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**Short Cruise Report
RV SONNE SO268/1+2**

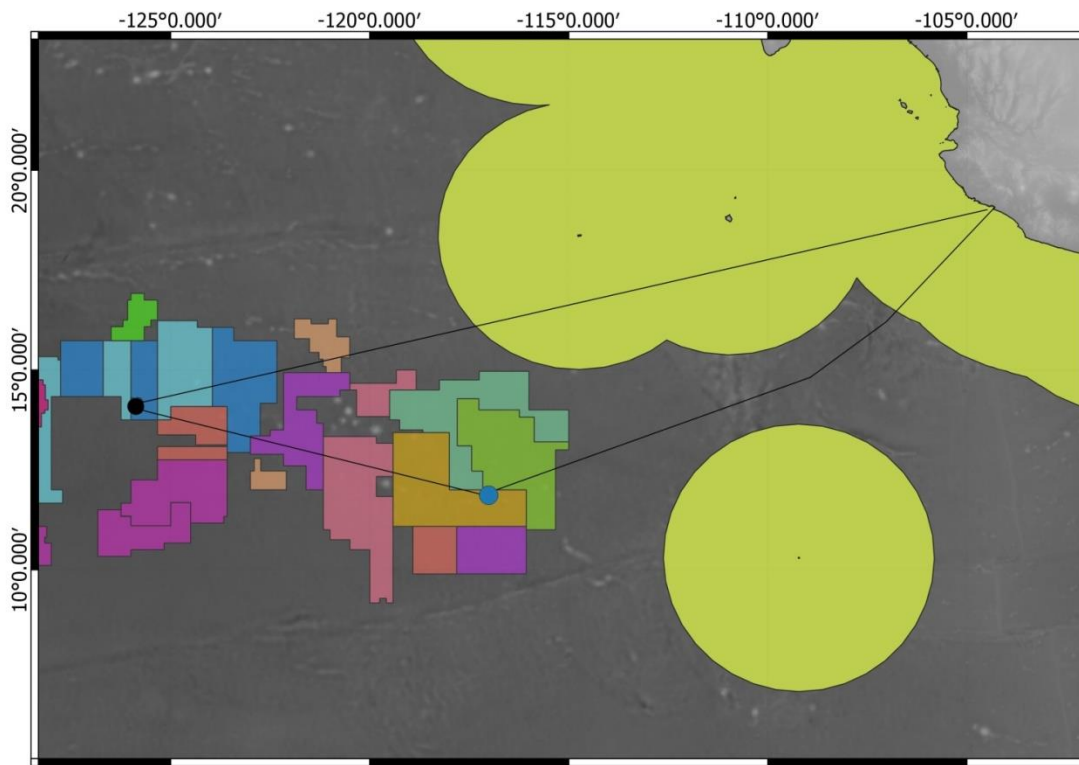
Manzanillo – Manzanillo – Vancouver

17.02.2019 – 27.05.2019

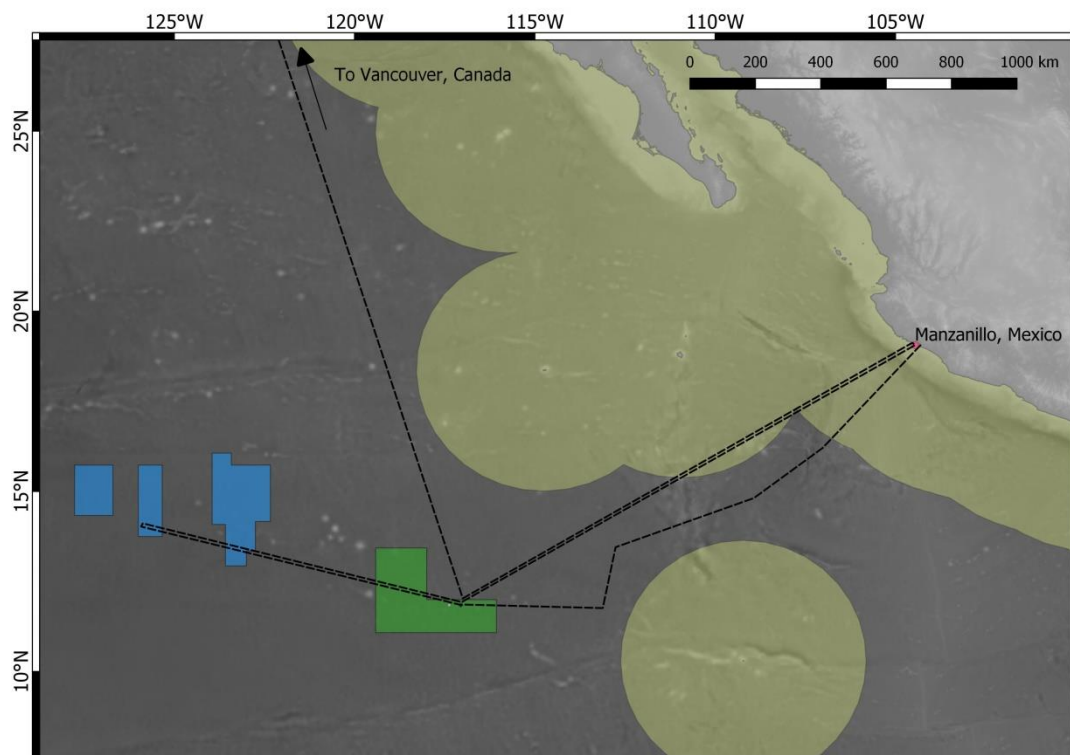
Chief Scientists: Dr. Peter Linke, Dr. Matthias Haeckel

Captain: Lutz Mallon





Cruise track of Leg 1: Map shows the working areas in the German (blue dot) and Belgian (black dot) contract areas of the Clarion-Clipperton Fracture Zone (CCZ). Colored shapes indicate the exploration license areas for polymetallic nodules issued by the International Seabed Authority in the Area, i.e. outside the Exclusive Economic Zones (yellow shapes) of any country.



Cruise track of Leg 2: Map shows the German and Belgian contract areas for polymetallic nodules. The main working areas were the same as on leg 1.

Objectives

Cruise SO268 is fully integrated into the second phase of the European collaborative JPI-Oceans project MiningImpact and is designed to assess the environmental impacts of deep-sea mining of polymetallic nodules in the Clarion-Clipperton Fracture Zone (CCZ). In particular, the cruise aimed at conducting an independent scientific monitoring of the first industrial test of a nodule collector by the Belgian company DEME-GSR. This includes collecting the required baseline data in the designated trial and reference areas in the Belgian and German contract areas, a quantification of the spread of the generated sediment plume during the trials as well as a first assessment of the induced impacts. However, during SO268 Leg 1 DEME-GSR informed us that the collector trials would not take place as scheduled due to unresolvable technical problems. Thus, we adjusted our work plan accordingly by implementing our backup plan. This involved conducting a small-scale sediment plume experiment with a small chain dredge to quantify the spatial and temporal spread of the suspended sediment particles, their concentration in the plume as well as the spatial footprint and thickness of the deposited sediment blanket from the plume.

Leg 1 and 2 acquired detailed environmental baseline data in the designated collector trial and reference areas as well as for the area of the small-scale sediment plume experiment. The plume experiment was monitored by an array of acoustic and optical sensors and the impacted area was investigated in order to develop standards and protocols for impact assessments and recommendations for policy and international legislation. A more technical aim of the cruise was to test tools, technologies, and a concept for the environmental monitoring of future deep-sea mining operations. This comprised oceanographic, biological, microbiological, biogeochemical, and geologic investigations which required the deployment of a multitude of seagoing equipment, such as ROV Kiel 6000 for sampling of sediments, nodules, and benthic fauna as well as carrying out in situ measurements and experiments. AUV ABYSS and ROV Kiel 6000 were used for high-resolution acoustic mapping of the seafloor using mounted multibeam systems and video/photo surveys of the manganese nodule habitat. This work was accompanied by video observations with OFOS. Several benthic landers and moorings with acoustic and optical sensors were deployed and recovered for the measurements of oceanographic, physical and chemical parameters. Coring devices (box corer, gravity corer, TV multi corer) were used for collecting sediment samples for biological, geochemical, and microbiological analyses, and the CTD rosette water sampler, in situ pumps, and a bottom water sampler for sampling the water column. In addition, a recolonization experiment for nodule-associated fauna was started by deploying artificial hard substrates on the seabed of the working areas.

Narrative

Leg 1 of the cruise started in Manzanillo, Mexico, with severe custom problems for all shipments, containers and airfreight, as well as the logistic handling of the research vessel, accumulating to a delay of one week before RV SONNE finally could set sail at 16:25 LT on the 24th of February. RV SONNE arrived in the German contract area for the exploration of polymetallic nodules in the Clarion-Clipperton Zone (CCZ) on February 27.

The working program started with the deployment of the long baseline transponder network for the underwater navigation of AUV Abyss and a CTD station to record a sound velocity profile required for multibeam mapping of the working area, which was conducted during the following night. This was followed by high-resolution mapping of a 12 square-kilometer large section of the working area by the AUV. Afterwards sediment sampling for the biology, microbiology and geochemistry groups started with a first deployment of the brand new multicorer of the Senckenberg Institute. This new multicorer is able to collect 20 cores of surface sediments per deployment. Before the AUV resurfaced after a 12-hr deployment, a mooring of BGR, deployed during SO262, was recovered and both elevator landers equipped with in situ modules and experiments were deployed for the upcoming ROV dive on 1st of March. This dive had to be aborted due to problems with the hydraulic oil system. Further problems occurred during the subsequent box coring for macrofauna sampling due to a failure of the trigger mechanism and a malfunctioning of the fiber optical cable of the video equipment of the OFOS sled during its descent to the seafloor. While the following deployments of the CTD with Niskin bottles and in situ pumps, the gravity corer and multiple corer were successful, the second deployment of the AUV did not record the intended photo mosaic of the trial area. The second ROV dive deployed the benthic chambers and profilers which had been brought down on the elevator landers a few days earlier. The pre-programmed measurement cycles were started, but the dive had to be terminated prematurely again due to continuous oil leakage problems.

After these initial technical problems, the sixth box corer did recover the desired sediment sample for macrofauna identification and quantification and also the following OFOS profile was successful. In the afternoon of March 4, a 500m-long mooring from the previous SO262 cruise with sediment trap and current meters was recovered followed by a second CTD station with in situ pumps and two more successful box corer stations. The two following ROV dives in the German trial area initiated the recolonization experiment with frames of artificial nodules, retrieved the scientific instrumentation placed at the seafloor on the previous dives by releasing the elevators mechanically, and sampled targeted macrofauna as well as push cores. On March 8 work in the German reference site proceeded with ROV dives placing microprofilers, benthic chambers, stand-alone cameras, amphipod traps and artificial nodule frames at the seafloor as well as push coring and macrofauna sampling. After a few successful multicorer and boxcorer deployments, the transponders and another mooring from SO262 were retrieved before RV SONNE started its transit to the Belgian working area.

After arriving in the Belgian trial area on March 13, the AUV transponder network was deployed and calibrated, followed by a CTD station recording a sound velocity profile for calibration of the subsequent ship's multibeam survey of the area. The next stations included the CTD with in situ pumps, multiple and box coring providing samples for the benthic fauna team. In the morning of the 15th of March both elevator landers were deployed loaded with benthic chambers and profilers, 2 stand-alone cameras and amphipod traps in the Belgian contract area. Whereas the first deployment went smoothly, the second elevator became a free fall deployment, but the elevator could be located by the ROV in 4500 m water depth. The dive was followed by multiple corer deployments and a Parasound survey to prepare the location of the gravity corer deployment. After both elevators were recovered the large MoLab Master Lander was deployed. This first deep-

sea deployment of MoLab turned out to be challenging: when the wire was hauled up, we noticed that the attachment part of the launcher had been ripped off and the lander with launcher on top was slowly descending to the seafloor. Luckily, the transponder signal provided the position of the lander at the seafloor and MoLab could be retrieved in a 2-wire operation during a ROV dive the following day. The sediment sampling program with multiple, gravity and box corer was continued during the nights between ROV dives. The dives focused on in situ benthic oxygen flux measurements, and on the last dive of this leg a benthic food experiment with labelled algae targeting holothurians was started. On March 22 RV SONNE headed back to Manzanillo to exchange some crew and scientists, where it arrived on 27th of March.

In port we exchanged 24 scientific participants, while 14 remained on board for the second leg. AUV Abyss was shipped back home, since its electronic problems could not be repaired, while a container with additional mooring equipment and several airfreight packages were loaded onto the vessel – this time without delay. Another container with lander weights got stuck in Cartagena and did not arrive in Manzanillo. Leg 2 set sail on 30th of March leaving Manzanillo harbour towards the German working areas.

The first destination of leg 2 was an ocean gyre (eddy) that had formed off the coast of Central America six months earlier and was moving towards the German working area. Since eddies in the NE Pacific are known to increase current velocities throughout the entire water column, i.e. also at the seafloor in more than 4000 m depth, by a factor of two to three, they may resuspend the fine-grained seafloor sediments. While crossing the eddy, its surface currents were characterized by the ship's ADCP as well as four CTD stations with in situ pumps conducting vertical ADCP profiles. On April 4, we arrived in the German working area, where we collected baseline data of the area chosen for a small-scale sediment plume experiment. This included gravity, multiple, and box coring of the surface sediment, surveying the benthic habitat with the OFOS sled and ROV dives for in situ measurements of microbial oxygen consumption and macrofauna sampling. Subsequently, various hydroacoustic and optical sensors on a variety of platforms were distributed in the plume experiment area by the ROV and the moorings were deployed on a north-south transect across the German contract area. During the night of 10th to 11th of April eleven dredge tracks were towed suspending the seafloor sediments. Afterwards, the immediate impact was sampled by multiple coring and ROV-pushcoring for geochemical analyses.

On April 14 we returned to the Belgian working area to sample the food experiment started on leg 1 and finish our baseline investigations of the designated trial and reference areas. This involved more box coring for macrofauna, OFOS surveys for megafauna identification, gravity coring for geochemistry as well as ROV dives for push coring, in situ measurements and megafauna sampling. In addition, a multibeam system was mounted to the ROV to collect high-resolution bathymetry data of the designated collector trial area. This operation was necessary because of the damage to AUV Abyss on leg 1 that prevented collecting such data. While retrieving one of the elevator landers in rough weather on April 18, it went under the ship and lost three microprofilers and benthic chambers. The lost equipment was recovered successfully during a subsequent additional ROV dive, but one chamber was only found shredded in pieces at the seafloor, likely from

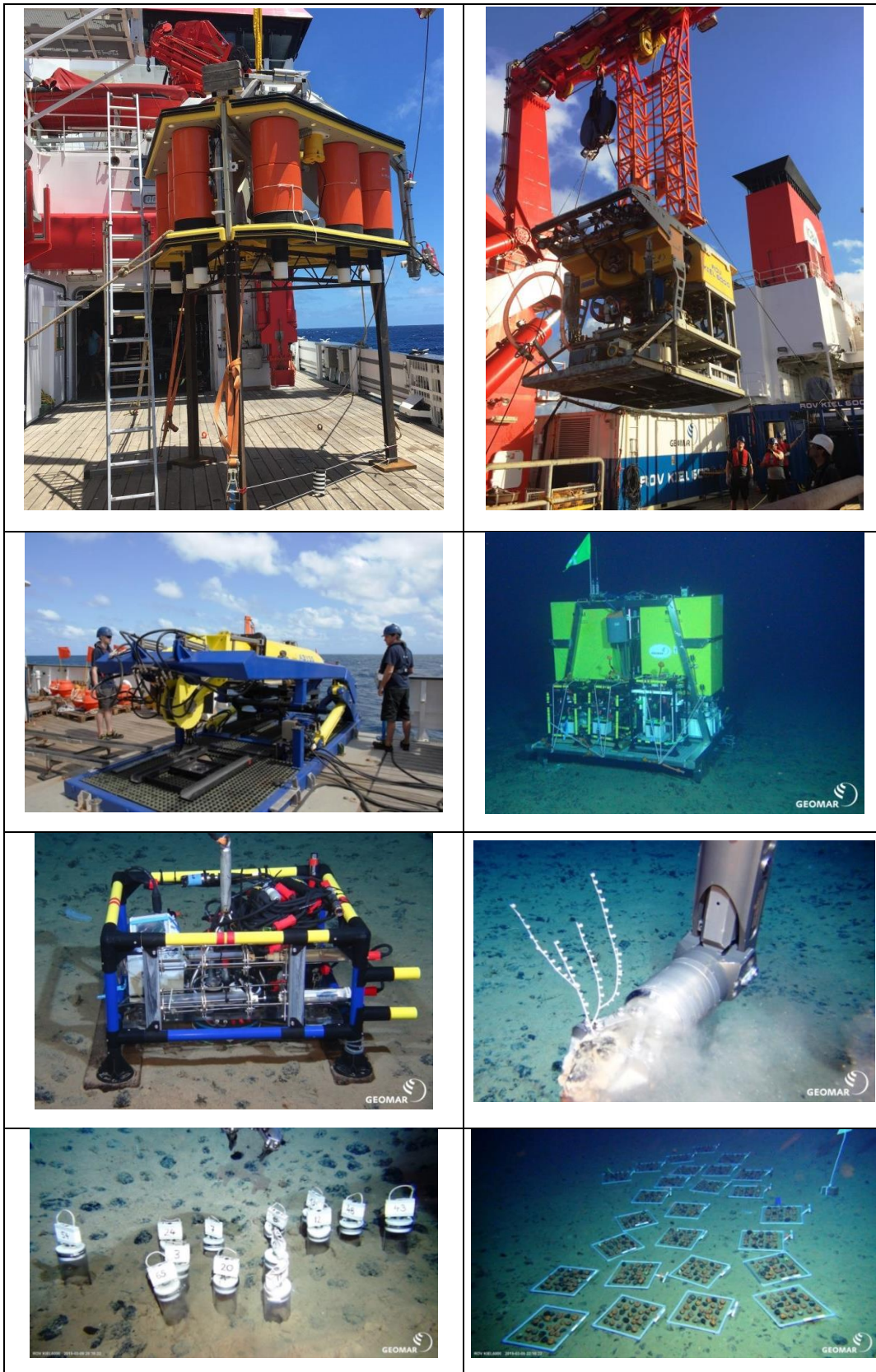
contact with the ship's propeller.

After investigations in the Belgian area were finalized on 24th of April, we returned to the German working area. Here, we deployed another set of artificial nodule frames in an area with no manganese nodules at the seabed as a control part of the recolonization experiment. On April 27 we arrived in the dredge experiment area to proceed with the impact assessment and also to continue the baseline investigations in the designated German trial and reference areas. However, after two OFOS surveys, box coring and two ROV dives, we had to interrupt our studies in order to return to Manzanillo due to a medical emergency. One of the elevator landers had to be left down at the seafloor during this time as well, because its weights could not be released. Six days later, on May 7, we were back in the German trial area to rescue the elevator by another two-wire operation. During this dive we discovered an amphipod trap that we had lost four years ago during cruise SO239. At the end of the dive we also recovered this amphipod trap.

During the next three days we finalized the baseline investigations in the German reference area by conducting the remaining multiple and box coring, an OFOS survey, and an ROV dive with in situ measurements. On 11th of May we moved to the plume experiment area. An intense sampling program of the impacts, particularly along the gradient of sediment redeposition, was conducted, including multiple and box coring as well as in situ measurements, amphipod deployments and megafauna sampling during ROV dives. The third part of the recolonization experiment, i.e. artificial nodule frames, was deployed in the four-year old EBS track from SO239 nearby. In addition, the moorings were recovered and redeployed a few days later in the plume experiment area and designated collector trial area. They will stay at the seafloor until the BGR cruise scheduled for 2020 in order to record bottom current velocities and directions as well as the amount of sinking particles in sediment traps. Our work program was finalized by ROV dives and elevator lander deployments retrieving the array of optical and acoustic sensors from the plume experiment area, a CTD deployment with in situ pumps as well as missing box coring in the German reference area.

On 17th of May we started the 2400 nautical miles long voyage towards Vancouver, Canada. Due to the customs problems in Manzanillo at the beginning of SO268, Vancouver had been chosen as new destination for this cruise in March. After 11 days of transit, we safely arrived in Vancouver on May 27. Here, we unloaded the five ROV containers from the ship and then packed eight containers with our large gear and equipment on the pier. These operations were rather slow and took until 29th of May, when the containers were finally sealed. Due to a union strike in the harbour of Vancouver the last container did not arrive before RV SONNE had to leave port again and hence, we decided to ship those pallets with equipment onboard SONNE to Singapore, the final destination of leg 3.

During the three and a half month long research expedition SO268 we accomplished a total of 210 stations.



Impressions from SO268 (photos from top left to bottom right): MoLab master lander, ROV Kiel 6000, AUV Abyss on its launch and recovery system, one of the elevator landers carrying in situ microprofilers and a benthic respiration chamber at the seafloor, the ROV arm carefully sampling a coral, ROV-deployed sediment push cores, and part of the frames with artificial nodules initiating the recolonization experiment.

Acknowledgements

We look back at a very challenging cruise with shipping logistics for a total of eighteen containers and a demanding schedule for deploying a suite of large-gear such as ROV, AUV, several benthic landers and in situ ROV tools. Despite some technical problems a comprehensive set of samples and data from the deep-sea was collected and the overall project goals were achieved. This would not have been possible without the professional collaboration and constant support by captain Lutz Mallon and his great crew. Thank you very much!

Furthermore, we thank all the shore-based colleagues (technicians, administration, and scientists) involved in this cruise. The German Federal Ministry of Education and Research (BMBF) is gratefully acknowledged for the funding of the cruise and the European collaborative project MiningImpact (grant nos. 03F0812A-H) of the Joint Programming Initiative of Healthy and Productive Seas and Oceans (JPI Oceans).

List of participants

Leg 1

	Name	Task	Institute
1	Peter Linke	Chief Scientist	GEOMAR
2	Friedrich Abegg	ROV team leader	GEOMAR
3	Teresa Amaro	Food web, ecotoxicology	CIIMAR
4	Volker Asendorf	ROV module technician	MPI
5	Eve-Julie Arsenault-Pernet	Lab technician Infauna	IFREMER
6	Jakob Barz	Lab technician Microbiology	MPI
7	Florian Bischof	ROV technician	GEOMAR
8	Matthias Bodendorfer	ROV pilot	GEOMAR
9	Yasemin Bodur	Megafauna, OFOS	MPI, AWI
10	Emanuela Buschi	Microbiology, Virus	UNIVPM
11	Magdalini Christodoulou	Meiofauna, Genetics, Maldi TOF	SGN
12	Patrick Cuno	ROV pilot	GEOMAR
13	Patricia Esquete	Macrofauna	UAveiro
14	Iason-Zois Gazis	Hydroacoustics, mapping	GEOMAR
15	Ana Hilario	Macrofauna	UAveiro
16	Hannes Huusmann	ROV pilot	GEOMAR
17	Felix Janssen	PI Microbiology, in situ fluxes	MPI, AWI
18	Marcus Köckritz	AUV technician	GEOMAR
19	Dennis Köhler	Lab technician Geochemistry	AWI
20	Kevin Koeser	Mapping	GEOMAR
21	Pedro Martinez Arbizu	PI fauna	SGN
22	Torge Matthiessen	ROV pilot	GEOMAR
23	Nancy Mercado Salas	Meiofauna, Metabarcoding	SGN
24	Annika Moje	Lab technician metal geochemistry	JUB
25	Massimiliano Molari	Microbiology, CTD	MPI
26	Ellen Pape	Meiofauna	UGhent
27	Sophie Paul	PI Metal geochemistry	JUB
28	Asmus Petersen	Lander technician	GEOMAR
29	Martin Pieper	ROV pilot	GEOMAR
30	Eva-Louise Posch	Coring technician	SGN
31	Timm Schoening	PI Mapping, Plume sensors	GEOMAR
32	Thorsten Schott	Lander technician	GEOMAR
33	Jens Schroeder	AUV technician	GEOMAR
34	Anja Steinführer	AUV team leader	GEOMAR
35	Tanja Stratmann	Food web	Utrecht
36	Inken Suck	ROV pilot	GEOMAR
37	Jessica Volz	PI Geochemistry	AWI
38	Tim Weiss	AUV technician	GEOMAR
39	Helena Wicklund	Sponges, ddPCR	URResearch
40	Daniela Zeppilli	Infauna, Meiofauna	IFREMER

Leg 2

	Name	Task	Institute
1	Matthias Haeckel	Chief Scientist	GEOMAR
2	Friedrich Abegg	ROV team leader	GEOMAR
3	Jakob Barz	Lab technician Microbiology	MPI
4	Matthias Bodendorfer	ROV pilot	GEOMAR
5	Yasemin Bodur	Megafauna, OFOS	MPI, AWI
6	Patrick Cuno	ROV pilot	GEOMAR
7	Hendrik Corstiaan de Stigter	PI Plume sensors	NIOZ
8	Coral Diaz-Recio Lorenzo	Restoration experiment	NIOZ
9	Ingrid Dohrmann	Lab technician Geochemistry	AWI
10	Patricia Esquete	Macrofauna	UAveiro
11	Eduard Fabrizio	Lander technician	GEOMAR
12	Dennis Hagedorn	Mooring technician	BGR
13	Sabine Haalboom	Plume sensors	NIOZ
14	Kristin Hamann	Geochemistry	GEOMAR
15	Freija Hauquier	PI fauna	UGent
16	Ana Hilario	Macrofauna	UAveiro
17	Torge Matthiessen	ROV technician	GEOMAR
18	Lenaick Menot	Infauna, Epifauna	IFREMER
19	Steffen Niemann	Camera footage	GEOMAR
20	Julia Otte	Microbiology	MPI
21	Tasnim Patel	Scavengers	RBINS
22	Sophie Paul	PI Metal geochemistry	JUB
23	Martin Pieper	ROV pilot	GEOMAR
24	Sofia Ramalho	Megafauna	IMAR
25	Jan Rindfleisch	ROV technician	GEOMAR
26	Sven Rossel	Meiofauna, Genetics, Maldi TOF	SGN
27	Elena Schiller	ROV module technician	MPI
28	Katja Schmidt	Metal geochemistry	BGR
29	Timm Schoening	PI Mapping, Plume sensors	GEOMAR
30	Thorsten Schott	Lander technician	GEOMAR
31	Peter Striewski	ROV technician	GEOMAR
32	Inken Suck	ROV pilot	GEOMAR
33	Katja Uhlenkott	Meiofauna, Metabarcoding	SGN
34	Peter Urban	Hydroacoustics, Plume sensors	GEOMAR
35	Jessica Volz	PI Geochemistry	AWI
36	Frank Wenzhöfer	PI Microbiology, in situ fluxes	MPI
37	Ann-Kathrin Wessels	Meiofauna	SGN
38	Batuhan Yapan	Microbiology	MPI

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Station list

Leg 1

Date Time (UTC)	Station_Device	Latitude	Longitude	Position	Water Depth / m	Area	Comment
27/02/19 17:00	001-1_AUV-01	11° 54.767' N	117° 02.378' W	Ship	4111.0	GER Trial	Transponder calibration
27/02/19 20:30	002-1_CTD-01	11° 54.674' N	117° 02.099' W	USBL	4094.8	GER Trial	sound velocity profile
28/02/19 01:08	003-1_EM122-01	11° 54.959' N	117° 12.179' W	Ship	4111.8	GER Trial	Start Transect
28/02/19 10:52	004-1_AUV-02	11° 54.636' N	117° 01.323' W	Ship	4123.7	GER Trial	Start Transect
28/02/19 15:52	005-1_MUC-01	11° 55.872' N	117° 01.588' W	Ship	4081.5	GER Trial	TV-MUC
28/02/19 19:31	006-1_MUC-02	11° 55.799' N	117° 01.475' W	Ship	4087.3	GER Trial	
28/02/19 23:06	007-1_MUC-03	11° 55.633' N	117° 01.258' W	Ship	4089.2	GER Trial	
01/03/19 00:26	008-1_MOOR-01	11° 55.338' N	117° 01.753' W	SO262	4088.7	GER Trial	Recovery SO262-005OBM
01/03/19 06:45	009-1_LANDER-01	11° 55.711' N	117° 01.450' W	USBL	4083.0	GER Trial	Elevator 1
01/03/19 10:49	010-1_LANDER-02	11° 55.732' N	117° 01.435' W	USBL	4087.1	GER Trial	Elevator 2
01/03/19 17:02	011-1_ROV-01	11° 55.726' N	117° 01.438' W	USBL	4084.0	GER Trial	Start Transect
01/03/19 22:03	012-1_BC-01	11° 55.873' N	117° 01.633' W	Ship	4081.0	GER Trial	failed
02/03/19 00:56	012-2_BC-02	11° 55.880' N	117° 01.631' W	Ship	4051.3	GER Trial	failed
02/03/19 03:12	013-1_OFOS-01	11° 56.306' N	117° 01.966' W	Ship	4083.3	GER Trial	aborted: technical problems
02/03/19 11:38	014-1_CTD-02	11° 56.299' N	117° 01.963' W	USBL	4085.3	GER Trial	
02/03/19 18:11	012-3_BC-03	11° 55.873' N	117° 01.633' W	Ship	4080.4	GER Trial	
02/03/19 21:22	015-1_BC-04	11° 55.798' N	117° 01.532' W	Ship	4082.9	GER Trial	failed
03/03/19 00:15	015-2_BC-05	11° 55.786' N	117° 01.540' W	Ship	4086.1	GER Trial	failed
03/03/19 03:01	016-1_GC-01	11° 55.863' N	117° 01.537' W	USBL	4083.5	GER Trial	
03/03/19 06:48	017-1_AUV-03	11° 54.653' N	117° 02.114' W	Ship	4109.8	GER Trial	Start Transect
03/03/19 09:33	018-1_MUC-04	11° 55.454' N	117° 01.039' W	USBL	4099.3	GER Trial	
03/03/19 12:45	019-1_MUC-05	11° 55.289' N	117° 00.819' W	USBL	4106.9	GER Trial	
03/03/19 17:11	020-1_ROV-02	11° 55.717' N	117° 01.440' W	USBL	4084.1	GER Trial	Start Transect
04/03/19 00:24	015-3_BC-06	11° 55.790' N	117° 01.530' W	USBL	4089.8	GER Trial	
04/03/19 08:30	021-1_OFOS-02	11° 55.770' N	117° 02.449' W	USBL	4093.9	GER Trial	Start Transect
04/03/19 21:44	022-1_MOOR-02	11° 55.268' N	117° 00.624' W	SO262	4092.7	GER Trial	Recovery SO262-028ST

05/03/19 03:50	023-1_CTD-03	11° 54.671' N	117° 02.131' W	Ship	4102.9	GER Trial	
05/03/19 11:02	024-1_BC-07	11° 55.874' N	117° 01.628' W	Ship	4087.0	GER Trial	failed
05/03/19 13:47	024-2_BC-08	11° 55.873' N	117° 01.633' W	Ship	4087.6	GER Trial	failed
05/03/19 18:45	025-1_ROV-03	11° 55.570' N	117° 01.432' W	USBL	4087.0	GER Trial	Start Transect
06/03/19 00:59	024-3_BC-09	11° 55.864' N	117° 01.641' W	USBL	4087.6	GER Trial	
06/03/19 04:03	026-1_MUC-06	11° 56.035' N	117° 01.775' W	USBL	4087.3	GER Trial	
06/03/19 07:03	027-1_BC-10	11° 56.032' N	117° 01.823' W	USBL	4085.3	GER Trial	
06/03/19 10:08	028-1_BC-11	11° 55.626' N	117° 01.313' W	USBL	4093.2	GER Trial	
06/03/19 16:51	029-1_ROV-04	11° 55.722' N	117° 01.452' W	USBL	4083.4	GER Trial	Start Transect
07/03/19 03:55	030-1_OFOS-03	11° 54.487' N	117° 00.534' W	USBL	4070.4	GER Trial	Start Transect
07/03/19 20:00	031-1_ROV-05	11° 55.781' N	117° 01.468' W	USBL	4088.5	GER Trial	
08/03/19 01:55	032-1_AUV-04	11° 55.655' N	117° 01.185' W	Ship	4088.3	GER Trial	Test dive
08/03/19 05:59	033-1_BC-12	11° 55.466' N	117° 01.085' W	Ship	4096.1	GER Trial	
08/03/19 12:27	034-1_LANDER-03	11° 50.633' N	117° 03.552' W	USBL	4128.8	GER Reference	Elevator 2
08/03/19 17:40	035-1_ROV-06	11° 50.676' N	117° 03.500' W	Ship	4131.8	GER Reference	
09/03/19 02:45	036-1_AUV-05	11° 55.664' N	117° 03.502' W	Ship	4128.8	GER Reference	Test dive
09/03/19 06:04	037-1_GC-02	11° 50.708' N	117° 03.593' W	USBL	4131.9	GER Reference	
09/03/19 09:03	038-1_MUC-07	11° 50.686' N	117° 03.612' W	USBL	4130.2	GER Reference	
09/03/19 13:16	039-1_MUC-08	11° 51.262' N	117° 02.368' W	USBL	4130.1	GER Reference	
09/03/19 17:36	040-1_ROV-07	11° 50.647' N	117° 03.541' W	USBL	4131.8	GER Reference	Start Transect
10/03/19 02:21	041-1_AUV-06	11° 54.649' N	117° 02.121' W	Ship	4110.0	GER Trial	Start Transect; failed
10/03/19 07:22	042-1_MUC-09	11° 51.716' N	117° 00.393' W	USBL	4118.1	GER Reference	
10/03/19 10:48	043-1_MUC-10	11° 55.834' N	117° 01.346' W	USBL	4087.8	GER Trial	
10/03/19 14:08	044-1_BC-13	11° 55.830' N	117° 01.349' W	Ship	4088.5	GER Trial	failed
10/03/19 20:29	044-2_BC-14	11° 55.835' N	117° 01.342' W	USBL	4089.1	GER Trial	
11/03/19 01:02	045-1_MOOR-03	11° 48.326' N	117° 31.895' W	SO262	4351.0	GER	Recovery SO262-157OBM
13/03/19 00:02	046-1_AUV-07	14° 05.402' N	125° 52.644' W	Ship	4467.8	BEL Trial	Transponder calibration
13/03/19 02:52	047-1_CTD-04	14° 04.982' N	125° 52.590' W	Ship	4485.7	BEL Trial	
13/03/19 06:20	048-1_EM122-02	14° 12.885' N	125° 41.836' W	Ship	4579.2	BEL Trial	Start Transect

14/03/19 09:07	049-1_CTD-05	14° 05.785' N	125° 52.954' W	Ship	4459.7	BEL Trial	
14/03/19 12:46	050-1_MUC-11	14° 06.831' N	125° 52.350' W	USBL	4496.7	BEL Trial	failed
14/03/19 15:44	050-2_MUC-12	14° 06.831' N	125° 52.350' W	USBL	4508.2	BEL Trial	
14/03/19 18:19	051-1_AUV-08	14° 05.302' N	125° 52.298' W	Ship	4484.6	BEL Trial	Start Transect
14/03/19 21:33	052-1_BC-15	14° 06.804' N	125° 52.273' W	USBL	4506.6	BEL Trial	
15/03/19 01:39	053-1_BC-16	14° 06.713' N	125° 52.458' W	USBL	4484.9	BEL Trial	
15/03/19 07:36	054-1_LANDER-04	14° 06.730' N	125° 52.212' W	USBL	4507.2	BEL Trial	Elevator 2
15/03/19 10:08	055-1_LANDER-05	14° 06.761' N	125° 52.258' W	USBL	4498.5	BEL Trial	Elevator 1
15/03/19 12:21	056-1_MUC-13	14° 06.599' N	125° 52.099' W	USBL	4501.9	BEL Trial	
15/03/19 16:53	057-1_ROV-08	14° 06.758' N	125° 52.230' W	USBL	4480.7	BEL Trial	Start Transect
16/03/19 03:25	058-1_AUV-09	14° 05.304' N	125° 52.303' W	Ship	4482.7	BEL Trial	Start Transect
16/03/19 06:18	059-1_CTD-06	14° 05.307' N	125° 52.301' W	Ship	4468.7	BEL Trial	
16/03/19 10:37	060-1_BC-17	14° 06.491' N	125° 51.849' W	Ship	4512.3	BEL Trial	
16/03/19 14:00	061-1_BC-18	14° 06.869' N	125° 52.324' W	Ship	4499.8	BEL Trial	
16/03/19 18:50	062-1_LANDER-06	14° 07.090' N	125° 52.116' W	Ship	4493.7	BEL Trial	MoLab: loss of weights
17/03/19 00:30	063-1_OFOS-04	14° 06.134' N	125° 52.931' W	USBL	4454.7	BEL Trial	Start Transect
17/03/19 17:01	064-1_ROV-09	14° 06.830' N	125° 52.651' W	USBL	4471.7	BEL Trial	Start Transect
18/03/19 05:05	065-1_MUC-14	14° 06.772' N	125° 52.297' W	USBL	4495.3	BEL Trial	
18/03/19 08:27	066-1_MUC-15	14° 06.438' N	125° 51.894' W	USBL	4508.7	BEL Trial	
18/03/19 11:51	067-1_MUC-16	14° 06.292' N	125° 51.678' W	Ship	4514.1	BEL Trial	
18/03/19 13:46	068-1_PS-01	14° 06.009' N	125° 54.692' W	Ship	4489.8	BEL Trial	Start Transect
18/03/19 17:34	069-1_ROV-10	14° 06.731' N	125° 52.229' W	USBL	4497.9	BEL Trial	Start Transect
19/03/19 01:00	070-1_LANDER-07	14° 07.110' N	125° 51.991' W	USBL	4511.1	BEL Trial	MoLab: loss of lander
19/03/19 08:38	071-1_GC-03	14° 06.696' N	125° 52.368' W	USBL	4487.3	BEL Trial	
19/03/19 11:54	072-1_BC-19	14° 06.638' N	125° 52.053' W	USBL	4508.8	BEL Trial	
19/03/19 18:26	073-1_ROV-11	14° 07.096' N	125° 52.074' W	USBL	4505.3	BEL Trial	MoLab recovery dive failed
20/03/19 02:30	074-1_MUC-17	14° 08.105' N	125° 51.819' W	USBL	4518.1	BEL Trial	
20/03/19 06:01	075-1_MUC-18	14° 06.992' N	125° 52.544' W	USBL	4500.2	BEL Trial	
20/03/19 12:28	076-1_BC-20	14° 02.167' N	125° 55.472' W	USBL	4540.5	BEL Reference	

20/03/19 17:56	077-1_ROV-12	14° 07.079' N	125° 52.003' W	USBL	4504.8	BEL Trial	MoLab recovery dive
21/03/19 05:03	078-1_GC-04	14° 08.125' N	125° 51.817' W	Ship	4502.1	BEL Trial	
21/03/19 09:38	079-1_MUC-19	14° 02.187' N	125° 55.471' W	Ship	4535.2	BEL Reference	
21/03/19 13:01	080-1_MUC-20	14° 02.013' N	125° 55.736' W	Ship	4527.7	BEL Reference	
21/03/19 18:26	081-1_ROV-13	14° 06.798' N	125° 52.266' W	USBL	4501.3	BEL Trial	Start Transect
22/03/19 06:40	082-1_BC-21	14° 01.999' N	125° 55.741' W	USBL	4538.9	BEL Reference	
22/03/19 10:09	083-1_BC-22	14° 01.734' N	125° 55.505' W	USBL	4543.6	BEL Reference	
22/03/19 13:18	084-1_GC-05	14° 02.163' N	125° 55.471' W	USBL	4539.6	BEL Reference	
22/03/19 16:47	085-1_MUC-21	14° 01.750' N	125° 55.509' W	USBL	4549.1	BEL Reference	

Leg 2

Date Time (UTC)	Station_Device	Latitude	Longitude	Position	Water Depth / m	Area	Comment
31/03/19 17:45	086-1_CTD-07	16° 12.368' N	107° 04.083' W	Ship	3396.3	Eddy	
31/03/19 21:00	087-1_EM122-03	15° 52.516' N	107° 22.876' W	Ship	3842.2	Eddy	Start Transect
02/04/19 16:30	088-1_CTD-08	11° 44.980' N	113° 07.013' W	USBL	4122.2	Eddy	
03/04/19 00:15	089-1_EM122-04	11° 45.205' N	113° 07.064' W	Ship	4119.2	Eddy	Start Transect
03/04/19 07:14	090-1_CTD-09	11° 46.000' N	114° 02.164' W	USBL	4150.3	Eddy	
03/04/19 10:57	091-1_EM122-05	11° 46.025' N	114° 02.163' W	Ship	4152.1	Eddy	Start Transect
03/04/19 18:30	092-1_CTD-10	11° 47.976' N	114° 56.401' W	USBL	4114.1	Eddy	
04/04/19 01:55	093-1_EM122-06	11° 47.882' N	114° 56.624' W	Ship	4110.9	Eddy	Start Transect
04/04/19 14:21	094-1_CTD-11	11° 51.598' N	117° 00.839' W	USBL	4126.7	GER Dredge	
04/04/19 19:52	095-1_BC-23	11° 51.740' N	117° 00.765' W	Ship	4119.1	GER Dredge	failed
04/04/19 22:39	095-2_BC-24	11° 51.740' N	117° 00.765' W	USBL	4120.2	GER Dredge	
05/04/19 01:41	096-1_BC-25	11° 51.736' N	117° 00.837' W	USBL	4122.4	GER Dredge	
05/04/19 07:59	097-1_LANDER-08	11° 51.818' N	117° 00.786' W	USBL	4123.3	GER Dredge	Elevator 1
05/04/19 14:10	098-1_LANDER-09	11° 51.728' N	117° 00.755' W	USBL	4122.5	GER Dredge	Elevator 2
05/04/19 17:43	099-1_ROV-14	11° 51.811' N	117° 00.746' W	USBL	4118.0	GER Dredge	Start Transect
06/04/19 05:16	100-1_OFOS-05	11° 51.488' N	117° 01.289' W	USBL	4124.9	GER Dredge	Start Transect
06/04/19 17:02	101-1_ROV-15	11° 51.807' N	117° 00.788' W	USBL	4126.0	GER Dredge	Start Transect

07/04/19 08:21	102-1_BC-26	11° 51.824' N	117° 00.880' W	Ship	4123.2	GER Dredge	
07/04/19 11:30	103-1_BC-27	11° 51.907' N	117° 00.720' W	Ship	4116.2	GER Dredge	
07/04/19 14:33	104-1_GC-06	11° 51.780' N	117° 00.742' W	USBL	4119.7	GER Dredge	
07/04/19 17:52	105-1_LANDER-10	11° 52.194' N	117° 00.834' W	Ship	4114.6	GER Dredge	BoBo free fall deployment
07/04/19 19:48	106-1_MUC-22	11° 51.773' N	117° 00.740' W	USBL	4122.3	GER Dredge	
07/04/19 23:09	107-1_MUC-23	11° 51.729' N	117° 00.844' W	USBL	4120.8	GER Dredge	
08/04/19 02:37	108-1_BC-28	11° 51.715' N	117° 00.669' W	Ship	4117.5	GER Dredge	failed
08/04/19 08:33	109-1_LANDER-11	11° 51.866' N	117° 00.798' W	USBL	4117.2	GER Dredge	Elevator 1
08/04/19 13:34	110-1_LANDER-12	11° 51.681' N	117° 00.753' W	USBL	4118.6	GER Dredge	Elevator 2
08/04/19 17:01	111-1_ROV-16	11° 51.845' N	117° 00.767' W	USBL	4118.0	GER Dredge	Start Transect
09/04/19 06:24	112-1_BWS-01	11° 51.773' N	117° 00.731' W	USBL	4118.6	GER Dredge	
09/04/19 14:32	113-1_MOOR-04	11° 06.777' N	116° 46.622' W	Ship	4220.4	Eddy	Deployment mooring 3
09/04/19 16:31	114-1_MOOR-05	11° 18.922' N	116° 50.347' W	Ship	4170.0	Eddy	Deployment mooring ST2
09/04/19 20:20	115-1_MOOR-06	11° 36.417' N	116° 55.205' W	Ship	4155.8	Eddy	Deployment mooring 2
10/04/19 01:15	116-1_BC-29	11° 51.711' N	117° 00.671' W	Ship	4117.2	GER Dredge	
10/04/19 04:58	117-1_OFOS-06	11° 51.441' N	117° 03.043' W	USBL	4122.2	GER Dredge	Start Transect
10/04/19 17:13	118-1_ROV-17	11° 51.835' N	117° 00.819' W	USBL	4120.7	GER Dredge	Start Transect
11/04/19 07:44	119-1_DRG-01	11° 51.752' N	117° 00.902' W	USBL	4122.2	GER Dredge	Start Dredge tracks
11/04/19 21:20	120-1_CTD-12	11° 51.769' N	117° 00.739' W	USBL	4118.3	GER Dredge	
12/04/19 06:02	121-1_BWS-02	11° 51.773' N	117° 00.739' W	USBL	4118.6	GER Dredge	
12/04/19 10:51	122-1_MUC-24	11° 51.773' N	117° 00.790' W	USBL	4123.7	GER Dredge	TV-MUC
12/04/19 14:51	123-1_MOOR-07	11° 47.484' N	116° 57.860' W	Ship	4072.5	Eddy	Deployment mooring ST1
12/04/19 18:50	124-1_ROV-18	11° 51.788' N	117° 00.749' W	USBL	4118.3	GER Dredge	Start Transect
13/04/19 08:02	125-1_MUC-25	11° 51.862' N	117° 00.768' W	Ship	4119.4	GER Dredge	TV-MUC; failed
13/04/19 11:57	125-2_MUC-26	11° 51.793' N	117° 00.797' W	USBL	4120.3	GER Dredge	TV-MUC
13/04/19 16:16	126-1_OFOS-07	11° 51.771' N	117° 01.052' W	USBL	4118.6	GER Dredge	Start Transect
14/04/19 03:44	127-1_EM122-07	11° 51.922' N	117° 00.877' W	Ship	4117.0	Transit	Start Transect
16/04/19 06:46	128-1_OFOS-08	14° 06.802' N	125° 50.903' W	USBL	4474.2	BEL Trial	Start Transect
16/04/19 18:10	129-1_BC-30	14° 07.004' N	125° 52.504' W	USBL	4503.0	BEL Trial	

16/04/19 21:42	130-1_GC-07	14° 05.217' N	125° 50.053' W	USBL	4487.3	BEL Trial	
17/04/19 02:00	131-1_CTD-13	14° 07.090' N	125° 52.003' W	USBL	4506.2	BEL Trial	
17/04/19 11:43	132-1_LANDER-13	14° 06.685' N	125° 52.305' W	USBL	4504.8	BEL Trial	Elevator 1
17/04/19 17:25	133-1_LANDER-14	14° 06.793' N	125° 52.102' W	USBL	4506.6	BEL Trial	Elevator 2
17/04/19 21:00	134-1_ROV-19	14° 06.698' N	125° 52.294' W	USBL	4508.7	BEL Trial	Start Transect
18/04/19 08:12	135-1_MUC-27	14° 01.109' N	125° 55.357' W	USBL	4548.9	BEL Reference	
18/04/19 12:02	136-1_MUC-28	14° 01.505' N	125° 55.234' W	USBL	4541.7	BEL Reference	
18/04/19 17:00	137-1_ROV-20	14° 06.697' N	125° 52.319' W	USBL	4503.1	BEL Trial	Start Transect
19/04/19 07:51	138-1_MUC-29	14° 01.126' N	125° 54.953' W	USBL	4526.7	BEL Reference	
19/04/19 11:48	139-1_MUC-30	14° 01.897' N	125° 55.003' W	USBL	4523.5	BEL Reference	
19/04/19 15:28	140-1_BC-31	14° 01.902' N	125° 55.005' W	USBL	4521.9	BEL Reference	
19/04/19 18:57	141-1_BC-32	14° 01.130' N	125° 55.346' W	Ship	4541.0	BEL Reference	
19/04/19 22:20	142-1_BC-33	14° 01.504' N	125° 55.249' W	Ship	4541.3	BEL Reference	
20/04/19 02:10	143-1_GC-08	14° 06.560' N	125° 53.398' W	USBL	4501.7	BEL Trial	
20/04/19 05:40	144-1_GC-09	14° 06.126' N	125° 51.550' W	USBL	4521.5	BEL Trial	
20/04/19 11:48	145-1_LANDER-15	14° 05.297' N	125° 53.831' W	USBL	4469.6	BEL Trial	Elevator 2
20/04/19 15:56	146-1_ROV-21	14° 05.016' N	125° 54.342' W	USBL	4468.5	BEL Trial	Elevator 2 recovery dive
21/04/19 07:13	147-1_OFOS-09	14° 00.983' N	125° 55.582' W	USBL	4542.1	BEL Reference	Start Transect
21/04/19 18:58	148-1_BC-34	14° 01.140' N	125° 54.949' W	USBL	4529.0	BEL Reference	
21/04/19 22:47	149-1_BC-35	14° 06.313' N	125° 51.648' W	USBL	4516.5	BEL Trial	
22/04/19 04:42	150-1_LANDER-16	14° 01.995' N	125° 55.506' W	USBL	4539.3	BEL Reference	Elevator 2
22/04/19 08:45	151-1_CTD-14	14° 01.141' N	125° 54.949' W	USBL	4520.6	BEL Reference	
22/04/19 17:22	152-1_ROV-22	14° 06.771' N	125° 52.583' W	USBL	4487.5	BEL Trial	Start Transect
23/04/19 05:58	153-1_OFOS-10	14° 00.109' N	125° 53.226' W	USBL	4509.7	BEL Reference	Start Transect
23/04/19 17:30	154-1_ROV-23	14° 02.003' N	125° 55.501' W	USBL	4540.4	BEL Reference	Start Transect
24/04/19 03:14	155-1_EM122-08	14° 01.663' N	125° 55.614' W	Ship	4540.5	Transit	Start Transect
26/04/19 09:10	156-1_LANDER-17	11° 50.988' N	117° 23.005' W	USBL	4272.2	GER NoNodule	Elevator 1
26/04/19 12:24	157-1_GC-10	11° 50.976' N	117° 22.956' W	USBL	4275.0	GER NoNodule	
26/04/19 16:37	158-1_ROV-24	11° 50.995' N	117° 23.000' W	USBL	4273.0	GER NoNodule	Start Transect

27/04/19 07:25	159-1_CTD-15	11° 51.587' N	117° 00.842' W	USBL	4123.3	GER Dredge	
27/04/19 16:41	160-1_OFOS-11	11° 51.820' N	117° 00.655' W	USBL	4116.4	GER Dredge	Start Transect
28/04/19 07:16	161-1_BC-36	11° 55.263' N	117° 00.825' W	USBL	4125.3	GER Trial	
28/04/19 12:56	162-1_LANDER-18	11° 55.695' N	117° 01.458' W	USBL	4080.2	GER Trial	Elevator 1
28/04/19 16:21	163-1_ROV-25	11° 55.701' N	117° 01.439' W	USBL	4082.3	GER Trial	Start Transect
29/04/19 04:10	164-1_OFOS-12	11° 51.548' N	117° 01.052' W	USBL	4123.4	GER Dredge	Start Transect
29/04/19 18:50	165-1_ROV-26	11° 54.632' N	117° 00.886' W	USBL	4112.0	GER Trial	Start Transect
30/04/19 07:19	166-1_BC-37	11° 50.715' N	117° 03.610' W	USBL	4123.8	GER Reference	
30/04/19 10:12	167-1_BC-38	11° 50.980' N	117° 03.320' W	USBL	4121.5	GER Reference	failed
30/04/19 11:40	168-1_EM122-09	11° 50.994' N	117° 03.326' W	Ship	4120.1	Transit	Start Transect
07/05/19 17:02	169-1_ROV-27	11° 55.696' N	117° 01.470' W	USBL	4081.1	GER Trial	Elevator 1 recovery dive
08/05/19 00:14	170-1_LANDER-19	11° 50.492' N	117° 03.506' W	USBL	4133.3	GER Reference	Elevator 2
08/05/19 03:41	171-1_MUC-31	11° 51.003' N	117° 03.323' W	Ship	4122.3	GER Reference	
08/05/19 06:52	172-1_MUC-32	11° 50.447' N	117° 03.314' W	USBL	4134.4	GER Reference	
08/05/19 12:09	173-1_LANDER-20	11° 50.478' N	117° 03.504' W	USBL	4132.0	GER Reference	Elevator 1
08/05/19 15:45	174-1_ROV-28	11° 50.481' N	117° 03.496' W	USBL	4131.7	GER Reference	Start Transect
09/05/19 07:50	175-1_BC-39	11° 50.547' N	117° 03.067' W	Ship	4129.1	GER Reference	
09/05/19 21:08	176-1_MOOR-08	11° 57.212' N	117° 00.658' W	SO262	4319.2	GER Reference	Recovery SO262-6OBM
10/05/19 00:33	177-1_OFOS-13	11° 51.359' N	117° 01.640' W	USBL	4128.6	GER Reference	Start Transect
10/05/19 13:07	178-1_MUC-33	11° 50.456' N	117° 03.323' W	USBL	4130.6	GER Reference	
10/05/19 16:15	179-1_MUC-34	11° 50.367' N	117° 03.578' W	USBL	4141.6	GER Reference	
10/05/19 19:21	180-1_BC-40	11° 50.370' N	117° 03.574' W	USBL	4143.2	GER Reference	
10/05/19 22:15	181-1_BC-41	11° 50.455' N	117° 03.321' W	USBL	4133.3	GER Reference	
11/05/19 01:10	182-1_BC-42	11° 50.983' N	117° 03.326' W	USBL	4119.3	GER Reference	
11/05/19 04:54	183-1_CTD-16	11° 51.600' N	117° 00.839' W	Ship	4122.9	GER Dredge	
11/05/19 11:18	184-1_MUC-35	11° 51.785' N	117° 00.701' W	USBL	4116.1	GER Dredge	TV-MUC
12/05/19 01:22	185-1_MUC-36	11° 51.774' N	117° 00.760' W	USBL	4121.4	GER Dredge	TV-MUC
12/05/19 04:47	186-1_MUC-37	11° 51.793' N	117° 00.747' W	USBL	4116.5	GER Dredge	TV-MUC
12/05/19 10:15	187-1_LANDER-21	11° 51.672' N	117° 00.740' W	USBL	4119.7	GER Dredge	Elevator 1

12/05/19 15:13	188-1_ROV-29	11° 51.605' N	117° 00.757' W	USBL	4117.1	GER Dredge	Start Transect
13/05/19 02:43	189-1_BC-43	11° 51.773' N	117° 00.845' W	USBL	4122.1	GER Dredge	
13/05/19 05:37	190-1_BC-44	11° 51.789' N	117° 00.779' W	USBL	4124.0	GER Dredge	
13/05/19 08:36	191-1_BC-45	11° 51.784' N	117° 00.748' W	USBL	4117.3	GER Dredge	
13/05/19 13:57	192-1_LANDER-22	11° 51.689' N	117° 00.744' W	Ship	4123.7	GER Dredge	Elevator 1
13/05/19 17:05	193-1_ROV-30	11° 51.726' N	117° 00.765' W	USBL	4120.2	GER Dredge	Start Transect
14/05/19 05:08	194-1_BC-46	11° 51.764' N	117° 00.813' W	USBL	4120.5	GER Dredge	failed
14/05/19 08:02	195-1_BC-47	11° 51.805' N	117° 00.694' W	USBL	4116.7	GER Dredge	failed
14/05/19 13:23	196-1_LANDER-23	11° 51.858' N	117° 00.778' W	USBL	4117.4	GER Dredge	Elevator 2
14/05/19 16:41	197-1_ROV-31	11° 51.874' N	117° 00.770' W	USBL	4118.0	GER Dredge	Start Transect
15/05/19 05:28	198-1_MUC-38	11° 51.763' N	117° 00.715' W	USBL	4145.5	GER Dredge	TV-MUC
15/05/19 08:45	199-1_MUC-39	11° 51.751' N	117° 00.761' W	USBL	4120.0	GER Dredge	TV-MUC
15/05/19 12:05	200-1_MUC-40	11° 51.761' N	117° 00.777' W	USBL	4128.5	GER Dredge	TV-MUC
15/05/19 14:50	201-1_MOOR-09	11° 51.798' N	117° 00.753' W	Ship	4119.6	GER Dredge	Deployment Mooring 1 (ADCP)
15/05/19 15:08	202-1_MOOR-10	11° 51.782' N	117° 00.810' W	Ship	4119.4	GER Dredge	Deployment Mooring 2 (ADCP)
15/05/19 16:09	203-1_MOOR-11	11° 56.813' N	117° 02.251' W	Ship	4098.7	GER Trial	Deployment Mooring 3 (ADCP)
15/05/19 18:25	204-1_MOOR-12	11° 55.311' N	117° 00.465' W	Ship	4097.0	GER Trial	Deployment Mooring 4 (ST)
16/05/19 00:17	205-1_BC-48	11° 50.228' N	117° 03.414' W	USBL	4131.7	GER Reference	failed
16/05/19 03:39	205-2_BC-49	11° 50.214' N	117° 03.418' W	USBL	4133.9	GER Reference	
16/05/19 06:41	206-1_BC-50	11° 50.319' N	117° 03.089' W	USBL	4129.1	GER Reference	failed
16/05/19 10:39	207-1_MUC-41	11° 51.790' N	117° 00.789' W	USBL	4117.8	GER Dredge	TV-MUC
16/05/19 14:19	208-1_CTD-17	11° 51.601' N	117° 00.834' W	USBL	4123.4	GER Dredge	
16/05/19 20:11	209-1_ROV-32	11° 51.772' N	117° 00.784' W	USBL	4117.1	GER Dredge	Start Transect
17/05/19 06:39	210-1_EM122-10	11° 51.102' N	117° 00.890' W	Ship	4123.5	Transit	Start Transect