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RV SONNE
Cruise SO295
Short Cruise Report

Port Hueneme - San Diego
October 31, 2022 - December 23, 2022

Chief Scientist: Pedro Martinez Arbizu
Captain: Tilo Birnbaum

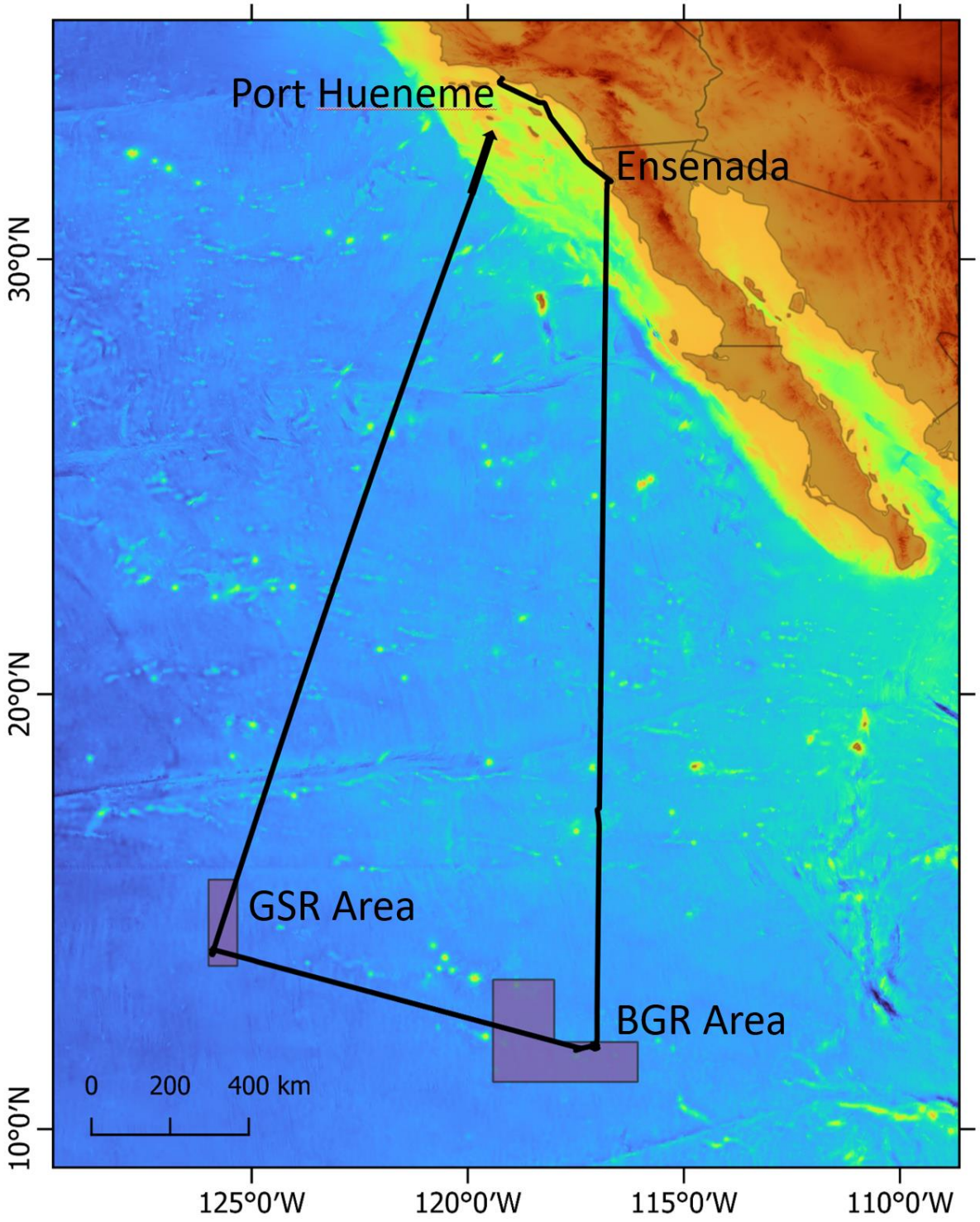

Fig. 1: Cruise track of RV SONNE cruise SO295. The right Box represents the BGR contract area, the left box is the central GSR contract area for the exploration of polymetallic nodules.

Objectives

The RV SONNE cruise SO295 builds on the results of the European collaborative JPI Oceans project “MiningImpact2” that assesses environmental impacts of polymetallic nodule mining. The expedition is connected to cruise SO268 from February to May in 2019, which collected the environmental baseline information in both working areas in the eastern BGR and the central GSR contract areas for polymetallic nodule exploration in the Clarion-Clipperton Zone (CCZ) in the Northeast Pacific. Cruise SO295 is further a direct follow-up of expedition IP21 with MV ISLAND PRIDE conducted from March to May in 2021, which collected independent scientific monitoring data of the first industrial nodule collector trial. Hence, SO295 established the important first data point in the time series assessing the environmental impacts induced by the mining of polymetallic nodules in the deep seabed after 1.5 years. Since nodule mining creates two main disturbances, (1) removal of the surface sediments and the nodule habitat where nodules are collected as well as (2) blanketing of the surrounding unmined seafloor with sediments suspended by the collector, both impact types were investigated in the two working areas. Within these, different sites representative for gradients and variability of the disturbances were identified, particularly addressing the impact due to varying thickness of the deposited sediment blanket. In addition, the restoration experiment, which was started during SO268, consisting of artificial hard substrates as substitutes of polymetallic nodules, was sampled. Natural variability was addressed by continuing the sampling of reference sites established in both working areas.

The conducted scientific work comprised oceanographic, biological, microbiological, biogeochemical, and geological methodologies. This required the deployment of a multitude of seagoing equipment, such as the diving robot ROV Kiel 6000 for sampling of sediments, nodules, and benthic fauna as well as carrying out *in situ* measurements and experiments at the abyssal seafloor. The AUV Abyss was used for high-resolution acoustic and optical mapping of the seafloor habitat. The RV SONNE towed camera system OFOS was used for photo surveys of the seafloor. Furthermore benthic platforms (elevators) for deploying and retrieval of equipment at the seafloor, moorings carrying hydrographic and acoustic sensors, several sediment coring devices (box-, TV-guided multiple-, and ROV-operated push-corers), CTD Rosette and bottom water samplers for sampling of the water column, have been deployed during SO295.

Narrative of the cruise

The PATANIA II pre-prototype collector system of the Belgian company GSR was tested in spring 2021 on two sites within the eastern contract area of the BGR and the central GSR contract area for the exploration of polymetallic nodules (Fig. 1) that were revisited during SO295. The cruise was divided into four phases, 1.) mobilization and transit to working area (October 30th – November 6th), 2.) working in the BGR contract area and transit to the GSR contract area (November 6th – December 1st), 3.) working in the GSR contract area (December 1st – December 17th) and 4.) transit back and demobilization (December 17th – December 23rd). RV SONNE arrived on the 26th of October at the small harbor of Port Hueneme, located about 70 km west of Los Angeles. On the 29th Oct. most scientists arrived at the vessel. Until we left Port Hueneme on the 31st of Oct., scientists were busy with unpacking containers, mobilizing the heavy gears like ROV, AUV and their launch and recovery systems and winches, and equipping the lab space on the vessel. Scientific meetings, for detailed planning of the sampling operations were held from 30th on. We departed from Port Hueneme with some delay, but without any issues, in the evening of the 31st in direction to Ensenada (Mexico). On Nov. 1st at 12:00 we reached Ensenada to pursue needed immigration formalities for the ship's crew and stayed in the roads, were we welcomed four additional crew members and some fresh provision. In the afternoon, around 16:00 we left Ensenada heading to the first working area. During the transit, the vessel stopped in international waters on Nov. 3rd for three hours to perform some necessary tests with the ROV and the AUV. The BGR contract area was reached on Nov. 6th and we firstly deployed and triangulated the AUV transponders. At each of the working areas we aimed to sample two main impact sites, the collector impact site, where the collector directly operated (Fig. 2) and the plume impact site (Fig. 4) where most of the sediment suspended during collector operation was deposited at different levels of blanketing thickness. In addition, a reference site, which was not influenced by the impact, was sampled. At each of these sites we aimed at no less than five replicate deployments with the video-guided Multicorer (TV-MUC) and the Boxcorer (BC), in addition to water column sampling with CTD, *in situ* pump, and Bottom Water Sampler (BWS). The ROV was used for targeted sampling of sediments and fauna, deploying oxygen profilers, benthic chambers (Fig 5) and other instrumentation, as well as for *in situ* experimentation and for recovering and sampling restoration experiments (Fig. 3) deployed and carried out during the previous expeditions SO268 and MANGAN 2021. The AUV was launched for acoustic and optical imaging surveys of the area disturbed by the collector in 2021 and to document the impact along a gradient of plume deposition. In the BGR contract area we started at the reference site conducting CTD measurements with *in situ* pumps. On Nov. 7th the ROV was used for the first time. The first deployments of ROV and AUV were marked by technical and navigation issues and some of the dives needed to be aborted. During the night of Nov. 7th to 8th, several BCs were deployed, and a lunar eclipse could be observed at about 2:45 shipboard time. We deployed the first OFOS consisting of a frame equipped with photo and video cameras that is towed about 1 m above the seabed to collect high-resolution images of the seafloor. In the morning of 8th Nov., the first successful ROV dive was performed at 4,125 m water depth devoted to sampling of sediments and organisms, and to recover the elevator that had sunk to the seafloor uncontrolled during the first deployment. Additional ROV dives in the reference site took place on Nov. 9th and Nov. 11th. Another objective of the dives was to recover recolonization frames deployed previously to study the restoration potential of artificial substrates, but which could not be located due to incorrect underwater navigation data in the first period of the cruise. The traces of the collector prototype were clearly visible in AUV photographs and on the side-scan sonar maps. Using the ROV's sonar, artificial nodule frames deployed in the collector impact site in 2021, were finally found. After taking five BCs and TV-MUCs each in the reference site, the first TV-MUCs were deployed in the collector

impact site on Nov. 12th. With the TV-MUC's camera, we were able to see the PATANIA II tracks well and land the instrument accurately. For the BC without a camera, we had to trust our luck. The exact position of the sampling in relation to the tracks was determined *a posteriori* based on AUV photographs taken before leaving the area. The BWS was was deployed successfully on Nov. 13th after it had failed twice to close the bottles during test deployments on Nov. 9th and 10th. During the first week (Nov. 7th to 13th) we concentrated our efforts in sampling the reference site and started the work on the collector impact site. We deployed four times the AUV, two times the CTD, five times the ROV, six times the BC, seven times the TV-MUC, two times the OFOS and four times the BWS. On Nov. 13th we tried to recover a mooring from the BGR deployed in 2021 at station IP21_064ST and equipped with two sediment traps, a passive acoustic recorder, and acoustic Doppler current profilers (ADCPs). Apparently, there was communication with the Mooring's acoustic releaser, but the mooring failed to reach the water surface. This made us conclude that some floating spheres may have imploded. Additional attempts to recover the mooring on Nov. 16th and 18th were also unsuccessful. During the week Nov. 14th to 20th we focused on sampling the collector impact site alternating with sampling the closely located plume impact site with thick sediment cover. In total seven BCs and eight TV-MUCs were deployed. Two successful OFOS dives documented the megafauna and the physical disturbance in the collector impact site and in the plume impact site (Fig. 6). In addition, three AUV dives and four ROV dives (to deploy oxygen profilers, benthic chambers and mesocosm experiments, and to recover five frames with artificial nodules and deploy 20 new frames) were achieved, but we still struggled with inaccurate underwater navigation. One of the antennas of the onboard USBL Posidonia system was exchanged and the whole system was calibrated on Nov. 19th. After this, the accuracy of the underwater navigation increased. On Nov. 15th and 19th, the BWS was successfully deployed to sample the bottom boundary layer and a CTD cast took place on the 16th. The following week was used to finalize sampling in the collector impact and thick plume impact sites and to sample and document a gradient of plume deposition in northwest direction of the trial area. Three OFOS, two AUV dives and four ROV dives were devoted to sample this area. In addition, ten TV-MUCs and nine BCs were deployed. The last five BCs on Nov. 24th - 26th were devoted to resample an area where samples were taken already in the pre-impact study for time series assessment. A last unsuccessful attempt to recover the mooring was undertaken on Nov. 26th and we were leaving the GER trial area after retrieval of the AUV transponders in direction of a western located area without nodules on the seabed. In this "No-Nodule area", a first ROV dive had to be aborted due to technical problems. A CTD (Nov. 27th) cast took place followed by a successful OFOS dive on Nov. 28th. Finally, a successful ROV dive, dedicated at recolonization frame recovery and sampling was achieved on Nov. 28th. Immediately after, we left the BGR contract area on Nov. 29th heading to the central GSR contract area, where we arrived in Dec. 1st. In the GSR contract area, we started again with deploying the transponders for AUV navigation and a first AUV dive was started to document the gradient of plume deposition. Subsequently, a CTD was deployed, and we started the work in the collector impact site with two TV-MUCs and five BCs until Nov. 4th. Coring during night hours alternated with ROV dives during the 2nd, 3rd and 4th of December. Also, an OFOS dive (Dec. 3rd) documented the collector tracks, traces of life, and megafauna (Fig. 7) in the collector impact site and the plume impact site along the gradient of sediment blanketing. In the following week (Dec. 5th-11th) our focus was to sample the collector impact site and the close-by plume impact site with a thick blanketing layer. We deployed nine TV-MUCs and five BCs between the 5th and the 9th. In addition, two AUV and two ROV dives took place between Dec. 5th and 8th. Two additional OFOS dives documented the extent and intensity of plume deposition on Dec. 8th and 9th. Sampling of the collector impact site was alternated from 9th Dec. onwards with sampling of the reference site, where we deployed six TV-MUCs and six BCs and performed one ROV and OFOS dive each. Our last week in the GSR

contract area (Dec. 12th-18th) was mainly devoted to finalizing the sampling at the reference site (two BCs, one OFOS dive, and one BWS) and to document and sample along a plume deposition gradient. For this purpose, five TV-MUCs deployments and one OFOS transect were carried out. Four ROV dives (Dec. 12th - 15th) were conducted to sample and deploy devices in the plume impact site in areas with thick cover as well as along a gradient with deposition of different thickness. Four AUV dives (Dec. 12th, 14th, 16th, and 17th) were devoted to produce a photomosaic of the collector impact site, but also to fill gaps in survey coverage and to document the plume deposition gradient. Starting on Thursday Dec. 15th, the first containers were being packed, and instruments that were no longer needed were dismantled in the laboratories. We left the GSR contract area on Dec. 17th after finalizing the station work with a successful deployment of the BWS, starting our 130-hour transit to Port Hueneme, where we arrived in the afternoon of the 22nd December 2022.

Additional figures

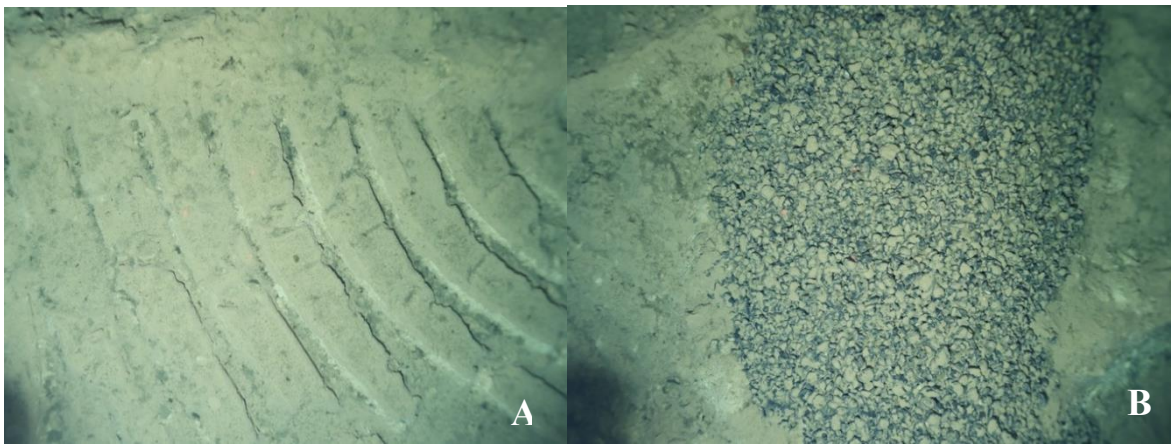

Fig. 2: OFOS image of a PATANIA II track (A) and piles of nodules left by PATANIA II (B).

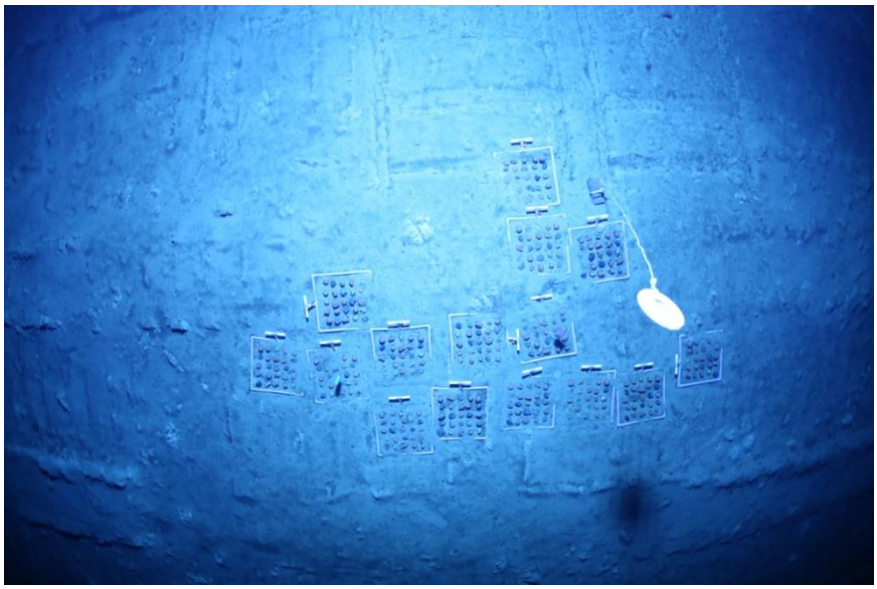

Fig. 3: Image of recolonization frames with artificial and cleaned nodules taken by AUV (restoration experiment).

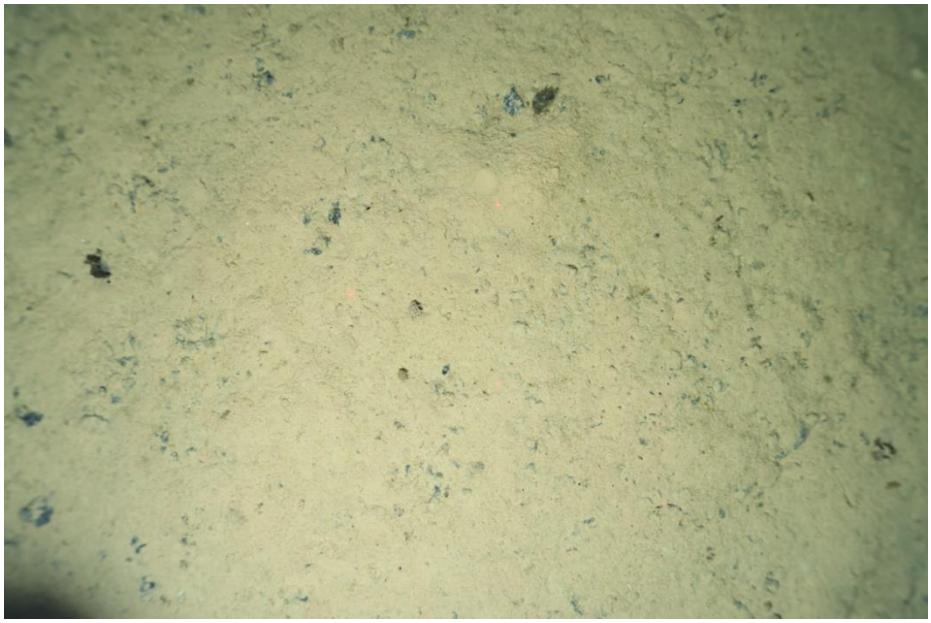

Fig. 4: The plume impact site with thick sediment blanketing, completely covering nodules and fauna.

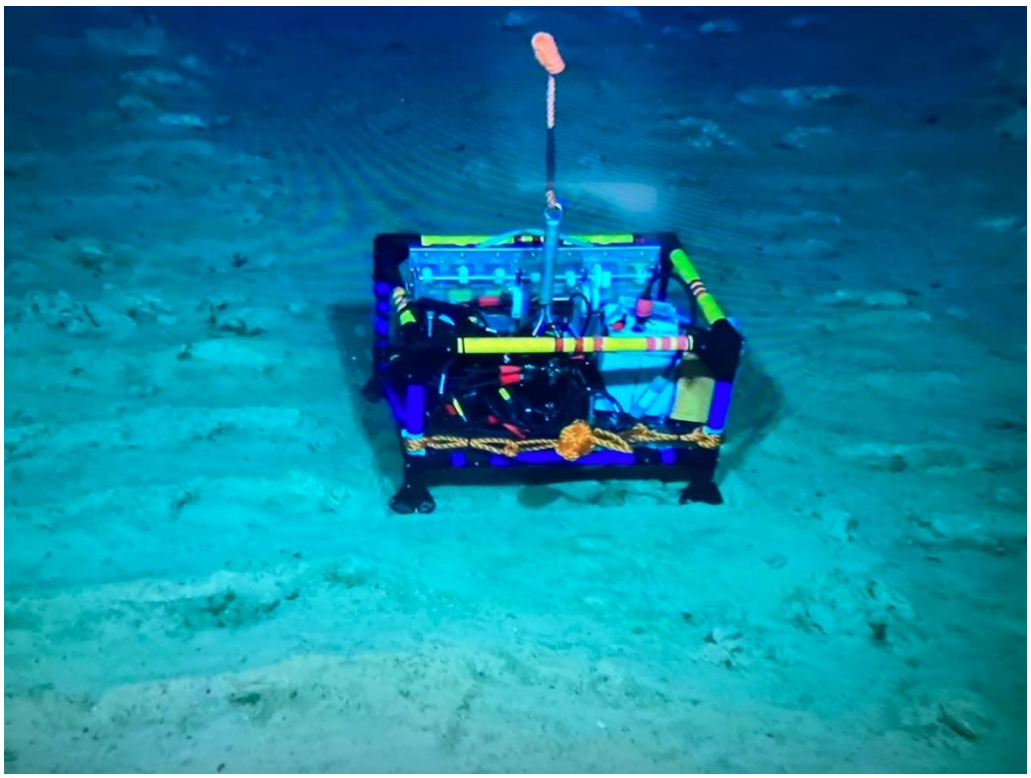

Fig. 5: Oxygen profiler deployed between caterpillar tracks in the collector impact site.

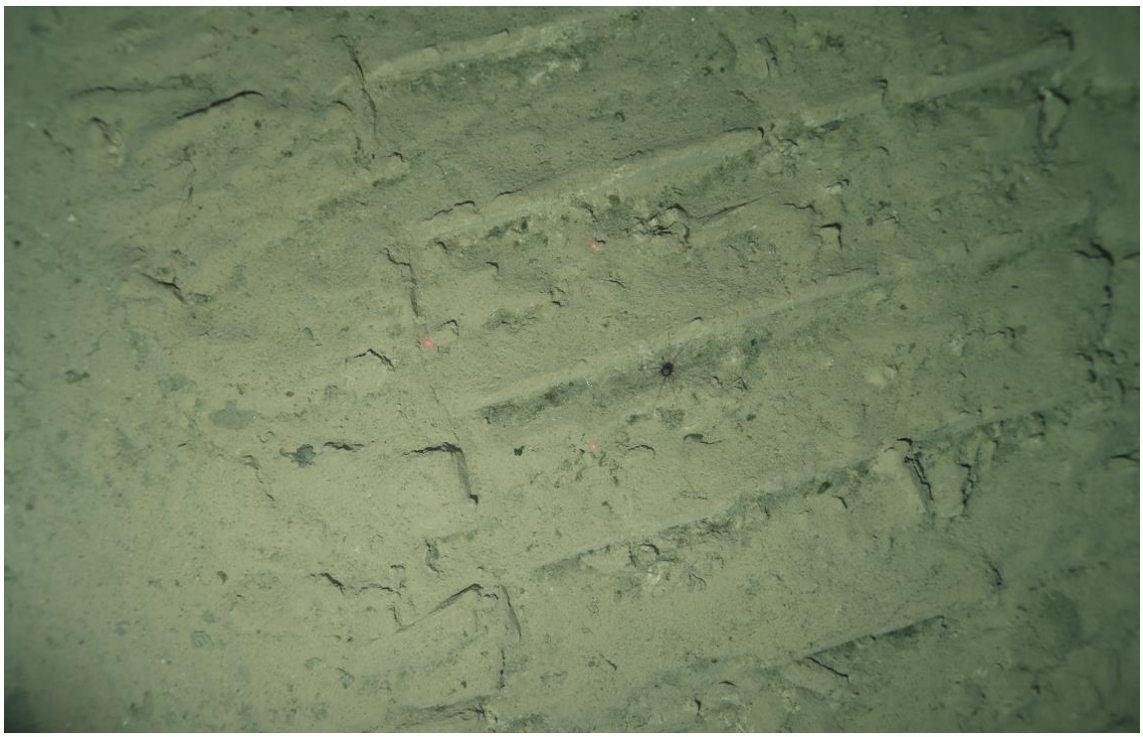

Fig. 6: Imprint of the caterpillar tracks of PATANIA II and a sea-urchin.

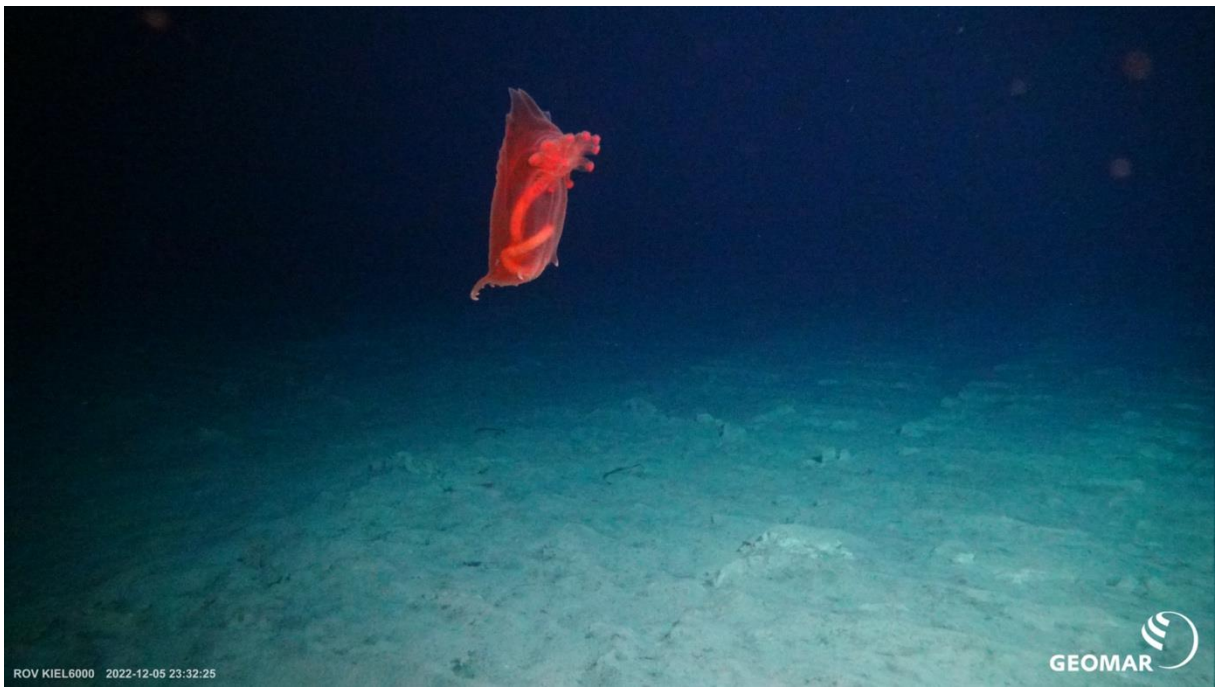

Fig. 7: A Peniagone sea cucumber swimming above the collector impact site.

Acknowledgements

The scientific party would like to thank Captain Tilo Birnbaum and the crew of SO295 for the very professional conduction and continuous support during the cruise. Funding for the cruise and for scientific work of the German institutions participating in the cruise was provided by the German Federal Ministry of Education and Research (BMBF) under grant 03G0295A-E and contributed to the European MiningImpact project (https://miningimpact.geomar.de).

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29.	Kurbjuhn, Torge	AUV	GEOMAR
30.	Jäkle, Anna	AUV	GEOMAR
31.	Abegg, Fritz	ROV	GEOMAR
32.	Pieper, Martin	ROV	GEOMAR
33.	Suck, Inken	ROV	GEOMAR
34.	Matthiessen, Torge	ROV	GEOMAR
35.	Cuno, Patrick	ROV	GEOMAR
36.	Striewski, Peter	ROV	GEOMAR
37.	Genz, Johannes	ROV	GEOMAR
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39.	Kalvelage, Tim	Journalist	

Institutes

AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar und Meeresforschung, Germany
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe, Germany
GSR	Global Sea Mineral Resources, DEME Group, Belgium
GEOMAR	GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Germany
IFREMER	Institut français de recherche pour l'exploitation de la mer,France
JUB	Jakobs Universität Bremen, Germany
MPI	Max-Planck-Institut für Marine Mikrobiologie, Germany
NIOZ	Royal Netherlands Institute for Sea Research, The Netherlands
Oktopus	Oktopus GmbH, Germany
SGN	Senckenberg Gesellschaft für Naturforschung, Germany
SIO	Scripps Institute of Oceanography, USA
UAveiro	University Aveiro, Portugal
UGhent	University Ghent, Belgium
UNIVPM	Università Politecnica delle Marche, Italy
UUtrecht	University Utrecht, The Netherlands

Fig. 8. Group picture of the SO295 cruise participants.

Station list

Date Time (UTC)	Station_Device	Latitude	Longitude	Position	Water Depth (m)	Area	Comment
07/11/22 00:30	001-1_TP	11° 55.488' N	117° 02.077' W	Ship	no data	GER	Transponder 1A deployment
07/11/22 00:47	002-1_TP	11° 56.118' N	117° 02.089' W	Ship	no data	GER	Transponder 2B deployment
07/11/22 02:54	002-1_TP	11° 55.754' N	117° 01.041' W	Ship	4079.0	GER	Transponder calibration
07/11/22 05:15	003-1_AUV-01	11° 56.074' N	117° 02.095' W	Ship	4080.3	GER Collector impact	Start transect / navigational drift
07/11/22 09:06	004-1_CTD-01	11° 51.588' N	117° 00.837' W	Ship	4116.9	GER Dredge	Max. depth, repetition SO268_094_CTD
07/11/22 14:14	005-1_LIFT-01	11° 51.796' N	117° 00.704' W	Ship	4111.6	GER Dredge	Elevator 1 deployment
07/11/22 17:09	006-1_ROV-01	11° 51.806' N	117° 00.700' W	Ship	4120.9	GER	Failed
07/11/22 20:50	007-1_BC	11° 50.807' N	117° 03.650' W	Ship	4127.0	GER Reference	Failed deployment
08/11/22 01:56	008-1_AUV-01	11° 52.208' N	117° 06.785' W	Ship	no data		Recovery
08/11/22 04:03	009-1_BC-01	11° 50.762' N	117° 03.575' W	Ship*	4125.8	GER Reference	
08/11/22 07:48	010-1_OFOS-01	11° 51.371' N	117° 01.650' W	Ship	4129.7	GER Reference	Start transect
08/11/22 18:19	011-1_BC-02	11° 50.756' N	117° 03.561' W	Ship	4124.4	GER Reference	
08/11/22 22:45	012-1_ROV-02	11° 51.810' N	117° 00.711' W	Ship	4120.3	GER Dredge	Start transect
09/11/22 03:42	013-1_LIFT-01	11° 51.827' N	117° 00.698' W	Ship	4119.4		Elevator 1 recovery
09/11/22 05:19	014-1_BWS-01	11° 51.821' N	117° 00.699' W	Ship*	4119.0	GER	Test deployment
09/11/22 07:43	015-1_TVMUC-01	11° 50.737' N	117° 03.602' W	Ship	4129.1	GER Reference	
09/11/22 10:43	016-1_TVMUC-02	11° 50.740' N	117° 03.573' W	Ship	4125.7	GER Reference	
09/11/22 13:12	017-1_AUV-02	11° 56.074' N	117° 02.097' W	Ship	4092.4	GER Plume impact gradient	Start transect
09/11/22 19:19	018-1_LIFT-02	11° 50.586' N	117° 03.554' W	Ship	4131.5	GER Reference	Elevator 2 deployment
09/11/22 18:12	019-1_ROV-03	11° 50.584' N	117° 03.546' W	Ship	4130.1	GER Reference	Start transect
10/11/22 05:32	020-1_AUV-02	11° 55.278' N	117° 09.010' W	Ship	4061.8		Recovery / mission aborted
10/11/22 05:46	021-1_BWS-02	11° 55.240' N	117° 09.044' W	Ship	4070.7	GER	Test deployment
10/11/22 08:31	022-1_BC-03	11° 50.752' N	117° 03.535' W	Ship	4127.6	GER Reference	
10/11/22 11:40	023-1_BC-04	11° 50.748' N	117° 03.489' W	Ship	4127.3	GER Reference	
10/11/22 15:06	024-1_TVMUC-03	11° 50.750' N	117° 03.612' W	Ship	4124.9	GER Reference	

10/11/22 18:29	025-1_TVMUC-04	11° 50.745' N	117° 03.536' W	Ship	4125.4	GER Reference	
10/11/22 22:16	026-1_OFOS-02	11° 52.434' N	116° 58.980' W	Ship	4093.7	GER Reference	Start transect
11/11/22 09:06	027-1_TVMUC-05	11° 50.750' N	117° 03.502' W	Ship	4126.9	GER Reference	
11/11/22 12:33	028-1_BC-05	11° 50.745' N	117° 03.452' W	Ship	4126.8	GER Reference	
11/11/22 17:17	029-1_ROV-04	11° 50.791' N	117° 03.444' W	Ship	4127.5	GER Reference	Start transect
12/11/22 04:11	030-1_AUV-03	11° 56.059' N	117° 02.108' W	Ship	4088.9	GER Plume impact gradient	Start transect
12/11/22 06:12	031-1_CTD-02	11° 55.807' N	117° 01.605' W	Ship*	4085.0	GER Collector impact	max. depth
12/11/22 08:26	032-1_AUV-03	11° 56.415' N	117° 01.688' W	Ship	4092.0		Recovery / mission aborted
12/11/22 10:18	033-1_TVMUC-06	11° 55.802' N	117° 01.692' W	Ship	4085.0	GER Collector impact	
12/11/22 13:12	034-1_TVMUC-07	11° 55.805' N	117° 01.663' W	Ship	4084.0	GER Collector impact	Likely sampled off tracks
12/11/22 17:34	035-1_ROV-05	11° 50.535' N	117° 03.447' W	Ship	no data	GER Reference	Start transect
13/11/22 04:14	036-1_LIFT-02	11° 50.596' N	117° 03.548' W	Ship	no data		Elevator 2 recovery
13/11/22 08:19	037-1_BWS-03	11° 55.799' N	117° 01.606' W	Ship	4084.3	GER Collector impact	Max. depth
13/11/22 13:38	038-1_BC-06	11° 55.798' N	117° 01.697' W	Ship	4083.0	GER Collector impact	
13/11/22 16:36	039-1_BC-07	11° 55.810' N	117° 01.665' W	Ship	4083.8	GER Plume impact thick	
13/11/22 18:55	040-1_MOOR	11° 55.304' N	117° 00.388' W	Ship	no data	GER	Failed recovery IP21_064ST
13/11/22 23:51	041-1_AUV-04	11° 56.119' N	117° 02.167' W	Ship	no data	GER Plume impact gradient	Start transect
14/11/22 03:30	042-1_AUV-04	11° 56.174' N	117° 02.920' W	Ship	no data		Recovery / mission aborted
14/11/22 05:55	043-1_OFOS-03	11° 55.438' N	117° 01.511' W	Ship	4081.1	GER Collector impact, plume impact gradient	Start transect
14/11/22 18:29	044-1_LIFT-03	11° 55.824' N	117° 01.498' W	Ship	no data	GER Collector impact	Elevator 2 deployment
14/11/22 17:02	045-1_ROV-06	11° 55.841' N	117° 01.490' W	Ship	no data	GER Collector impact	Start transect
15/11/22 04:52	046-1_TVMUC-08	11° 55.844' N	117° 01.695' W	Ship	4081.5	GER Plume impact thick	
15/11/22 07:49	047-1_TVMUC-09	11° 55.844' N	117° 01.664' W	Ship	4080.9	GER Plume impact thick	
15/11/22 11:13	048-1_BC-08	11° 55.840' N	117° 01.693' W	Ship	4081.0	GER Plume impact thick	
15/11/22 14:08	049-1_BC-09	11° 55.842' N	117° 01.680' W	Ship	4081.3	GER Plume impact thick	
15/11/22 19:37	050-1_BWS-04	11° 51.600' N	117° 00.844' W	Ship	4126.2	GER Dredge	Max. depth
16/11/22 00:48	051-1_AUV-05	11° 56.080' N	117° 02.093' W	Ship	4088.2	GER Collector impact	Start transect / no images
16/11/22 03:32	052-1_CTD-03	11° 56.101' N	117° 01.634' W	Ship*	4083.2	GER Plume impact thin	Max. depth, repetition IP21_074_CTD
16/11/22 09:52	053-1_BC-10	11° 55.854' N	117° 01.655' W	Ship	4085.7	GER Plume impact thick	

16/11/22 12:47	054-1_AUV-05	11° 52.524' N	117° 07.968' W	Ship	4135.7		Recovery
16/11/22 14:31	055-1_MOOR	11° 55.397' N	117° 00.645' W	Ship	no data	GER	Failed recovery IP21_064ST
16/11/22 17:38	056-1_OFOS-04	11° 55.807' N	117° 01.252' W	Ship	4085.9	GER Collector impact, plume impact thick	Start transect
17/11/22 03:14	057-1_TVMUC-10	11° 55.848' N	117° 01.658' W	Ship*	4081.3	GER Plume impact thick	
17/11/22 06:06	058-1_TVMUC-11	11° 55.859' N	117° 01.626' W	Ship	4081.7	GER Plume impact thick	
17/11/22 09:21	059-1_BC-11	11° 55.851' N	117° 01.623' W	Ship	4081.4	GER Plume impact thick	
17/11/22 14:56	060-1_BC-12	11° 55.845' N	117° 01.601' W	Ship	4082.4	GER Plume impact thick	Second deployment after initial failure
17/11/22 18:38	061-1_ROV-07	11° 55.811' N	117° 01.469' W	Ship	4081.7	GER Collector impact	Start transect
18/11/22 04:03	062-1_LIFT-03	11° 55.817' N	117° 01.476' W	Ship	4080.7		Elevator 2 recovery
18/11/22 04:53	063-1_AUV-06	11° 56.063' N	117° 02.127' W	Ship	no data	GER Collector impact	Start transect
18/11/22 05:36	064-1_MOOR	11° 55.665' N	117° 01.276' W	Ship	no data	GER	Failed recovery IP21_064ST
18/11/22 09:22	065-1_TVMUC-12	11° 55.847' N	117° 01.606' W	Ship	4084.2	GER Plume impact thick	
18/11/22 12:12	066-1_TVMUC-13	11° 55.807' N	117° 01.656' W	Ship	4082.7	GER Collector impact	
18/11/22 18:45	067-1_LIFT-04	11° 55.805' N	117° 01.496' W	Ship	4084.8	GER Collector impact	Elevator 1 deployment
18/11/22 18:01	068-1_ROV-08	11° 55.792' N	117° 01.502' W	Ship	4082.9	GER Collector impact, plume impact thick	Start transect
19/11/22 02:29	069-1_AUV-06	11° 58.170' N	117° 07.457' W	Ship	4130.9		Recovery
19/11/22 03:49	070-1_POSIDONIA	11° 55.792' N	117° 01.492' W	Ship	4085.1	GER	Transponder calibration
19/11/22 08:34	071-1_BWS-05	11° 56.107' N	117° 01.630' W	Ship	4080.7	GER Plume impact thin	Max. depth
19/11/22 13:28	072-1_TVMUC-14	11° 55.809' N	117° 01.635' W	Ship	4085.9	GER Collector impact	
19/11/22 17:12	073-1_ROV-09	11° 55.749' N	117° 01.455' W	Ship	4084.9	GER Collector impact	Start transect
20/11/22 03:01	074-1_LIFT-04	11° 55.792' N	117° 01.486' W	Ship	4084.2		Elevator 1 recovery
20/11/22 03:57	075-1_AUV-07	11° 56.084' N	117° 02.065' W	Ship	4096.1	GER Plume impact gradient	Start transect / navigational drift
20/11/22 05:23	076-1_OFOS-05	11° 57.779' N	117° 02.080' W	Ship	4112.3	GER Plume impact gradient	Failed
20/11/22 16:39	077-1_TVMUC-15	11° 55.805' N	117° 01.645' W	Ship	4082.3	GER Collector impact	Failed
20/11/22 20:06	078-1_BC-13	11° 55.806' N	117° 01.660' W	Ship*	4082.2	GER Collector impact	
20/11/22 22:06	079-1_AUV-07	11° 55.235' N	117° 01.021' W	Ship	4108.4		Recovery
20/11/22 23:59	080-1_BC-14	11° 55.811' N	117° 01.640' W	Ship	4081.9	GER Plume impact thick	
21/11/22 03:53	081-1_OFOS-06	11° 57.773' N	117° 02.086' W	Ship	4107.9	GER Plume impact gradient	Start transect, repetition 076-1_OFOS_05

21/11/22 18:00	082-1_LIFT-05	11° 55.843' N	117° 01.511' W	Ship	4085.1	GER Plume impact thick	Elevator 2 deployment
21/11/22 17:04	083-1_ROV-10	11° 55.837' N	117° 01.510' W	Ship	4086.3	GER Plume impact thick	Start transect
22/11/22 02:25	084-1_AUV-08	11° 56.143' N	117° 02.058' W	Ship	4096.2	GER Trial baseline time series	Start transect
22/11/22 04:03	085-1_TVMUC-16	11° 55.809' N	117° 01.617' W	Ship	4083.8	GER Collector impact	
22/11/22 07:11	086-1_BC-15	11° 55.807' N	117° 01.616' W	Ship	4082.2	GER Collector impact	
22/11/22 10:13	087-1_BC-16	11° 55.807' N	117° 01.674' W	Ship	4083.5	GER Collector impact	
22/11/22 17:22	088-1_LIFT-06	11° 50.650' N	117° 03.543' W	Ship	4135.4	GER Reference	Elevator 1 deployment
22/11/22 17:11	089-1_ROV-11	11° 50.645' N	117° 03.549' W	Ship	4136.0	GER Reference	Start transect
22/11/22 23:44	090-1_LIFT-06	11° 50.635' N	117° 03.548' W	Ship	4136.9		Elevator 1 recovery
23/11/22 03:27	091-1_AUV-08	11° 56.717' N	117° 06.439' W	Ship	4122.8		Recovery
23/11/22 05:40	092-1_TVMUC-17	11° 55.803' N	117° 01.626' W	Ship*	4085.3	GER Collector impact	
23/11/22 08:36	093-1_TVMUC-18	11° 55.791' N	117° 01.608' W	Ship	4084.6	GER Collector impact	
23/11/22 11:55	094-1_BC-17	11° 55.796' N	117° 01.620' W	Ship	4083.9	GER Collector impact	
23/11/22 16:45	095-1_ROV-12	11° 51.571' N	117° 00.693' W	Ship	4122.4	GER Dredge, decompaction experiment	Start transect
24/11/22 02:56	096-1_AUV-09	11° 56.091' N	117° 02.079' W	Ship	4091.3	GER Reference	Start transect / navigation problems
24/11/22 04:49	097-1_TVMUC-19	11° 55.803' N	117° 01.622' W	Ship	4082.2	GER Collector impact	
24/11/22 07:51	098-1_BC-18	11° 55.798' N	117° 01.611' W	Ship	4082.6	GER Collector impact	
24/11/22 10:43	099-1_BC-19	11° 55.635' N	117° 01.308' W	Ship	4087.9	GER Trial baseline time series	
24/11/22 16:51	100-1_ROV-13	11° 55.807' N	117° 01.468' W	Ship	4087.3	GER Plume impact thick	Start transect
25/11/22 01:40	101-1_LIFT-05	11° 55.832' N	117° 01.502' W	Ship	4081.7		Elevator 2 recovery
25/11/22 03:24	102-1_AUV-09	11° 56.773' N	117° 07.666' W	Ship	4132.9		Recovery
25/11/22 05:58	103-1_OFOS-07	11° 55.793' N	117° 01.061' W	Ship	4084.2	GER Plume impact gradient	Start transect
25/11/22 15:34	104-1_BC-20	11° 55.629' N	117° 01.281' W	Ship	4090.3	GER Trial baseline time series	
25/11/22 18:30	105-1_BC-21	11° 55.629' N	117° 01.256' W	Ship	4091.1	GER Trial baseline time series	
25/11/22 22:13	106-1_TVMUC-20	11° 55.946' N	117° 01.616' W	Ship	4079.4	GER Plume impact 220m NW of tracks	Sediment surface disturbed
26/11/22 01:03	107-1_TVMUC-21	11° 55.949' N	117° 01.622' W	Ship	4081.3	GER Plume impact 220m NW of tracks	Repetition 106-1_TVMUC-20
26/11/22 02:33	108-1_AUV-10	11° 55.947' N	117° 01.621' W	Ship	4081.5	GER Collector impact,	Start transect

						plume impact gradient	
26/11/22 02:49	109-1_MOOR	11° 55.940' N	117° 01.612' W	Ship	no data	GER	Failed recovery IP21_064ST
26/11/22 06:20	110-1_OFOS-08	11° 51.730' N	117° 00.368' W	Ship	4116.5	GER Dredge, decompaction experiment	Start transect
26/11/22 15:56	111-1_BC-22	11° 55.637' N	117° 01.237' W	Ship	4089.8	GER Trial baseline time series	
26/11/22 18:46	112-1_BC-23	11° 55.630' N	117° 01.209' W	Ship*	4089.0	GER Trial baseline time series	
26/11/22 22:11	113-1_TVMUC-22	11° 56.980' N	117° 01.632' W	Ship	4096.9	GER Plume impact 2000m N of tracks	
27/11/22 00:21	114-1_AUV-10	11° 58.604' N	117° 05.614' W	Ship	4118.5		Recovery
27/11/22 03:34	114-1_AUV-10	11° 56.420' N	117° 02.515' W	Ship	4100.2	GER	Transponder recovery
27/11/22 05:19	115-1_TVMUC-23	11° 55.904' N	117° 01.601' W	Ship	4082.7	GER Plume impact 150m NW of tracks	
27/11/22 08:16	116-1_TVMUC-24	11° 56.094' N	117° 01.692' W	Ship	4082.3	GER Plume impact 500m NW of tracks	
27/11/22 11:11	117-1_TVMUC-25	11° 55.632' N	117° 01.259' W	Ship	4090.2	GER Trial baseline time series	
27/11/22 16:59	118-1_LIFT	11° 51.015' N	117° 23.024' W	Ship	4275.0	GER NoNodule	Elevator 1 failed deployment
27/11/22 17:00	119-1_ROV-14	11° 51.015' N	117° 23.024' W	Ship	4274.6	GER	Failed
27/11/22 22:34	120-1_CTD-04	11° 50.988' N	117° 22.801' W	Ship	4275.4	GER NoNodule	Max. depth
28/11/22 03:17	121-1_OFOS-09	11° 48.653' N	117° 30.585' W	Ship	4373.4	GER NoNodule	Start transect
28/11/22 17:53	122-1_LIFT-07	11° 51.020' N	117° 23.034' W	Ship*	4275.8	GER NoNodule	Elevator 1 deployment
28/11/22 17:21	123-1_ROV-15	11° 51.016' N	117° 23.031' W	Ship	4272.9	GER NoNodule	Start transect
29/11/22 03:30	124-1_LIFT-07	11° 51.056' N	117° 23.084' W	Ship	4277.0		Elevator 1 recovery
01/12/22 10:19	125-1_TP	14° 06.938' N	125° 51.762' W	Ship	4502.9	BEL	Transponder 3A deployment
01/12/22 10:46	126-1_TP	14° 06.560' N	125° 52.372' W	Ship	4485.0	BEL	Transponder 4B deployment
01/12/22 12:35	126-1_TP	14° 06.778' N	125° 52.941' W	Ship	4468.5	BEL	Transponder calibration
01/12/22 14:34	127-1_AUV-11	14° 06.798' N	125° 52.035' W	Ship	4504.6	BEL Plume impact gradient & trial baseline time series	Start transect / gaps in imaging
01/12/22 17:05	128-1_CTD-05	14° 06.612' N	125° 52.173' W	Ship	4497.3	BEL Plume impact thin	Max. depth, repetition IP21_015_CTD
02/12/22 00:28	129-1_TVMUC-26	14° 06.748' N	125° 52.468' W	Ship	4488.8	BEL Collector impact	Likely sampled collector turn area
02/12/22 03:30	130-1_TVMUC-27	14° 06.772' N	125° 52.494' W	Ship	4486.1	BEL Collector impact	
02/12/22 06:54	131-1_BC-24	14° 06.768' N	125° 52.489' W	Ship	4487.3	BEL Collector impact	

02/12/22 10:00	132-1_BC-25	14° 06.773' N	125° 52.490' W	Ship	4490.1	BEL Collector impact	
02/12/22 12:15	133-1_AUV-11	14° 06.786' N	125° 54.795' W	Ship	4514.2		Recovery
02/12/22 17:23	134-1_LIFT-08	14° 06.740' N	125° 52.425' W	Ship	4489.4	BEL Collector impact	Elevator 2 deployment
02/12/22 17:13	135-1_ROV-16	14° 06.729' N	125° 52.421' W	Ship	4488.4	BEL Collector impact	Start transect
03/12/22 03:51	136-1_OFOS-10	14° 07.158' N	125° 52.181' W	Ship	4506.5	BEL Collector impact, plume impact thick & gradient	Start transect
03/12/22 13:11	137-1_AUV-12	14° 06.818' N	125° 52.027' W	Ship	4503.2	BEL Plume impact gradient & trial baseline time series	Start transect / gaps in imaging
03/12/22 18:05	138-1_LIFT-09	14° 06.703' N	125° 52.381' W	Ship	4482.9	BEL Collector impact	Elevator 1 deployment
03/12/22 17:09	139-1_ROV-17	14° 06.674' N	125° 52.375' W	Ship	4484.9	BEL Collector impact, plume impact thick	Start transect
04/12/22 03:57	140-1_BC-26	14° 06.812' N	125° 52.480' W	Ship	4486.2	BEL Plume impact thick	
04/12/22 07:02	141-1_BC-27	14° 06.826' N	125° 52.467' W	Ship	4488.4	BEL Collector impact	
04/12/22 10:12	142-1_BC-28	14° 06.844' N	125° 52.445' W	Ship	4492.8	BEL Collector impact	
04/12/22 12:19	143-1_AUV-12	14° 05.975' N	125° 53.022' W	Ship	4456.3		Recovery
04/12/22 17:04	144-1_ROV-18	14° 06.715' N	125° 52.344' W	Ship	4497.6	BEL Collector impact	Start transect
05/12/22 02:50	145-1_LIFT-09	14° 06.758' N	125° 52.452' W	Ship	4487.8		Elevator 1 recovery
05/12/22 05:51	146-1_TVMUC-28	14° 06.812' N	125° 52.602' W	Ship	4486.0	BEL Plume impact thick	
05/12/22 08:56	147-1_TVMUC-29	14° 06.827' N	125° 52.462' W	Ship	4494.8	BEL Collector impact	
05/12/22 11:55	148-1_TVMUC-30	14° 06.844' N	125° 52.437' W	Ship	4490.8	BEL Collector impact	
05/12/22 13:34	149-1_AUV-13	14° 06.846' N	125° 52.441' W	Ship	4494.3	BEL Collector impact, Plume impact thick	Start transect / gaps in imaging
05/12/22 15:59	150-1_CTD-06	14° 06.738' N	125° 52.435' W	Ship	4488.9	BEL Collector impact	Max. depth
05/12/22 20:02	151-1_ROV-19	14° 06.748' N	125° 52.379' W	Ship	4494.4	BEL Collector impact	Start transect
06/12/22 05:10	152-1_LIFT-08	14° 06.838' N	125° 52.497' W	Ship	4485.7		Elevator 2 recovery
06/12/22 08:29	153-1_CTD-07	14° 01.138' N	125° 54.949' W	Ship	4529.8	BEL Reference	Max. depth, repetition SO268_151_CTD
06/12/22 14:29	154-1_AUV-13	14° 08.625' N	125° 53.826' W	Ship	4495.6		Recovery
06/12/22 16:33	155-1_TVMUC-31	14° 06.813' N	125° 52.488' W	Ship	4488.8	BEL Collector impact	
06/12/22 19:59	156-1_TVMUC-32	14° 06.119' N	125° 52.876' W	Ship*	4457.9	BEL Trial site 1200m SW of tracks	
06/12/22 23:14	157-1_TVMUC-33	14° 06.701' N	125° 52.473' W	Ship	4483.6	BEL Plume impact thick	
07/12/22 02:26	158-1_TVMUC-34	14° 06.671' N	125° 52.347' W	Ship	4491.1	BEL Plume impact thick	

07/12/22 05:59	159-1_BC-29	14° 06.820' N	125° 52.498' W	Ship	4489.0	BEL Collector impact	
07/12/22 09:05	160-1_BC-30	14° 06.683' N	125° 52.465' W	Ship	4486.6	BEL Plume impact thick	
07/12/22 12:19	161-1_BC-31	14° 06.672' N	125° 52.351' W	Ship	4490.8	BEL Plume impact thick	
07/12/22 17:59	162-1_LIFT-10	14° 06.698' N	125° 52.327' W	Ship	4492.3	BEL Plume impact thick	Elevator 1 deployment
07/12/22 17:34	163-1_ROV-20	14° 06.692' N	125° 52.328' W	Ship	4493.5	BEL Plume impact thick	Start transect
08/12/22 02:37	164-1_AUV-14	14° 06.795' N	125° 52.045' W	Ship	4503.9	BEL Collector impact, Plume impact thick	Start transect / gaps in imaging
08/12/22 04:51	165-1_OFOS-11	14° 06.944' N	125° 52.471' W	Ship	4488.1	BEL Collector impact, plume impact thick & gradient	Start transect
08/12/22 17:22	166-1_TVMUC-35	14° 06.777' N	125° 52.297' W	Ship	4504.1	BEL Plume impact thick	
08/12/22 20:23	167-1_TVMUC-36	14° 06.815' N	125° 52.398' W	Ship	4488.8	BEL Plume impact thick	
08/12/22 22:17	168-1_AUV-14	14° 07.119' N	125° 52.487' W	Ship	4491.6		Recovery
09/12/22 00:17	169-1_BC-32	14° 06.778' N	125° 52.290' W	Ship	4501.6	BEL Plume impact thick	
09/12/22 03:26	170-1_BC-33	14° 06.818' N	125° 52.390' W	Ship	4490.4	BEL Plume impact thick	
09/12/22 07:44	171-1_OFOS-12	14° 03.952' N	125° 52.396' W	Ship	4493.9	BEL Plume impact gradient	Start transect
09/12/22 18:10	172-1_TVMUC-37	14° 02.160' N	125° 55.501' W	Ship	4536.9	BEL Reference	
09/12/22 21:15	173-1_TVMUC-38	14° 02.168' N	125° 55.452' W	Ship	4540.7	BEL Reference	Failed
10/12/22 00:26	174-1_TVMUC-39	14° 02.158' N	125° 55.456' W	Ship	4538.4	BEL Reference	Repetition 173-1_TVMUC-38
10/12/22 03:55	175-1_BC-34	14° 02.160' N	125° 55.494' W	Ship	4543.5	BEL Reference	Failed
10/12/22 07:08	176-1_BC-35	14° 02.158' N	125° 55.446' W	Ship	4536.3	BEL Reference	
10/12/22 10:02	177-1_BC-36	14° 02.156' N	125° 55.401' W	Ship	4535.8	BEL Reference	
10/12/22 13:40	178-1_TVMUC-40	14° 02.158' N	125° 55.351' W	Ship	4491.8	BEL Reference	
10/12/22 16:51	179-1_TVMUC-41	14° 02.165' N	125° 55.300' W	Ship	4535.7	BEL Reference	
10/12/22 20:01	180-1_TVMUC-42	14° 02.159' N	125° 55.403' W	Ship	4536.0	BEL Reference	
10/12/22 23:51	181-1_OFOS-13	14° 00.868' N	125° 55.552' W	Ship	4538.6	BEL Reference	Start transect
11/12/22 09:17	182-1_BC-37	14° 02.159' N	125° 55.349' W	Ship	4536.2	BEL Reference	
11/12/22 12:25	183-1_BC-38	14° 02.154' N	125° 55.299' W	Ship	4783.8	BEL Reference	Discarded / sampled unidentified track
11/12/22 15:30	184-1_BC-39	14° 02.162' N	125° 55.496' W	Ship	4538.3	BEL Reference	Failed
11/12/22 19:12	185-1_ROV-21	14° 02.031' N	125° 55.332' W	Ship	4537.9	BEL Reference	Start transect
12/12/22 03:06	186-1_AUV-15	14° 06.792' N	125° 52.014' W	Ship	4502.2	BEL Collector impact, Plume impact thick	Start transect

12/12/22 04:58	187-1_TVMUC-43	14° 06.743' N	125° 52.244' W	Ship	4500.8	BEL Plume impact 25m SE of tracks	
12/12/22 08:11	188-1_TVMUC-44	14° 06.730' N	125° 52.226' W	Ship	4501.2	BEL Plume impact 75m SE of tracks	
12/12/22 11:12	189-1_TVMUC-45	14° 06.695' N	125° 52.190' W	Ship	4500.9	BEL Plume impact 175m SE of tracks	
12/12/22 16:55	190-1_ROV-22	14° 06.688' N	125° 52.249' W	Ship	4503.4	BEL Plume impact thick	Start transect
13/12/22 01:43	191-1_LIFT-10	14° 06.680' N	125° 52.311' W	Ship	4488.0		Elevator 1 recovery
13/12/22 02:32	192-1_AUV-15	14° 08.279' N	125° 54.715' W	Ship	4520.5		Recovery
13/12/22 04:55	193-1_BC-40	14° 02.161' N	125° 55.301' W	Ship*	4537.7	BEL Reference	Repetition 183-1_BC-38
13/12/22 08:06	194-1_BC-41	14° 02.153' N	125° 55.479' W	Ship	4536.1	BEL Reference	Repetition 175-1_BC-34
13/12/22 12:07	195-1_TVMUC-46	14° 06.658' N	125° 52.147' W	Ship	4503.0	BEL Plume impact 275m SE of tracks	
13/12/22 17:59	196-1_LIFT-11	14° 06.721' N	125° 52.189' W	Ship	4502.4	BEL Plume impact 200m SE of tracks	Elevator 1 deployment
13/12/22 17:05	197-1_ROV-23	14° 06.682' N	125° 52.203' W	Ship	4499.5	BEL Plume impact gradient, distance to tracks (m): 200m SE	Start transect
14/12/22 02:40	198-1_LIFT-11	14° 06.727' N	125° 52.173' W	Ship	4499.1		Elevator 1 recovery
14/12/22 02:53	199-1_AUV-16	14° 06.725' N	125° 52.183' W	Ship	4500.3	BEL Collector impact, Plume impact gradient, trial baseline time series	Start transect
14/12/22 05:10	200-1_OFOS-14	14° 06.486' N	125° 52.244' W	Ship	4489.8	BEL Plume impact gradient	Start transect
14/12/22 17:17	201-1_LIFT-12	14° 07.105' N	125° 52.569' W	Ship	4494.8	BEL Trial baseline time series	Elevator 1 deployment
14/12/22 17:01	202-1_ROV-24	14° 07.103' N	125° 52.567' W	Ship	4492.3	BEL Trial baseline time series	Start transect
15/12/22 02:20	203-1_LIFT-12	14° 07.082' N	125° 52.556' W	Ship	4489.7		Elevator 1 recovery
15/12/22 03:18	204-1_AUV-16	14° 09.471' N	125° 56.646' W	Ship	4536.6		Recovery
15/12/22 05:40	205-1_TVMUC-47	14° 06.546' N	125° 52.018' W	Ship	4505.4	BEL Plume impact 600m SE of tracks	
15/12/22 09:25	206-1_BC-42	14° 06.981' N	125° 52.754' W	Ship	4484.7	BEL Trial baseline time series	
15/12/22 12:25	207-1_BC-43	14° 06.992' N	125° 52.759' W	Ship	4482.4	BEL Trial baseline time series	Discarded / sample disturbed
15/12/22 18:21	208-1_LIFT-13	14° 06.764' N	125° 52.327' W	Ship	4498.1	BEL Plume impact thick	Elevator 1 deployment
15/12/22 17:46	209-1_ROV-25	14° 06.761' N	125° 52.324' W	Ship	4497.1	BEL Plume impact thick	Start transect
16/12/22 02:40	210-1_LIFT-13	14° 06.753' N	125° 52.311' W	Ship	4497.9		Elevator 1 recovery

16/12/22 03:01	211-1_AUV-17	14° 06.798' N	125° 52.067' W	Ship	4505.6	BEL Plume impact gradient, trial baseline time series	Start transect / gaps in imaging
16/12/22 04:59	212-1_BC-44	14° 06.993' N	125° 52.809' W	Ship	4482.5	BEL Trial baseline time series	
16/12/22 08:05	213-1_BC-45	14° 06.991' N	125° 52.860' W	Ship	4473.0	BEL Trial baseline time series	
16/12/22 12:18	214-1_OFOS-15	14° 00.469' N	125° 53.797' W	Ship	4519.0	BEL Reference	Start transect
16/12/22 22:28	215-1_BC-46	14° 06.980' N	125° 52.858' W	Ship	4480.7	BEL Trial baseline time series	
17/12/22 01:43	216-1_BC-47	14° 06.986' N	125° 52.903' W	Ship	4479.3	BEL Trial baseline time series	
17/12/22 04:10	217-1_AUV-17	14° 06.785' N	125° 54.893' W	Ship	4512.5		Recovery
17/12/22 06:41	217-1_AUV-17	14° 07.027' N	125° 51.872' W	Ship	4505.4	BEL	Transponder recovery
17/12/22 11:03	218-1_BWS-06	14° 01.141' N	125° 54.943' W	Ship	4789.0	BEL Reference	Max. depth

* stations where sudden GPS jumps of several tens of meters and in rare cases >100m were observed in the Ship’s track. Position information hence has to be treated with caution.