units
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_001_05_1, 2, 3, 4, 5, 6, 7, 9, 11, 14, 19 and 24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_002_01_24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_013_05_1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 15, 16, 22 and 24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_015_03_24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_017_01_24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_019_03_24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_021_06_1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 16, 18, 23 and 24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_024_01_24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_026_03_1, 8, 9, 12, 19 and 22	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_029_03_23-24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_032_05_1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 22 and 24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_034_01_24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_038_05_1, 2, 3, 5, 12, 15, 18, 23 and 24	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_042_03_23	dpm/L
^{431}Pa, ^{430}Th, ^{432}Th	Geoh_044_05_1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 17, 20 and 24	dpm/L

^{231}Pa, ^{230}Th, ^{232}Th	Geoh_053_05_22	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_060_06_1, 3, 4, 5, 7, 10, 12, 15, 19, 23 and 24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_061_05_23	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_064_05_1, 2, 3, 4, 5, 8, 11, 13, 16, 21 and 24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_064_11_17	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_068_01_24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_069_05_1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 14, 18 and 24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_071_01_24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_075_01_24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_077_05_1, 2, 3, 4, 5, 6, 7, 8, 11, 13, 18, 23 and 24	dpm/L
^{231}Pa, ^{230}Th, ^{232}Th	Geoh_078_01_23	dpm/L

4. Preliminary result: no results yet.

5. Post-cruise sampling analyses and dead-lines

   Seawater samples will be analysed for ^{232}Th, ^{230}Th, U and ^{231}Pa using MC-ICP-MS at Oxford. Briefly, these elements are extracted by Fe-coprecipitation after spiking with ^{229}Th and ^{236}U and, purified with an anion exchange column. They will be analysed on a Nu instruments MC-ICP-MS, concentrations being calculated by isotope dilution. This approach is fully detailed in Thomas et al. (2006).

   A proposal was submitted to cover the analysis cost of these samples to the UK funding council, NERC. We anticipate analysing the samples starting towards the end of 2014 and to complete mid 2015.

6. Data base organization (general cruise base and/or specific data base(s))

   Data will be submitted to the GEOTRACES Data Assembly Centre at the British Ocean Data Centre.

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III.5.5. $^{210}Po/^{210}Pb$ for particle cycling

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Résumé/Abstract:
Polonium (Po) is more particle reactive than lead (Pb) and therefore a deficiency of ^{210}Po relative to ^{210}Pb is observed in the upper water column. This deficiency can be used to investigate particle related processes such as rates of scavenging, aggregation –disaggregation and remineralisation and it is often used as a proxy to estimate particulate carbon export. A total of 199 seawater and particulate (small, 1 to 53 µm; large, >53 µm) samples were collected at 10 super stations and one large station covering the whole water column. Samples were pre-concentrated on board using the Co-APDC method and will be later purified and counted in the laboratory. This dataset will provide a high resolution distribution of natural radionuclides with depth allowing to investigate the export and cycling of carbon and other major and minor nutrients associated to marine particulate matter.

1. Scientific context.

Po is more particle reactive than Pb [Kharkar *et al.,* 1976] and therefore a deficiency of ^{210}Po relative to ^{210}Pb is observed in the upper water column. This deficiency can be used in a similar way to the $^{234}Th/^{238}U$ to investigate particle cycling in the ocean, addressing aspects such as rates of scavenging, aggregation/disaggregation, remineralisation and the role of types and/or composition of particles involved in these processes. The $^{210}Po/^{210}Pb$ pair, however, differs to the $^{234}Th/^{238}U$ pair in that: i) Pb is also particle reactive, while U is not; ii) unlike Pb or Th, Po not only adsorbs onto particle surfaces but it is also assimilated by marine organisms [Verdeny *et al.,* 2009 and references therein]. The pair is also used as a proxy to estimate particle export (especially regarding carbon) from the upper ocean and it is often employed together with the $^{234}Th/^{238}U$ proxy, as they allow tracing of the particulate matter over time scales of weeks to months (Friedrich and Rutgers van der Loeff, 2002; Cochran and Masqué, 2003; Verdeny *et al.,* 2009).

2. Overview of the project and objectives.

The focus of this project is to study the relationship between the natural radionuclides ^{210}Po and ^{210}Pb and carbon and bioactive trace metals. Recent studies suggest that particles may be an important source of iron (Fe) for phytoplankton growth. Particulate Fe is involved in key processes such as remineralization, scavenging and export, affecting the oceanic absorption of atmospheric CO_2. Sinking particles are deemed important as they sequester C and may reduce the availability of trace metals, limiting the primary production in surface waters. Our interest is to quantify C and particulate trace metal fluxes in and out of the surface layer using the $^{210}Po/^{210}Pb$ pair, especially in regions with larger particle supply due to upwelling and/or continental exchange, and enhanced primary production. The GEOVIDE cruise sailed along Greenland and

Iberian margins among other exchange areas, offering a great opportunity to pursue this study.

3. Methodology and sampling strategy.

A total of 199 seawater samples (5-10 L each) were collected at 10 super stations and one large station. At these sites, 15 to 22 depths where sampled obtaining a high-resolution profile over the whole water column. Samples were first collected into volume pre-calibrated bottles and then transferred to 10L clean containers. All containers and calibrated bottles were rinsed 3 times with the sample. Samples were acidified immediately to pH<2 using concentrated HCl and ^{209}Po tracer and stable Pb were added as yield tracers. After vigorous mixing samples were allowed to settle for at least 6 hours. The Co-APDC [*Boyle and Edmond*, 1975] method was used to pre-concentrate the samples onboard. ^{210}Po and ^{210}Pb will be also analyzed in size-fractionated particles (1 to 53 µm and >53 µm) collected using in situ pump filtration. The ratio of concentrations of POC, PON and metal concentrations to ^{210}Po in sinking particles will be used to estimate their fluxes, in combination with the export rates of ^{210}Po, determined from its deficit with respect to ^{210}Pb in the upper water. Export from the upper ocean and remineralisation rates below the photic layer are to be obtained as part of the main objectives of the cruise.

Table 1. : List of seawater samples taken during Geovide cruise. *Particulate samples can be found in the In situ pump report.

Parameter	code of operation	Unit
^{210}Po/^{210}Pb	Geoh_001_05_2-3, 4, 5-6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 22 and 23	dpm/L
^{210}Po/^{210}Pb	Geoh_013_5_2-1, 4-3, 6-5, 8-7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_021_6_2-1, 4-3, 6-5, 8-7, 9, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_026_5_1, 4, 8, 9, 12, 15, 16, 19 and 22	dpm/L
^{210}Po/^{210}Pb	Geoh_032_5_2-1, 4-3, 6-5, 8-7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_038_5_2-1, 4-3, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_044_5_2-1, 4-3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_060_6_3-1, 5-4, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_062_5_2-1, 4-3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 19, 20, 21, 22 and 24-23	dpm/L
^{210}Po/^{210}Pb	Geoh_069_5_2-1, 4-3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L
^{210}Po/^{210}Pb	Geoh_077_5_2-1, 4-3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	dpm/L

4. Post-cruise analyses and deadlines:

Back in the laboratory, Co-APDC precipitates will be digested and deposited onto silver discs that will be measured in alpha spectrometers at UAB and QC. The samples will be re-plated and purified through exchange columns in order to remove any residual Po left in solution. Six months or more after the first measurement, samples will be re-plated onto silver discs in order to quantify the ^{210}Po ingrowth from natural ^{210}Pb present in the seawater sample. This will allow determining the initial concentrations of ^{210}Po and ^{210}Pb at the sampling time after applying adequate ingrowth-decay corrections (Rigaud et al., 2013). Pb yields are determined through measurement of stable Pb by atomic absorption spectrometry. Results shall be available by summer 2015.

5. Data base organization

The dataset shall be included in the Geotraces database.

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III.5.6. Artificial radionuclides (Pu isotopes, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs, and ^{90}Sr)

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Résumé/Abstract:
Artificial radionuclides (Plutonium isotopes, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr) have been introduced to the oceans primarily as a result of atmospheric and surface testing of nuclear weapons in the late 1950's and early 1960's. While the main source of these nuclides has been global stratospheric fallout, close-in fallout from equatorial Pacific test sites has also contributed (mainly in the early 1950's) as well as other inputs from nuclear fuel reprocessing facilities (e.g., Sellafield and La Hague) and accidents (e.g. Chernobyl and Fukushima). Improving our knowledge of the fate, transport, and distribution of these nuclides is important for the assessment of environmental and human health impacts as well as the assessment of future accidental or intentional releases. Further, their absence in the environment at appreciable levels prior to ~1950, accurate knowledge regarding the different sources and release histories of these radionuclides, different geochemical behaviours, and, in the case of plutonium isotopes, the ability to identify and resolve inputs from different sources make these isotopes extremely useful tools for the study of processes such as oceanic circulation and particle cycling. A total of 145 seawater samples were collected at 10 super stations and 2 XL stations during the GEOVIDE cruise. Additional surface samples were collected using the towed Fish. Bottom sediments and particles from the water column were also collected. Radionuclides will be separated and purified from 20L seawater samples using a novel sequential extraction method. This dataset will provide a comprehensive distribution of artificial radionuclides in the study area, improving our understanding of the oceanic processes (i.e. ocean circulation, particle cycling) governing their distributions. Furthermore, the dataset will allow i) estimating water mass transfer times between basins, ii) calculating deep water formation rates, iii) estimating the vertical mixing and iv) studying scavenging rates in the different biogeochemical regions of the north Atlantic Ocean.

1. Scientific context.

Artificial radionuclides have been introduced to the environment in significant amounts since late 1950's. The Atlantic Ocean (mainly in the northern hemisphere) has been since then subject to the direct input of a variety of artificial radionuclides via several paths: stratospheric deposition of global fallout resulting from nuclear weapons tests (which peaked in 1963), accidents such as Chernobyl and Fukushima, and authorized discharges from nuclear reprocessing plants such as those in Sellafield (UK) and Cap de la Hague (France). Also to be taken into account is the interchange with other oceans/basins (Arctic and Southern Oceans, Pacific, Indian and Mediterranean) via water masses with different

signatures. Studying the fate, transport, and distribution of these nuclides is of paramount importance for the assessment of environmental and human health impacts as well as the assessment of future accidental or intentional releases. Absence of these radionuclides in the environment prior to ~1950, accurate knowledge of their different sources and release histories and different geochemical behaviours make these isotopes extremely useful tools for the study of processes such as oceanic circulation and particle cycling. For instance, conservative-type radionuclides such as ^{137}Cs, ^{90}Sr, ^{129}I and more recently ^{236}U and ^{237}Np allow estimates of circulation rates, whereas, particle-reactive plutonium, allows to identify and resolve inputs from different sources and provides information regarding particle fluxes and/or export and scavenging rates.

2. Overview of the project and objectives.

The GEOVIDE section intersects all important water masses in the subpolar North Atlantic including young (recently formed) deep waters originating from the Labrador Sea and the Greenland Sea as well as old (formed in the pre-nuclear era) Antarctic Bottom Waters. We therefore expect to find a strong gradient of artificial radionuclides in the water column reflecting the input from different anthropogenic sources such as global fallout (bomb tests), the Chernobyl accident and nuclear reprocessing wastes. Furthermore, the GEOVIDE section encompasses a large variety of biogeochemical provinces, including coastal, platform and open sea areas that will allow studying the particle cycling and the influence of these particles in the distribution of particle reactive radionuclides. Obtaining a comprehensive, high resolution (12 depth profiles) distribution of anthropogenic radionuclides in the water column will allow: 1) estimating their inventories and evaluating the fate of such contaminants in the global ocean, 2) calculating transfer times, e.g. from the North Sea into the deep Atlantic Ocean, (3) investigating deep water formation and spreading rates e.g. of Labrador Sea Water (LSW), (4) estimating the intensity of vertical mixing in regions without deep water formation and (5) understanding the particle cycling and particle effect in particle-reactive radionuclides. These dataset will be compared with GEOSECS data providing an updated situation of artificial radionuclide distribution in the contemporary ocean.

3. Methodology and sampling strategy.

Seawater samples of 20L were collected in LDPE cubitainers using a stainless rosette equipped with 12L Niskin bottles. Samples were weighed and acidified to pH<2 using conc. Nitric acid (suprapure) immediately after collection. 0,5L of seawater were collected in dark HDPE bottles for ^{129}I and stored without acidification. Additional samples were using the towed fish, which was deployed at about 2 m depth.

Table 1. : List of artificial samples taken during Geovide cruise.

Parameter	code of operation	units
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_001_11_21-23	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_001_13_1-2, 3-4, 5-6, 7-8, 9-10, 11-12,	Bq/m^3

	13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_002_1_22-23	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_1	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_013_13_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_2	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_021_14_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_3	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_026_03_2-3, 6-7, 10-11, 13-14, 17-18, 20-21 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_4	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_032_03_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_038_03_3-4, 9-10, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_5	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_044_14_fish	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_044_14_24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_044_05_21-22	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_044_14_1-2, 5, 3-4, 6-7, 8-9, 10-11, 12-13, 14-15, 16-17, 18-19, 20-21 and 22-23	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_053_05_13-14, 16-17 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_060_12_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_061_05_12-13, 15-16 and 21-22	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_064_13_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_6	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_069_13_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_7	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geof_AR_8	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_077_13_1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22 and 23-24	Bq/m^3
Pu, ^{237}Np, ^{236}U, ^{129}I, ^{137}Cs and ^{90}Sr	Geoh_078_05_6-7, 11-12, 14-15, 18-19 and 23-24	Bq/m^3

4. Post-cruise analyses and deadlines:

Pu isotopes, ^{237}Np, ^{236}U and ^{137}Cs will be extracted from the 20L sample using a sequential extraction technique similar to the one described by Casacuberta *et al.* (in prep). Briefly, Pu isotopes, ^{237}Np and ^{236}U will be extracted in sub-samples using the iron hydroxide precipitation technique. The remaining supernatant will be passed through a column filled with KNiFC-PAN ion exchange resin retaining the Cs isotopes (Kameník *et al.,* 2013). Recovery of the radiochemical procedure will be quantified measuring the spikes and stable elements added to the sample. Additionally, a mass tracer will be used to check possible losses of the sample throughout the steps. ^{90}Sr will be analysed in the Cs-free sample through the

measurement of its decay product ^{90}Y via radiochemical purification and beta counting at UAB (Wapples and Orlandini, 2010, Casacuberta *et al.,* 2013). Pu isotopes and ^{237}Np will be analyzed adapting the methods described by Kenna (2002) at LDEO (USA). Briefly, samples will be purified for Pu and Np using ionic exchange columns, and measurements will be carried out by ICP-MS. ^{236}U will be analysed at ETH Zurich using low energy AMS after radiochemical purification using ion-exchange columns (Christl *et al.,* 2012; Casacuberta *et al.,* 2014). Analysis of ^{137}Cs will be conducted by gamma spectrometry at UAB and in collaboration with EAWAG (Zurich). Analytical work and the first results are expected along the 2015.

5. Data base organization

The dataset shall be included in the Geotraces database and in the "Global Marine Radioactivity Database (GLOMARD)" hosted by the International Atomic Energy Agency (IAEA, www.iaea.org).

6. References

Casacuberta, N., Masqué, P., Garcia-Orellana, J., López-Castillo, E., Kenna, T.C., and García-Tenorio, R. A sequential method for the determination of 90Sr, Pu- isotopes, and 137Cs in seawater. In prep.

Casacuberta, N., Christl, M., Lachner, J., Rutgers van der Loeff, M., Masqué and Synal, H. A. A first transect of U-236 in the North Atlantic Ocean, Geochim. et Cosmochimica Acta, 2014.

Christl, M., Lachner, J., Vockenhuber, C., Lechtenfeld, O., Stimac, I., Rutgers van der Loeff, M and Synal, H.-A. A depth profile of uranium-236 in the Atlantic Ocean, Geochim. et Cosmochimica Acta, 2012.

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III.5.7. ^{7}Be, ^{210}Po and ^{210}Pb in seawater, precipitation and aerosols

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Résumé/Abstract:

Naturally occurring ^{7}Be is a short lived (53.4 d) cosmogenic nuclide produced in the atmosphere by the interaction with cosmic rays and it can be used to estimate the atmospheric inputs of relevant TEIs to the surface of the ocean. A total of 35 large volume seawater (50-100 L each), 18 aerosol and 8 rain samples were collected along the Geovide cruise between 15th May and 30th June onboard R/V "Pourquoi Pas?". These results will allow quantifying the export of certain TEIs from the atmosphere to the upper ocean and infer the fate of TEIs within the upper water column using the natural radionuclides ^{7}Be, ^{210}Pb and ^{210}Po.

8. Scientific context.

^{7}Be is a short-lived radionuclide (53.4 d) that can be used to estimate the atmospheric inputs of relevant TEIs to the surface of the ocean. The principle is based on determining the inventory of ^{7}Be in the upper water column, which is a balance between the atmospheric deposition and the radioactive decay of ^{7}Be (Cámara-Mor *et al.,* 2011). Then, the atmospheric flux of the TEIs of interest can be estimated multiplying the TEI/^{7}Be ratio in aerosols and rainfall by the ^{7}Be flux. This methodology can be coupled with measurements of ^{210}Pb and ^{210}Po, which will allow constraining steady state assumptions. A potential refinement of the model can be the estimate of the ^{7}Be export from the mixed layer by sinking particles, which can be addressed from estimates of ^{234}Th and ^{210}Po export fluxes and the ^{7}Be/^{234}Th and ^{7}Be/^{210}Po ratios in large (> 53 µm) particles collected using in-situ pumps (see specific reports).

9. Overview of the project and objectives.

The GEOVIDE section covers the area between 40º and 60ºN, crossing air and water masses of different origin. Air masses carry particles and radionuclides with different intensity associated to various wind regimes and different geographical origin. Some particles are expected to be enriched in anthropogenic-industrial TEIs whereas others might show more terrigenous and natural component. This cruise will allow to quantify the export of certain TEIs from the atmosphere to the upper ocean and infer the fate of TEIs within the upper water column using the natural radionuclides ^{7}Be, ^{210}Pb and ^{210}Po.

10. Methodology and sampling strategy.

A total of 35 large volume seawater (50-100 L each), 18 aerosol and 8 rain samples were collected along the Geovide cruise. Seawater samples were collected at superstations using the stainless rosette and occasionally the ship intake. Sampling depths included the surface, the mixed layer and waters below the mixed layer. Seawater collected using the ship intake will be used to compare our ^{7}Be method with the method developed by Dr. Peter van Beek and Virginie Sanial (Toulouse). Seawater samples were collected into pre-calibrated carboys or weighed to ensure accurate volumes. A rain collector was placed in the monkey-island next to the trace metal rain sampler. Rainfall samples were collected so as to obtain a representative distribution along the Geovide transect and, in particular, next to the superstations. After collection, all water samples (seawater and rainfall) were acidified by adding 1 mL HCl conc./L and spiked with 5 mg of stable Be as internal tracer. $FeCl_3$ was also added as a carrier. Rain and surface seawater samples were also spiked with ^{209}Po and stable Pb as tracers. After vigorous stirring and equilibration of spikes for at least 12h, ammonia was added until iron precipitate was clearly observable (pH≈8.5). The iron precipitate was allowed to settle and the supernatant was removed by syphoning. The precipitate was stored and will be analysed at the home laboratory. Filtration of aerosols was carried out by Rachel Shelley. Aerosol samples for ^{7}Be, ^{210}Pb and ^{210}Po determination were kept frozen and shipped for analyses at the home laboratory.

Table 1: Seawater samples taken during Geovide cruise. Aerosol samples are the same as for trace metal samples described in its corresponding report.

Parameter	Code of operation	Units
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_001_11_17-22	dpm/L
^{7}Be	Geoh_001_11_1-8 and 9-16	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_013_11_18-24	dpm/L
^{7}Be	Geoh_013_11_2-8 and 10-17	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_021_12_18-24	dpm/L
^{7}Be	Geoh_021_12_1-8 and 10-17	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geo_021_ship intake1, ship intake 2	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_032_12_1-7	dpm/L
^{7}Be	Geoh_032_12_10-16 and 18-24	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_038_13_17-24	dpm/L
^{7}Be	Geoh_038_13_1-8 and 9-16	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_044_11_17-24	dpm/L
^{7}Be	Geoh_044_11_1-7 and 8-15	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geo_044_ship intake	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_060_04_21-24 and 18	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_060_08_17-24	dpm/L
^{7}Be	Geoh_060_08_1-8 and 9-16	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_069_ship intake1	dpm/L

^{7}Be, ^{210}Po, ^{210}Pb	Geoh_069_11_17-24	dpm/L
^{7}Be	Geoh_069_11_1-8 and 10-16	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_069_ship intake2	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_077_ship intake1 and intake 2	dpm/L
^{7}Be, ^{210}Po, ^{210}Pb	Geoh_077_11_17-24	dpm/L
^{7}Be	Geoh_077_11_1-8 and 10-16	dpm/L

11. Post-cruise analyses and deadlines:

The iron precipitates will be dissolved using conc. HCl and measured by gamma spectrometry in 2M HCl media to quantify ^{7}Be concentrations. Aerosol samples will be traced with ^{7}Be, ^{210}Pb and ^{210}Po, digested in a mixture of acids (HNO_3, HCl and HF conc.) and measured by gamma spectrometry as described for water samples for the determination of ^{7}Be. Gamma measurements will be conducted at Universitat Autònoma de Barcelona within two months after collection to minimize ^{7}Be decay. Samples will be analysed by alpha spectrometry to determine ^{210}Po and ^{210}Pb in rain, surface seawater and aerosols. Chemical recoveries of Be and Pb will be determined by optic emission spectrometry. The model described above will be applied for any TEI of atmospheric origin measured by other teams participating in GEOVIDE, particularly bioactive and anthropogenically enriched trace metals. Strong collaboration is anticipated with Rachel Shelley (aerosol trace metals) and, P. van Beek and V. Sanial (Be in Mn fibers and large particles) from Toulouse.

Results are expected to be avaliable by the end of October 2014 for ^{7}Be and by summer 2015 for ^{210}Po and ^{210}Pb.

12. Data base organization

The dataset shall be included in the Geotraces database.

13. References

Cámara-Mor P., Masqué P., Garcia-Orellana J., Kern, S., Cochran J.K. and Hanfland, C. (2011). Interception of atmospheric fluxes by Arctic sea ice: evidence from cosmogenic ^{7}Be. Journal of Geophysical Research,116, C12, doi:10.1029/2010JC006847.

III.5.8. Dissolved Nd isotopes

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Résumé/Abstract:
Among the REE elements, Nd is characterized by 7 isotopes. “Nd isotopic composition” refers to the very precise analysis of the $^{143}Nd/^{144}Nd$ ratio. The variation of this ratio in the different oceanic compartments (water masses, particles…) is a good tracer of 1) the sources of chemical element to the water masses at the ocean boundaries and 2) trajectory and history of the water masses in a low frequency circulation dynamic.
In the framework of GEOVIDE, we collected 175 samples (average V= 10 L) of filtered seawater and 25 samples of unfiltered one in order to determine the Nd isotopic composition in the dissolved seawater. Comparison of these dissolved data with the suspended particle ones (see the PNd isotope file) will help to constrain dissolve/particulate exchanges.

1. Scientific context (1/2 page max.)

Nd isotopes sampling and analyses are integrated in the general scientific framework of GEOVIDE. GEOVIDE cruise (May15th-June30th 2014) realized an integrated oceanographic transect in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. Tracers like Nd isotopes are precious in this context. GEOVIDE will also allow determining a variety of sources and sinks that influence the distribution of tracers (as Nd isotopes) in this area. Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated.

2. Overview of the project and objectives (1/2 page max.)

The oceanic waters are strongly suspected to acquire their Nd concentration and isotopic signatures at the continent/ocean interface, mostly through a significant exchange of Nd between water masses and the margin along which they flow. This isotopic signature reflects the abundance variation of ^{143}Nd isotope.

It is commonly expressed as $\varepsilon_{Nd} = \left(\frac{\left(\frac{^{143}Nd}{^{144}Nd}\right)_{Sample}}{\left(\frac{^{143}Nd}{^{144}Nd}\right)_{CHUR}} - 1 \right) \times 10^4$ where “CHUR” is a reference, representing the average 143Nd/144Nd earth value. The continental margins surrounding the world ocean display different isotopic signature, mostly reflecting their different geological origin and story: from margins covered by old granitic sediments with a low $^{143}Nd/^{144}Nd$ ratios (i.e. negative εNd values, Greenland is a good example) to the volcanic ones, with high $^{143}Nd/^{144}Nd$ ratios (εNd values positive or close to 0, Iceland and Reykjanes ridge for example). This property allows the quantification of the fraction of weathered material that dissolves at the continent/ocean interface (Lacan and Jeandel, 2005; Arsouze et al, 2009). Once water masses have acquired their Nd isotopic composition in a specific area, Nd isotopes behave quasi conservatively and can be assimilated to a “color” used to trace the pathways of the

water masses (Piepgras and Wasserburg, 1983; Jeandel, 1993; Lacan and Jeandel, 2004). Nd isotopes have already been measured in the Norvegian, Greenland seas and Denmark and Iceland-Scotland overflows in the framework of F. Lacan and recent M. Lambelet (Imperial College of London) theses. However, regional modeling coupling NATL4 and Nd isotopes (Arsouze et al, 2010) revealed that important pieces of the puzzle are missing to establish 1) a precise characterization of how the water masses composing the NADW are acquiring their Nd signature (mostly the ISOW and LSW) and their further evolution before composing the core of the NADW; 2) an understanding of the impact of Reykjanes ridge on values of the water recirculating in the Irminger gyre 3) an extensive characterization of the water in the North East Atlantic waters. Owing to the importance of the Nd parameters as "tags" of the thermohaline circulation, as imprinted for example in the deep water corals, solving these issues is essential. In addition, close analyses of the dissolved/particulate exchange -conducted with that dedicated to the Fe speciation at the particle surface- will allow understanding better the processes yielding the release of REE at the sediment/water (or particle/water) interface.
In this goal, dissolved Nd isotopes were collected as often as possible in order to 1) map their distribution and their physical and chemical speciation along a full-depth ocean section 2) Characterize their sources and sinks and quantify their fluxes at the ocean boundaries 3) investigate the link between the isotope transport and the production, export and remineralisation of particulate organic matter

3. Methodology and sampling strategy (2 pages max.)

For Nd isotope analyses, ~175 samples of 10 L of seawater were collected from Niskin bottles of the classic rosette at each SUPER stations, X-Large stations and at some large stations in order to ensure the best vertical and horizontal resolutions, and "tag" the water masses as precisely as possible. Samples were immediately filtered onboard in polycarbonate cylinders under pressured clean air (Nuclepore membrane, 47mm 0.4µm). They were immediately loaded on C18 pre-cleaned cartridges at pH 3.7, following the procedure initially described in Tachikawa et al (1999).
Planned Analytical procedure : Back to the laboratory, Nd will be extracted from the water sample following a procedure based on reverse liquid chromatography and then isotopic ratios are measured using a mass spectrometer. Details are given in Lacan and Jeandel (2001)
Units:
The isotopic neodymium composition (ε_{Nd}) corresponds to the $^{143}Nd/^{144}Nd$ ratio (no units) defined by:
$\varepsilon_{Nd} = ([(^{143}Nd/^{144}Nd)_{sample}/(^{143}Nd/^{144}Nd)_{CHUR}]-1)*10000$,

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1.Dissolved Nd isotopes	Classic CTD	Eps units (see above)
2.		
3.		
4.		
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

Later

5. Post-cruise sampling analyses and dead-lines

At least 2 years after the cruise

6. Data base organization (general cruise base and/or specific data base(s))

General cruise data base, and GEOTRACES data base of course!

7. References

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Lacan, F. and Jeandel, C., *2004. Geochemistry, Geophysics, and Geosystems, 5*, doi:10.1029/2004GC000742.
Lacan, F. and Jeandel, C., 2005. *Earth Planet. Sci. Lett., 232(3-4): 245-257.*
Piepgras, D. J., and G. J. Wasserburg (1983), *Journal of Geophysical Research*, 291 *88*, 5997-6006.
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8- Acknowledgements

We deeply thank the captain and the crew of the “Pourquoi Pas?” for their professional but also very kind help during the different CTD deployments. We also thank our chief scientists Geraldine Sarthou and Pascale Lherminier, who managed this pluri disciplinary and intensive cruise with serenity and happiness. We also thank our colleagues of “pont 3”: Maxi, Yi, Nolwenn and Virginie!

III.5.9. Dissolved REE analysis

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Résumé/Abstract:
Rare Earth Elements are a family of 14 elements that slightly differ from each other by their weight and their atomic radius. These differences induce a slightly different behaviour between the different REE in the physico-chemical reactions as dissolution/precipitation, adsorption/desorption and all processes involved in the dissolved/particle exchange. REE are therefore a good tracer of the dissolved/particle exchange; they also help to constrain the "apparent ageing" of the water masses: when the later encounter clouds of particles, this is quickly imprinted in their REE patterns. In the framework of GEOVIDE, we collected 175 samples (V= 500 ml) of filtered seawater and 25 samples of unfiltered one in order to determine the dissolved and sometimes "total REE" concentrations in the seawater. Comparison of these dissolved data with the suspended particle ones (see the PREE file) will help to constrain dissolve/particulate exchanges.

1. **Scientific context (1/2 page max.)**

Dissolved REE sampling and analyses are integrated in the general scientific framework of GEOVIDE. GEOVIDE realized an integrated oceanographic transect (May 15th-June 30th) in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. GEOVIDE will also allow determining a variety of sources and sinks that influence the distribution of TEIs –among them the REE- in this area. Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated.

2. **Overview of the project and objectives (1/2 page max.)**

In this general framework, dissolved REE were collected as often as possible in order to 1) map their distribution and their physical and chemical speciation along a full-depth ocean section 2) Characterize their sources and sinks and quantify their fluxes at the ocean boundaries 3) investigate the link between the REE and the production, export and remineralisation of particulate organic matter

3. **Methodology and sampling strategy (2 pages max.)**

For dissolved REE concentration analyses, 10 L of seawater collected from Niskin bottles at each SUPER stations, X-Large stations and at some large stations in order to ensure the best vertical and horizontal resolutions, and to characterize the water masses as precisely as possible. Samples were immediately filtered onboard in polycarbonate cylinders under pressured clean air (Nuclepore membrane, 47mm 0.4µm). Aliquotes of 500 ml bottles for REE measurements were acidified to pH = 1.5 with twice-distilled HCl. The samples were stored at room temperature and then transferred to the laboratory on land (LEGOS, Toulouse, France).

Planned analytical procedure *(Could be modified later):* The purification and preconcentration of REE will be performed following the methods published by Tachikawa et al. 1999; Lacan and Jeandel 2001. Briefly, the acidified seawater samples will be spiked with ^{150}Nd and ^{172}Yb. Then 2.5 mg Fe (dissolved $FeCl_3$) will be added. After isotopic equilibration for at least 48 hours, the pH will be increased to 7 – 8 by addition of NH_4OH, yielding REE-Fe(OH)3 co-precipitation. The precipitate will be then extracted by centrifugation and rinsed 3 times with deionized water. An anion exchange column will be used to purify the REE from the remaining matrix. Dissolved Rare Earth Element concentrations will be then measured by High ResolutionInductively Coupled Plasma Mass Spectrometers (ICP-MS) using an Element-XR (using Aridus desolvation introduction system). All the REEs will be determined by the external standard method, whereas Nd and Yb are additionally determined by isotopic dilution. The values obtained for Nd and Yb concentrations by both methods enable us to determine the analytical recovery yields of these two elements in each sample, which ranges are: 88-96% and 83-94% for Nd and Yb, respectively. Efficiencies of the chemical protocol for the other REE are calculated by linear interpolation. Potential sensibility variations during the measurement session are monitored by In/Re internal standard method so that the final REE concentrations are corrected accordingly.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1.Dissolved Rare Earth Elements	Classic CTD	pmol/kg
2.		
3.		
4.		
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.) *After having measured the samples*
5. Post-cruise sampling analyses and dead-lines *At least 2 years after the cruise*
6. Data base organization (general cruise base and/or specific data base(s))

General cruise data base, and GEOTRACES data base of course!

References

Tachikawa K., Jeandel C. and Roy-Barman M., 1999. A new approach to the Nd residence time in the ocean: the role of atmospheric inputs. Earth Planet. Sci. Lett. 170, 433-446.

Lacan, F. and Jeandel, C., 2001. Earth Planet. Sci. Lett., 5779: 1-16.

8- Acknowledgements

We deeply thank the captain and the crew of the “Pourquoi Pas?” for their professional but also very kind help during the different CTD deployments. We also thank our chief scientists Geraldine Sarthou and Pascale Lherminier, who managed this pluri disciplinary and intensive cruise with serenity, constant positive mood and happiness. We also thank our colleagues of “pont 3”: Maxi, Yi, Nolwenn and Virginie!

III.5.10. Particulate Nd isotopes

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Résumé/Abstract:
Among the REE elements, Nd is characterized by 7 isotopes. “Nd isotopic composition” refers to the very precise analysis of the $^{143}Nd/^{144}Nd$ ratio. The variation of this ratio is a good tracer of 1) the sources of chemical element to the water masses at the ocean boundaries and 2) particulate/dissolved exchange and 3) trajectory and history of the water masses.
A good understanding and application of Nd isotope as tracer requires to measure its particulate distribution as often as possible and to compare the results to the dissolved one (see “Dissolved Nd isotope file”)
In the framework of GEOVIDE, we filtered large volumes of seawater using in-situ pumps (details in the ISP file). After aliquoting for trace metal and REE concentration analyses, precleaned Supor membranes (0,8µm porosity) will be dedicated to the particulate radionuclides, Pa/Th and Nd isotope analyses, when filtered volume will allow it.

1. Scientific context (1/2 page max.)

Particulate Nd isotopes sampling and analyses are integrated in the general scientific framework of GEOVIDE. GEOVIDE realized an integrated oceanographic transect (may 15th-June 30th) in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. GEOVIDE will also allow determining a variety of sources and sinks that influence the distribution of tracers (as Nd isotopes) in this area. Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated.

2. Overview of the project and objectives (1/2 page max.)

The oceanic waters are strongly suspected to acquire their Nd concentration and isotopic signatures at the continent/ocean interface, mostly through a significant exchange of Nd between water masses and the margin along which they flow. This isotopic signature reflects the abundance variation of ^{143}Nd isotope.

It is commonly expressed as $\varepsilon_{Nd} = \left(\frac{\left(\frac{^{143}Nd}{^{144}Nd}\right)_{Sample}}{\left(\frac{^{143}Nd}{^{144}Nd}\right)_{CHUR}} - 1 \right) \times 10^4$ where “CHUR” is a reference, representing the average 143Nd/144Nd earth value. The continental margins surrounding the world ocean display different isotopic signature, mostly reflecting their different geological origin and story: from margins covered by old granitic sediments with a low $^{143}Nd/^{144}Nd$ ratios (i.e. negative εNd values as Greenland for ex.) to the volcanic ones, with high $^{143}Nd/^{144}Nd$ ratios (εNd values positive or close to 0 as Iceland for ex.). This property allows the quantification of the fraction of weathered material that dissolves at the continent/ocean interface (Lacan and Jeandel, 2005; Arsouze et al, 2009). Once water masses have acquired their Nd isotopic composition in a specific area, Nd isotopes behave quasi conservatively and can be

assimilated to a “color” used to trace the pathways of the water masses (Piegras and Wasserburg, 1983; Jeandel, 1993; Lacan and Jeandel, 2004) Nd isotopes have already been measured in the Norvegian, Greenland seas and Denmark and Iceland-Scotland overflows in the framework of F. Lacan and recent M. Lambelet theses. However, no particle were measured during this thesis. In addition, regional modeling coupling NATL4 and Nd isotopes (Arsouze et al, 2010) revealed that important pieces of the puzzle are missing to establish 1) a precise characterization of how the water masses composing the NADW are acquiring their Nd signature (mostly the LSW, ISOW) and their further evolution before composing the core of the NADW; 2) an understanding of the impact of Reykjanes ridge on values of the water recirculating in the Irminger gyre 3) an extensive characterization of the water in the North East Atlantic waters. Owing to the importance of the Nd parameters as “tags” of the thermohaline circulation, as imprinted for example in the deep water corals, solving these issues is essential. In addition, close analyses of the dissolved/particulate exchange - conducted with that dedicated to the Fe speciation at the particle surface- will allow understanding better the processes yielding the release of REE at the sediment/water (or particle/water) interface

In this goal, dissolved Nd isotopes were collected as often as possible in order to 1) map their distribution and their physical and chemical speciation along a full-depth ocean section 2) characterize their sources and sinks and quantify their fluxes at the ocean boundaries 3) investigate the link between the isotope transport and the production, export and remineralisation of particulate organic matter

3. Methodology and sampling strategy (2 pages max.)

For particulate Nd isotope analyses, ~147 aliquots of the SUPOR filters that were mounted on the ISP pumps (refer to the ISP file synthesis) have been dried and stored. Back to the laboratory, the filter will be acid digested and Nd isotopes will be extracted from the acid solution following a procedure based on reverse liquid chromatography and then isotopic ratios are measured using a mass spectrometer. Details are given in Lacan and Jeandel (2001)

Units:

The isotopic neodymium composition (ε_{Nd}) corresponds to the $^{143}Nd/^{144}Nd$ ratio (no units) defined by:

$\varepsilon_{Nd} = ([(^{143}Nd/^{144}Nd)_{sample}/(^{143}Nd/^{144}Nd)_{CHUR}]-1)*10000$,

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1.Particulate Nd isotopes	ISP	Eps units (see above)
2.		
3.		
4.		
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

Not before having analysed the samples

5. Post-cruise sampling analyses and dead-lines

At least 2-3 years after the cruise

6. Data base organization (general cruise base and/or specific data base(s))

General cruise data base, and GEOTRACES data base of course!

7. References

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8- Acknowledgements

We deeply thank the captain and the crew of the “Pourquoi Pas?” for their professional and very kind help during the different CTD and ISP deployments. We also thank our chief scientists Geraldine Sarthou and Pascale Lherminier, who managed this pluri disciplinary and intensive cruise with serenity and happiness. Special warm thanks to Emmanuel de Saint Léger and Fabien Pérault, the “always ready team of la DT INSU” , for the tedious ISP deployments. We finally thank our night and day colleagues of “pont 3”: Maxi, Yi, Nolwenn and Virginie!

III.5.11. Particulate REE analysis

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Résumé/Abstract:
Rare Earth Elements are a family of 14 elements that slightly differ from each other by their weight and their atomic radius. These differences induce a slightly different behaviour between the different REE in the physico-chemical reactions as dissolution/precipitation, adsorption/desorption and all processes involved in the dissolved/particle exchange. REE are therefore a good tracer of the dissolved/particle exchange; they also help to constrain the "apparent ageing" of the water masses: when the later encounter clouds of particles, this is quickly imprinted in their REE patterns. To this extent, it's important to compare the dissolved REE distribution to their particulate one. In the framework of GEOVIDE, we filtered 175 samples of 10 l of seawater in order to determine the REE concentrations on the Nuclepore membranes. Comparison of these particulate data with the dissolved particle ones (see the DREE file) will help to constrain dissolve/particulate exchanges.

1. **Scientific context (1/2 page max.)**

Particulate REE sampling and analyses (together with the dissolved ones) are integrated in the general scientific framework of GEOVIDE. GEOVIDE realized an integrated oceanographic transect in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. GEOVIDEg oal is also to determine a variety of sources and sinks that influence the distribution of TEIs –including REE- in this area. Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated.

2. **Overview of the project and objectives (1/2 page max.)**

In this general framework, dissolved REE were collected as often as possible in order to 1) map their distribution and their physical and chemical speciation along a full-depth ocean section 2) Characterize their sources and sinks and quantify their fluxes at the ocean boundaries 3) investigate the link between the REE and the production, export and remineralisation of particulate organic matter

3. **Methodology and sampling strategy (2 pages max.)**

For particulate REE concentration analyses, 10 L of seawater collected from Niskin bottles at each SUPER stations, X-Large stations and at some large stations in order to ensure the best vertical and horizontal resolution, and to characterize the water masses as good as possible. Samples were immediately filtered onboard in polycarbonate cylinders under pressured clean air (Nuclepore membrane, 47mm 0.4µm). The solid material collected on the membranes will be dedicated to particulate REE analysis, together with complementary tracers (Al, Baxs etc…) and SEM observation.

Planned analytical procedure*:* Back to the laboratory, the filter will be acid digested and REE will be extracted from the acid solution following a procedure based on reverse liquid chromatography and then isotopic ratios are measured using a mass spectrometer. The purification and preconcentration of REE will be performed following the methods published by Tachikawa et al. 1999; Lacan and Jeandel 2001. An anion exchange column will be used to purify the REE from the remaining matrix. Dissolved Rare Earth Element concentrations will be then measured by High Resolution Inductively Coupled Plasma Mass Spectrometers (ICP-MS) using an Element-XR (using Aridus desolvation introduction system).All the REEs will be determined by the external standard method. Potential sensibility variations during the measurement session are monitored by In/Re internal standard method so that the final REE concentrations are corrected accordingly.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1.Particulate Rare Earth Elements	Classic CTD	pmol/kg
2.		
3.		
4.		
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

Not before having analysed the samples

5. Post-cruise sampling analyses and dead-lines

At least 2-3 years after the cruise

6. Data base organization (general cruise base and/or specific data base(s))

General cruise data base, and GEOTRACES data base of course!

7. References

Tachikawa K., Jeandel C. and Roy-Barman M., 1999. A new approach to the Nd residence time in the ocean: the role of atmospheric inputs. Earth Planet. Sci. Lett. 170, 433-446.

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8- Acknowledgements

We deeply thank the captain and the crew of the “Pourquoi Pas?” for their professional but also very kind help during the different CTD deployments. We also thank our chief scientists Geraldine Sarthou and Pascale Lherminier, who managed this pluri disciplinary and intensive cruise with serenity and constant positive mood and happiness. We also thank our colleagues of “pont 3”: Maxi, Yi, Nolwenn and Virginie!

III.5.12. Particulate Trace Metals (Al, Ba, P, Ca, Ti, V, Cr, Zn, Y, Mo, Fe, Cu, Mn, Co, Ni, Cd, and Pb) during the GEOVIDE cruise

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Résumé/Abstract:
L'objectif de ce travail est d'apporter de nouveaux éclairages sur les métaux traces contenus dans les particules marines en suspension, à la fois en termes de composition, de sources, de distribution mais aussi de biodisponibilité. Les échantillons prélevés pendant la campagne GEOVIDE nous permettront d'étudier la composition en éléments traces de la phase particulaire dans des fractions de tailles différentes (0.45-5µm ; >5 µm). Ces résultats permettront d'évaluer les sources et les flux des éléments traces et contribueront à une meilleure appréhension des mécanismes d'échanges entre les compartiments dissous et particulaire qui restent pour le moment à élucider. Ces données pourront également être implémentées dans des modèles couplés physique-biogéochimie. Ce projet se concentrera essentiellement sur les éléments clés identifiés par le programme international GEOTRACES (Comité scientifique pour les recherches océaniques du Groupe de travail 2007) du programme: notamment l'aluminium, le manganèse, le fer, le cobalt, le cuivre, le zinc, le cadmium, ainsi que le phosphore et le barium.

The main objective of this work is to provide new insights on the trace elements contained in marine suspended particulate matter. Samples collected during the GEOVIDE cruise will allow the study of the trace element composition of the suspended particles in different size fractions (0.45-5µm,> 5 µm). These results will also allow to assess the sources and fluxes of trace elements and their bioavailability. Overall this will contribute to a better understanding of exchanges between the dissolved and particulate compartments that are yet to elucidate. These data will also be implemented in physical-biogeochemical coupled models. This project will mainly focus on the key elements identified by the International GEOTRACES program (Scientific Committee on Oceanic Research Working Group 2007) program including aluminum, manganese, iron, cobalt, copper, zinc , cadmium, and phosphorous and barium.

1. Scientific context

Trace elements and their isotopes (TEIs) play a crucial role in the ocean. They are also very complex to study as they have multiple sources and are present in operationally defined colloidal (5 kDa–0.2 µm), dissolved (< 0.2-0.45 µm) and particulate (>0.2-0.45 µm) phases.
Sources and concentrations of particulate TM vary greatly among oceanic basins. Particles can be of atmospheric origin (e.g. Jickells et al., 2005), of riverine origin and can be laterally transported over large distances (e.g. Lam et al., 2006; 2012), hydrothermal (e.g. Tagliabue et al., 2010), sedimentary (e.g. Kalnejais et al., 2007), icebergs (e.g. Raiswell et al., 2008), sea-ice melting (e.g. Lannuzel et al., 2011), and finally, of living and non living biogenic origin. In the water column, ***myriad physical and biological processes exert major influences on TM spatial distribution and evolution***, creating chemical gradients in the ocean.
Studying the suspended particulate trace element distribution can therefore provide information on their sources, adsorptive scavenging processes through the water column, deep-water or shelf-water mixing, boundary exchange processes, and will give clues on phytoplankton micronutrient status . Elemental ratios or spatial distribution (Planquette et al., 2013) are among useful tools for tracing trace metals sources and sinks.

2. Overview of the project and objectives

During GEOVIDE, we aimed to a ***simultaneous quantification and distribution of both dissolved and particulate species*** as interactions between these species control the oceanic distribution of trace elements in seawater. Our main objective is to study the distributions, sources and internal cycle of trace metals (mainly Fe, Mn, Cu, Co, Ni, Zn, Cd and Pb), focusing on the particulate phase.

3. Methodology and sampling strategy

Seawater were collected using a Trace Metal Clean Rosette (TMR, General Oceanics Inc. Model 1018 Intelligent Rosette), attached to a 6 mm Kevlar line. After collection, Go-Flo bottles were transferred into a clean container for sampling, and filters processed under a laminar flow unit.
On each TMR cast, nutrient and/or salinity samples were taken to check potential leakage of the Go-Flo bottles.
At each depth, two size fractions will be investigated: **0.45- 5 µm** (in order to catch small picoplankton and clays; using a polysulfone filter (Supor®)); **>5 µm** (using a mixed ester cellulose filter MF). Nearly all filters were 25 mm diameter in order to optimize signal over filter blank except in surface where we used 47mm diameter filters.
Additional samples were taken from in-situ pumps (please report to this section of the cruise report)
All filters will be digested and analyzed back in LEMAR by HR-ICP-MS following Planquette and Sherrell (2012) method. Acetic acid leaches (Berger et al., 2008) will also be undertaken in order to assess the biovailable fraction. A subset of samples will also be dedicated for SEM imaging.

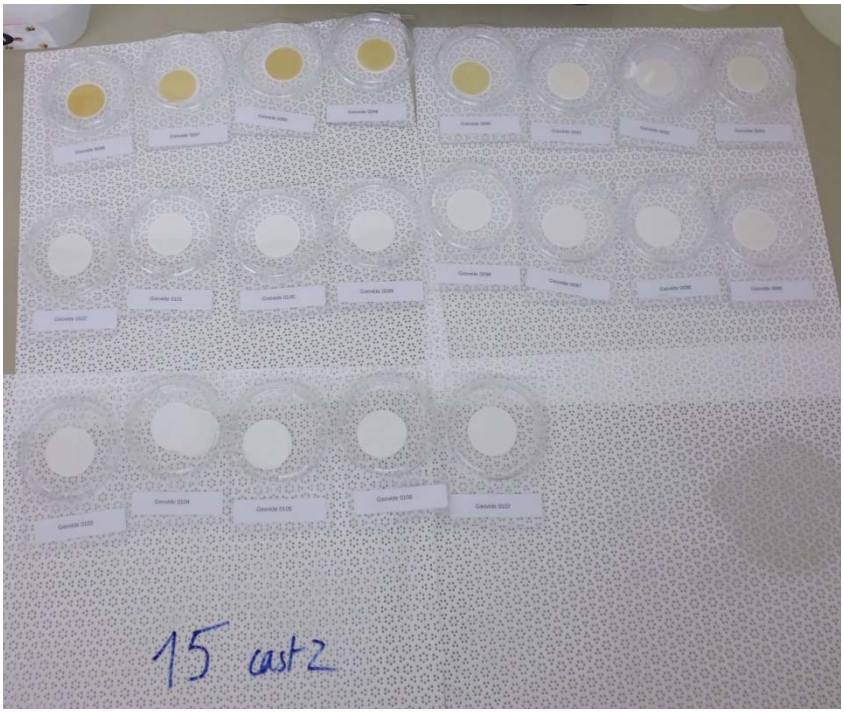
Table 1: stations summary for particulate TE

Summary of sampling:	**31** Stations (10 Super; 5 Xlarge; 16 Large) **546** depths **1093** filters Size Fractions : Supor 0.45 µm; Millipore 5µm; * Polycarbonate 10 µm

Volume of seawater filtered (L):	**4293**

Station	Type of station	number of depths	Number of Size fractions per depth	Elements to be measured
1	Sp	24	2	
2	XL	7	2	
11	L	19	2	
13	Sp	22	2	
15	L	21	2	
17	L	22	2	
19	L	21	2	
21	Sp	22	2	
23	L	20	2	
25	L	22	2	
26	XL	22	2	
29	L	22	2	
32	Sp	22	2	
34	L	22	2	
36	L	11	2	
38	Sp	18	2; 3* on one depth	**Al, Ba, P, Ca, Ti, V, Cr, Zn, Y,Mo, Fe, Cu, Mn, Co, Ni, Cd, Pb**
40	L	11	2	
42	L	22	2	
44	Sp	22	2	
49	L	22	2	
53	XL	6	2	
56	L	7	2	
60	Sp	22	2	
61	XL	6	2	
63	L	11	2	
64	Sp	22	2	
68	L	12	2	
69	Sp	20	2	
71	L	20	2	
77	Sp	20	2	
78	XL	6	2	
31		546	1093	total

Figure 1: example of filters collected at one station



4. Post-cruise sampling analyses and dead-lines

The analyses of all the parameters should be completed within the next 18-24 months, and will involve the recruitment of one postdoctoral researcher (grant ANR BITMAP, PI H.Planquette).

5. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

6. References

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This work was funded by the ANR RPDOC BITMAP and ANR BLANC GEOVIDE, IFREMER, CNRS-INSU (programme LEFE), and LabEX MER. For the logistics: DT-INSU, IFREMER and GENAVIR.

III.5.13. Radium isotopes (^{226}Ra, ^{228}Ra) and Actinium (^{227}Ac)

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Résumé/Abstract:
Radium isotopes (^{226}Ra, ^{228}Ra) and Actinium (^{227}Ac) are produced in the sediments and rapidly diffuse to the water column. Thus, water mass that entered in contact with sediments are enriched in radium and actinium. The activities decrease with the increasing distance from the source, as a result of dilution and radioactive decay. Ra isotopes and Ac can thus be used as tracers of water masses (advection), as chronometer of their transit times. They mostly provide information on both horizontal and vertical mixing in the ocean.

1. Scientific context

Natural radionuclides have been widely used as geochemical tracers to study the oceanic circulation and mixing. Among these radionuclides, radium isotopes (^{226}Ra, $T_{1/2}$=1600 y; ^{228}Ra, $T_{1/2}$=5.75 y) and actinium-227 (^{227}Ac, $T_{1/2}$=21.77 y) display different half lives that allow us to chronometer processes at various space and time scales. Radium isotopes and ^{227}Ac are supplied to the ocean by diffusion from deep-sea and continental shelf sediments. Therefore, water masses that enter in contact with the margin sediments are enriched in Ra and Ac. The Ra activity of the water mass then decreases with increasing distance from the source, as a result of dilution (mixing) and radioactive decay (Moore, 2000). Ra isotopes and ^{227}Ac can thus be used as tracers of water masses (advection), to chronometer the transit times of these water masses and to provide information on both horizontal and vertical mixing in the ocean (van Beek et al., 2008; Charette et al., 2007; Kaufman et al., 1973).

2. Overview of the project and objectives (1/2 page max.)

In this general framework, dissolved natural radionuclides were collected as often as possible in order to 1) map their distributions in the North Atlantic and to trace the interactions with the continental margins (^{228}Ra) 2) trace deep water formation e.g. North Atlantic Deep Water and Labrador Sea Water (^{226}Ra, ^{226}Ra/Ba) and 3) study the variability of the mixing from deep sediments (^{228}Ra, ^{227}Ac). Particulate natural radionuclides were collected in order to 1) study the dynamic of the particles in the water column and 2) estimate the settling velocity of suspended particle.

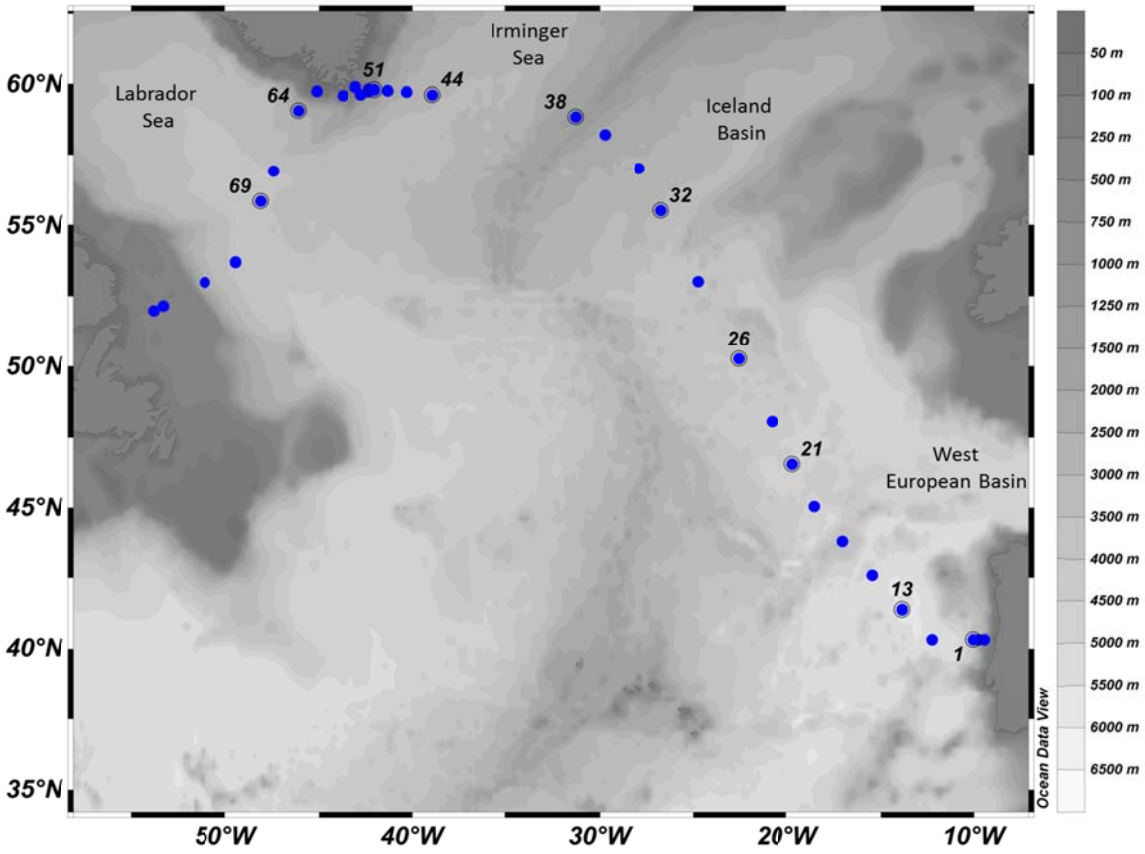
3. Methodology and sampling strategy (2 pages max.)

Large-volume samples are needed to analyse natural radionuclide in the dissolved and in the particulate phases. Particulate radionuclides were collected using the in-situ pumps (cf. in-situ pump file). Filters will be analysed using low-background gamma spectrometers at the LAFARA underground laboratory located in the French Pyrénées (van Beek et al., 2010, 2013). Acrylic cartridges impregnated with MnO_2 were also deployed on the in-situ pumps (after the filtering system) in order to collect the dissolved ^{228}Ra, ^{226}Ra and ^{227}Ac. Other radionuclides such as ^{210}Pb, ^{228}Th, ^{7}Be, also be retained in the Mn cartridges, will be measured using the gamma spectrometers. Smaller (ca 10l) seawater volumes were collected from Niskin bottles to determine the efficiencies of fixation of ^{226}Ra on the Mn cartridges. The ^{228}Ra activities will be deduced using the $^{228}Ra/^{226}Ra$ ratios measured on the cartridges. The efficiencies of fixation of the other natural radionuclides as ^{7}Be will be obtained in collaboration with Maxi Castrillejo and Peré Masqué from UAB (cf. beryllium file). Large seawater volumes were collected underway in surface using the ship intake. Mn-fibers will be analysed once back to the laboratory using gamma spectrometers.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1. ^{226}Ra	Classic CTD	dpm/ 100 kg
2. ^{228}Ra	Classic CTD	dpm/ 100 kg
3. ^{227}Ac	Classic CTD	dpm/ m^{-3}

* Classic CTD, ISP, TMR, NET, CORER, FISH



Locations of stations where samples were collected. The station numbers where Mn cartridges were deployed on *in-situ* pumps are indicated.

		Source					
		Ship intake		CTD		ISP	
Type	Station #	^{226}Ra	^{228}Ra	^{226}Ra	^{228}Ra	^{226}Ra	^{228}Ra
Super	1	x	x	x		x	x
Xlarge	2	x	x				
Large	4	x	x				
Large	11	x	x				
Super	13	x	x	x		x	x
Large	15	x	x				
Large	17	x	x				
Large	19	x	x				
Super	21	x	x	x		x	x
Large	23	x	x				
Xlarge	26	x	x	x		x	x
Large	29	x	x				
Super	32	x	x	x		x	x
Large	34	x	x				
Large	36	x	x				
Super	38	x	x	x		x	x
Super	44	x	x	x		x	x
Underway	47b	x	x				
Large	49	x	x				
Super	51	x	x	x		x	x
Xlarge	53	x	x	x			
Large	60			x			
Underway	60b	x	x				
Underway	60c	x	x				
Xlarge	61	x	x	x			
Super	64	x	x	x		x	x
Large	68	x	x				
Super	69	x	x	x		x	x
Super	77	x	x	x		x	x
Xlarge	78	x	x	x			

4. Preliminary results (2 pages max.)

Latter

5. Post-cruise sampling analyses and dead-lines

Analyses conducted with the low-background gamma spectrometers will be performed right away once back to the laboratory

6. Data base organization (general cruise base and/or specific data base(s))

No specific comment

7. References

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III.5.14. Surface export and remineralization

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Abstract:
The work focuses on the assessment of the surface export flux of particles and associated the remineralization of exported matter in the subsurface, mesopelagic waters along the GEOVIDE transect in the North-Atlantic. Two main proxy-tools are used: (1) the ^{234}Th-deficit method to assess the export flux of biogenic elements (C, N, BSi and trace elements) and (2) The build-up of the biogenic particulate Ba stock in subsurface waters to assess remineralization. Sampling strategy consisted in resolving as much as possible the features in the upper 1000m of water column. In addition ^{234}Th activity ($t_{1/2}$ 24.1 days) was measured on size-fractionated particles (1-53 µm, >53 µm) to identify the POC/^{234}Th, PON/^{234}Th, BSi/^{234}Th, ETMs/^{234}Th (ETMs: Fe, Mn, Al, Cu, Co, Zn, Ba, P, Y, Cd, Ti, V, Ni, Ca, Mo) ratios of those particles most likely responsible for the export flux. While samples for biogenic Ba were saved for analysis later, beta-activity of the short-lived ^{234}Th isotope was measured directly on board for all samples, but final results await corrections for background activity and recovery, which can only be carried out after 6 to 7 ^{234}Th decay periods (~6 months).

1. Scientific context (1/2 page max.)

GEOVIDE proposes to undertake an integrated oceanographic transect in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. GEOVIDE will also allow determining a variety of sources and sinks that influence the distribution of TEIs in this area.

Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated. Another main objective is to investigate the link between the TEIs, and the production, export and remineralisation of particulate organic matter. To finish, GEOVIDE will allow understanding and quantifing the paleoproxies 231Pa/230Th, εNd and δ30Si.

2. Overview of the project and objectives (1/2 page max.)

This project is totally included in one of the main objective of GEOVIDE: the production, export and remineralisation of particulate organic matter. Fluxes of POC, PON, BSi, and TE will be determined.

3. Methodology and sampling strategy

Naturally occurring ^{234}Th is the decay product of ^{238}U, which is conservatively distributed in open ocean and proportional to salinity. Unlike ^{238}U, ^{234}Th has a strong affinity for particulate matter and its activity distribution through the water column offers a means for quantifying fluxes and aggregation/disaggregation rates of particles on a regional and seasonal scale (Buesseler et al., 1992). Beta-activity of the short-lived ^{234}Th isotope was measured directly on board in small-volume (4 L) seawater samples and in size-fractionated particles collected by large volume in-situ pumping systems (ISP). Total ^{234}Th activity profiles will be used to assess vertical export of ^{234}Th. Using the elements (C, N, BSi, and TE) to ^{234}Th ratio of large "potentially sinking" particles, the ^{234}Th flux can then be converted into export fluxes of elements.

Profiles of particulate biogenic Ba (Ba_{xs}) in the open ocean generally display a maximum in the upper mesopelagic (~ 150 – 500m) (Jacquet et al. 2008; Dehairs et al., 2008). This Ba_{xs} is mostly present as microcrystalline barite ($BaSO_4$), which forms inside oversaturated micro-environments, mostly aggregates of organic material where bacterial activity is intense. When these particles are remineralized in the mesopelagic zone, barites are spread over the water layer and Ba_{xs} content can be related to carbon remineralization activity. The time-scale involved in this process integrates a period of a few weeks (cf. Baxs file).

Sampling strategy consisted in resolving as much as possible the features in the upper 1000m of water column. Samples were obtained at 10 Super and 2 XLarge stations, combined profiles of ^{234}Th activity and Ba_{xs} were obtained from seawater samples collected from the surface to 1500 m depth. Particulate ^{234}Th activity was measured on size-fractionated samples obtained with large volume in-situ pumps. Two size fractions (1-53 µm and >53 µm) were considered and were subsampled to allow the determination of POC, PON, BSi and ETMs (Fe, Mn, Al, Cu, Co, Zn, Ba, P, Y, Cd, Ti, V, Ni, Ca, Mo) concentrations. Punches on QMA membranes (1-53µm) were obtained for POC and PON, and Supor membranes (1-53µm) were used for ETMs and BSi. Petex membranes (>53µm) were divided and particles were resuspended using filtered seawater on 25 mm Ag, GFF, PC, and Supor filters.

4. Post-cruise sampling analyses and dead-lines

The analyses will be completed after a delay of six months in order to measure residual beta activity. The elemental analysis will start in 2015 and will be completed within 1-2 years.

5. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

Acknowledgements

We would like to thank the crew of the R.V. Pourquoi Pas?, for their great help during the operations. We acknowledge the Co-Chief Scientists Pascale Lherminier and Géraldine Sarthou. This work was funded by the ANR Blanc (ANR-13-BS06-0014), IFREMER, CNRS-INSU (programme LEFE), and LabEX MER. For the logistics: DT-INSU, IFREMER and GENAVIR.

III.5.15. Particulate Barite (Baxs)

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Abstract:
This work focuses on the assessment of the remineralisation flux of exported matter particles within the subsurface and mesopelagic waters. To this aim, we are using the build-up of the biogenic particulate Ba stock in subsurface waters to assess remineralisation. Sampling strategy consisted in resolving as much as possible the features in the upper 1000m of water column.
Samples for biogenic Ba were saved for analysis back in the lablab.

1. Scientific context (1/2 page max.)

Particulate Barite sampling and analyses are integrated in the general scientific framework of GEOVIDE. GEOVIDE proposes to undertake an integrated oceanographic transect in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. GEOVIDE will also allow determining a variety of sources and sinks that influence the distribution of TEIs in this area. Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated. Another main objective is to investigate the link between the TEIs, and the production, export and remineralisation of particulate organic matter

2. Overview of the project and objectives (1/2 page max.)

This project is totally included in one of the main objective of GEOVIDE: the remineralisation of particulate organic matter will allow determining real fluxes of different chemical elements.

3. Methodology and sampling strategy

Profiles of particulate biogenic Ba (Baxs) in the open ocean generally display a maximum in the upper mesopelagic (~ 150 – 500m) (Jacquet *et al.* 2008; Dehairs *et al.*, 2008). This Baxs

is mostly present as microcrystalline barite (BaSO4), which forms inside oversaturated microenvironments, mostly aggregates of organic material where bacterial activity is intense. When these particles are remineralized in the mesopelagic zone, barites are spread over the water layer and Baxs content can be related to carbon remineralization activity. The time-scale involved in this process integrates a period of a few weeks.
5-10L of seawater were filtered onto 0.4 µm polycarbonate membranes (ø 47mm) using Perspex filtration under slight overpressure of filtered air (0.4µm). Membranes were rinsed with a few mL of Milli-Q water to remove most of the sea salt, dried under the hood and stored in plastic Petri dishes. Filtration blanks were also performed. In the home-based laboratory particles will be digested with a tri-acid mixture (1.5 ml HCl 30%, 1.0 ml HNO3 65% and 0.5ml HF 40%, all Suprapur grade) in closed teflon beakers overnight at 90°C (Cardinal *et al.*, 2001; 2005). Samples are evaporated close to dryness and redissolved into ~13ml of HNO3 2%. These solutions are analyzed by ICP-MS (Thermo). Ba, Na and Al contents are analyzed simultaneously. Calibration curves made by analyzing certified standards of diverse origins to check that matrix effect, if present, is adequately corrected by internal standards (99Ru, 115In, 187Re, 209Bi). The standards used for calibration are dilute acid-digested rocks (e.g. BHVO-1, GA, SGR-1), natural water (SLRS-4) and multi-element artificial solutions.

Table: **Exhaustive** list of sampling

Type of station	Station #	Number of samples
Super	1	18
Super	13	18
Super	21	18
Xlarge	26	10
Super	32	18
Super	38	18
Super	44	18
XLarge	53	8
Super	60	18
Super	64	18
Super, Crossover	69	20
Super	77	18

4. Post-cruise sampling analyses and dead-lines

The analyses will be completed within the year

5. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

6. References

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Acknowledgements

We would like to thank the crew of the R.V. Pourquoi Pas?, for their great help during the operations. We acknowledge the Co-Chief Scientists Pascale Lherminier and Géraldine Sarthou. This work was funded by the ANR Blanc (ANR-13-BS06-0014), IFREMER, CNRS-INSU (programme LEFE), and LabEX MER. For the logistics: DT-INSU, IFREMER and GENAVIR.

III.5.16. Silicon isotopes ($\delta^{30}Si$)

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1. Scientific context (1/2 page max.)

Proxies of nutrient utilization, such as the silicon stable isotopic composition ($\delta^{30}Si$) of diatom silica, provide a means of reconstructing the behavior of past geochemical cycles and the past strength of the biological pump and its influence on atmospheric concentrations of CO_2. They do this by recording the extent to which upwelled nutrients (in this case dissolved silicon, also known as silicic acid, or DSi) were consumed during primary production (or in this case, biogenic silica production), with CO_2 being converted into particulate organic matter at the same time.

Successful use of the $\delta^{30}Si$ of diatoms accumulating in sediments for reconstruction of past silica cycling, however, requires a reasonable understanding of the $\delta^{30}Si$ of DSi throughout the ocean and the processes that control its distribution. Work in the laboratory has confirmed that silicon isotopes are fractionated during biogenic silica production (De La Rocha et al., 1997; De La Rocha 2003; Milligan et al., 2004) and revealed that the isotopes are also fractionated during biogenic silica dissolution (Demarest et al., 2009). Work in the Southern Ocean (De La Rocha et al., 2000; De La Rocha et al., 2011; Fripiat et al., 2011) and North and Equatorial Pacific (De La Rocha et al., 2000) and with a global circulation model (Wischmeyer et al., 2003) has revealed the role that ocean circulation and biogeochemical cycling play together in concert with fractionation to control the distribution of silicon isotopes within the ocean.

Largely missing from this dataset, however, is the North Atlantic. Aside from a handful of data from the Bermuda Atlantic Time-series and a profile taken off the eastern seaboard of North America (De La Rocha et al., 2000), the only data we have concerning Si isotopes in the Atlantic come from the Atlantic Sector of the Southern Ocean (De La Rocha et al., 2011).

2. Overview of the project and objectives (1/2 page max.)

Measurement of $\delta^{30}Si$ during the OVIDE cruise will allow us to map the $\delta^{30}Si$ of key water masses in the North Atlantic. It will also allow us to know the extent of the seasonal increase in $\delta^{30}Si$ of DSi in surface waters of the North Atlantic due to biogenic silica production by diatoms.

3. Methodology and sampling strategy

Seawater samples were collected using the classical Rosette.

Samples for the silicon isotopic composition ($\delta^{30}Si$) of dissolved silicon (DSi) and biogenic silica (BSi) in seawater were filtered through 0.4 µm polycarbonate filters immediately upon collection. DSi in filtered seawater for the measurement of $\delta^{30}Si$ will be preconcentrated via co-precipitation with magnesium hydroxide (Cardinal et al., 2005; Reynolds et al., 2006) and purified via ion-exchange chromatography (Reynolds et al., 2006). Samples of BSi for $\delta^{30}Si$ measurements will be digested with a weak alkaline digestion and then also purified via ion-exchange chromatography. $\delta^{30}Si$ will be measured on purified aliquots using a Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) via Mg-correction of the mass bias and sample-standard-sample bracketing (Cardinal et al., 2003; De La Rocha et al., 2011).

Table: **Exhaustive** list of sampled parameters

Type of station	Station number	$\delta^{30}Si$ in the dissolved phase	$\delta^{30}Si$ in the particulate phase
Super station	1	x	x
Super station	13	x	x
Super station	21	x	x
XLarge station	26	x	x
Super station	32	x	x
Super station	44	x	x
Super station	60	x	x
Super station	64	x	x
Super station	69	x	x
Super station	75	x	x

Parameter	code of operation *	units
1. □^{30}Si in the dissolved phase	Classic CTD	Per mil
2. □^{30}Si in the particulate phase	Classic CTD	Per mil
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

None

5. Post-cruise sampling analyses and dead-lines

The analyses of all the parameters should be completed in the next 18-24 months.

6. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

7. References

Acknowledgements

We would like to thank the crew of the R.V. Pourquoi Pas?, for their great help during the Classic CTD operations. We acknowledge the Co-Chief Scientists Géraldine Sarthou and Pascale Lherminier.

This work was funded by the ANR Blanc (ANR-13-BS06-0014), IFREMER, CNRS-INSU (programme LEFE), and LabEX MER. For the logistics: DT-INSU, IFREMER and GENAVIR.

III.5.17. Trace and Major Elements in Aerosols and Rainwater

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Résumé/Abstract:
Dust supply impacts global climate ; directly, by altering atmospheric aerosol loading through the production of cloud condensation nuclei and radiative forcing, and indirectly, via the supply of trace elements to the surface ocean (Jickells et al. 2005; Mahowald et al, 2013). Primary production in the ocean is dominated by phytoplankton which remove carbon dioxide from the atmosphere via photosynthesis. Marine primary production accounts for ca. 50% of global photosynthesis (e.g. Falkowski and Raven, 2007). Thus, marine primary production helps moderate our climate, but in up to 40% of the global ocean production is limited by iron (Fe) (e.g. Boyd et al, 2007), which is primarily supplied via atmospheric deposition. Furthermore, there is strong evidence for Fe-limitation of nitrogen fixation (Turk et al., 2011), which also has implications for carbon export (Broecker and Henderson, 1998). In addition, there is growing evidence for (co-)limitation by other trace metals in marine systems (Saito et al., 2008). Yet only a fraction of the trace elements (TEs) associated with marine aerosols are soluble and, therefore, potentially available for uptake by primary producers, the drivers of the biological pump. Consequently, Fe solubility is a key parameter in many ecosystem and biogeochemical models. However, a large range of values are reported in the literature (0.01-90%; Aguilar-Islas et al, 2010). This is further compounded by the finding that the soluble percentage is not a uniform value either between or within ocean basins. Furthermore, the partitioning of Fe between the particulate, colloidal and soluble fractions is critical in determining bioavailability. Although there are exceptions, the soluble fraction is widely considered to be the most easily accessible by phytoplankton.
During the GEOVIDE cruise in the North Atlantic Ocean (17/5/14–30/6/14) aerosol and rainwater samples will be collected using a mass flow controlled, high-volume aerosol sampler and a rainwater collection system fabricated in-house in order to quantify aerosol fluxes to the study area. To compliment the LEMAR aerosol flux data, the UAB group will determine ^{7}Be in the aerosol samplers, and from their rainwater collection system. The ratios of TEs/^{7}Be will be used as an alternative technique to determine aerosol fluxes to the study region.

1. Scientific context (1/2 page max.)

By combining aerosol fluxes with water column and surface water TE data, carbon export fluxes, tracers of water mass movement, and organic speciation data (from the water column and aerosol dissolution experiments), it will be possible to close budgets and quantify residence times, greatly adding to existing knowledge of the complexity of the biological pump in the region that drives global ocean circulation.

2. Overview of the project and objectives (1/2 page max.)

The aim of this project is to collect aerosol data that will be used to estimate TE fluxes to the study area. Perhaps the largest source of error in aerosol deposition flux calculations is the choice of deposition velocity, which results in errors of up to a factor of 2-3 (Duce et al., 1991). In order to better constrain the deposition flux estimates, the use of ^{7}Be as a tracer of atmospheric deposition will be explored. The radioisotope, ^{7}Be, is formed in both the troposphere and the stratosphere, and rapidly adsorbs to aerosols. The ratio of ^{7}Be/TE will

be used to estimate TE deposition flux, and can also be used to indicate the appropriate deposition velocity (Landing et al., 2012).

In addition, solubility experiments will be conducted on return to the home laboratory. This data will be used to explore the relationship between aerosol source region (determined by air mass back trajectory simulations) and TE solubility.

3. Methodology and sampling strategy (2 pages max.)

Aerosols: Samples were collected using a mass flow controlled high volume aerosol sampler (model TE 5171, Tisch Environmental). The aerosol sampler was sector (± 60° from the bow) and wind speed (<0.9 m/s) controlled to minimise the risk of contamination from the ship's exhaust stack, using a anemometer and vane attached to a 3 m pole mounted on the railings near the aerosol sampler. The aerosol sampler was positioned on the forward railings (starboard side) on the flight deck above the bridge (~ 15 m above sea level). Twelve replicate samples were collected on 47 mm diameter W41 filter discs, which were positioned on a 12-position PVC adapter plate. Initially, aerosol samples represented 24 h integrations. However, during GEOVIDE the wind was predominantly from the north, and air mass back trajectory simulations, using the Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT; http://www.ready.noaa.gov/HYSPLIT.php), indicated little-to-no interaction with any major landmasses with the 5 days of the model simulation. Visual inspection of the filters on collection confirmed that the aerosol loading was extremely low. Therefore, the sampling duration was increased to 48 h deployments from 25/5/14.

On return to the home laboratory, samples will be digested to determine 'total TE' concentrations. Sequential leaches (0.45 um and 25% acetic acid; Buck et al., 2006 and Berger et al., 2008, respectively) will be conducted (on separate filters to the total digestions) to determine the fractional solubility of a suite of TEs, with the focus on iron. Aliquots will be taken from the leaches for the determination of major seawater anions (Cl^-, NO_3-, PO_4^-, SO_4^{2-}). Trace and major elements will be determined by ICP-MS, and seawater anions by ion chromatography (IC). This will yield results for many key bioactive elements (e.g. Fe, Cu, Zn), as well as tracers of pollution (e.g. Zn, Pb) and mineral dust inputs (e.g. Al, Ti).

Rain: Rain samples were collected on an event basis. The cover of the rain sampler was removed manually on commencement of a rain event, and replaced after the rain had stopped. The sample was immediately removed from the sampler and the sample bottle replaced with a new, clean bottle. Unfiltered and filtered samples will be analysed by ICP-MS for trace and major elements, and an aliquot taken from the unfiltered samples for major seawater anion determination by IC.

Table : **Exhaustive** list of measured parameters

Parameter	code of operation *	units
1.Aerosol trace & major elements	a = aerosols	ng of TE/m^3 air filtered
2.Aerosol anions	a = aerosols	µg of anion/m^3 air filtered
3.Rainwater trace & major elements	r = rainwater	µg of TE/L rainwater
4.Rainwater anions	r = rainwater	µg of TE/L rainwater
...		

* Classic CTD, ISP, TMR, NET, CORER, FISH

4. Preliminary results (2 pages max.)

- 18 aerosol samples were collected (12 x47 mm diameter W41 filter). Collaborators:
  - P. Masque (UAB) – ^7Be
  - V. Sanial/ C. Jeandel (LEGOS) – radioisotopes
  - L.-E. Heimberger (U. Bremen) – Hg
- 10 rain samples were collected
  - 10 unfiltered aliquots

- 3 filtered aliquots
- 10 frozen aliquots
- In addition, where volume allowed, subsamples were provided for Fe organic speciation (M. Cheize), total Hg (L.-E. Heimberger), radioisotopes (V. Sanial) and Fe isotopes (F. Lacan)

Air mass back trajectory simulations indicated a predominantly northerly origin, with occasionally a north-easterly trajectory (Fig. 1).

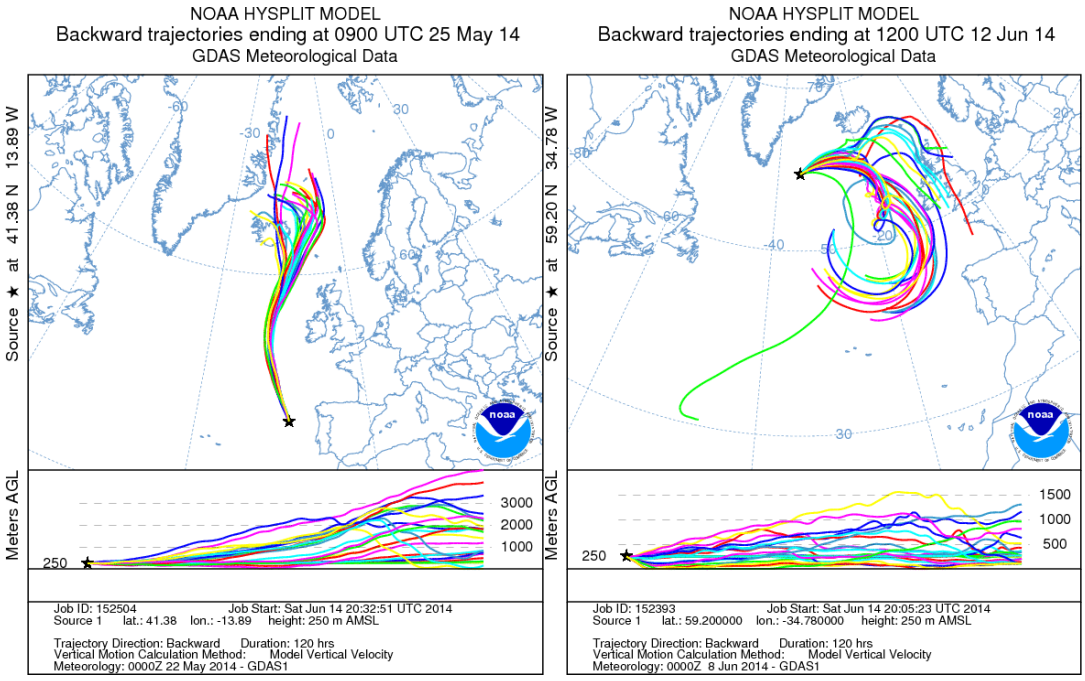

Figure 1. Representative air mass back trajectories indicating primarily northerly trajectories (left panel) and north-easterly trajectories (right panel).

5. Post-cruise sampling analyses and dead-lines

Deadline: Analysis = March 2015

6. Data base organization (general cruise base and/or specific data base(s))

General cruise database

7. References

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III.5.18. In-situ Pumps : (POC, PON, BSi, ^{210}Po, ^{210}Pb, Hg, ^{14}C, Pu, REE, ε_{Nd}, Fe, Mn, Al, Cu, Co, Zn, Ba, P, Y, Cd, Ti, V, Ni, Ca, Mo, ^{226}Ra, ^{228}Ra, ^{7}Be, ^{227}Ac, ^{231}Pa, ^{232}Th, ^{234}Th, ^{230}Th, bio markers)

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Résumé/Abstract:
24 casts of in-situ pumps were carried out in order to collect large amounts of particles along the GEOVIDE section. Studying the suspended and sinking particles can provide many information on their sources, adsorptive scavenging processes through the water column, deep-water or shelf-water mixing, boundary exchange processes, and will give clues on phytoplankton micronutrient status. These samples will allow the determination of many parameters, including TEIs, paleoproxies, circulation proxies in the North Atlantic, that will be useful tools for tracing their sources and sinks.

1. Scientific context

GEOVIDE proposes to undertake an integrated oceanographic transect in the North Atlantic and Labrador Sea. This area is crucial for the Earth climate and the thermohaline circulation as it represents a major overturning area of the so-called Meridional Overturning Circulation (MOC). Combining physical oceanography and tracers can strongly help to better constrain the uncertainties on the MOC estimation across the cruise track, notably by adding information on the deep water mass export and circulation. GEOVIDE will also allow determining a variety of sources and sinks that influence the distribution of TEIs in this area. Advective and scavenging processes, biological uptake, exchanges with the margins, atmospheric deposition, and hydrothermalism along the Mid Atlantic Ridge will be investigated. Another main objective is to investigate the link between the TEIs, and the production, export and remineralisation of particulate organic matter. To finish, GEOVIDE will allow the investigation of the paleoproxies $^{231}Pa/^{230}Th$, εNd and $\delta^{30}Si$.

2. Overview of the project and objectives

In this project, our main objective is to study the distributions, sources and internal cycle of different particulate elements (mainly POC,PON, BSi, ^{210}Po, ^{210}Pb, Hg, ^{14}C, Pu, REE, εNd, Fe, Mn, Al, Cu, Co, Zn, Ba, P, Y, Cd, Ti, V, Ni, Ca, Mo, ^{226}Ra, ^{228}Ra, ^{7}Be, ^{227}Ac, ^{231}Pa, ^{232}Th, ^{234}Th, ^{230}Th).

3. Methodology and sampling strategy

In-Situ pumps (Challenger and McLane) were deployed using a Stainless steel cable.

Pump heads were loaded with mainly four types of filters:
- at shallow casts, QMA+Petex (51 µm porosity) or Supor (0.8 µm porosity)+Petex (51 µm porosity)
- ar deep casts, QMA or Supor (0.8 µm porosity). In addition, some pumps were equipped with Mn cartridges ISP table). or other types of filters such as MF (Millipore, 5 µm porosity) or PC (10 µm porosity) (cf. table ISP).

Immediately after recovery, *in-situ* pump heads were covered with bags to avoid air contamination of particles, then transferred into a lab for sampling. Aliquots for sensitive tracers (on Supor membrane: trace metals, REE, εNd.) were processed under a laminar flow unit in a clean lab (the bubble). Aliquots for the remaining tracers (on QMA membrane) were processed in a standard room.

On each Supor membrane, 3 to 4 punches (13mm each) will be dedicated to trace elements determination (LEMAR), Biogenic Silica (LEMAR) and Rare Earth Element concentrations (LEGOS) whereas the remaining filter will allow determining radionucleides, Pa/Th (Oxford), εNd (LEGOS)…

On each QMA membrane, 3 punches will be dedicated to POC/PON/^{234}Th, 6 punches will be dedicated to ^{14}C, some punches for Po/Pb and Hg. The remaining QMA is dedicated for bio markers.

Petex membranes were cut in four parts. One quarter of Petex was resuspended with filtered seawater (taken from GO-FLO bottles, see the section of particulate trace metals) onto 25mm supor (0.45µm) or MF (5 µm) depending on particle abundance, then sent for immediate β counting (^{234}Th). One other quarter was also β counted and the last two quarters stored for further analysis (bio markers + trace metal elements).) in petri dishes at -20°C.
Mn cartridges were deployed to collect radionucleides (Ra, Ac, Th, Pb, Be…) in the dissolved phase (cf. Radium file).

Finally, at four stations (2; 60; 61; 78), 2 pump heads were deployed in surface and close to the bottom. Each head was loaded with one supor (0.8 µm porosity) + one Petex, or one MF (5 µm porosity) and one PC (10 µm porosity). For these casts, the entire filters were kept at -20°C and will serve as a basis for incubation experiments in LEMAR later on.

Table 1: list of stations and number of filters

Type of station	Station #	Number of Casts	Number of Supor filters	Number of QMA filters	Number of Nuclepore filters	Number of Cartridges
Super	1	2	6 (isp1)+8 (isp2)	6 (isp1)+5 (isp2)	-	5 (isp1)+8 (isp2)
Xlarge	2	1	4 (isp3)	0	-	0
Super	13	2	6 (isp4)+6 (isp5)	6 (isp4)+3 (isp5)	-	5 (isp4)+9 (isp5)
Super	21	2	8 (isp6)+5 (isp7)	6 (isp6)+3 (isp7)	-	4 (isp6)+9 (isp7)
Xlarge	26	1	9 (isp8)	6 (isp8)	-	10 (isp8)
Super	32	2	9 (isp9)+6 (isp10)	6 (isp9)+2 (isp10)	-	5 (isp9)+10 (isp10)
Super	38	1	10 (isp11)	5 (isp11)	-	12 (isp11)
Super	44	2	6 (isp12)+5 (isp13)	6 (isp12)+3 (isp13)	-	5 (isp12)+9 (isp13)
Super	51	1	7 (isp14)	7 (isp14)	-	3 (isp14)
XLarge	53	1	8 (isp15)	4 (isp15)	-	0
Super	60	1	5 (isp16)	1 (isp16)	-	0
XLarge	61	1	6 (isp17)	0	2 (isp17)	0
Super	64	2	7 (isp18)+4 (isp19)	6 (isp18)+3 (isp19)	-	5 (isp18)+9 (isp19)
Super, Crossover	69	2	5 (isp20)+6 (isp21)	7 (isp20)+ 3 (isp21)	-	3 (isp20)+9 (isp21)
Super	77	2	5 (isp22)+6 (isp23)	7 (isp22)+3 (isp23)	-	3 (isp22)+2 (isp24)
XLarge	78	1	4 (isp24)	0	1 (isp24)	0

4. Post-cruise sampling analyses and dead-lines

The analyses of all the parameters should be completed in the next 18-24 months.

5. Data base organization (general cruise base and/or specific data base(s))

Data will be posted on the GEOVIDE database in a timely manner after analysis and processing.

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IV. Public outreach

Before, during, and after the cruise, we developed one web site and a blog :
- web site: http://www.geovide.obs-vlfr.fr/
- blog: http://geovide.tumblr.com/

Moreover, we had on board, two members of the association “Les Etoiles Brillent pour Tous” (OMP, Toulouse), which aims at developing public outreach in closed environments, such as jails. In this framework, Catherine Jeandel and Virginie Sanial developed a proposal with the school of a jail in Seysses close to Toulouse. The proposal is based on exchanges between scientists and prisoners and lasted 6 months (before, during and after the cruise). It ended during the festival NOVELA in Toulouse last October with the projection of a movie realized during the cruise (http://www.obs-vlfr.fr/proof/php/geovide/IMG/Reportage_Geovide_Novela.mp4).

During the Sea Tech Week in Brest last October (13-17 Oct 2014), a GEOVIDE photography exhibition was shown.
http://www.seatechweek.com/index.php/en/