Leibniz Institute for Baltic Sea Research Warnemünde

C r u i s e R e p o r t

r/v "ALKOR"

Cruise- No. AL439

This report is based on preliminary data

Institut für Ostseeforschung Warnemünde
an der Universität Rostock
Seestraße 15
D-18119 Rostock- Warnemünde
GERMANY
☎ +49-381-5197-0
🗐 +49-381-5197 440

1. **Cruise No.:** AL439

2. **Dates of the cruise:** 04.06.2014 to 19.06.2014

3. **Particulars of the research vessel:**
   Name: RV ALKOR
   Nationality: Germany
   Operating Authority: Baltic Sea Research Institute (BSRI) Warnemünde

4. **Geographical area in which ship has operated:**
   Baltic Sea

5. **Dates and names of ports of call**
   -

6. **Purpose of the cruise**

   The Baltic Sea is characterized by its distinct horizontal and vertical salinity gradients, with the unique feature that 62% of its surface zone is represented by brackish conditions. Salinity-related distribution patterns and a diversity minimum at brackish conditions are known for higher benthic and pelagic organisms. In a first analysis for microorganisms, based on pyrosequencing of bacterial 16S rRNA genes, we were able to show that also bacterial communities experience distinct shifts at different phylogenetic levels along the salinity gradient. Moreover, there is evidence for an adapted brackish water bacterial community, represented by a phylogenetic member of the *Verrucomicrobia*. However, knowledge on accordant functional features and potential successions is rare. Thus, based on samples taken and experiments performed on this cruise we will investigate how the shift in bacterioplankton community composition from marine to brackish and limnic conditions affects bacterially mediated functions. This was done by two different approaches: (1) Functional microbial fingerprints will be generated based on the *in situ* fixed water samples taken by the Automatic Fixation – Injection Sampler (AFIS), resulting in a functionally based biogeographic microbial mapping of the Baltic Sea along its horizontal and vertical salinity gradients. (2) More specifically, microbial activities related to the pelagic carbon cycle will be studied. Manipulative ship-board experimental investigations at five stations of different salinity were done and will assess, besides prokaryotic diversity, microbial functionality covering broad to highly specific bacterial activities related to organic carbon processing. The direct impact of salinity on the composition and function of surface bacterioplankton in the central, brackish Baltic Sea will be examined by experimentally manipulating salinity levels in the laboratory.

7. **Crew:**
   Name of master: Norbert Hechler
   Number of crew: 11

8. **Research staff:**
   Chief scientist:

   LABRENZ, Matthias Biologie IOW

   Scientists:

   JOST, Günter Biologie IOW

KRÜGER, Siegfried	Meßtechnik	IOW
BOMBAR, Deniz	Biologie	Univ. Copenhagen
BENNKE, Christin	Biologie	IOW
SHEN, Dandan	Biologie	IOW
WOELK, Jana	Biologie	IOW
ROGGE, ANDREAS	Biologie	IOW
HENTZSCH, Alexander	Biologie	IOW

Technicians:

BENTERBUSCH-BROCKMÖLLER, Heike	Biologie	IOW
HANSEN, Regina	Biologie	IOW
HANSEN, Jaenett	Biologie	Univ. Copenhagen

9. **Co-operating institutions:**
University of Copenhagen

10. **Scientific equipment**

IOW CTD-/Rosette System #11 SN -1072/0870

Isotope-Container 20 ft.

AFIS bottles

11. **General remarks and preliminary result** (ca. 2 pages)

The cruise AL439 started June 4th at 08:00 a.m. and covered the whole horizontal and vertical salinity gradients of the Baltic Sea. In total, 31 stations were sampled (Appendix Fig. 1). It ended June 19th at 01:00 p. m.

Cruise AL439 is essential for the implementation of three projects:

(1) [Viable Ecosystem] BONUS-Projekt "Biological lenses using gene prints" (BLUEPRINT)

Abstract: Sustainable management practice of the Baltic Sea depends on a fundamental knowledge and definition of this ecosystem, enabling a prediction of its ecological status and balance for decades to come. Current descriptors in Baltic Sea monitoring to assess biologically driven processes are largely focusing on structural components and cannot cover

this demand adequately anymore. A general understanding exists that new indicators representing distinct biogeochemical processes are needed, but remained undeveloped. The complex aquatic nutrient biogeochemistry is practically driven by bacterioplankton and it seems mandatory that only microbial descriptors can improve Baltic biogeochemistry models or environmental indicators applied by HELCOM. In consequence, through combined experimentation and in situ analyses, this project will advance accordant knowledge based on the identification of key functional genes or general genetic metagenomic/-transcriptomic fingerprints determining distinct pelagic nutrient fluxes. The overarching goal is to link distinct genetic BLUEPRINTs with specific environmental conditions in the Baltic Sea. On this basis, novel and sensitive indicators of environmental status will be developed and their practical applicability proofed. Verified new descriptors will integrated in current biogeochemical models of nutrient cycling in the Baltic Sea, and finally guided into its political and practical implementation in environmental monitoring. The project is by necessity multi-disciplinary in nature, involving data and knowledge transfer between experts in (micro)biology, chemistry, physics, bioinformatics and biogeochemical modeling. For the project to be successful, and for efficient transfer of the project outcome into monitoring and modeling programs in the future, a discussion forum will be established where members of the different disciplines of BLUEPRINT itself, but also policymakers, legislators, and stakeholders, will evaluate the scientific content, practicability, and development of BLUEPRINT, and also provide support for monitoring and technical development.

(2) [Innovation] BONUS-Projekt "Development of an autonomous multisampler system for the monitoring of biogeochemical processes" (AFISmon)

Abstract: Microorganisms are the driving catalysts of biogeochemical cycles sustaining life in the ocean. Thus, the determination of their metabolic processes is fundamental for the understanding of marine ecosystems. Nevertheless, these are practically absent from current monitoring programs because of the considerable analysis complexity. Nowadays, advanced molecular techniques overcome former challenges. One of the promising approaches is the analysis of the transcripts in natural microbial assemblages (metatranscriptomes). Unfortunately, transcripts can degrade in less than 30 sec. Their unbiased detection in nature, especially from hypoxic or deep water habitats, is a challenge because they are subject to considerable modification simply due to sampling procedures. We developed already an adequate sampling technique for use at the CTD rosette. However, for monitoring of temporal and spatial variations autonomous event and/or time triggered in situ fixation instruments are essential on ocean observatories. Based on our system these independent instruments will be developed and tested in hypoxic waters. The procedure will be optimized concerning the sampling volume, fixative, and storage time under varying conditions, but also concerning bioinformatics to get reproducible data. Project outcome will be an AFISmon prototype applicable for the monitoring of biogeochemical processes.

(3) [DFG] Microbial diversity and function within the salinity gradient of the Baltic Sea (MicroFUN)

Abstract: Based on the existent knowledge that bacterial community composition shifts along the horizontal salinity gradient of the Baltic Sea the potential accompanying functional consequences will be elucidated. This should be achieved, for representative stations of the marine, brackish, and nearly limnic areas, by a combination of experimental and cultivation-independent analyses of bacterial diversity and functionality. As processing of organic carbon is a major function of bacterioplankton in the photic zone, focus will be the functional analysis on organic carbon processing and substrate utilisation patterns.

The cruise was based on two complementary components:

a) Comprehensive underway microbial sampling (water sampling for nucleic acid filtration, fixed water sampling for nucleic acid filtration, total cell numbers, gene probe analyses, zooplankton net) combined with nutrient analyses including sampling for basic properties (Temperature, salinity, O_2, Chlorophyll a, nutrients, H_2O_2) and

b) Process studies at 5 selected stations (Fig. 1). Extensive studies were carried out in the Kattegat, Arkona Sea, Bornholm Sea, eastern & western Gotland Sea, Bothnian Bay. In addition to samplings also taken underway, ^{3}H-Leucinincorporation, ^{13}C-Thymidin incorporation, $^{13}CO_2$-incorporation, ^{13}C-Cellulose-incorporation, and N_2-fixation rates were determined for several of the stations.

For 10 stations in total (only surface water) samples were taken for further gene expression analyses after addition of H_2O_2 in the laboratory.

Preliminary results exist with regard to the test of the Automatic Fixation – Injection Sampler (AFIS). In order to proof the reproducibility of the in situ addition of the used fixative to the AFIS bottles, the fixative was supplemented with ink and the resulting fixed water samples measured photometrically directly on board. As result it turned out that most of the time the fixative was injected reproducibly (with a mean absorbance of 0.09 + 0.02 [Fig. 1]).

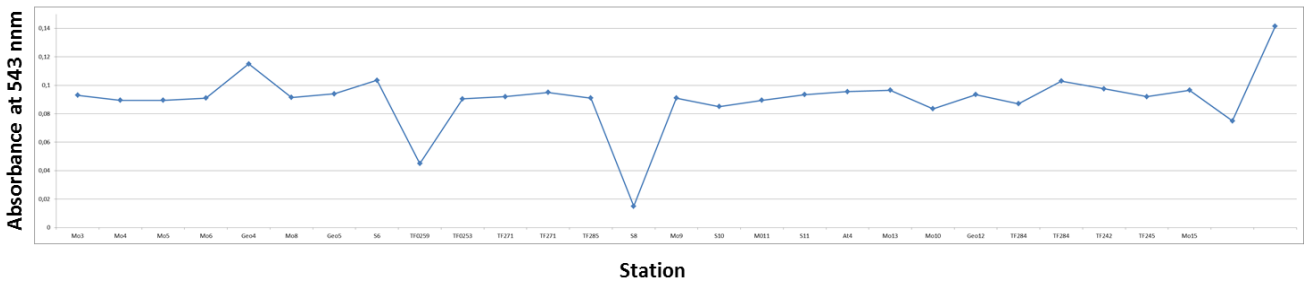

Figure 1. Absorbance [543 nm] of AFIS-fixed and stained water samples.

Appendix: map and list of stations

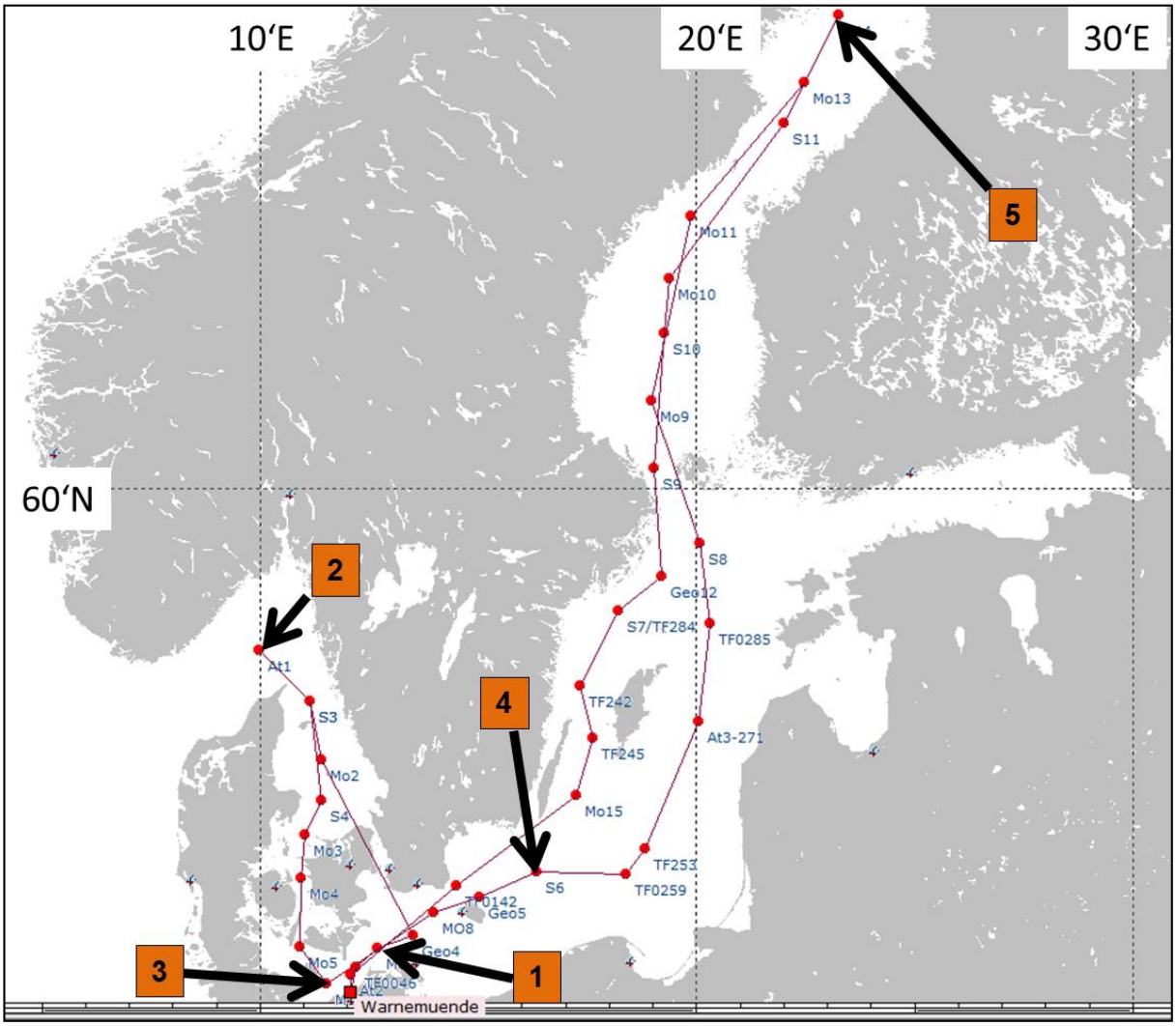

Figure 1. Cruise track of RV ALKOR (AL439). Each red dot indicates a temporary station, numbers in orange boxes process stations in sequential arrangement. Station S9: was not sampled.

In general, the transect follows the route: Rostock – Oresund – Kattegat – Great Belt – Bornholm – Gotland Deep – Gulf of Bothnia – Landsort Deep – Rostock. Map generated by eMission (D. Rüß)

Table 1: List of stations and preliminary nutrient data

	Station	Position	Position	Date	Time	Serial	Sampling depths	Phosphate	NO2	NO3	NH4	SiO2	O2	O2	H2S	H2S
ALKOR CRUISE 2014 (AL439)	No.	Lat	Lon		[UTC]	No.	[m]	µM	µM	µM	µM	µM	mL/L	µmol/l	mL/L	µmol/l
							surface: 2 m									
04.06.-20.06.2014	TF0046	54 27.9543N	12 12.8494E	04.06.2014	10:30	01F01										
							Surface	0,20	-0,01	0,05	0,36	7,34	7,05	314,85		
							Middle (11 m)	0,25	0,02	0,00	0,20	8,50	6,51	290,74		
							Bottom (21m)	0,71	0,28	2,79	0,48	17,74	4,62	206,33		
	Mo7	54 41.9066N	12 42.2971E	04.06.2014	14:00	02F01										
						02F02	Surface	0,15	-0,01	0,05	0,40	0,70	7,46	333,16		
							Middle (13 m)	0,28	-0,01	0,22	0,59	9,92	6,01	268,41		
							Bottom (19 m)	0,47	0,17	1,00	0,33	12,90	5,39	240,72		
					14:40	02F03	Surface	0,20	-0,01	0,05	0,25	31,86	7,32	326,91		
05.06.2014	S4	56 23.3951N	11 26.2466E	05.06.2014	06:00	03F01										
							Surface	0,04	0,00	0,00	0,14	3,08	6,40	285,82		
							Middle (13m)	0,08	0,00	0,03	0,15	2,55	7,25	323,79		
							Bottom (18m)	0,64	0,17	9,02	0,20	9,72	5,13	229,11		
	S3	57 31.9881N	11 10.9991E	05.06.2014	12:30	04F01										
							Surface	0,01	0,04	0,00	0,11	1,30	6,47	288,95		
							Middle (20m)	0,04	0,11	0,93	0,59	1,68	6,04	269,75		
							Bottom (41m)	0,80	0,08	3,68	1,96	4,28	5,79	258,58		
	At1	58 07.9376N	9 59.9990E	05.06.2014	18:00	05F01										
							Surface	0,04	-0,01	0,00	0,05	0,36	6,46	288,50		
							Middle (80m)	0,51	0,04	7,82	0,16	3,50	6,30	281,36		
							Bottom (242m)	0,74	0,21	9,99	0,11	4,22	6,13	273,77		
						05F02	Surface	0,01	0,02	0,00	0,07	0,30	6,45	288,06		
06.06.2014	Mo2	56 52.0225N	11 26.0338E	06.06.2014	08:30	06F01										
							Surface	0,01	0,00	0,00	0,08	2,52	6,31	281,80		
							Middle (9.5m)	0,02	0,01	0,14	0,12	2,21	6,70	299,22		
							Bottom (11m)	0,02	0,02	0,17	0,15	1,80	6,73	300,56		
	Mo3	56 00.0615N	11 04.6438E	06.06.2014	18:15	07F01										
							Surface	0,08	0,03	0,00	0,22	0,45	6,80	303,69		
							Middle (11m)	0,09	0,03	0,00	0,22	0,45	6,90	308,15		
							Bottom (21m)	0,62	0,21	5,90	0,32	0,46	4,27	190,70		
	Mo4	55 29.9914N	10 57.9890E	06.06.2014	22:45	08F01										
							Surface	0,14	0,01	0,00	0,23	5,26	6,72	300,12		
							Middle (10m)	0,21	0,09	0,12	0,20	5,61	6,17	275,55		
							Bottom (24m)	0,65	0,18	7,58	0,46	9,39	4,65	207,67		
07.06.2014	Mo5	54 42.0908N	10 55.6851E	07.06.2014	05:00	09F01										
							Surface	0,17	0,03	0,00	0,19	7,30	7,10	317,09		
							Middle (4m)	0,16	0,05	0,00	0,14	7,12	6,91	308,60		
							Bottom (10m)	0,17	0,04	0,25	0,21	7,36	6,67	297,88		
	Mo6	54 16.9269N	11 34.0792E	07.06.2014	08:30	10F01										
							Surface	0,09	-0,01	0,05	0,61	5,14	7,09	316,64		
							Middle (16m)	0,09	0,03	0,00	0,52	4,45	6,34	283,14		
							Bottom (23m)	0,43	0,29	1,46	1,11	5,10	4,36	194,72		
	Geo4	54 50.3358N	13 32.0501E	07.06.2014	19:30	11F01										
							Surface	0,15	-0,01	0,03	0,45	8,67	7,91	353,26		
							Middle (20m)	0,20	-0,02	0,03	0,27	8,75	7,62	340,31		
							Bottom (43m)	0,43	0,33	0,69	0,30	9,65	5,62	250,99		
	Mo8	55 06.0393N	1359.9620E	07.06.2014	22:30	12F01										
							Surface	0,21	-0,03	0,03	0,34	9,08	7,72	344,78		
							Middle (20m)	0,25	0,00	0,00	0,30	8,84	7,31	326,46		
							Bottom (43m)	1,15	0,08	3,50	3,03	32,67	2,95	131,75		
08.06.2014	Geo5	55 16.9250N	15 02.7361	08.06.2014	06:00	13F01										
							Surface	0,14	0,01	0,00	0,24	7,23	7,88	351,92		
							Middle (30m)	0,27	0,01	0,00	0,19	6,90	7,59	338,97		
							Bottom (68m)	0,93	0,12	2,50	1,45	15,66	4,24	189,36		
	S6	55 33.9539N	16 21.9907E	08.06.2014	12:15	14F01										
							Surface	0,22	-0,01	0,00	0,41	8,95	7,67	342,54		
							Middle (30m)	0,31	-0,04	0,02	0,41	9,43	7,61	339,86		
							Bottom (67m)	2,88	0,08	6,31	1,64	47,12	0,37	16,52		
	TF0259	55 32.9810N	18 24.0058E	08.06.2014	18:30	15F01										
							Surface	0,11	0,01	0,00	0,32	18,19	8,26	368,89		
							Middle (40m)	0,44	0,01	0,00	1,13	17,91	7,96	355,49		
							Bottom (83m)	1,47	0,08	1,01	1,68	36,16	2,56	114,33		
	TF0253	55 50.3598N	18 51.9741E	08.06.2014	22:30	16F01										
							Surface	0,04	0,00	0,00	0,28	3,94	8,08	360,85		
							Middle (44m)	0,46	0,01	0,05	1,02	4,37	7,80	348,35		
							Bottom (96m)	1,35	0,10	1,72	1,43	10,63	2,77	123,71		
09.06.14	At3-TF271	57 18.3160N	20 04.5955E	09.06.2014	08:30	17F01										
							Surface	0,01	0,01	0,00	0,36	4,19	8,53	380,95		
							Middle (65m)	0,59	0,01	0,00	0,34	5,45	7,12	317,98		
							Bottom (116m)	2,73	0,02	3,27	0,28	19,23	0,21	9,38		
				09.06.2014	11:00	17F02										
				09.06.2014	11:15	17F03	123 m	3,01	0,04		5,94318182	22,64				8,09
				09.06.2014	13:00	17F04	Surface	0,02	0,01	0,00	0,24	4,33		7,27		
							64m	0,66	0,01	0,04	0,30	6,42		6,85		
							116m	2,67	0,06	1,98	1,69	21,21		0,13		0,09
							120m	3,61	0,00		4,47	22,58				2,32
							123m	3,66	0,02		4,56	23,27				4,86
				09.06.2014	15:00	17F05	Surface	0,00	-0,01	0,00	0,24	4,36	8,56	382,29		
				09.06.2014	18:30	17F06	116m	2,79	0,02	3,15	0,25	15,22	0,15	6,70		0,21
							122m	3,93	0,00		6,82	16,71				12,57
							124m	3,86	-0,02		6,93	16,22				13,04
							132m	4,14	-0,01		9,95	16,55				24,73
							142m	5,15	0,00		17,33	17,52				75,76

Table 1 (continued): List of stations and preliminary nutrient data

ALKOR CRUISE 2014 (AL439)	Station No.	Position Lat	Position Lon	Date	Time [UTC]	Serial No.	Sampling depths [m]	Phosphate µM	NO2 µM	NO3 µM	NH4 µM	SiO2 µM	O2 mL/L	O2 µmol/l	H2S mL/L	H2S µmol/l
							surface: 2 m									
10.06.2014	TF0285	58 26.5053N	20 20.0554E	10.06.2014	01:00	18F01										
							Surface	0,04	0,01	0,00	0,28	4,45	7,80	348,35		
							Middle (40m)	0,44	0,00	0,05	0,40	5,15	8,25	368,45		
							Bottom (78m)	2,83	0,03	3,35	0,16	17,19	0,13	5,81		0,09
	S8	59 21.5258N	20 05.8925E	10.06.2014	08:30	19F01										
							Surface	0,12	0,00	0,00	0,23	4,65	8,16	364,43		
							Middle (15m)	0,20	0,00	0,00	0,23	4,48	8,31	371,12		
							Bottom (45m)	0,31	0,00	0,00	0,51	3,80	7,65	341,65		
	Mo9	61 00.0739N	19 00.1347E	10.06.2014	19:00	20F01										
							Surface	0,07	0,04	0,00	0,20	5,09	8,94	399,26		
							Middle (67m)	0,80	0,30	3,42	1,57	11,14	7,48	334,06		
							Bottom (86m)	1,27	0,13	7,19	0,80	14,58	5,41	241,61		
11.06.2014	S10	61 46.9727N	19 17.7102E	11.06.2014	00:20	21F01										
							Surface	0,06	-0,02	0,00	0,33	3,22	8,76	391,22		
							Middle (34m)	0,05	0,00	0,07	0,28	3,53	8,81	393,45		
							Bottom (56m)	0,59	-0,02	2,66	0,94	8,05	8,17	364,87		
	Mo11	63 07.9507N	19 54.1866E	11.06.2014	08:30	22F01										
							Surface	0,01	0,00	0,00		5,58	8,30	370,68		
							Middle (68m)	0,13	0,10	4,00		8,63	7,97	355,94		
							Bottom (106m)	1,10	0,01	6,60		13,35	5,79	258,58		
	S11	64 12.1968N	22 01.6783E	11.06.2014	20:00	23F01										
							Surface	0,02	0,11	2,79	0,23	27,65	9,09	405,96	0,01	0,19
							Middle (56m)	0,04	0,20		0,44	28,47	9,06	404,62		
							Bottom (106m)	0,16	0,08		0,32	30,38	8,36	373,36		
					22:15		Surface	0,00	0,10		0,22	17,59	9,09	405,96		
							Middle (66m)	0,01	0,10		0,63	19,94	8,93	398,81		
							Bottom (105m)	0,11	0,09		0,47	15,84	8,54	381,40		
12.06.2014	At4	65 26.7574N	23 17.8358E	12.06.2014	06:00	24F01										
							Surface	0,10	0,10		0,22	9,38	8,73	389,88		
							Middle (43m)	0,02	0,12		0,34	33,39	9,29	414,89		
							Bottom (79m)	0,02	0,10		0,22	31,92	8,98	401,05		
					08:15	24F02	Surface	0,06	0,10		0,25	11,62	8,72	389,44		
					12:30	24F03	Surface	0,08	0,09		0,23	9,28	8,67	387,20		
							Middle (38m)	0,00	0,14		0,43	31,01	9,54	426,06		
							Bottom (65m)	0,00	0,11		0,36	28,45	9,19	410,43		
14.06.2014	Mo13	64 40.0906N	22 29.8094	14.06.2014	06:00	25F01										
							Surface	0,01	0,10		0,25	6,66				
							Middle (54m)	0,02	0,11		0,35	6,54				
							Bottom (91m)	0,07	0,02		0,22	6,65				
14.06.2014	Mo10	62 24.9504N	19 24.8891E	14.06.2014	21:00	26F01										
							Surface	0,01	0,00		0,30	3,02				
							Middle (54m)	0,34	0,21		0,18	6,57				
							Bottom (88m)	0,91	0,05		0,18	7,15				
15.06.2014	Geo12	58 58.4714N	19 14.5314E	15.06.2014	17:30	27F01										
							Surface	0,14	-0,01	0,00	0,21	14,05	8,15	363,98		
							Middle (46m)	0,51	0,00	0,00	0,70	14,52	8,06	359,96		
							Bottom (61m)	2,17	0,07	0,04	0,87	31,99	3,14	140,23		
							suboxic ((64m)						1,15	51,36	0,00	0,07
							interface (68m)						0,54	24,12	0,00	0,06
							sulfidic (72m)						0,04	1,79	0,04	1,09
	TF284	58 34.9843N	18 13.9710E	15.06.2014	22:00	28F01										
							Surface	0,13	-0,01	0,00	0,13	13,70	7,93	354,15		
							61m	0,77	0,04	0,09	0,81	16,17	7,73	345,22		
							76m	3,23	0,03	0,65	3,18	48,65	0,29	12,95	0,00	0,09
							77m	6,55	0,02	0,21	3,72	51,06	0,06	2,68	0,00	0,12
							80m	3,68	-0,02		5,26	53,95			0,23	6,64
				15.06.2014		28F02	169m	3,93	0,00		7,89	13,34			0,94	27,64
							197m	4,07	0,00		8,90	14,00			1,16	34,10
							312m	4,25	-0,01		10,47	15,07			1,60	47,04
							429m	4,33	-0,01		12,80	26,46			1,83	53,70
				16.06.2014	08:30	28F03	Surface	0,17	0,00	0,00	0,56	14,73	7,73	345,22		
							Middle (60m)	0,93	0,11	0,78	0,60	12,41	7,57	338,08		
							Bottom (77m)	3,30	0,04	0,87	3,37	46,68	0,39	17,42		
				16.06.2014	10:45	28F04	81 m	3,65	0,02		4,59550562	43,36			0,02	0,55
				16.06.2014	12:30	28F05	Surface	0,19	-0,01	0,01	0,18	47,53	7,72	344,78		
												-0,02				
				16.06.2014	13:45	28F06	Surface	0,18	0,02	0,00	0,09	11,10	7,80	348,35		
							Middle (62m)	1,08	0,10	0,90	12,78	16,23	6,93	309,49		
							Bottom (78m)	3,17	0,07	1,59	2,17	43,68	0,27	12,06		
				16.06.2014	16:30	28F07	Surface	3,08	0,03	0,00	3,11	49,80	0,13	5,81	0,00	0,04
							79m	3,79	-0,01	1,30	4,99	53,05	0,05	2,23	0,09	2,65
							83m	3,82	0,00		5,31	53,01			0,17	4,90
							85m	3,89	-0,03		7,49	56,15			0,60	17,74
							97m	0,18	-0,03		0,10	13,67	7,67	342,54		
							107m	3,88	-0,03		7,42	53,65			0,60	17,50
	TF242	57 42.9924N	17 21.9589E	17.06.2014	06:00	29F01										
							Surface	0,29	-0,01	0,01	0,29	11,96	7,79	347,90		
							Middle (60m)	0,99	0,08	0,59	0,81	10,35	7,16	319,77		
							Bottom (73m)	2,71	0,03	4,38	0,45	6,26	1,18	52,70	0,00	0,04
	TF245	57 06.9741N	17 39.8541E	17.06.2014	10:30	30F01										
							Surface	0,14	-0,01	0,00	0,27	9,00	7,60	339,42		
							Middle (56m)	0,86	0,03	0,11	0,94	9,66	7,69	343,44		
							Bottom (86m)	2,95	-0,01	5,85	0,08	5,74	0,62	27,69	0,00	0,04
							above sediment (105m)	4,39	-0,01		10,24	8,01			0,11	3,10
	Mo15	56 26.9873N	17 16.9632E	17.06.2014	15:30	31F01										
							Surface	0,33	-0,01	0,01	0,19	13,02	7,76	346,56		
							Middle (28m)	0,50	-0,01	0,00	0,14	13,36	7,37	329,14		
							Bottom (51m)	0,75	0,01	0,87	0,76	13,41	6,61	295,20		