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Short Cruise Report

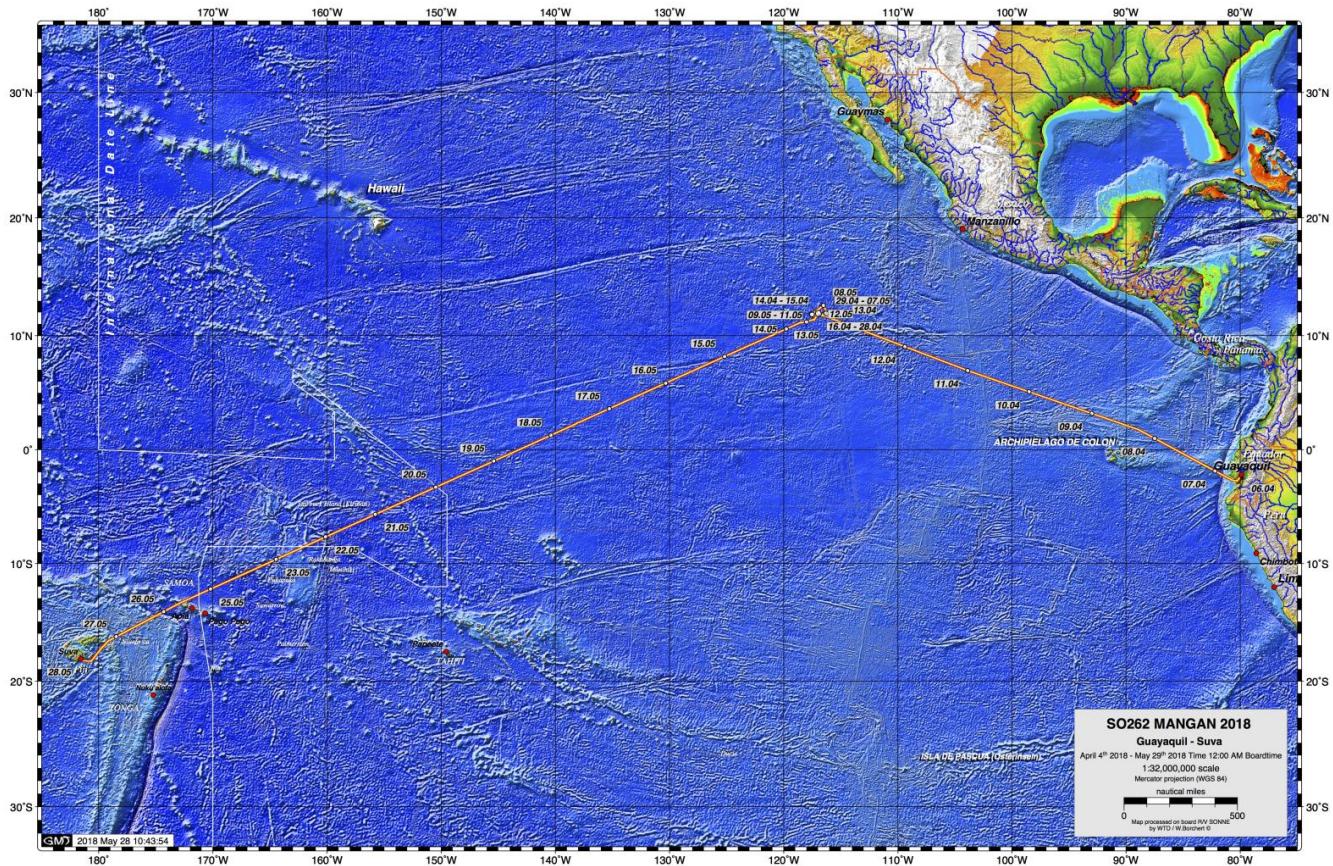
FS SONNE - SO262

Guayaquil (Ecuador) - Suva (Fidschi)

05.04. - 29.05.2018

Chief Scientist: Carsten Rühlemann

Captain: Lutz Mallon



Objectives

On behalf of the German Federal Ministry for Economics and Energy, the Federal Institute for Geosciences and Natural Resources (BGR) holds an exploration license for manganese nodules with the International Seabed Authority (ISA) since 2006. To date, BGR together with scientific partners investigated the nodule deposits in its license area with a size of 75,000 km² in the eastern Pacific, and conducted detailed environmental studies of benthic faunal assemblages and their diversity, sediment properties and water column characteristics. In April/May 2019, a pre-prototype nodule collector will be tested for four days in the license area. The test is accompanied by an extensive environmental monitoring program within the European JPI-Oceans research project “MiningImpact2”, which allows to evaluate the environmental impacts of a potential future industrial-scale mining under realistic conditions, including nodule and sediment removal and the formation and dispersal of suspension plumes.

The RV SONNE cruise SO-262 in April/May 2018 had three major goals. First, the exploration of a new prospective manganese nodule field in the eastern part of the license area and the evaluation of its economic potential. Second, the recovery of at least 10 tons of manganese nodules for metallurgical experiments at pilot plant scale. And third, the collection of high-resolution baseline environmental data from the nodule collector test area. These investigations include (i) detailed studies of the benthic and pelagic biodiversity, (ii) studies of trace metals and their association with different (nano)particulate size pools in (sub)bottom waters, (iii) studies on particle size distribution and particle concentrations throughout the water column, (iv) studies of physical properties and chemical composition of the sediment, (v) the mooring of three ADCP current meters for analysis of the bottom current regime until April 2019, and (vi) the mooring of a sediment trap for one year in order to determine background particle fluxes in this mesotrophic part of the Pacific Ocean. Furthermore, we aimed to continue our biodiversity time series studies in two reference areas for which annual samples for the period between 2013 and 2016 are available. To achieve our goals, we sampled planktonic and benthic fauna, sediments, pore water, seawater, manganese nodules, and marine snow. We recorded oceanographic data and deployed moorings to obtain such data over one year, and we collected photo and video material from the seafloor on nodule coverage and size, scavenger diversity and behavior, and on particle size and concentration throughout the water column.

The three main working areas of cruise SO262 were located in the eastern part of the German license area (Figure 2): **Working area WA-1**, which is equivalent to BGR's prospective area PA-1, was subdivided in two separate study areas. The northern part included the area selected for the collector test in 2019. The southern part represents the “Impact Reference Zone” of the German license area, which will serve to analyze the impacts of possible future mining activities in this region in comparison to the “Preservation Reference Zone” in WA-3. There, we continued our time series of sampling for biodiversity studies and carried out the nodule mass sampling. **Working area WA-2**, located about 80 km east of WA-1, includes the third prospective area PA-3 and has been explored with respect to its economic potential. The third **working area WA-3** represents the “Preservation Reference Zone” of the German license area, where we also continued the biodiversity time series. Further working areas were chosen for individual stations: a prominent seamount of 2100 m height between WA-1 and WA-2 served to obtain oceanographic data required for hydrodynamic models on sediment plume dispersion, and two gravity corer stations in the south of the license area were selected to obtain long sediment cores.

Cruise Narrative

Cruise SO262 started in Guayaquil on 4 April 2018 with the embarkation of 23 scientists from Germany and Scotland, and two trainees from the International Seabed Authority (ISA). We left port in the night of 6 April, heading 2400 nm northwest to the first working area WA-1 (north) in the eastern part of the German License Area, where we arrived in the evening of 13 April. At the site chosen for the nodule collector component test/disturbance experiment (100 x 900 m) and its surroundings (4 x 5 km), we focused on obtaining pre-test baseline environmental data from the seafloor and the water column.

The deployment of a full water depth CTD / rosette water sampler down to 4100 m started our 30-day work program. Besides Niskin water samplers and a specific water sampler to collect seawater for the analysis of trace metals, the CTD was equipped throughout the cruise with a high-resolution particle drift camera to observe particles in the water column. Together with a laser particle sizer (LISST) applied to water samples from the Niskin bottles, this allows to investigate the natural behavior of sinking particulate matter in the size range of 2.5 µm to 1 mm. Between 14 April and 21 April, we used the multicorer (MUC) to take sediment cores at 26 locations in the area, for a high-spatial-resolution analysis of meiofaunal biodiversity, geochemical composition, and particle size distribution. At four of these stations, we additionally extracted pore water from the sediment for geochemical analyses. Close to the test area, two moorings with ADCP current flow sensors and turbidity meters were deployed and will record the velocity and direction of bottom currents and the suspended particle load close to the seafloor for a period of one year.

On 17 April, we further deployed a mooring system equipped with a sediment trap, two Aquadopp current meters and turbidity sensors in 3600 m water depth. The sampling of natural particles and quantification of their fluxes in the water column and oceanographic parameters over one year will form the baseline against which the tolerance of benthic organisms to the input of suspended material during possible future deep-sea mining operations can be assessed. In the night from 17 April to 18 April, two ten kilometer long profiles at the seafloor were obtained with the video sledge STROMER, for the analysis of manganese nodule coverage and size distribution, as well as the diversity of megafaunal organisms. Furthermore, a lander (ANONYX) equipped with a baited trap and a high resolution camera was deployed three times for 24-36 hours each, to observe and analyze the bait-attending community diversity of benthic scavengers. Our work in the collector test area was completed by two marine snow catcher (MSC) stations and two multinet (MN) stations to recover plankton throughout the water column.

On 21 April we started the sampling for biodiversity analyses in the “Impact Reference Zone” in the southern part of WA-1 with six MUC stations and two epibenthic sledge (EBS) profiles. We further deployed the CTD at three stations, one cast throughout the full water column, and collected water samples for particle and metal concentration analyses. Along a short video sledge transect on 22 April, we mapped the area close to a three year old 1.5 m-wide EBS track. Interestingly, the sediment blanketing of nodules up to 40 m north and 100 m south of the track, as observed in 2015 shortly after the disturbance due to the EBS deployment, is no longer present. This suggests re-suspension of the thin sediment layer during periods of enhanced current velocities, in agreement with experimental results showing that resettled particle aggregates are resuspended at velocities >8 cm/s. Between 24 April and 27 April we recovered 11.5 tons of nodules with nine dredge deployments for future metallurgical experiments at pilot plant scale.

We left WA-1 on 28 April and headed 40 nautical miles eastward to WA-2, where we explored a new prospective manganese nodule field in a water depth of 4100 m and with a spatial extent of 350 km² with 41 box core samples and two transects of high resolution video sledge mapping. The box core samples and onboard XRF measurements showed consistently high nodule abundances of 23 kg/m² and very high metal concentrations of 3% nickel, copper, and cobalt on average. The total quantity of manganese nodules in this area amounts to eight million metric tons (wet weight), which could sustain two to three years of deep-sea mining. In addition, we deployed the ANONYX lander at another four stations to collect video material on scavenger diversity and behavior. At one of the two CTD stations in this area we collected bottom water for trace metal analyses. Seven MUC stations, two EBS tracks, four MSC stations, and one MN station complemented our work, and on 7 May we resumed station work in WA-2. Afterwards, we sailed 44 nm north to the license area of UK Seabed Resources Ltd (UKSRL). Upon request of colleagues from UKSRL and the University of Hawaii, we recovered on 8 May two moored sediment traps that were deployed in 2015 and which UKSRL was not able to recover within the last two years.

On 9 May, we started our work in WA-3, the “Preservation Reference Zone” of the German license area, where we continued the biodiversity time series started in 2013 by sampling at six multicorer and two epibenthic sledge stations. We further deployed a mooring with two current meters. During mapping of a 13.5 km long transect of the seafloor with the video sledge, we were able to detect three 1.5 m wide EBS tracks from previous years and a fresh track from the day before. As already observed in WA-1, resettled sediment on nodules in proximity to the old EBS tracks has obviously been resuspended and drifted away, likely during phases of enhanced current velocities. We further deployed a MSC at one station, carried out a full depth CTD station and a MN station. With one more lander station in this working area we finished nine lander deployments in total during this cruise. A first evaluation shows that relatively few species dominate the bait-attended population, which appear in an arrival sequence on the bait.

During the last three working days we collected oceanographic data and three long sediment cores. After a 50 nm transit to the east to a 2100 m-high seamount we started on 11 May a tow-yo transect with a CTD from the top of the seamount to the abyssal plain over 14 hours in order to cover a full tidal cycle. The data obtained will be used to model the hydrodynamic effects of large topographic structures on the bottom current regime in the deep-sea plain. Between 12 and 13 May we obtained three sediment cores of 8 m to 14.5 m length. One core was taken in the south of WA-1, where the presence of manganese nodules in 7.6 m core depth confirmed a (potentially widespread) buried nodule layer which was previously indicated by sediment echo sounder recordings. A second long core was taken about 40 nm to the south-west where we also recovered two box cores in order to obtain undisturbed in-situ seafloor samples for sediment resuspension and settling experiments. The last long sediment core and two additional multicores were taken another 40 nm to the west-south-west. Before finishing our station work, a final dredge tow in the night from 13 to 14 May in the very south of the license area brought up an additional 340 kg of nodules. Despite applying exactly the same dredging technique as in WA-1, we recovered only a third of the amount of nodules which was obviously due to the lower nodule abundance in this region.

The cruise ended after 177 stations and the successful completion of all planned activities of the exploration program. On 14 May we started our transit to Suva where we arrived at the port on 29 May, 2018.

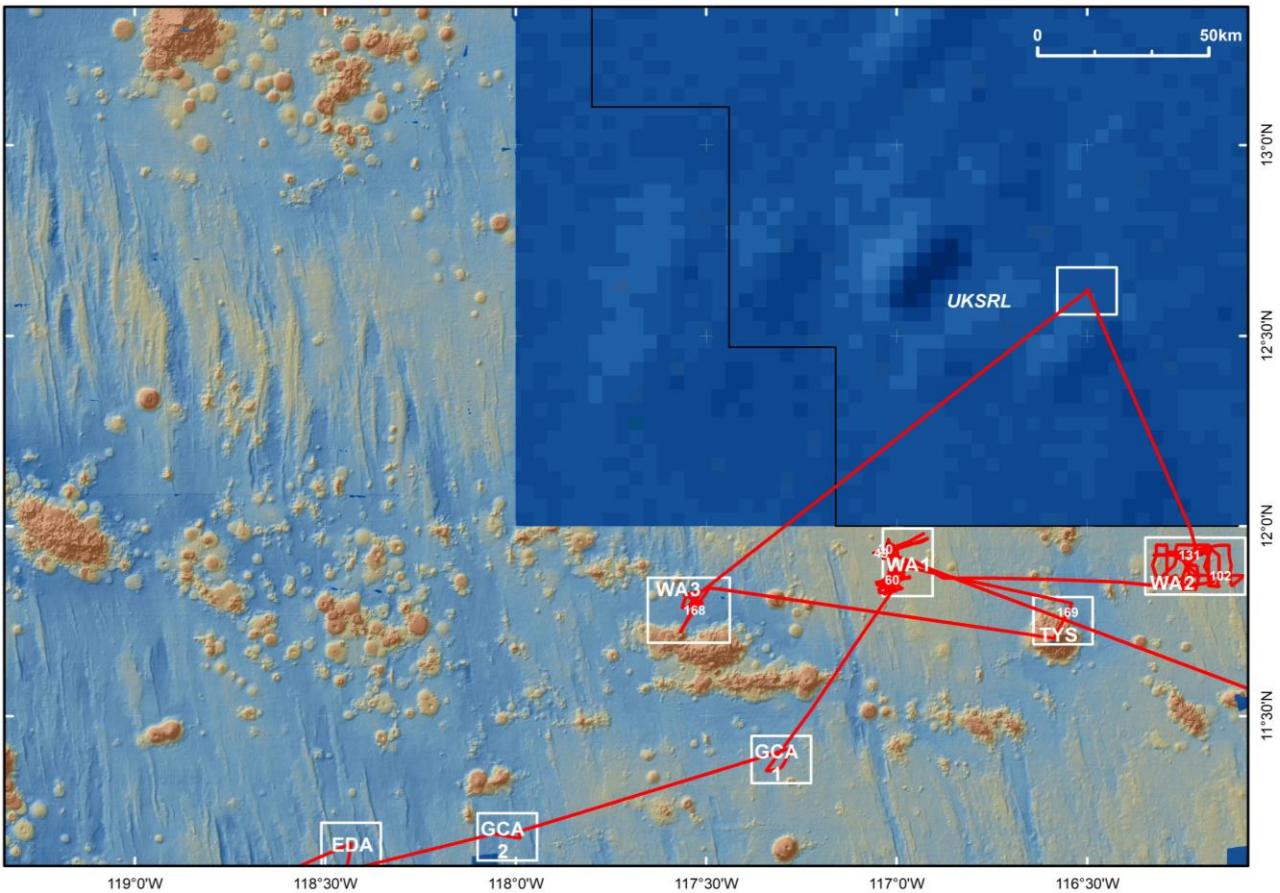


Figure 2: Working areas and cruise track of SO262 in the eastern German license area. WA: working area, TYS: tow-yo seamount, GCA: gravity corer area, EDA: extra dredge area.

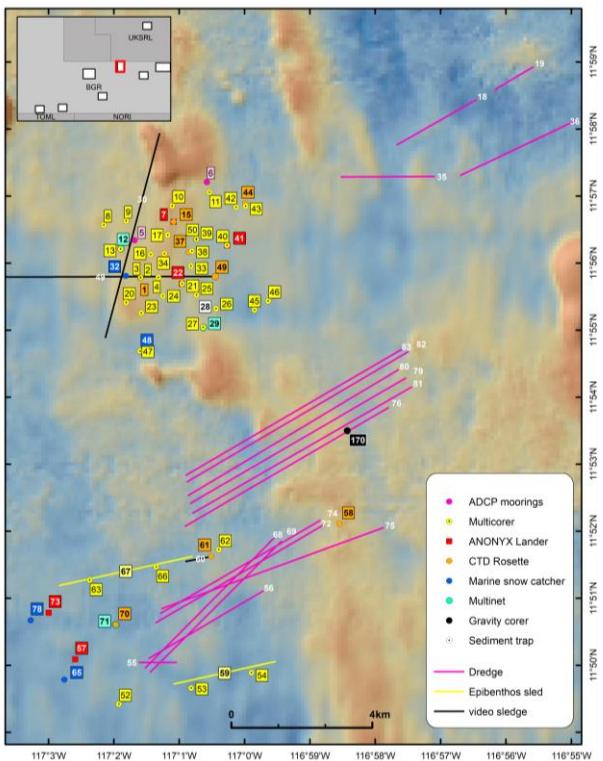


Figure 3: Bathymetry and stations in WA-1.

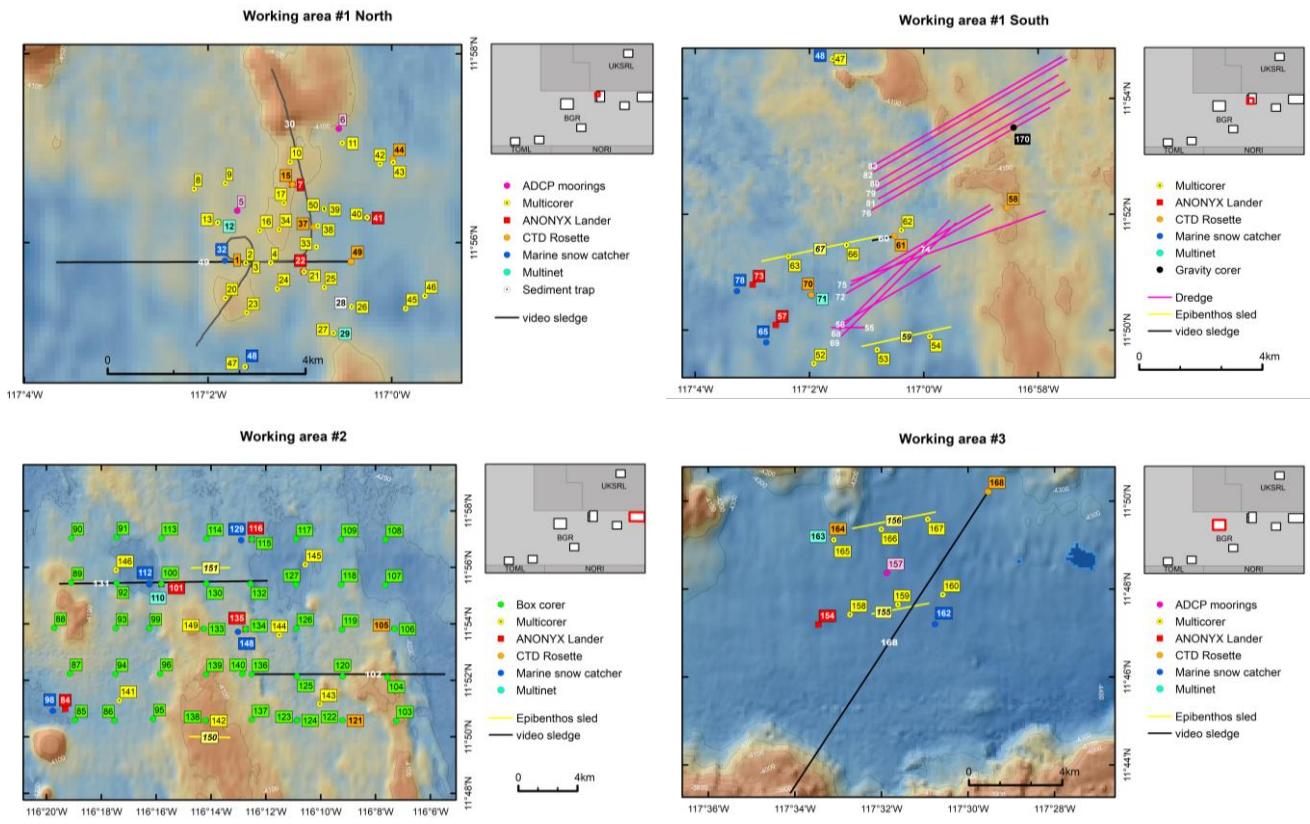


Figure 4: Bathymetry and stations in WA-1 North, WA-1 South, WA-2, and WA-3.

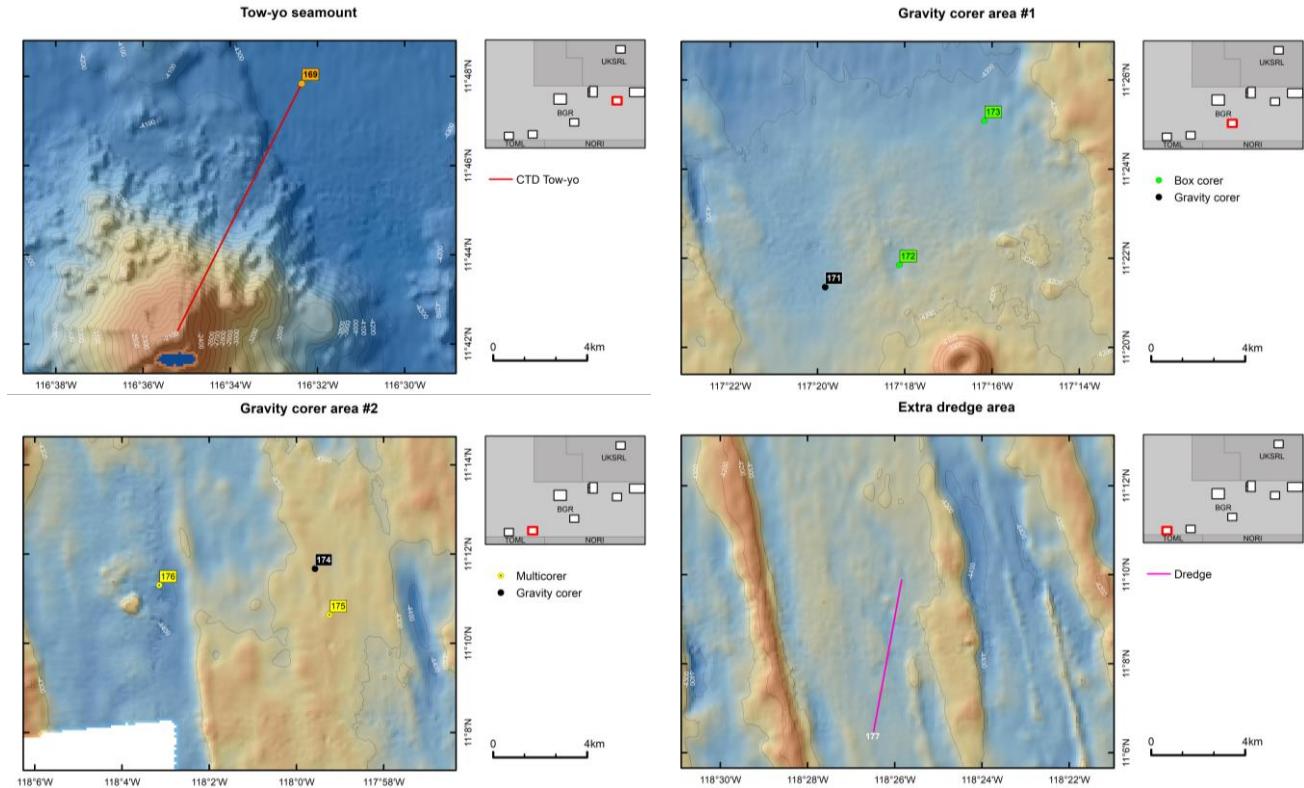


Figure 5: Bathymetry and stations at seamount (upper left), in gravity core sampling areas #1 and #2 (upper right and lower left), and in the area where we carried out the last dredge tow.

Acknowledgements

The successful completion of our exploration program has largely been due to the professional and dedicated work of the captain and the crew of RV SONNE, and we would like to thank them sincerely for their competent and professional support. We also appreciate the support by the Control Station (Leitstelle Deutsche Forschungsschiffe) and the shipping company Briese during all activities related to cruise SO262.

LIST OF PARTICIPANTS

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2. Bruns, Angelika	Technician	Geolab, logistics
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LIST OF STATIONS

Table 1. List of stations during cruise SO262 (MANGAN 2018). “UTC” indicates Universal Time Coordinated of bottom contact or maximum depth of the respective device, affixes “B” and “E” after UTC for STR, EBS, and dredge operations indicate beginning and end of bottom visibility or contact. Position and water depth refer to time of bottom contact or visibility and start of heave, respectively. Medium-sized nodules are ca. 4-5 cm. Abbreviations behind station number refer to the device that was deployed: MUC = multicorer, OBM = ocean bottom mooring, ANX = Anonyx lander, MN = multinet, KD = chain bag dredge, ST = sediment trap, STR = STROMER video sledge, MSC = marine snow catcher, EBS = epibenthic sledge, KG = box corer, SL = gravity corer.

Station SO262-	Date 2018	UTC			Position		Water depth [m]	Remarks
		start	bottom	end	latitude (N)	longitude (W)		
001CTD	14.04.	02:51	07:06	09:07	11°55.778'	117°01.593'	4083	water samples from 4046 to 15 m, releaser test
002MUC	14.04.	01:32	03:01	04:22	11°55.780'	117°01.586'	4083	all tubes empty
003MUC	14.04.	04:33	05:58	07:25	11°55.782'	117°01.591'	4082	10 biosamples, 1 eDNA, 1 geochemistry
004MUC	14.04.	15:50	17:22	18:40	11°55.786'	117°01.317'	4092	7 biosamples, 1 eDNA, 3 geochem., 1 tube empty
005OBM	14.04.	19:19	20:04	20:08	11°56.338'	117°01.682'	4088	deployment of ADCP mooring # 1
006OBM	14.04.	20:47	21:30	20:51	11°57.208'	117°00.576'	4096	deployment of ADCP mooring # 2
007ANX	14.04.	21:17		21:33	11°56.616'	117°01.083'	4083	deployment of lander
008MUC	14.04.	22:09	23:41	01:05	11°56.568'	117°02.152'	4091	10 biosamples, 1 geochemistry, 1 tube empty
009MUC	15.04.	01:26	03:02	04:24	11°56.629'	117°01.811'	4097	10 biosamples, 1 eDNA, 1 geochemistry
010MUC	15.04.	04:49	06:21	06:25	11°56.855'	117°01.106'	4080	10 biosamples, 1 eDNA, 1 geochemistry
011MUC	15.04.	08:03	09:38	11:00	11°57.056'	117°00.538'	4014	10 biosamples, 1 eDNA, 1 geochemistry
012MN	15.04.	11:45	14:02	17:40	11°56.215'	117°01.889'	4085	4000 m to surface, mesh size of net: 100 µm
013MUC	15.04.	17:58	19:32	20:50	11°56.210'	117°01.895'	4083	10 biosamples, 1 eDNA, 1 geochemistry
014ANX	15.04.	21:14	21:19	22:28	11°56.622'	117°01.085'	4055	recovery of lander
015CTD	15.04.	21:38		22:20	11°56.616'	117°01.083'	4055	max depth: 400 m; water samples from 140 to 12 m
016MUC	15.04.	23:26	01:02	02:31	11°56.129'	117°01.436'	4079	10 biosamples, 1 eDNA, 1 geochemistry
017MUC	16.04.	02:54	04:24	05:43	11°56.419'	117°01.174'	4077	10 biosamples, 1 eDNA, 1 geochemistry
018KD	16.04.	06:50	08:06B		11°57.763'	116°57.667'	4131	125 kg nodules
018KD	16.04.		12:48E	14:07	11°58.433'	116°56.459'	4141	WL[bottom]: 4195 m, WL[max.]: 4514 m
019KD	16.04.	14:26	15:48B		11°58.592'	116°56.161'	4131	empty
019KD	16.04.		17:45E	19:02	11°58.924'	116°55.583'	4116	WL[bottom]: 4196 m, WL[max.]: 4252 m
020MUC	16.04.	20:06	21:37	21:39	11°55.412'	117°01.810'	4070	10 biosamples, 1 eDNA, 1 geochemistry
021MUC	17.04.	23:33	01:08	02:33	11°55.691'	117°00.955'	4090	8 biosamples, 1 eDNA, 3 geochemistry
022ANX	17.04.	02:54		02:57	11°55.692'	117°00.960'	4091	deployment of lander
023MUC	17.04.	03:20	04:54	06:11	11°55.257'	117°01.579'	4081	10 biosamples, 1 eDNA, 1 geochemistry
024MUC	17.04.	06:34	08:01	09:23	11°55.510'	117°01.246'	4091	10 biosamples, 1 eDNA, 1 geochemistry
025MUC	17.04.	10:03	11:32	12:57	11°55.526'	117°00.733'	4095	10 biosamples, 1 eDNA, 1 geochemistry
026MUC	17.04.	13:21	14:55	16:19	11°55.320'	117°00.435'	4102	8 biosamples, 1 eDNA, 3 geochemistry
027MUC	17.04.	16:43	18:13	19:35	11°55.042'	117°00.634'	4098	10 biosamples, 1 eDNA, 1 geochemistry
028ST	17.04.	19:38		21:09	11°55.325'	117°00.438'	4101	deployment of sediment trap
029MN	17.04.	21:28	23:11	03:05	11°55.037'	117°00.629'	4092	4000 m to surface, mesh size of net: 100 µm
030STR	18.04.	04:31	06:30B		11°54.891'	117°02.127'	4122	length of transect: 9.26 km, 1599 photos
030STR	18.04.		15:48E	17:10	11°57.926'	117°01.302'	4090	video mapping of nodule size/coverg., megafauna
031ANX	18.04.	18:08	18:10	19:25	11°55.365'	117°01.498'	4090	recovery of lander
032MSC	18.04.	20:17		20:38	11°55.809'	117°01.817'	4085	70 m to surface, water sample
033MUC	18.04.	21:07	22:42	00:03	11°55.954'	117°00.819'	4092	8 biosamples, 1 eDNA, 3 geochemistry
034MUC	19.04.	00:25	01:59	03:23	11°56.140'	117°01.225'	4075	9 biosamples, 1 eDNA, 2 geochemistry
035KD	19.04.	04:45	06:01B		11°57.284'	116°58.519'	4107	230 kg nodules
035KD	19.04.		08:40E	10:01	11°57.290'	116°57.094'	4117	WL[bottom]: 4132 m, WL[max.]: 4757 m
036KD	19.04.	10:33	11:52B		11°57.310'	116°56.690'	4115	257 kg nodules
036KD	19.04.		16:30E	17:47	11°58.119'	116°54.945'	4133	WL[bottom]: 4150 m, WL[max.]: 4738 m
037CTD	19.04.	19:13		20:04	11°56.164'	117°00.850'	4090	max depth: 200 m; water samples from 140 to 12 m
038MUC	19.04.	20:18	21:46	23:03	11°56.178'	117°00.804'	4091	10 biosamples, 1 eDNA, 1 geochemistry
039MUC	19.04.	23:26	00:57	02:23	11°56.352'	117°00.733'	4095	all tubes empty
040MUC	20.04.	02:42	04:16	05:32	11°56.266'	117°00.266'	4105	11 biosamples, 1 geochemistry
041ANX	20.04.	05:41		5:55	11°56.264'	117°00.264'	4106	deployment of lander
042MUC	20.04.	06:13	07:45	09:06	11°56.833'	117°00.127'	4109	9 biosamples, 1 eDNA, 1 geochemistry, 1 tube empty
043MUC	20.04.	09:35	11:02	12:55	11°56.850'	116°59.983'	4107	10 biosamples, 1 eDNA, 1 geochemistry
044CTD	20.04.	12:34		13:53	11°56.888'	116°59.987'	4107	max depth: 400 m; water samples from 140 to 12 m
045MUC	20.04.	14:26	15:57	17:19	11°55.301'	116°59.847'	4124	9 biosamples, 1 geochemistry, 2 tubes empty
046MUC	20.04.	17:40	13:16	20:38	11°55.435'	116°59.638'	4099	11 biosamples, 1 geochemistry

Table 1. continued

Station SO262-	Date 2018	UTC			Position		Water depth [m]	Remarks
		start	bottom	end	latitude (N)	longitude (W)		
047MUC	20.04.	21:24	22:58	00:19	11°54.685'	117°01.597'	4128	10 biosamples, 1 geochemistry, 1 empty
048MSC	21.04.	00:28		00:46	11°54.682'	117°01.591'	4129	70 m to surface, water sample
049STR	21.04.	05:46	07:43B		11°55.791'	117°03.647'	4107	length of transect: 5.92 km, 2948 photos
049STR	21.04.		13:25E	14:50	11°55.800'	117°00.443'	4142	video mapping of nodule size/coverg., megafauna
050MUC	21.04.	15:19	16:54	18:14	11°56.362'	117°00.738'	4096	10 biosamples, 1 geochemistry, 1 tube empty
051ANX	21.04.	18:22	19:33	19:56	11°56.109'	117°00.442'	4158	recovery of lander
052MUC	21.04.	20:57	22:30	23:52	11°49.420'	117°01.921'	4136	11 biosamples, 1 geochemistry
053MUC	22.04.	00:18	01:49	03:11	11°49.660'	117°00.815'	4141	11 biosamples, 1 geochemistry
054MUC	22.04.	03:30	05:04	06:19	11°49.890'	116°59.895'	4139	11 biosamples, 1 geochemistry
055KD	22.04.	07:02	08:22B		11°50.043'	117°01.043'	4133	125 kg nodules
055KD	22.04.		11:44E	13:14	11°50.043'	117°01.610'	4133	WL[bottom]: 4450 m, WL[max.]: 4487 m
056KD	22.04.	13:56	15:14B		11°50.101'	117°01.464'	4126	415 kg nodules
056KD	22.04.		18:53E	20:15	11°51.107'	116°59.717'	4121	WL[bottom]: 4166 m, WL[max.]: 4540 m
057ANX	22.04.	21:03		21:11	11 50.089'	117° 02.596'	4136	deployment of lander
058CTD	22.04.	21:12		22:18	11°52.114'	116°58.546'	4097	max depth: 400 m; water samples from 140 to 12 m
059EBS	22.04.	22:46	01:28B		11°49.720'	117°01.080'	4097	
059EBS	23.04.		03:40E	5:13	11°50.055'	116°59.530'	4128	WL[bottom]: 4565 m, WL[max.]: 6000 m
060STR	23.04.	06:21	07:43B		11°51.549'	117°00.896'	4126	length of transect: 0.92 km, 1477 photos
060STR	23.04.		09:14E	10:35	11°51.621'	117°00.508'	4115	video mapping of nodule size/coverg., megafauna
061CTD	23.04	11:09	14:04	16:09	11°51.627'	117°00.511'	4115	water samples from 4096 to 9 m
062MUC	23.04.	16:12	17:47	19:06	11°51.725'	117°00.393'	4116	11 biosamples, 1 geochemistry
063MUC	23.04.	19:44	21:19	22:38	11°51.271'	117°02.368'	4131	8 biosamples, 3 geochemistry, 1 tube empty
064ANX	23.04.	23:13	00:24	00:39	11°49.976'	117°02.749'	4129	recovery of lander
065MSC	23.04.	23:20		23:35	11°49.785'	117°02.757'	4129	100 m to surface, water sample
066MUC	24.04.	01:17	02:47	04:06	11°51.469'	117°01.351'	4127	8 biosamples, 3 geochemistry, 1 tube empty
067EBS	24.04.	04:45	06:27B		11°51.190'	117°02.830'	4131	
067EBS	24.04.		08:32E	10:12	11°51.621'	117°00.804'	4131	WL[bottom]: 4564 m, WL[max.]: 6002 m
068KD	24.04.	10:59	12:18B		11°49.960'	117°01.517'	4127	796 kg nodules
068KD	24.04.		16:34E	17:52	11°51.896'	116°59.549'	4123	WL[bottom]: 4168 m, WL[max.]: 4650 m
069KD	24.04.	18:50	20:09B		11°49.898'	117°01.439'	4130	630 kg nodules
069KD	25.04.		00:27E	01:45	11°51.845'	116°59.440'	4120	WL[bottom]: 4178 m, WL[max.]: 4580 m
070CTD	25.04.	02:45	04:31	06:33	11°50.608'	117°01.970'	4129	water samples from 4119 to 12 m
071MN	25.04.	07:31	09:12	12:50	11°50.605'	117°01.969'	4130	4000 m to surface, mesh size: 100 µm
072KD	25.04.	13:11	14:32B		11°50.635'	117°01.356'	4126	700 kg nodules
072KD	25.04.		18:56E	20:13	11°52.087'	116°58.799'	4105	WL[bottom]: 4180 m, WL[max.]: 4599 m
073ANX	25.04.	21:06		21:06	11°50.784'	117°02.995'	4124	deployment of lander
074KD	25.04.	21:37	23:00B		11°50.773'	117°01.282'	4127	771 kg nodules
074KD	26.04.		03:08E	04:24	11°52.158'	116°58.845'	4105	WL[bottom]: 4226 m, WL[max.]: 4578 m
075KD	26.04.	05:09	06:35B		11°50.845'	117°01.263'	4121	1024 kg nodules
075KD	26.04.		12:00E	13:20	11°52.051'	116°57.876'	4114	WL[bottom]: 4196 m, WL[max.]: 4560 m
076KD	26.04.	14:16	15:34B		11°52.073'	117°00.910'	4121	925 kg nodules
076KD	26.04.		20:55E	22:22	11°53.842'	116°57.798'	4108	WL[bottom]: 4156 m, WL[max.]: 4537 m
077ANX	26.04.	23:25	00:38	00:50	11°50.748'	117°03.172'	4118	recovery of lander
078MSC	26.04.	20:36		20:42	11°50.672'	117°03.271'	4118	70 m to surface, water sample
079KD	27.04.	01:27	02:47B		11°52.417'	117°00.825'	4120	804 kg nodules
079KD	27.04.		08:15E	09:31	11°54.281'	116°57.538'	4100	WL[bottom]: 4160 m, WL[max.]: 4547 m
080KD	27.04.	10:22	11:46B		11°52.533'	117°00.858'	4119	1089 kg nodules
080KD	27.04.		17:13E	18:35	11°54.406'	116°57.650'	4101	WL[bottom]: 4175 m, WL[max.]: 4550 m
081KD	27.04.	19:37	21:00B		11°52.268'	117°00.793'	4118	1331 kg nodules
081KD	28.04.		02:31E	03:51	11°54.149'	116°57.445'	4104	WL[bottom]: 4169 m, WL[max.]: 4555 m
082KD	28.04.	04:47	06:10B		11°52.737'	117°00.876'	4124	1100 kg nodules
082KD	28.04.		11:51E	13:13	11°54.676'	116°57.498'	4113	WL[bottom]: 4171 m, WL[max.]: 4585 m
083KD	28.04.	14:04	15:28B		11°52.836'	117°00.893'	4120	1232 kg nodules
083KD	28.04.		20:59E	22:22	11°54.716'	116°57.589'	4113	WL[bottom]: 4167 m, WL[max.]: 4545 m
084ANX	29.04.	03:22		03:25	11°50.990'	116°19.315'	4185	deployment of lander
085KG	29.04.	03:43	05:03	06:22	11°50.592'	116°18.960'	4185	46 cm core
086KG	29.04.	06:55	08:15	09:53	11°50.584'	116°17.514'	4181	42 cm core
087KG	29.04.	10:53	12:09	13:31	11°52.236'	116°19.150'	4150	41 cm core

Table 1. continued

Station SO262-	Date 2018	UTC			Position		Water depth [m]	Remarks
		start	bottom	end	latitude (N)	longitude (W)		
088KG	29.04.	14:05	15:26	16:46	11°53.856'	116°19.722'	4130	42 cm core
089KG	29.04.	17:18	18:36	19:55	11°55.463'	116°19.103'	4104	45 cm core
090KG	29.04.	20:43	21:59	23:21	11°57.039'	116°19.096'	4157	45 cm core
091KG	30.04.	00:01	01:21	02:38	11°57.066'	116°17.443'	4186	40 cm core
092KG	30.04.	03:18	04:38	05:56	11°55.449'	116°17.439'	4172	46 cm core
093KG	30.04.	05:32	07:50	09:15	11°53.847'	116°17.474'	4152	39 cm core
094KG	30.04.	10:19	11:37	13:00	11°52.224'	116°17.484'	4164	44 cm core
095KG	30.04.	13:29	14:47	16:09	11°50.636'	116°16.112'	4165	42 cm core
096KG	30.04.	16:34	17:53	19:13	11°52.239'	116°15.853'	4144	42 cm core
097ANX	30.04.	19:50	21:04	21:23	11°50.931'	116°19.778'	4188	recovery of lander
098MSC	30.04.	20:02		20:12	11°50.921'	116°19.774'	4188	70 m to surface, water sample
099KG	30.04.	22:08	23:27	00:54	11°53.845'	116°16.246'	4179	45 cm core
100KG	01.05.	01:28	02:44	04:07	11°55.416'	116°15.811'	4173	43 cm core
101ANX	01.05.	04:18		04:20	11°55.413'	116°15.812'	4177	deployment of lander
102STR	01.05.	05:01	06:24B		11°52.221'	116°12.524'	4139	length of transect: 12.59 km, 3366 photos
102STR	01.05.		16:07E	17:30	11°52.219'	116°05.477'	4211	video mapping of nodule size/coverg., megafauna
103KG	01.05.	18:12	19:25	20:42	11°50.571'	116°07.244'	4099	42 cm core
104KG	01.05.	21:17	22:37	00:00	11°52.114'	116°07.562'	4090	44 cm core
105CTD	02.05.	00:35		01:25	11°53.833'	116°07.310'	4172	max depth: 400 m; water samples from 400 to 60 m
106KG	02.05.	01:41	03:02	04:24	11°53.825'	116°07.305'	4171	45 cm core
107KG	02.05.	05:01	06:20	07:38	11°55.384'	116°07.638'	4191	42 cm core
108KG	02.05.	08:20	09:42	11:03	11°56.986'	116°07.628'	4207	41 cm core
109KG	02.05.	11:44	13:00	14:28	11°56.991'	116°09.262'	4181	43 cm core
110MN	02.05.	15:21	17:01	19:29	11°55.423'	116°16.252'	4205	4000 m to surface, mesh size of net: 100 µm
111ANX	02.05.	19:38	20:55	21:10	11°55.414'	116°16.247'	4163	recovery of lander
112MSC	02.05.	19:52		20:05	11°55.422'	116°16.255'	4163	60 m to surface, water sample
113KG	02.05.	21:49	23:09	00:36	11°57.038'	116°15.811'	4155	41 cm core
114KG	03.05.	01:07	02:27	03:48	11°57.017'	116°14.157'	4175	40 cm core
115KG	03.05.	04:21	05:37	06:69	11°56.998'	116°12.512'	4169	40 cm core
116ANX	03.05.	07:07		07:08	11°56.998'	116°12.515'	4169	deployment of lander
117KG	03.05.	07:26	08:57	10:18	11°57.007'	116°10.892'	4195	41 cm core
118KG	03.05.	11:05	12:26	13:53	11°55.397'	116°09.247'	4159	41 cm core
119KG	03.05.	14:23	15:38	16:58	11°53.798'	116°09.224'	4158	41 cm core
120KG	03.05.	17:31	18:50	20:11	11°52.138'	116°09.200'	4155	41 cm core
121CTD	03.05.	20:56	23:44	02:45	11°50.589'	116°09.206'	4157	water samples from 4150 to 50 m
122KG	04.05.	02:57	04:14	05:52	11°50.588'	116°09.206'	4157	39 cm core
123KG	04.05.	06:07	07:27	08:51	11°50.589'	116°10.866'	4170	empty box
124KG	04.05.	08:59	10:18	11:42	11°50.590'	116°10.861'	4175	42 cm core
125KG	04.05.	12:12	13:34	14:58	11°52.147'	116°10.863'	4173	42 cm core
126KG	04.05.	15:28	16:46	18:04	11°53.834'	116°10.880'	4180	43 cm core
127KG	04.05.	18:33	19:52	21:16	11°55.395'	116°10.899'	4185	43 cm core
128ANX	04.05.	21:55	23:03	23:29	11°56.968'	116°12.899'	4175	recovery of lander
129MSC	04.05.	22:12		22:20	11°56.964'	116°12.898'	4175	70 m to surface, water sample
130KG	05.05.	00:01	01:27	02:55	11°55.428'	116°14.169'	4165	44 cm core
131STR	05.05.	03:52	05:51B		11°55.421'	116°19.515'	4088	length of transect: 13.70 km, 3535 photos
131STR	05.05.		15:34E	16:58	11°55.525'	116°11.956'	4186	video mapping of nodule size/coverg., megafauna
132KG	05.05.	17:23	18:51	20:13	11°55.423'	116°12.556'	4147	41 cm core
133KG	05.05.	20:49	22:09	23:23	11°53.833'	116°14.262'	4107	43 cm core
134KG	06.05.	23:59	01:17	02:39	11°53.818'	116°12.731'	4157	43 cm core
135ANX	06.05.	02:54		02:58	11°53.818'	116°12.737'	4158	deployment of lander
136KG	06.05.	03:28	04:50	06:11	11°52.220'	116°12.517'	4068	43 cm core
137KG	06.05.	06:48	08:05	09:28	11°50.609'	116°12.514'	4125	45 cm core
138KG	06.05.	10:02	11:16	12:38	11°50.588'	116°14.199'	4057	44 cm core
139KG	06.05.	13:07	14:58	16:20	11°52.221'	116°14.175'	4084	25 cm core
140KG	06.05.	16:46	18:07	19:28	11°52.229'	116°12.856'	4143	44 cm core
141MUC	06.05.	20:15	21:47	23:04	11°51.287'	116°17.343'	4183	10 biosamples, 1 geochemistry, 1 tube empty
142MUC	06.05.	23:40	01:14	02:36	11°50.584'	116°14.189'	4067	11 biosamples, 1 geochemistry
143MUC	07.05.	03:16	04:50	06:10	11°51.160'	116°10.030'	4179	11 biosamples, 1 geochemistry

Table 1. continued

Station SO262-	Date 2018	UTC		Position		Water depth [m]	Remarks
		start	Bottom	end	latitude (N)	longitude (W)	
144MUC	07.05.	06:41	08:16	09:38	11°53.611'	116°11.511'	4168 11 biosamples, 1 geochemistry
145MUC	07.05.	10:11	11:42	13:10	11°56.103'	116°10.560'	4207 10 biosamples, 1 geochemistry, 1 tube empty
146MUC	07.05.	14:00	15:30	16:51	11°55.906'	116°17.459	4160 11 biosamples, 1 geochemistry
147ANX	07.05.	17:35	18:51	19:06	11°53.811'	116°12.880'	4145 recovery of lander
148MSC	07.05.	17:45		18:00	11°53.722'	116°13.017'	4147 70 m to surface, water sample
149MUC	07.05.	19:34	21:02	22:24	11°53.833'	116°14.268'	4105 9 biosamples, 3 geochemistry
150EBS	07.05.	23:10	01:02B		11°50.009'	116°14.780'	4074 32 kg nodules
150EBS	07.05.		03:03E	04:39	11°49.978'	116°13.316'	4095 WL[bottom]: 4685 m, WL[max.]: 6001 m
151EBS	08.05.	05:33	07:23B		11°55.986'	116°14.706'	4150 7 kg nodules
151EBS	08.05.		09:21E	11:18	11°55.992'	116°13.320'	4151 WL[bottom]: 4567 m, WL[max.]: 6000 m
152ST	08.05.	15:26	16:39	18:02	12°37.079'	116°30.033'	4237 recovery of sediment trap in UKSRL license area
153CTD	08.05.	18:27	18:46	18:37	12°37.316'	116°29.741'	4236 max depth: 400 m; water samples from 400 to 40 m
154ANX	09.05.	03:02		03:06	11°47.198'	117°33.452'	4357 deployment of lander
155EBS	09.05.	03:22	05:11B		11°47.436'	117°32.213'	4352 9.3 kg nodules
155EBS	09.05.		07:11E	09:00	11°47.677'	117°30.910'	4351 WL[bottom]: 4585 m, WL[max.]: 6000 m
156EBS	09.05.	09:48	11:42B		11°49.381'	117°32.663'	4340 4.3 kg nodules
156EBS	09.05.		13:32E	15:20	11°49.752'	117°30.760'	4340 WL[bottom]: 4740 m, WL[max.]: 6000 m
157OBM	09.05.	15:55	16:38	16:40	11°48.370'	117°31.874'	4359 deployment of ADCP mooring # 3
158MUC	09.05.	17:05	18:45	20:10	11°47.420'	117°32.725'	4358 10 biosamples, 1 geochemistry, 1 tube empty
159MUC	09.05.	20:37	22:14	23:43	11°47.650'	117°31.619'	4357 11 biosamples, 1 geochemistry
160MUC	10.05.	00:10	01:48	03:18	11°47.876	117°30.580'	4365 11 biosamples, 1 geochemistry
161ANX	10.05.	03:58	05:44	06:05	11°47.204'	117°33.762'	4343 recovery of lander
162MSC	10.05.	04:27		04:40	11°47.203'	117°30.764'	4341 70 m to surface, water sample
163MN	10.05.	06:40	08:30	11:22	11°49.123'	117°33.106'	4332 4000 m to surface, mesh size of net: 100 µm
164CTD	10.05.	11:50	14:33	17:48	11°49.123'	117°33.104'	4327 water samples from 4321 to 54 m
165MUC	10.05.	17:59	19:36	21:03	11°49.120'	117°33.098'	4327 11 biosamples, 1 geochemistry
166MUC	10.05.	21:36	23:12	00:40	11°49.360'	117°32.003'	4359 11 biosamples, 1 geochemistry
167MUC	11.05.	01:02	02:39	04:08	11°49.587'	117°30.930'	4359 9 biosamples, 3 geochemistry
168STR	11.05.	05:04	06:30B		11°43.365'	117°34.100'	3753 length of transect: 15.55 km, 3996 photos
168STR	11.05.		16:56E	18:23	11°50.217'	117°29.537'	4337 video mapping of nodule size/coverg., megafauna
169CTD	11.05.	23:41	00:31B		11°42.305'	116°35.204'	2026 tow-yo profile from top to foot of seamount (2317 m)
169CTD	12.05.		13:40E	15:11	11°47.837'	116°32.362'	4343 water samples from 4325 to 60 m
170SL	12.05.	17:40	18:56	20:20	11°53.499'	116°58.427'	4104 947 cm core length, nodule layer at 760 cm
171SL	13.05.	00:08	01:25	02:58	11°21.354'	117°19.826'	4266 1439 cm core length
172KG	13.05.	03:33	04:50	06:11	11°21.850'	117°18.124'	4243 intact nodule and sediment sample for JUB
173KG	13.05.	06:52	08:10	09:35	11°25.085'	117°16.176'	4259 intact nodule and sediment sample for JUB
174SL	13.05.	13:45	15:07	16:38	11°11.672'	117°59.575'	4255 796 cm core length
175MUC	13.05.	16:58	18:30	19:52	11°10.639'	117°59.243'	4253 10 biosamples, 1 geochemistry, 1 tube empty
176MUC	13.05.	20:28	22:07	23:33	11°11.303'	118°03.144'	4375 11 biosamples, 1 geochemistry
177KD	14.05.	01:56	03:17B		11°06.477'	118°26.483'	4317 342 kg nodules
177KD	14.05.		08:55E	10:36	11°09.880'	118°25.840'	4330 WL[bottom]: 4363 m, WL[max.]: 4828 m