LEIBNIZ INSTITUTE FOR
BALTIC SEA RESEARCH
WARNEMÜNDE

Date: 20.10.15

Cruise Report

Compiled by: Dr. Joanna Waniek

R.V. Poseidon Cruise No.: POS485

Dates of Cruise: from 13.05.2015 to 30.05.2015

Areas of Research: Biogeochemistry, Physical Oceanography, Maritime Technology

Port Calls: Malaga (Spain), Ponta Delgada (Portugal)

Institute: Leibniz Institut für Ostseeforschung Warnemünde, Seestraße 15, 18119 Rostock

Chief Scientist: PD. Dr. habil. Joanna Waniek

Number of Scientists: 10

Project: DFG: WA2157/5-1, BMWI: 03SX276 A/B

Cruise Report

This cruise report consists of 19 pages including cover:

1. Scientific crew:

Name	Function	Institute	Cruise/Leg
Dr. Waniek, Joanna	Chief scientist	IOW	485
Reimann, Wiebke	Technician	IOW	485
Hehl, Uwe	Technician	IOW	485
Mars, Robert	Technician	IOW	485
Rentzow, Erik	Scientist	URO	485
Geissler, Andree	Technician	Enitech	485
Körner, Gerhard	Scientist	Enitech	485
Ritz, Sebastian	Scientist	TUB	485
Golz, Matthias	Scientist	TUB	485
Oertel, David	Scientist	KIT	485
Total : 10			

IOW Leibniz Institut für Ostseeforschung Warnemünde

Enitech Enitech GmbH, Rostock

TUB Technische Universität Berlin

URO Universität Rostock

KIT Karlsruhe Institut für Technolgie

Chief scientist:

PD. Dr. habil. Joanna Waniek

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2. Research program (J. Waniek, IOW)

The research program and the aims of the cruise mirror the plans of both involved projects (DECADE & SMIS) and are depicted in the working plan of the expedition: By means of hydrographic work the physical and biogeochemical conditions in the upper 2000 m of the water column in the catchment area of Kiel276 will be registered. Those CTD registrations are used to locate the Azores Front relative to the position of the deep sea mooring Kiel 276 along three meridians (23°W, 22°W and 21°W) between 30°N and 37°N allowing for a 3-D mapping of the front. The mooring Kiel276-29 will be recovered following the emergency warning send by the subsurface buoy prior to the cruise. Additionally, extensive tests of the SMIS fleet composed of surface vehicle and bottom unit will be carried out. The work is completed by trials of several AUV components and test of acoustic systems in various configurations.

3. Narrative of the cruise with technical details (J. Waniek, IOW)

12.05.2015- In the morning the cruise participants embark the ship and after uploading the containers started setting up the laboratories and testing the gear.

13.05.2015 - At 12:00 UTC after safety instruction Poseidon left the port of Malaga and started the transit to our working area at 35°N, 21°W. Our estimated arrival time in the working area is the 17th May.

14.05-16.05.2015-Transit to our working area under relatively good weather and sea conditions

17.05.-18.05.2015- Hydrographic work along the 21°W meridian and some trials of the SMIS components.

19.05.2015- We started the day work at 8:00 UTC with the attempt to release the broken mooring (May 2013, Kiel276-29a). Unfortunately, there was no response from the release units and no instruments surfaced until lunch time. We have started searching the area for buoyancy spheres at surface, but without success. At mid day the decision was made to abandon the position and continue with the hydrographic work over night.

20.05.2015- Today at 8:00 UTC the replacement mooring Kiel276-29b deployed in September 2013 was release and surfaced 1 hour later. We have collected the instruments and realized that the surface buoy and 1500 m lines, several buoyancy spheres and 2 current meters are missing. The remaining recovered instruments e.g. 4 current meters, inclinometer and both sediment traps worked over the entire deployment period. After finishing the recovery of the Kiel276-29 we continued our trials with the bottom-unit, later to be used as underwater fuel station for the SMIS fleet.

21.05-27.05.2015-The seven days were used for hydrographic work by means of CTD along 21°W, 22°W, and 23°W with additional test of SMIS components. Most of the CTD casts were done over full depth and samples taken for a variety of parameters.

28.05.2015-Over most of the cruise, the sea conditions did not allow deployment of the AUV, but today day before the cruise finishes the sea was relatively calm and the swell reasonable (less than 1.5 m). Therefore the AUV was deployed and dived to approximately 1000 m depth. The AUV mission was successful and we collected additional data allowing for additional optimization of the system on land.

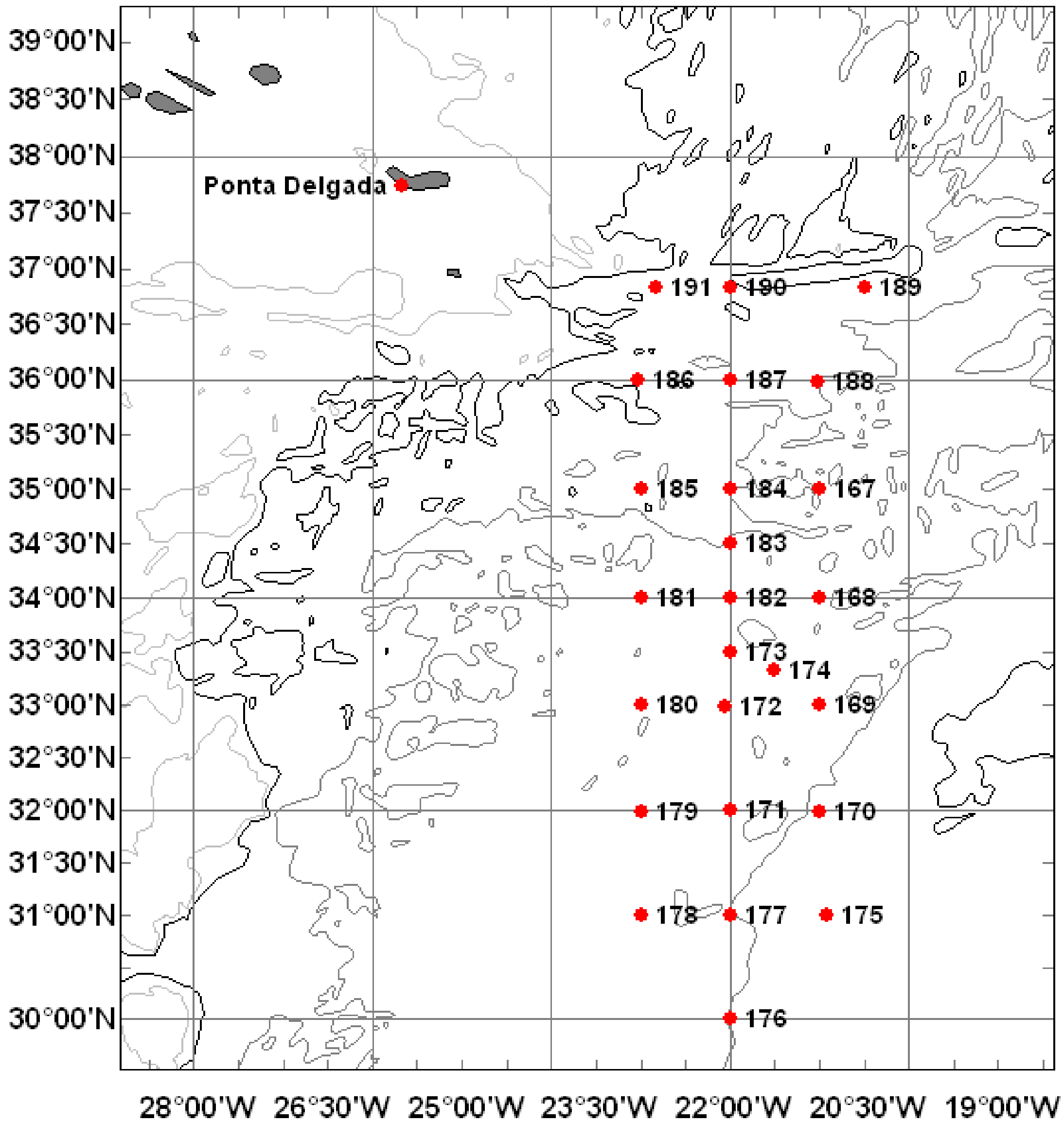


Fig. 1: Cruise track of POS485 in Mai 2015 from Malaga (Spain) to Ponta Delgada (Portugal). Numbers indicate the positions of hydrographic stations (CTDs).

4. Scientific report and first results

4.1 Hydrographic sections (J. Waniek, R. Mars, W. Reimann, IOW)

One of the objectives of the cruise POS485 was to investigate the water column properties along three meridians (23°W, 22°W and 21°W) between 30°N to 37°N in order to localize the Azores Front and to understand the changes in the biogeochemical properties corresponding to the frontal area (Fig. 1). For this purpose, CTD measurements were done at 20 stations every 30 nm along the meridians 21°W, 22°W and 23°W. Most of the CTD casts were performed down to the bottom (~5000 m) and at selected depth samples for a number of parameters were taken (Chlorophyll a, suspended particulate matter, nutrients, particulate organic carbon, dissolved organic carbon, raster electron microscopy). Additionally, oxygen and fluorescence data were recorded at all stations.

To detect the Azores Front, in-situ measurements of at least temperature and salinity are necessary, because the front does not have any surface indication and therefore cannot be detected via remote sensing. The position of the frontal system is typically defined through the 15°C isotherm upward movement from 300 m to above 200 m depth. Figure 2 shows the vertical temperature distribution in the upper 500 m of the water column along all three meridians.

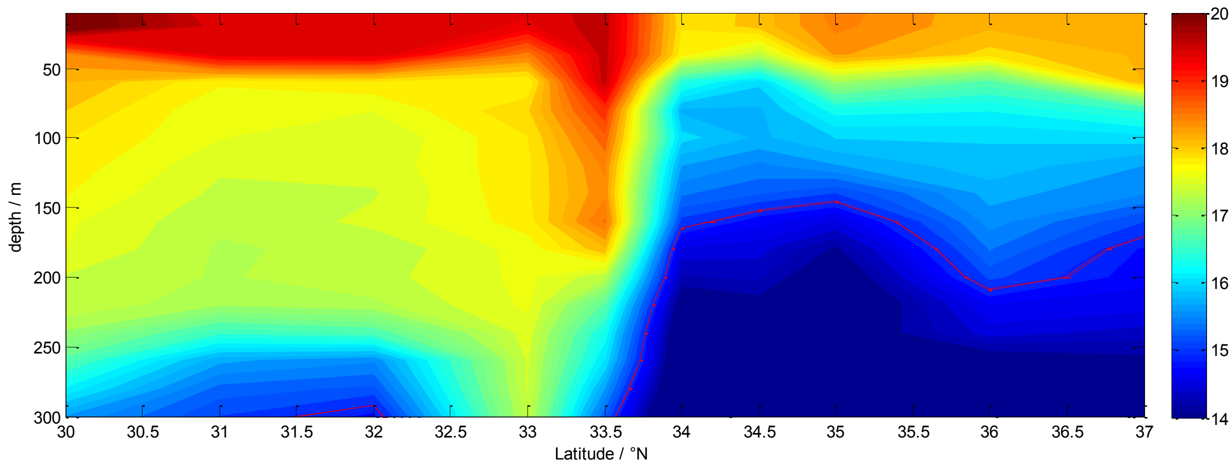


Fig. 2: Vertical temperature distribution in the upper 300 m depth during the POS485 cruise in Mai 2015 along the 22°W meridian. The 15°C isotherm is marked red, indicating the Azores Front by lifting up from below 300 m to above 200 m between 33.5°N and 34°N.

Further analyses of the hydrographic section, especially those along 23°N and 21°N will give insight into the 3-D Structure of the front and together with the results of the laboratory analyses of the collected samples will allow to assess the impact of the frontal system on the particles collected with the deep sea mooring Kiel276.

4.2 Depth control system of the AUV DORISα (E. Rentzow, URO)

Motivation: The objective, given by the scientific partner IOW, is to monitor the temperature pattern of the Azores Front in the water column, especially its changes with location and depth. Therefore, a control system to monitor and follow an unknown temperature distribution in the water column has been designed. The main purpose for the cruise was testing of the control loops for pitch, depth and temperature gradient following algorithm in the area of the Azores Front. Additionally further data should be recorded for extending the dynamic motion model of the AUV DORISα.

Method: Before testing the gradient following controller, the AUV has to be equipped with a depth control system. The depth control system has a cascaded structure. The inner loop's controlled variable and actuated variable are the pitch angle of the AUV and the elevator rudder deflection angle respectively. The actual depth is fed back into the superior loop. A big benefit of that structure is the easy adaptability of the parameters of the different controllers in field. The temperature gradient following controller has been designed as add on system for the depth controlled AUV. The temperature is measured by a CTD and converted into the desired depth reference for the vehicle.

First Results: Due to bad sea condition, the AUV had merely short operating time at the last day of the cruise. Hence, only the depth control loop could be examined. Fig. 3 shows the controller state, the determined depth reference and the actual depth measurement of the AUV. The performance of the depth control cascade with the preset parameters is satisfactorily. Aboard the temperature control system has been tested Hardware in the Loop.

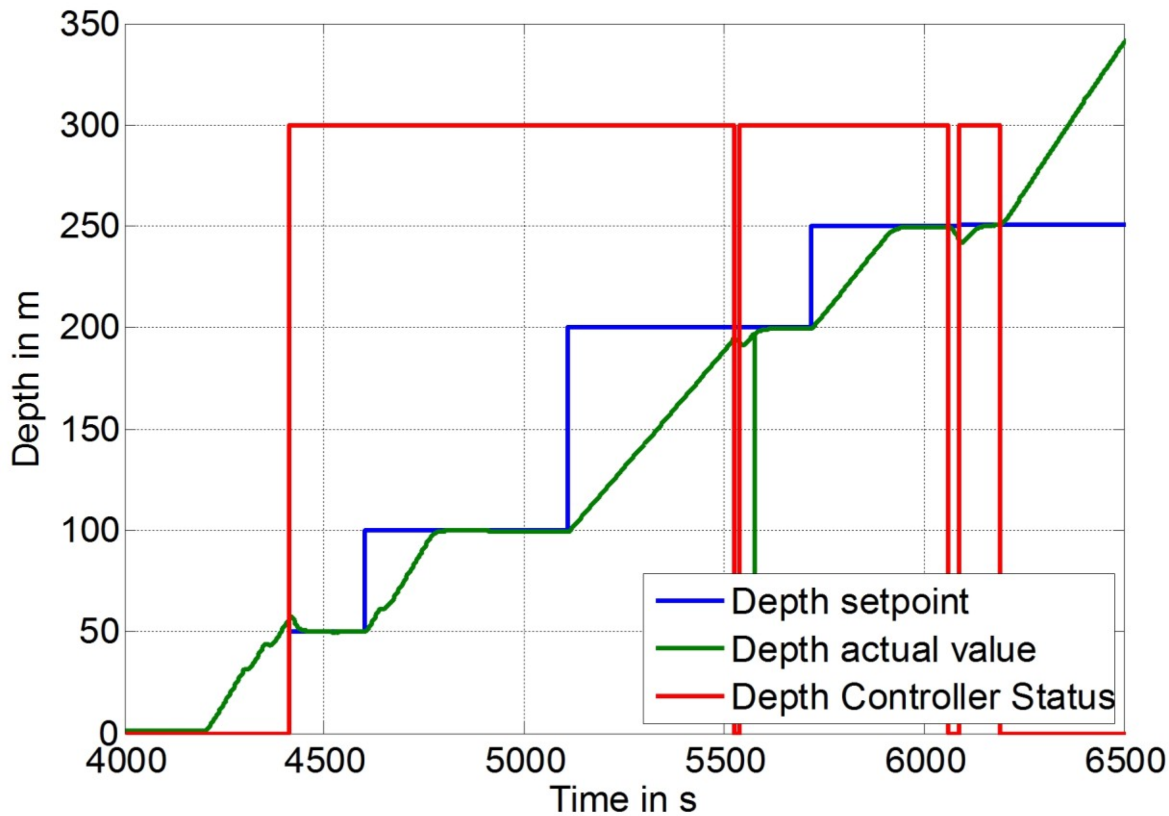


Fig. 3: Depth controlled diving maneuver of the AUV DORIS α

4.4 „SMIS" work packages (A. Geissler, G. Körner, Enitech GmbH)

Motivation: The primary aim of this research cruise for Enitech GmbH was checking the diving behavior of the AUV's DORIS at greater depths, as well as checking the operational capability of the AUV's in the deep sea, especially regarding the deployment and recovery of the vehicle. Another aim was the completion of a dive trip with the ROV ERNO 2 as well as the successful use of Enitech modules in the test carrier of the TUB. Furthermore, the Enitech GmbH was involved in the tests performed by KIT using the access points.

Realization: To meet the objective, the AUV should, for a given schedule and under consideration of weather and the tasks of the other research participants, take trips at depths of up to 5500 m depth. Each trip was set up with new tasks to test the relevant aspects; in total all dives should be executed. One of the test tasks was to test the function for dropping the emergency weight. Moreover, it should be practiced every time you dive the deployment and recovery of the AUV's. The use of Enitech modules in the test carrier of the TUB was carried out in collaboration with TUB, the test itself however was conducted by the TUB.

Results: Due to the weather conditions throughout the journey and the tasks of the other research participants only one test drive at the end of the expedition at a location south of the Azores was possible and carried out. The test ride was over the duration of half a day. Because of incomplete trimming of the vehicle several individual trips were necessary with corresponding deployment and recovery of the AUV's. The deployment and recovery was smooth and without any problems.

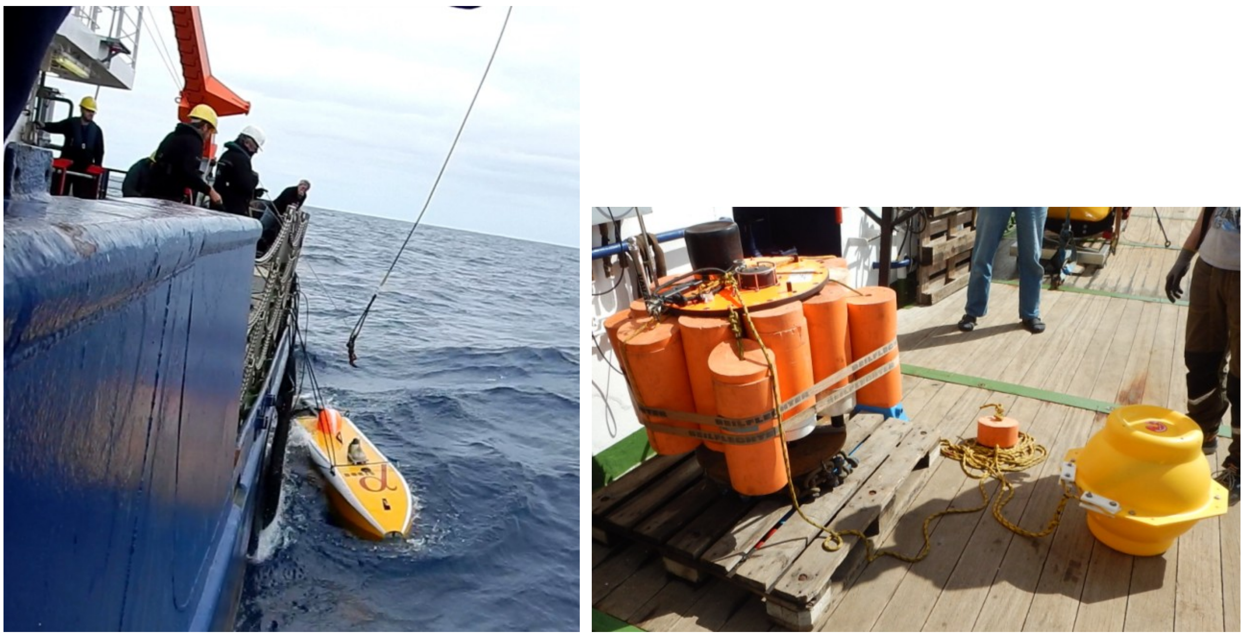


Fig. 4 Working with DORIS, the recovery of the AUV (left) and preparation of the access point (right).

During the dive with the AUV's the heading and the depth regulation has been successfully tested. The AUV reached approximately 1000 m depth. Deeper diving trip had to be canceled due to lack of time. During the dive trip there was a failure of the Xsens compass because of flooding, but this did not lead to abortion of the dive. Additionally, the dropping of the emergency weight was carried out successfully.

The only dive with the AUV has been a great success so far, that the relevant components of the AUV's successfully performed their duties, and the vehicle has passed a depth of over 1000 m successfully. During the dive new insights especially on the operation of the AUV's and the visualization of the dive-related parameters could be obtained and that will be applied in future operations. The ROV ERNO 2 could also complete a dive trip and reached here to a depth over 5000 m. Unfortunately, ERNO 2 could not be separated from the garage, as at depth a single drive was not working. The error could be fixed on board, but for time reasons no second dive of the ROV was possible (Fig. 4).

At the dives of the test carrier of the TUB, there was a failure of multiple Enitech modules by a short circuit and a subsequent fire. All modules could also be repaired on board and then allowed a successful application of these modules in the test carrier the TUB. For the tests of the company KIT, Enitech GmbH assisted in a supportive role.

4.5 (D. Oertel, KIT)

Motivation: Besides participating in the AUV tests (see report by Enitech and University of Rostock), there was one major test by KIT referring to acoustic communication. The aim of the performed test was to receive data for the absolute positioning accuracy of long range USBL measurements over the full targeted sea depth (5000 m) and collecting test data for possible positioning improvements by incorporating the sound velocity profile obtained by a CTD-probe.

Test Description: As a test preparation, an acoustic USBL modem was mounted on a mooring device – called Access Point (AP) here. Preliminary buoyancy and weight releaser tests were performed in advance to ensure a safe return to the surface. A second modem was mounted on the ship's moon pool. The AP at the sea bottom should be located periodically by the ship's modem to receive absolute positioning fix accuracy. Complementary, the AP's communication and positioning output was logged. After releasing the AP to the sea (evening of May 25th), it descended to the sea bottom for about 1:20h. An acoustic baffle was then mounted to the ship's modem in order to decrease noise influence. After taking a full-depth CTD-probe, the actual AP-related tests started, which consisted of circling the AP at several horizontal distances (0.5, 1, 2, 3, 3.5 to 4 nautical miles) for about half an hour each while tracking it acoustically via the ship's modem. Upon finishing the circling, the AP's weight was released, and after ascending to the surface, it was collected by the crew (morning of May 26th).

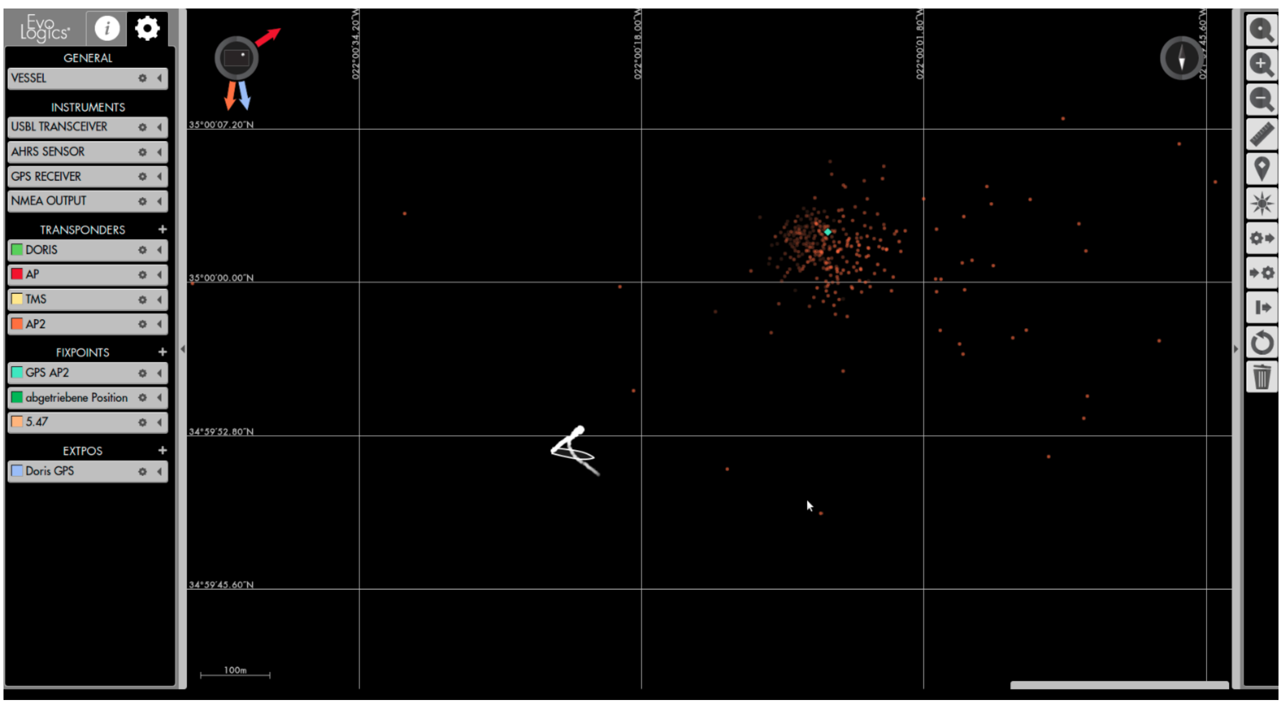


Fig. 5. AUV positioning (red dots) relative to the vessel (here R/V Poseidon, white in center)

Results: When the modem reached a depth of more than 1600 m, the ship's modem was almost not able to calculate a positioning fix from the acoustic signal received by the AP although it did receive many of the acoustic responses by the AP. This was probably due to ship's and waves' noise impairing the received signal strength. Thus, the exact AP's position was not known during the trials. Moreover, the estimated position during descending (up to 1600 m) scattered a lot, partly due to inaccuracies/delays in taking ship's motion into account. An overview of this can be found in the first picture attached (Fig. 5). On the other hand, the AP positioned on the floor had no problems receiving the acoustic signal from the ship's modem. Due to in general very slow currents in the deep sea, AP was assumed to remain motionless while resting on the sea bottom. Thus, the logged USBL-angles calculated by the AP's modem were used to obtain the desired accuracy information. To achieve this, ship's GPS information, slant range (estimated by successful round trip signal runtime) and USBL angles from the AP were merged to obtain the desired accuracy information (I). Moreover, the test data was evaluated with respect to improvements by incorporating the sound velocity profile and known depth of the participants into the data (II). Based on the results so far, the latter delivers improved results for horizontal distances greater than 2000 m (at surface-to-bottom communication). A first impression can be seen in the second picture attached [Colors are as follows: Blue line - ship's GPS track; Red dots – ship position estimation through (I); yellow dots – ship position estimation through (II)]. Details will be published at a conference later (Fig. 6).

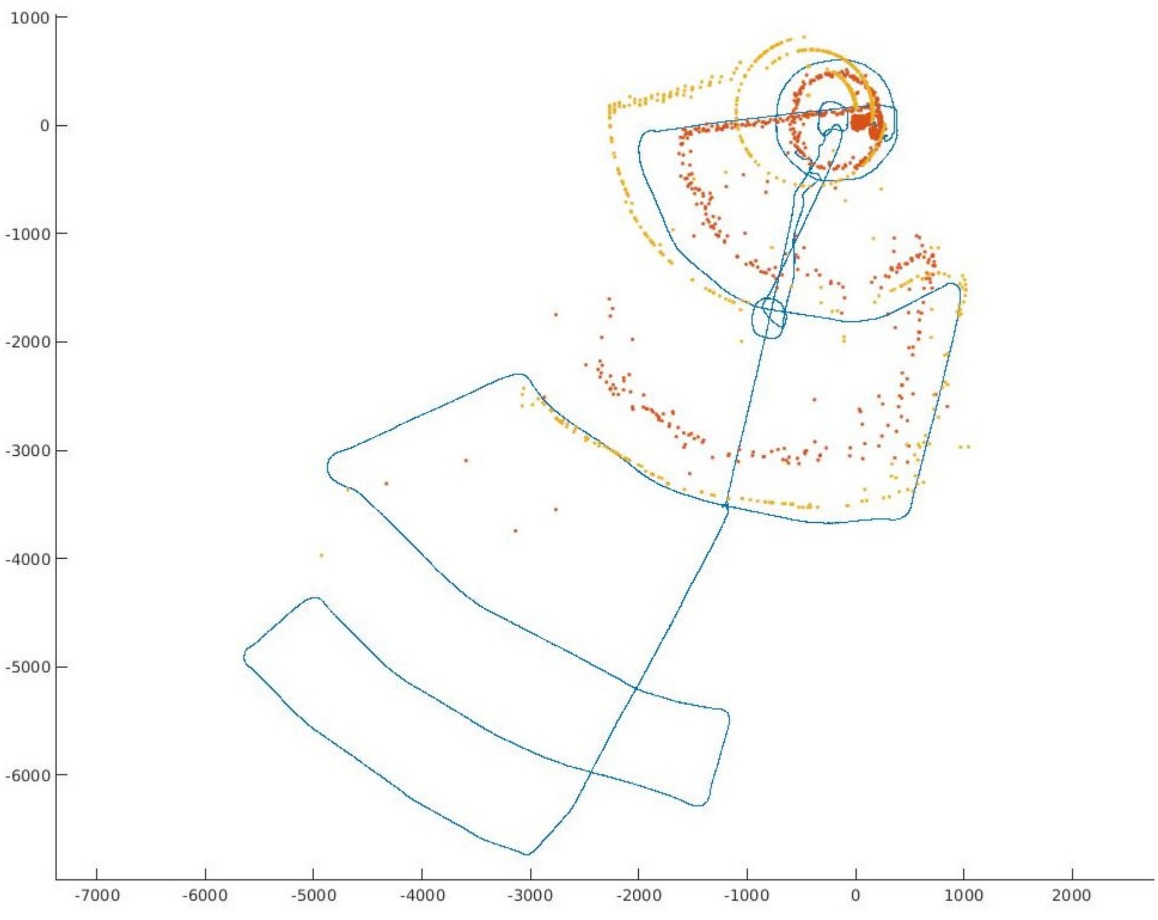


Fig. 6. Underwater communication between different SMIS components: Blue line - ship's GPS track; Red dots – ship position estimation through AP; yellow dots – ship position estimation through a setup including measured sound velocity.

4.5. Test carrier VBS-VT – suction pump and variable ballast system (VBS) in deep sea (S. Ritz, M. Golz , TU Berlin)

For the intended test of the variable ballast system and the suction pump in deep sea, a purpose-built aluminium framework is used. Differently to the previous tests, the VBS-VT is not coupled with a tether management system (TMS). It is directly attached to the umbilical of the ship for communication purpose and for lowering / heaving the test carrier down to full ocean depth. Therefore, it is equipped with an own power supply system, a subsea communication unit, a light / camera system and different sensors to monitor the test run. Figure **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the test carrier during the recovery operation. The main characteristics can be summarized as: aluminium structure: 800 x 800 x 2000 mm (L x W x H); weight approx. 400 kg (excl. VBS) and variable ballast system (VBS): Ø 500 mm x 1200 mm, weight approx. 330 kg (incl. ballast water), fluid capacity approx. 60 liters.

The trials are used to determine the functionality and the characteristics of the suction pump and the variable ballast system (VBS). Furthermore the pressure resistance and reliability of some new components within the power supply system need to be checked. All tests are performed to utilize the gathered information for the prospected prototype of a seabed station. The VBS will be used to adjust the buoyancy of the seabed station to control its ascent and descent operation. The suction pump is the main component of the seabed anchoring system, which was successfully tested during the research cruise EMB091 in December 2014 down to 40 m (Baltic Sea). The influence of the deep-sea conditions (low temperature and high pressure) on the rubber impeller of the pump (EPDM) remained unclear. In order to fulfill the objectives, the following test campaigns were conducted:

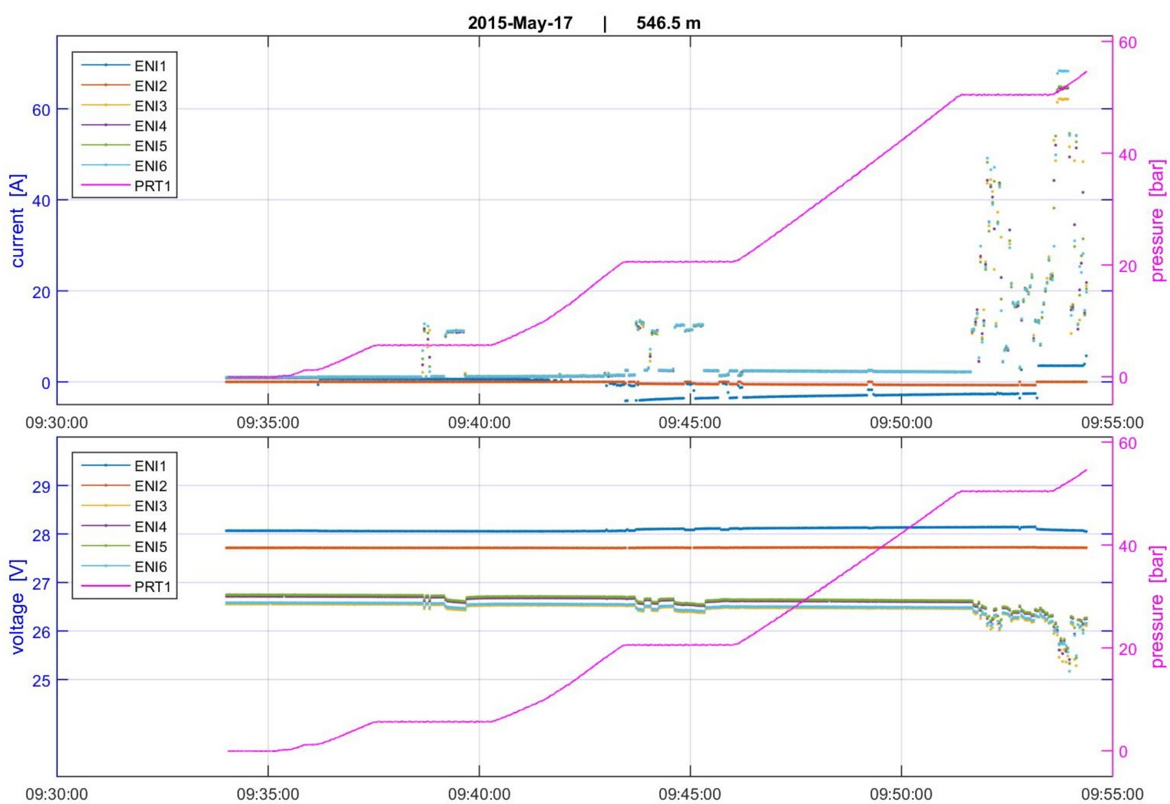


Fig. 7. Battery behaviour during the first trial (batteries: ENI 1 - ENI 6).

1. Trial (17.05.2015, UTC 09:34, 35°00.00'N | 21°00.00'W, 550 m)

An overall check at 50 m and 200 m depth passed without any failure. Figure 7 shows the battery behavior during the trial. The pressure history (nearly depth/10) is represented by the magenta line. The measurement sequences can be identified by the pressure plateaus (sequence with constant pressure) and the power consumption (running motor). At 500 m the current of the batteries increased significantly, while the voltage dropped down. At 550 m the current reached almost 70 ampere before the system broke down. Reason: The 110 volts conducting paths caused a short circuit to the auxiliary voltage system, this forced some copper conductors to melt and end up with a fire in three electronic devices (Enitech devices: BG155, BG166, BG113). As a result, three electronic devices, three underwater lamps and two fuses were damaged.

2. Trial (21.05.2015, UTC 09:04, 31°00.00'N | 21°00.00'W, 4530 m)

A workaround within the power system helped to get the VBS-VT ready-to-operate for a second and third trial. The test procedure was as follows: After pre-tests in 50 m and 200 m, the power consumption of the VBS pump and the suction pump, the water outlet and the overall system behavior was logged in 500 m steps. Figure 8 shows the history of the motor speed and current consumption of the suction pump. It can be seen that the power consumption of the suction pump is roughly constant with varying depth. This implies that the rising pressure and low temperature has no influence on the impeller material.

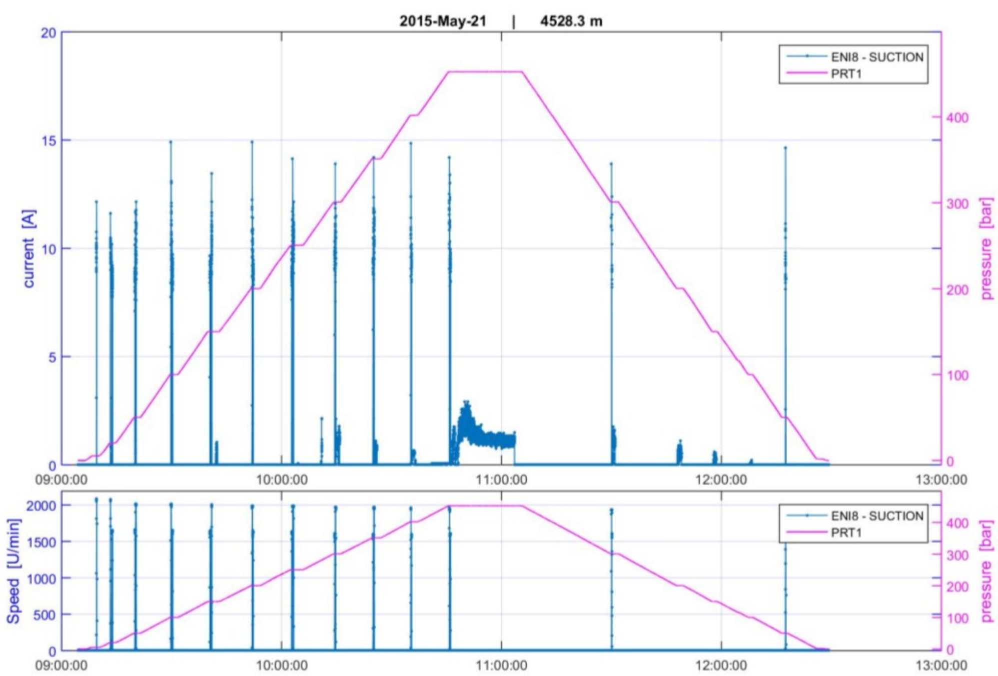


Fig. 8. Motor speed and current consumption of the suction pump.

3. Trial (22.05.2015, UTC 17:50, 31°00.00'N | 23°00.00'W, 4630 m)

Only some modifications were made for the third deep-sea trial, e.g. nearly constant motor gain values of the VBS pump motor for every depth and more measurement points during the heaving phase. Figure

9 shows the motor speed and current consumption of the VBS pump. With rising depth the required power to drive the water-hydraulic pump increased nearly in a linear manner. At 4630 m it took around 2100 Watts to pump the water out of the ballast tank, which is about 60 % of the available motor power. Furthermore the function of a passive sonar reflector could be verified. The track of the test carrier could be seen very clear even in depth of more than 4500 m on the display of the 12 kHz echo sounder, which wasn't proven by the manufacturer before. Other structures with similar size and without a sonar reflector were not or hardly even seen on the monitor.

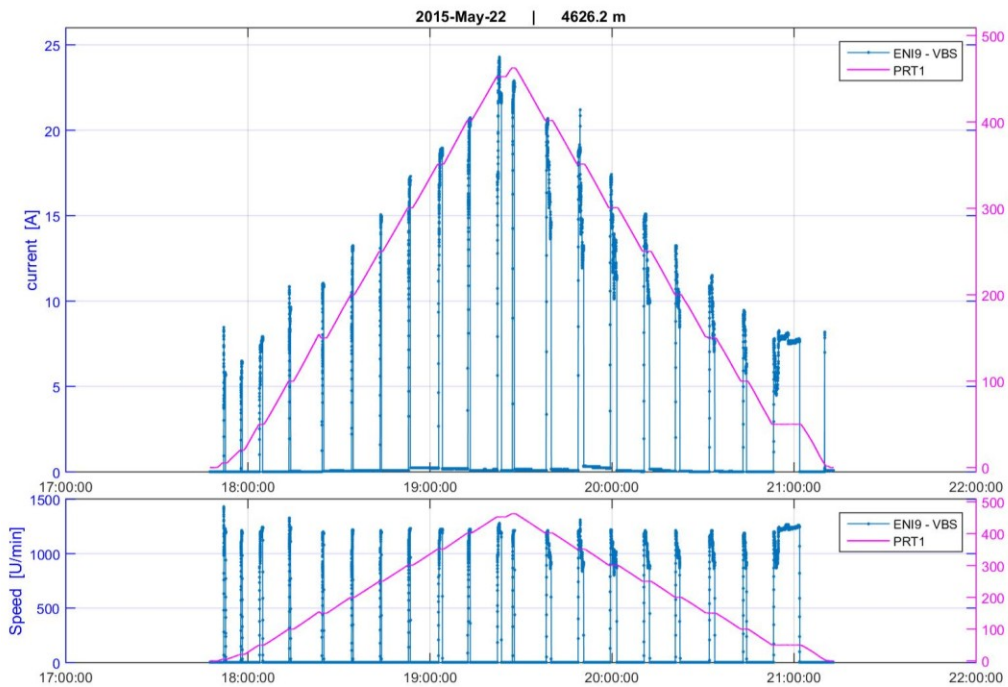


Fig. 9. Motor speed and current consumption of the VBS pump.

All in all, and despite the fire during (Fig. 10) the first trial it was a successful expedition for Technical University of Berlin. The VBS pump system and the suction pump worked reliable and without any failure down to 4600 m. Power reserves of the VBS motor and the pressure and temperature independent behavior of the suction pump signalize the potential to operate even in deeper regions.

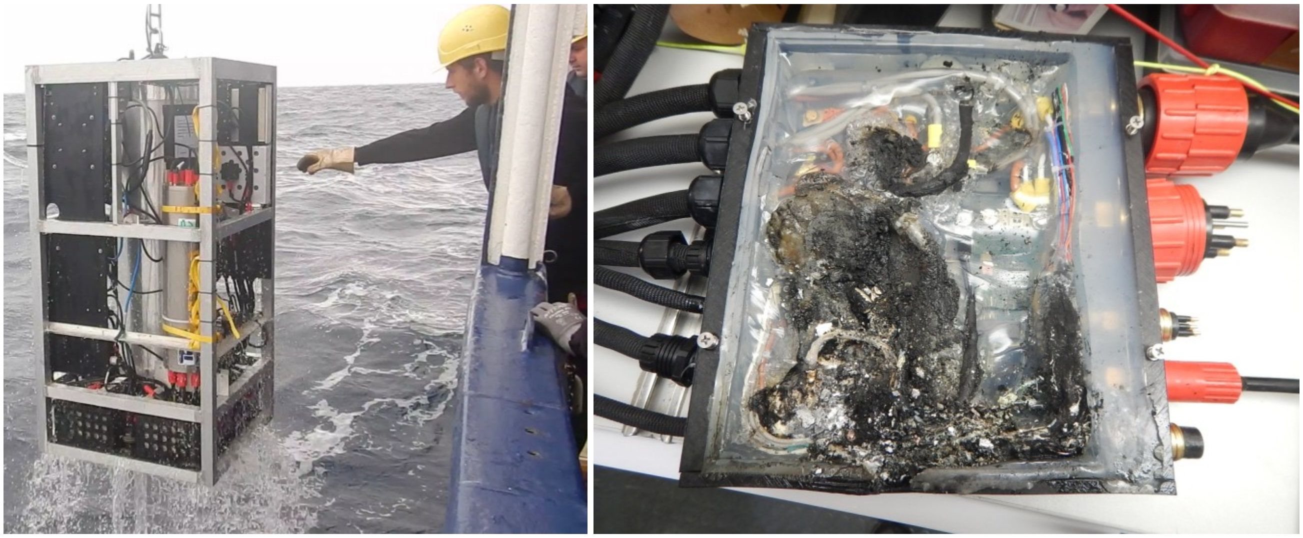


Fig. 10. Test carrier: VBS-VT and scorched Enitech component after the first sea trial.

5. Scientific equipment, moorings and instruments

5.1. CTD/ Water Sampling (J. Waniek, R. Mars, W. Reimann IOW)

During the cruise a CTD system composed of SBE9plus and a 14 Hydrobios free flow bottles of 5L each was used. The CTD had additionally a second temperature sensor and sensors for dissolved oxygen, turbidity and chlorophyll a as well mounted and an altimeter devise to detect the bottom. Almost all cast were carried out over the full water depth. After initial problems with some of the connecting cables, the entire system runs smoothly. In total 25 CTD profiles of 5000 m or more were obtained during the cruise.

5.2. Kiel276-29 mooring

During the cruise Kiel276-29b deployed in September 2013 was recovered. The sub-surface buoy, several buoyancy spheres, 2 Aanderaa current meters and 1500 m of line were lost, as already notified by the ARGIS beacon in December 2014. The remaining mooring components were successfully recovered including 4 Aanderaa RCM7/8, 2 sediment traps, 30 buoyancy spheres, inclinometer and two releaser units.

6. Acknowledgements

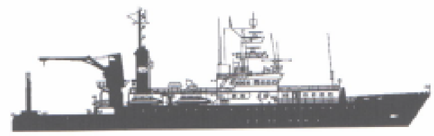
We thank Captain Matthias Günther and the crew of R/V Poseidon for their support and help during this cruise.

7. Appendices

Appendix A: Mooring protocol

Briese Schiffahrts GmbH & Co. KG Abteilung Forschungsschifffahrt
Hafenstraße 12 26789 Leer Germany

Forschungsschiff / Research Vessel
„POSEIDON" DBKV IMO 7427518
Phone: +49 421 944024 3011
Fleet77: 00870 761651773
GSM: 0049 1716070932
Fax: 00870 60027 3636
E-Mail: bruecke@poseidon.briese-research.de



Bergungsprotokoll

Datum:	20.05.2015
Reise Nr.:	POS 485
Stations Nr.:	174-2
Zeitzone:	UTC +1

Verankerung

Bezeichnung:	KIEL 276-29b
Betreiber:	IOW
Kurzbeschreibung:	Lange Verankerung mit 2 Sedimentfallen und mehreren RCMs

Wetter/Seebedingungen

Wetter:	Bedeckt, gute Sicht
Luft:	17,4 °C
Wasser:	19,3 °C
See/Dünung:	2,5 m
Strom:	nicht feststellbar
Luftdruck:	1029,2 hPa
Wassertiefe:	5250 m

Zeit	Aktion	Position	
07:02 UTC	Hydrophon zu Wasser	33°18,96´N	021°31,10´W
07:13 UTC	Ausgelöst	33°18,98´N	021°31,08´W
08:07 UTC	Verankerung aufgetaucht und gesichtet	33°19,03´N	021°31,15´W
08:22 UTC	3 Benthos und RCM an Deck	33°19,02´N	021°31,16´W
08:36 UTC	5 Benthos an Deck	33°18,80´N	021°31,13´W
08:43 UTC	Sedimentfalle an Deck	33°18,70´N	021°31,11´W
09:23 UTC	5 Benthos und RCM an Deck	33°18,29´N	021°31,10´W
09:31 UTC	Sedimentfalle an Deck	33°18,17´N	021°31,14´W
09:47 UTC	2 Bentos an Deck	33°17,96´N	021°31,07´W
10:17 UTC	2 Benthos an Deck	33°17,65´N	021°31,01´W
10:31 UTC	8 Benthos und RCM an Deck	33°17,53´N	021°31,02´W
10:32 UTC	Releaser an Deck	33°17,52´N	021°31,03´W

Bemerkungen: Die Reste der im Herbst 2013 ausgelegten Verankerung Kiel 276-29b konnten trotz fehlender Kopfboje problemlos geborgen werden. Die Kopfboje und der obere Teil der Verankerung waren zwischen ca. 1000 m und ca. 1500 m Wassertiefe aus unbekannter Ursache abgerissen.

Briese Schiffahrts GmbH & Co. KG
POSEIDON

Matthias Günther, Kapitän FS Poseidon

Appendix B: List of stations

Station No.	Date	Time UTC	PositionLat	PositionLon	Depth m	Wind m/s	Instrument	Action	Remarks
167-1	17.05.	05:42	35° 0,01' N	21° 0,03' W	5141,2	ENE 9	CTD/rosette water sampler	zu Wasser	06:42 LT (05:42 UTC) Beginn der Arbeiten POS 485
167-1	17.05.	07:17	35° 0,01' N	21° 0,06' W	5137,9	NE 8	CTD/rosette water sampler	auf Tiefe	SL max.: 5234 m
167-1	17.05.	09:02	35° 0,02' N	21° 0,07' W	5139	ENE 8	CTD/rosette water sampler	an Deck	
167-2	17.05.	09:34	34° 59,98' N	20° 59,99' W	5140,4	ENE 7	AUV Bottom Station	Zu Wasser	
167-2	17.05.	09:55	34° 59,99' N	21° 0,01' W	5137,4	NE 8	AUV Bottom Station	Auf Tiefe	SL max.: 563 m, Versuch abgebrochen
167-2	17.05.	10:08	34° 59,98' N	20° 59,99' W	5137,1	NE 7	AUV Bottom Station	An Deck	
168-1	17.05.	17:27	33° 59,99' N	20° 59,84' W	5176,4	NNE 9	CTD/rosette water sampler	zu Wasser	
168-1	17.05.	18:57	33° 59,95' N	20° 59,60' W	5176,7	NE 7	CTD/rosette water sampler	auf Tiefe	SL max.: 5276 m
168-1	17.05.	20:40	33° 59,78' N	20° 59,38' W	5178,8	NE 8	CTD/rosette water sampler	an Deck	
169-1	18.05.	04:13	33° 0,01' N	21° 0,03' W	5157,2	NNE 9	CTD/rosette water sampler	zu Wasser	
169-1	18.05.	05:47	32° 59,87' N	20° 59,88' W	5146,4	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 5244 m
169-1	18.05.	07:30	32° 59,56' N	20° 59,66' W	5158,3	NNE 10	CTD/rosette water sampler	an Deck	
170-1	18.05.	14:27	31° 59,96' N	21° 0,04' W	4856,9	NE 8	CTD/rosette water sampler	zu Wasser	
170-1	18.05.	15:51	32° 0,01' N	21° 0,02' W	4857,6	NNE 10	CTD/rosette water sampler	auf Tiefe	SL max.: 4936 m
170-1	18.05.	17:26	32° 0,04' N	21° 0,05' W	4855,4	NNE 9	CTD/rosette water sampler	an Deck	
171-1	18.05.	22:53	31° 59,99' N	22° 0,01' W	5053,2	NE 10	CTD/rosette water sampler	zu Wasser	
171-1	19.05.	00:22	31° 59,99' N	22° 0,02' W	5052,8	NE 10	CTD/rosette water sampler	auf Tiefe	SL max.: 5147 m
171-1	19.05.	01:52	32° 0,03' N	21° 59,98' W	5052,4	NE 9	CTD/rosette water sampler	an Deck	
172-1	19.05.	08:39	32° 58,69' N	22° 4,18' W	5222,9	E 6	Mooring	Hydrophon zu Wasser	
172-1	19.05.	08:48	32° 58,64' N	22° 4,18' W	0	ENE 8	Mooring	ausgelöst	1. Auslöseversuch, keine Antwort
172-1	19.05.	08:48	32° 58,64' N	22° 4,18' W	0	ENE 8	Mooring	Hydrophone an Deck	
172-1	19.05.	10:28	32° 58,70' N	22° 3,87' W	0	ENE 6	Mooring	Hydrophon zu Wasser	
172-1	19.05.	12:38	32° 58,68' N	22° 3,98' W	0	NE 7	Mooring	Hydrophone an Deck	
172-1	19.05.	12:52	32° 58,94' N	22° 3,60' W	0	ENE 5	Mooring	Hydrophon zu Wasser	
172-1	19.05.	13:02	32° 58,94' N	22° 3,61' W	0	ENE 6	Mooring	Hydrophone an Deck	
172-1	19.05.	13:02	32° 58,94' N	22° 3,61' W	0	ENE 6	Mooring	Aktion	Bergungsversuch der Verankerung abgebrochen.
172-2	19.05.	13:07	32° 58,96' N	22° 3,57' W	5223,8	ENE 7	CTD/rosette water sampler	zu Wasser	
172-2	19.05.	14:37	32° 58,99' N	22° 3,59' W	5223,6	NE 7	CTD/rosette water sampler	auf Tiefe	SL max.: 5328 m

172-2	19.05.	16:17	32° 59,02' N	22° 3,46' W	5223,3	ENE 7	CTD/rosette water sampler	an Deck	
173-1	19.05.	20:31	33° 30,00' N	22° 0,00' W	5269,8	ENE 9	CTD/rosette water sampler	zu Wasser	
173-1	19.05.	22:03	33° 29,87' N	21° 59,71' W	5270,1	ENE 7	CTD/rosette water sampler	auf Tiefe	SL max.: 5380 m
173-1	19.05.	23:42	33° 29,81' N	21° 59,28' W	5269,5	ENE 7	CTD/rosette water sampler	an Deck	
174-1	20.05.	02:57	33° 18,90' N	21° 32,17' W	5250,1	ENE 7	CTD/rosette water sampler	zu Wasser	
174-1	20.05.	04:27	33° 18,75' N	21° 31,94' W	5250,5	ENE 7	CTD/rosette water sampler	auf Tiefe	SL max.: 5354 m
174-1	20.05.	05:59	33° 18,46' N	21° 31,71' W	5250,1	ENE 8	CTD/rosette water sampler	an Deck	
174-2	20.05.	07:02	33° 18,96' N	21° 31,10' W	5250,3	ENE 7	Mooring	Hydrophon zu Wasser	
174-2	20.05.	07:13	33° 18,98' N	21° 31,08' W	0	ENE 7	Mooring	ausgelöst	1. Auslöseversuch, keine Antwort vom Releaser
174-2	20.05.	08:07	33° 19,03' N	21° 31,15' W	0	ENE 7	Mooring	aufgetaucht	
174-2	20.05.	08:12	33° 19,02' N	21° 31,18' W	0	ENE 7	Mooring	Hydrophone an Deck	
174-2	20.05.	08:22	33° 19,02' N	21° 31,16' W	0	NE 7	Mooring	Aktion	3 Benthoskugeln mit RCM-8 AVTP an Deck
174-2	20.05.	08:36	33° 18,80' N	21° 31,13' W	0	NE 8	Mooring	Aktion	5 Benthoskugeln an Deck
174-2	20.05.	08:43	33° 18,70' N	21° 31,11' W	0	ENE 7	Mooring	Aktion	Sedimentfalle 1 an Deck
174-2	20.05.	09:23	33° 18,29' N	21° 31,10' W	0	ENE 7	Mooring	Aktion	5 Benthoskugeln mit RCM-8 AVT LR an Deck
174-2	20.05.	09:31	33° 18,17' N	21° 31,14' W	0	ENE 8	Mooring	Aktion	Sedimentfalle 2 an Deck
174-2	20.05.	09:47	33° 17,96' N	21° 31,07' W	0	NE 7	Mooring	Aktion	2 Benthoskugeln an Deck
174-2	20.05.	10:17	33° 17,65' N	21° 31,01' W	0	NE 8	Mooring	Aktion	2 Benthoskugeln an Deck
174-2	20.05.	10:31	33° 17,53' N	21° 31,02' W	0	ENE 7	Mooring	Aktion	2 Benthoskugeln an Deck
174-2	20.05.	10:31	33° 17,53' N	21° 31,02' W	0	ENE 7	Mooring	Aktion	6 Benthoskugeln mit RCM-8 AVT LR an Deck
174-2	20.05.	10:32	33° 17,52' N	21° 31,03' W	0	NE 6	Mooring	Releaser an Deck	
175-1	21.05.	05:31	31° 0,01' N	21° 0,02' W	4845,7	NE 10	CTD/rosette water sampler	zu Wasser	
175-1	21.05.	07:00	31° 0,02' N	20° 59,98' W	4904,2	NE 12	CTD/rosette water sampler	auf Tiefe	SL max.: 4878 m
175-1	21.05.	08:28	30° 59,99' N	21° 0,06' W	4869,5	ENE 11	CTD/rosette water sampler	an Deck	
175-2	21.05.	09:06	30° 59,97' N	21° 0,04' W	4884,7	NE 11	AUV Bottom Station	Zu Wasser	
175-2	21.05.	10:47	31° 0,00' N	20° 59,96' W	0	NE 10	AUV Bottom Station	Auf Tiefe	SL max.: 4500 m
175-2	21.05.	12:29	30° 59,96' N	21° 0,02' W	4873,6	NE 10	AUV Bottom Station	An Deck	
176-1	21.05.	21:58	30° 0,00' N	22° 0,07' W	4810,2	NE 12	CTD/rosette water sampler	zu Wasser	
176-1	21.05.	23:05	29° 59,98' N	22° 0,04' W	0	NE 10	CTD/rosette water sampler	auf Tiefe	SL max.: 3895 m
176-1	22.05.	00:24	29° 59,95' N	22° 0,06' W	4993,6	NE 11	CTD/rosette water sampler	an Deck	
177-1	22.05.	08:24	31° 0,01' N	21° 59,98' W	0	NE 10	CTD/rosette water sampler	zu Wasser	

177-1	22.05.	09:51	30° 59,92' N	21° 59,82' W	5009,1	NE 10	CTD/rosette water sampler	auf Tiefe	SL max.: 5099 m
177-1	22.05.	11:27	30° 59,80' N	21° 59,19' W	4852,8	NNE 8	CTD/rosette water sampler	an Deck	
178-1	22.05.	17:49	31° 0,02' N	23° 0,01' W	5203,2	NE 9	AUV Bottom Station	Zu Wasser	
178-1	22.05.	19:26	30° 59,97' N	22° 59,93' W	5202,4	NE 9	AUV Bottom Station	Auf Tiefe	SL max.: 4600 m
178-1	22.05.	19:27	30° 59,97' N	22° 59,93' W	5203,4	NE 8	AUV Bottom Station	Hieven	
178-1	22.05.	21:12	30° 59,91' N	22° 59,86' W	5204,8	NNE 8	AUV Bottom Station	An Deck	
178-2	22.05.	22:59	30° 59,98' N	22° 59,94' W	5201,8	NE 9	CTD/rosette water sampler	zu Wasser	
178-2	23.05.	00:29	30° 59,98' N	23° 0,00' W	5217,3	NE 8	CTD/rosette water sampler	auf Tiefe	SL max.: 5303 m
178-2	23.05.	01:55	30° 59,95' N	23° 0,08' W	5202,3	NE 8	CTD/rosette water sampler	an Deck	
179-1	23.05.	09:51	31° 59,99' N	22° 59,97' W	5263,4	NE 10	Access Point	zu Wasser	Trimmtest
179-1	23.05.	09:53	31° 59,99' N	22° 59,96' W	5265,4	NE 10	Access Point	an Deck	
179-2	23.05.	10:15	31° 59,93' N	22° 59,90' W	5270,9	NE 9	Access Point	zu Wasser	Test am Kabel
179-2	23.05.	10:16	31° 59,93' N	22° 59,89' W	5263,1	NE 9	Access Point	auf Tiefe	SL max.: 15 m
179-2	23.05.	10:41	31° 59,86' N	22° 59,76' W	0	NNE 9	Access Point	an Deck	
179-3	23.05.	10:53	31° 59,83' N	22° 59,69' W	0	NE 9	CTD/rosette water sampler	zu Wasser	
179-3	23.05.	11:06	31° 59,78' N	22° 59,63' W	5262	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 301 m
179-3	23.05.	11:12	31° 59,75' N	22° 59,61' W	5270,1	NNE 10	CTD/rosette water sampler	an Deck	
179-4	23.05.	11:18	31° 59,76' N	22° 59,60' W	5237,8	NNE 9	CTD/rosette water sampler	zu Wasser	
179-4	23.05.	12:59	31° 59,64' N	22° 59,38' W	5262,6	NE 10	CTD/rosette water sampler	auf Tiefe	SL max.: 5376 m
179-4	23.05.	14:26	31° 59,69' N	22° 59,27' W	5262,8	NE 9	CTD/rosette water sampler	an Deck	
179-5	23.05.	14:34	31° 59,68' N	22° 59,30' W	5261,1	NE 11	Access Point	zu Wasser	Trimmtest mit W4
179-5	23.05.	14:49	31° 59,64' N	22° 59,27' W	5264,2	NE 10	Access Point	an Deck	
179-6	23.05.	15:10	31° 59,65' N	22° 59,26' W	5262	NE 9	Remote operated vehicle	zu Wasser	ROV ERNO 2
179-6	23.05.	17:47	31° 59,61' N	22° 59,22' W	5262,3	NE 11	Remote operated vehicle	Information	Verschiedene Tests mit ROV ERNO 2
179-6	23.05.	17:48	31° 59,62' N	22° 59,22' W	5265,4	NNE 11	Remote operated vehicle	auf Tiefe	SL max.: 5383 m
179-6	23.05.	20:02	31° 59,55' N	22° 59,27' W	5260,9	NNE 9	Remote operated vehicle	an Deck	
180-1	24.05.	04:32	33° 0,00' N	23° 0,01' W	5324,8	NNE 9	CTD/rosette water sampler	zu Wasser	
180-1	24.05.	06:08	33° 0,05' N	22° 59,96' W	5325,1	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 5408 m (Max. Länge W2)
180-1	24.05.	07:50	33° 0,12' N	22° 59,97' W	5319,3	ENE 6	CTD/rosette water sampler	an Deck	
181-1	24.05.	15:46	33° 59,97' N	23° 0,05' W	5297,9	NNE 8	CTD/rosette water sampler	zu Wasser	
181-1	24.05.	17:27	33° 59,99' N	22° 59,95' W	5298	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 5401 m

181-1	24.05.	19:07	33° 59,96' N	22° 59,98' W	5308,4	NNE 9	CTD/rosette water sampler	an Deck	
182-1	25.05.	01:32	33° 59,92' N	21° 59,97' W	5290,5	NE 12	CTD/rosette water sampler	zu Wasser	
182-1	25.05.	03:08	33° 59,92' N	22° 0,01' W	5298,9	NE 10	CTD/rosette water sampler	auf Tiefe	SL max.: 5395 m
182-1	25.05.	04:42	33° 59,97' N	22° 0,00' W	5290,9	NNE 7	CTD/rosette water sampler	an Deck	
183-1	25.05.	08:44	34° 30,02' N	22° 0,01' W	5165,5	NE 6	CTD/rosette water sampler	zu Wasser	
183-1	25.05.	10:24	34° 29,96' N	21° 59,90' W	5164,1	NE 8	CTD/rosette water sampler	auf Tiefe	SL max.: 5264 m
183-1	25.05.	11:57	34° 29,98' N	21° 59,83' W	5213,3	NE 8	CTD/rosette water sampler	an Deck	
183-2	25.05.	12:17	34° 29,96' N	21° 59,88' W	5184	NE 8	Access Point	zu Wasser	
183-2	25.05.	12:19	34° 29,96' N	21° 59,89' W	0	NE 8	Access Point	Information	Releasertest, Hydrophon z. W.
183-2	25.05.	12:20	34° 29,96' N	21° 59,89' W	0	NE 8	Access Point	Information	Hydrophon a. D.
183-2	25.05.	12:22	34° 29,96' N	21° 59,88' W	5162,8	NNE 8	Access Point	an Deck	
184-1	25.05.	16:36	35° 0,03' N	22° 0,07' W	4996,6	NNE 9	Access Point	Information	Access Point zu Wasser - Trimmtest
184-1	25.05.	16:58	35° 0,04' N	22° 0,08' W	5041,4	NNE 8	Access Point	zu Wasser	
184-2	25.05.	18:42	35° 0,01' N	21° 59,99' W	0	NE 9	CTD/rosette water sampler	zu Wasser	
184-2	25.05.	20:14	35° 0,05' N	21° 59,97' W	0	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 5103 m
184-2	25.05.	21:46	34° 59,96' N	21° 59,85' W	0	NE 9	CTD/rosette water sampler	an Deck	
184-1	25.05.	22:05	35° 0,03' N	21° 59,77' W	0	ENE 8	Access Point	Information	Beginn Meßfahrt
184-1	26.05.	06:00	34° 59,71' N	22° 0,28' W	0	NE 7	Access Point	Information	Ende Meßfahrt
184-1	26.05.	06:11	34° 59,79' N	22° 0,27' W	0	NE 7	Access Point	Information	Hydrophon z. W.
184-1	26.05.	06:15	34° 59,80' N	22° 0,27' W	0	ENE 8	Access Point	Information	Hydrophon a. D.
184-1	26.05.	08:17	34° 59,88' N	22° 0,30' W	0	ENE 9	Access Point	Information	Hydrophon z. W.
184-1	26.05.	08:23	34° 59,88' N	22° 0,28' W	0	ENE 8	Access Point	ausgelöst	
184-1	26.05.	09:37	34° 59,90' N	22° 0,18' W	0	NE 9	Access Point	Oberfläche	
184-1	26.05.	09:38	34° 59,90' N	22° 0,17' W	0	NE 9	Access Point	Information	Hydrophon a. D.
184-1	26.05.	09:47	34° 59,99' N	22° 0,04' W	0	ENE 8	Access Point	an Deck	
185-1	26.05.	16:27	35° 0,02' N	22° 59,98' W	4916,5	NE 5	CTD/rosette water sampler	zu Wasser	
185-1	26.05.	17:54	34° 59,97' N	22° 59,85' W	4880,2	NE 7	CTD/rosette water sampler	auf Tiefe	SL max.: 4980 m
185-1	26.05.	19:14	34° 59,91' N	22° 59,87' W	4956,1	NNE 9	CTD/rosette water sampler	an Deck	
186-1	27.05.	02:55	35° 59,96' N	23° 0,07' W	4423,6	NE 6	CTD/rosette water sampler	zu Wasser	
186-1	27.05.	04:16	36° 0,00' N	23° 0,02' W	4416,4	NE 8	CTD/rosette water sampler	auf Tiefe	SL max.: 4482 m
186-1	27.05.	05:35	36° 0,04' N	23° 0,03' W	4415,2	NE 11	CTD/rosette water sampler	an Deck	

187-1	27.05.	12:16	35° 59,93' N	22° 0,06' W	4216,4	NE 8	CTD/rosette water sampler	zu Wasser	
187-1	27.05.	13:32	36° 0,00' N	22° 0,06' W	4202,2	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 4275 m
187-1	27.05.	14:52	35° 59,95' N	22° 0,10' W	4251	NE 10	CTD/rosette water sampler	an Deck	
188-1	27.05.	21:34	35° 59,99' N	21° 0,02' W	5033,1	NE 10	CTD/rosette water sampler	zu Wasser	
188-1	27.05.	21:43	35° 59,97' N	20° 59,99' W	5035,1	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 183 m
188-1	27.05.	21:47	35° 59,97' N	20° 59,99' W	5033,9	NE 9	CTD/rosette water sampler	an Deck	
188-2	27.05.	21:53	35° 59,98' N	20° 59,98' W	5033,1	NE 9	CTD/rosette water sampler	zu Wasser	
188-2	27.05.	23:22	35° 59,96' N	20° 59,91' W	5034,8	NE 9	CTD/rosette water sampler	auf Tiefe	SL max.: 5129 m
188-2	28.05.	00:54	36° 0,00' N	20° 59,86' W	5035,1	NE 9	CTD/rosette water sampler	an Deck	
189-1	28.05.	09:58	36° 49,99' N	20° 30,00' W	4426,8	NE 10	CTD/rosette water sampler	zu Wasser	
189-1	28.05.	10:51	36° 49,95' N	20° 29,91' W	4423,5	NE 8	CTD/rosette water sampler	auf Tiefe	SL max.: 2991 m
189-1	28.05.	11:53	36° 50,00' N	20° 29,85' W	4457,9	NE 7	CTD/rosette water sampler	an Deck	
190-1	28.05.	21:07	36° 50,01' N	22° 0,01' W	4123,3	ENE 7	CTD/rosette water sampler	zu Wasser	
190-1	28.05.	22:25	36° 50,00' N	21° 59,89' W	4124,6	NE 7	CTD/rosette water sampler	auf Tiefe	SL max.: 4190 m
190-1	28.05.	23:44	36° 49,97' N	21° 59,74' W	4125	ENE 8	CTD/rosette water sampler	an Deck	
191-1	29.05.	04:59	36° 50,01' N	22° 50,01' W	4311,8	NE 8	CTD/rosette water sampler	zu Wasser	
191-1	29.05.	06:20	36° 50,04' N	22° 49,96' W	4311,5	NE 8	CTD/rosette water sampler	auf Tiefe	SL max.: 4383 m
191-1	29.05.	07:43	36° 50,03' N	22° 50,03' W	4401,6	NE 7	CTD/rosette water sampler	an Deck	
191-2	29.05.	08:39	36° 49,99' N	22° 50,00' W	4311,7	NE 8	Autonomous Underwater Vehicle	AUV zu Wasser	
191-2	29.05.	09:37	36° 50,07' N	22° 49,96' W	4311,5	ENE 7	Autonomous Underwater Vehicle	AUV an Deck	Gerät taucht nicht ab, Einsatz abgebrochen.
191-3	29.05.	10:24	36° 49,99' N	22° 50,02' W	4312,2	ENE 6	Autonomous Underwater Vehicle	AUV zu Wasser	
191-3	29.05.	11:04	36° 49,99' N	22° 49,98' W	4312,1	NE 8	Autonomous Underwater Vehicle	AUV an Deck	Gerät taucht nicht ab, Einsatz abgebrochen.
191-4	29.05.	12:10	36° 50,01' N	22° 49,96' W	4311,4	NE 8	Autonomous Underwater Vehicle	AUV zu Wasser	Tauchgang mit AUV, Tiefe: 1100 m
191-4	29.05.	15:27	36° 50,08' N	22° 50,21' W	4312,3	NE 6	Autonomous Underwater Vehicle	AUV an Deck	
191-4	29.05.	15:45	36° 50,10' N	22° 50,14' W	4315,5	NE 7	Autonomous Underwater Vehicle	Information	15:45 UTC Ende der Stationsarbeiten Reise POS 485