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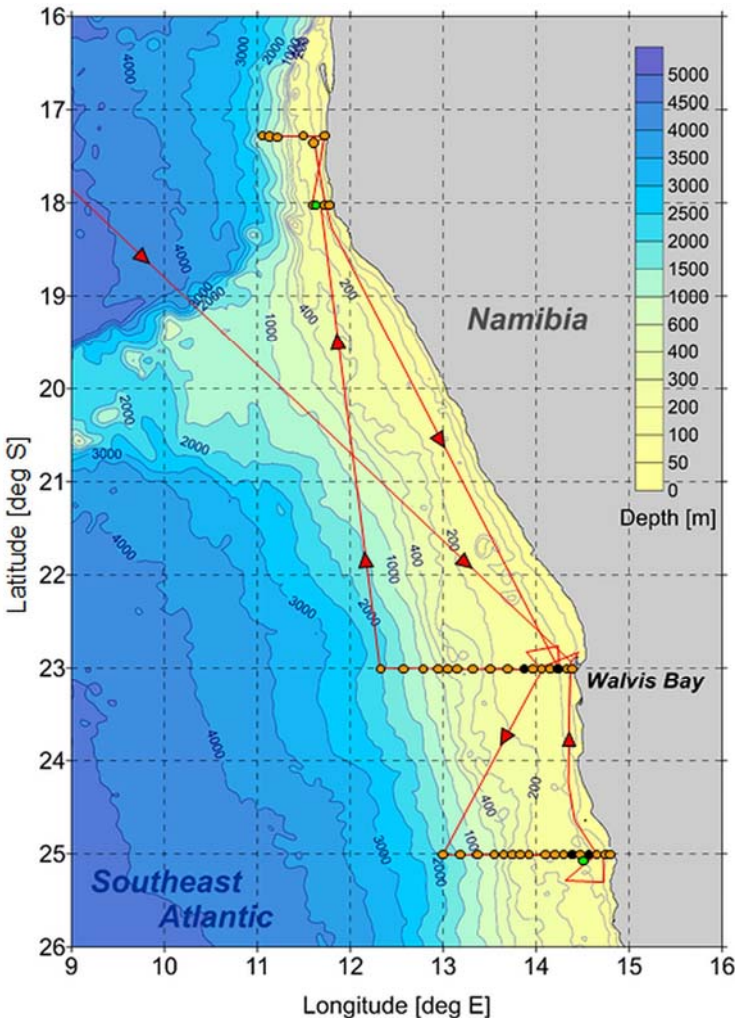
Short Cruise Report
RV METEOR Cruise M157

Mindelo (Cape Verde) – Walvis Bay (Namibia)
04. August – 16. September 2019
Chief Scientist: Matthias Zabel
Captain: Detlef Korte



Ship track of RV Meteor cruise M157 with locations of sampling

Summary / Objectives

This research cruise was directly connected with the collaborative research project EVAR (*The Benguela Upwelling System under Climate Change – Effects of Variability in Physical Forcing on Carbon and Oxygen Budgets*), which is funded by the Ministry of Education and Research (BMBF). The major goal of this expedition, and a second cruise planned in 2021, was to obtain high-resolution data and samples to document and to understand the variability of the geochemical environment and the present day physical forcing of the Benguela Upwelling System (BUS). For this purpose, comprehensive, multidisciplinary investigations were conducted along three transects perpendicular to the coast of Namibia at about 17,5°S, 23°S and 25°S. The work concentrated in particular on 4 selected locations at which all planned measuring methods and sampling could be carried out. This program was complemented by comparative studies at numerous other stations along the mentioned transects, as well as profiling measurements in the water column between all stations. Specific aims of the different working groups were as follows:

Hydrographic Regime

- Detection of short term upwelling peaks by recording standard hydrographic parameters.
- Exchange the long-term mooring at 23°S and deployment of similar sensors at 25°S.

Assessing variability in past upwelling intensity

- Recovering of high resolution sediment archives to investigate the history of geochemical environmental conditions during the Holocene.

Fluxes and turnover in response to variable redox conditions

- Estimate the pelagic microbial potential to react towards changes in abiotic parameters such as a sudden increase in sulfide or decrease in oxygen, and how this is related to trace gas production and sulfide oxidation. Identification of specific biogeochemical transformation zones and the involved microbial key organisms. Investigation of the effect of sulfide accumulation in the water column on the phosphorus cycling.
- Elucidation of the magnitude and pathways of benthic fluxes of nutrient (N-species, phosphate, Fe), dissolved gases (CH_4, $_pCO_2$, N_2/Ar) as well as dissolved inorganic carbon (DIC), sulfide and silicate in response to fluctuating and shifting regimes of the bottom water availability of O_2 and NO_3^-. Determine microbial controls and tipping points of the sequestration and release of phosphate, as well as of the benthic N and S cycling. Investigation of the tolerance of distinct microbenthic species to oxygen availability
- Determination of the timing and magnitude of sulfidic events after stepwise depletion of O_2 and NO_3^- in the bottom water.
- Determination of the contribution of the macro- and microbenthic communities to the overall solute turnover in sediments at the upper and lower boundary of the OMZ.

Trace gases

- Determination of sea surface concentration and fluxes of trace gases and relation to upwelling intensity and chemical physicochemical signature of the feed waters. Linking trace gas transformations to the microbial key players. Determination of the key depth horizons and processes for trace gas transformations and sensitivity of the underlying processes to variations in redox conditions (O_2 and H_2S levels).

Research Program and Narrative

The expedition M157 was divided into two parts. The official start was on August 4th with the departure from the port of Mindelo on the Cape Verde Islands. The scientific crew on the transit to the working area off Namibia consisted of 6 scientists from the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) and two secondary users, one from the Federal Maritime and Hydrographic Agency (BSH) and one from the Max-Planck-Inst. for Chemistry (MPI-C). The transfer was interrupted only by a few short stops to test different instruments. The first 14 days were used very effectively for unloading our scientific equipment, setting up the different laboratories and first test measurements, like on-the-go measurements of the flow field, surface water properties and trace substances as well as air pollutants. For the latter, concentration of persistent organic pollutants (POPs) was of particular interest. Despite their negative effects on the environment and human health, the proliferation of many of these pollutants is still insufficient or in areas far from primary sources almost not described at all in the literature. While valuable samples for the analysis of POPs were taken from the air and from the surface waters, the second, accompanying mission was unfortunately not successful. As the ordered Argo floats were not delivered to the Vessel in Mindelo in time, the floats could not be deployed as planned. On the morning of 18 August, the first transit leg of expedition M157 ended with the arrival of R/V METEOR at the port of Walvis Bay.

The two secondary users disembarked and 22 scientific participants, mostly members of the EVAR cluster project, boarded. Unfortunately, none of the Namibian partners was able to participate in the cruise.

According to our working plan in the proposal, investigations in the following four weeks concentrated on the coastal region off Namibia and here on three transects at 17.5° S, 23°S and 25°S respectively. Already 2 hours after leaving the port of Walvis Bay, the first profiling oceanographic measurements could be started. the excellent preparatory work during the transits from Mindelo for the laboratory setup and the instrumentation proved to be extremely important. The same strategy was successfully applied to all three transects. In order to get a first impression of the current chemical and physical conditions in the water column, especially the distribution and concentration of oxygen, a towed measuring device (the so-called Scanfish) was used and towed along the profile lines from the coast line up to 75 nautical miles off the coast. At the same time, the ship's sediment acoustic systems were used to explore the bathymetry and the internal structure of the sediments on the seabed. On the base of both information, the locations were determined where we expected to gain the most promising results to answer our questions by using other devices. The data set was supplemented by the multiple use of a microstructure probe, which provided high-resolution measurements of the characteristics of the water mass structure. For the selection of the individual locations for sampling, we followed the monitoring scheme of the National Marine Information and Research Centre (NatMIRC) in Swakopmund. The first successful sampling of the seabed surface by means of a large box grab could already be carried out in the late evening of 19 August. In rapid succession, we frequently used all our sampling devices. In addition, long-term measuring systems (moorings) placed on previous expeditions could be recovered at two stations and one could be newly deployed. The different needs of the individual investigation devices and methods (e.g. clean ship during CTD operations), as well as the short distances between neighboring investigation stations (max. 20 nautical miles) required the repeated visiting of the individual stations. A major difference compared to the previous planning

concerned the time requirements of the two Biogeochemical Observatories (lander systems) BIGO-1/-2. The complicated preparation of the instruments required that this work, the deployments and recoveries should only be carried out in daylight. Additionally, the necessary processing of the samples obtained forced the deployment of the systems on different consecutive days. The conception of the in-situ measurements and experiments required several missions of the systems at all of the so-called main stations, where also all other devices were used and investigations were carried out. This meant that the ship had to go at all respective stations 4 times within 7 days, a very time-limited procedure with an unexpected large number of transits. Consequently, the observatories could only be used at 4 instead of 5 stations and there only with 2 instead of 3 missions. On the other hand, it were precisely the relatively short transits that brought some recovery in the densely and ambitiously packed work program. Nevertheless, on the second EVAR expedition a significant optimization in this point is aimed. This also applies to the competing use of the various ship winches for launching the landers and the use of other heavy equipment (e.g. gravity corer).

As written above, the first investigations took place along the 23°S transect, followed by work at 17.5°S and finally at 25°S. On the transit from 17.5°S to the southernmost profile, some few follow-up investigations could be carried out at 23°S. All in all, with the large number of different devices, only a few defects occurred, most of which could be successfully repaired with own and on-board resources. Only the Drifter could not be used and the Bottom Trace Profiler had only one successful deployment. Despite the difficult conditions due to the very soft sediment surface in the area of the coastal mud belt, almost all planned samples could be obtained. In total, R/V METEOR expedition M157 covered 6,300 nautical miles, half of which was the transit from Mindelo to Walvis Bay. We were able to collect extremely valuable samples and measurement data at 49 individual stations and along different transit routes. 330 instrument operations were carried out in water depth between 32 and 2078 m.

On the morning of September 16th the cruise ended in Walvis Bay. As promised when applying for the work permit, a workshop was held at the NatMIRC on the following two days, where the first, preliminary results could be presented to Namibian colleagues and discussed with them.

Acknowledgements

The overall successful course of this expedition needs to be attributed to the friendly cooperation and very efficient technical assistance of Captain Detlef Korte, his officers and the whole crew. It was always obvious that all people on board worked on a common task. We would like to thank everybody involved, last but not least also the German Research Fleet Coordination Centre in Hamburg, among other things, for help with the currently quite complex procedure for obtaining work permits.

The expedition was funded by the Federal Ministry of Education and Research (BMBF; 03F0814).

Scientific Party

Name	Discipline	Institution
Amorim, Katherine [B]	Biological Oceanography	IOW
Anderson, Chloe, Dr. [B]	Sediment Geochemistry	MARUM
Beck, Antje [B]	Technician	GEOMAR
Beier, Sebastian [A+B]	Technician	IOW
Burmeister, Christian [B]	Technician	IOW
Dangl, Gabriela [B]	Biological Oceanography	IOW
Fabian, Jenny, Dr. [B]	Biological Oceanography	IOW
Glockzin, Michael [A+B]	Technician	IOW
Heene, Toralf [B]	Technician	IOW
Herrán, Natalia, Dr. [B]	Physical Oceanography	IOW
Kolbe, Martin [A+B]	Technician	IOW
Kossak, Michael [B]	Sediment Geochemistry	MARUM
Langeloh, Hendrik [B]	Technician	IOW
Meckelnburg, Isabelle [B]	Technician	GEOMAR
Meeske, Christian [B]	Technician	IOW
Mohrholz, Volker, Dr. [A+B]	Physical Oceanography	IOW
Otto, Stefan, Dr. [A+B]	Technician	IOW
Nolte, Gabriel [B]	Technician	GEOMAR
Sabbaghzadeh, Bita, Dr. [A+B]	Marine Chemistry	IOW
Scholz, Florian, Dr. [B]	Sediment Geochemistry	GEOMAR
Schulz-Vogt, Heide, Prof. [B]	Biological Oceanography	IOW
Sommer, Stefan, Dr. [B]	Marine Biogeochemistry	GEOMAR
Stelzner, Martin [A+B]	Technician	DWD
Tambo, Munyaradzi, Dr. [B]	Geomicrobiology	IOW
Tewes, Simon [A]	Oceanography	BSH
Türk, Matthias [B]	Engineer	GEOMAR
Wäge, Janine, Dr. [B]	Microbial Ecology	IOW
Wiezoreck, Marco [A]	Chemistry	MPI-C
Zabel, Matthias, Dr. [B]	Sediment Geochem. / Chief Scientist	MARUM
Zettler, Michael, Dr. [B]	Biological Oceanography	IOW

A – Leg/Transit 04.-18.08.2019; B – Leg 18.08.-16.09.2019

Participating Institutions

BSH	Bundesamt für Seeschifffahrt und Hydrographie Bernhard-Nocht-Str. 78, 20359 Hamburg, Germany	www.bsh.de
DWD	Deutscher Wetterdienst, Geschäftsfeld Seeschifffahrt, Bernhard-Nocht-Str. 76, 20359 Hamburg, Germany	www.dwd.de
GEOMAR	Helmholtz-Zentrum für Ozeanforschung Kiel Wischhofstraße 1-3, 24148 Kiel, Germany	www.geomar.de

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IOW	Leibniz-Institut für Ostseeforschung Warnemünde Seestraße 15, 18119 Rostock, Germany	www.io-warnemuende.de
MARUM	Zentrum für Marine Umweltwissenschaften Leobener Str., D 28359 Bremen, Germany	www.marum.de
MPI-C	Max-Planck-Institut für Chemie Hahn-Meitner-Weg 1 , 55128 Mainz, Germany	www.mpic.de

Station List

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
Transit from Mindelo to Walvis Bay							
M157_1-1	12.08.	12:16	CTD	max depth	09° 26,716'	000° 25,532'	5462
M157_1-2	12.08.	12:44	AC-S	max depth	09° 26,716'	000° 25,533'	5444
M157_1-3	12.08.	13:31	P-CTD	in water	09° 26,717'	000° 25,533'	5443
M157_1-4	12.08.	14:13	MSS	in water	09° 26,841'	000° 25,604'	5915
M157_1-5	12.08.	15:06	Scanfish	profile start	09° 28,146'	000° 26,392'	5428
Transect at 23°S							
M157_2-1	18.08.	18:10	Scanfish	profile start	23° 00,512'	014° 21,937'	46 / 605
M157_3-1	19.08.	10:19	MSS	in water	22° 59,898'	012° 56,764'	602
M157_4-1	19.08.	12:31	MSS	in water	23° 00,028'	012° 46,972'	948
M157_5-1	19.08.	14:42	MSS	in water	22° 59,991'	012° 34,815'	1441
M157_6-1	19.08.	18:02	CTD	max depth	23° 00,000'	012° 20,008'	2072
M157_6-2	19.08.	19:20	AC-S	max depth	23° 00,001'	012° 20,005'	2074
M157_6-3	19.08.	19:36	MSS	in water	23° 00,012'	012° 20,011'	2078
M157_6-4	19.08.	21:43	BC	on ground	23° 00,004'	012° 20,000'	2071
M157_4-2	20.08.	02:56	BC	on ground	22° 59,997'	012° 46,996'	946
M157_7-1	20.08.	05:37	MSS	in water	23° 00,007'	013° 02,989'	386
M157_8-1	20.08.	07:24	MSS	in water	22° 59,985'	013° 08,999'	322
M157_9-1	20.08.	10:22	MSS	in water	23° 00,030'	013° 18,991'	361
M157_10-1	20.08.	13:25	MSS	in water	22° 59,970'	013° 30,017'	240
M157_11-1	20.08.	15:14	MSS	in water	23° 00,017'	013° 41,004'	150
M157_12-1	20.08.	17:12	MSS	in water	23° 00,005'	013° 51,974'	152
M157_13-1	20.08.	18:55	MSS	in water	22° 59,963'	013° 57,477'	145
M157_14-1	20.08.	20:33	MSS	in water	22° 59,981'	014° 02,725'	140
M157_15-1	20.08.	22:06	MSS	in water	23° 00,062'	014° 07,962'	136
M157_16-1	21.08.	00:19	MSS	in water	23° 00,005'	014° 12,962'	112
M157_17-1	21.08.	01:53	MSS	in water	23° 00,062'	014° 18,952'	2704
M157_2-2	21.08.	02:59	MSS	in water	22° 59,988'	014° 21,996'	94
M157_12-2	21.08.	06:10	CTD	max depth	23° 00,003'	013° 51,997'	152
M157_12-3	21.08.	06:49	AC-S	max depth	23° 00,000'	013° 51,993'	151
M157_12-4	21.08.	08:28	OFOS	profile start	22° 59,994'	013° 52,142'	148
M157_12-5	21.08.	09:27	MC	on ground	22° 59,996'	013° 51,994'	151
M157_12-6	21.08.	10:03	MC	on ground	22° 59,995'	013° 51,995'	151
M157_12-7	21.08.	10:37	MC	on ground	22° 59,995'	013° 51,994'	150
M157_12-8	21.08.	11:04	MC	on ground	22° 59,995'	013° 51,994'	150
M157_12-9	21.08.	11:29	MC	on ground	22° 59,995'	013° 51,994'	151
M157_12-10	21.08.	18:09	Lander	deployed	23° 00,006'	013° 52,005'	148

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_14-2	21.08.	20:00	CTD	max depth	23° 00,007'	014° 02,798'	138
M157_14-3	21.08.	20:32	AC-S	max depth	23° 00,008'	014° 02,800'	139
M157_14-4	21.08.	20:55	P-CTD	in water	23° 00,009'	014° 02,804'	138
M157_14-5	22.08.	07:39	Mooring	on deck	22° 59,944'	014° 02,956'	139
M157_14-6	22.08.	08:26	Dredge	on ground	23° 00,001'	014° 02,934'	140
M157_14-7	22.08.	09:46	OFOS	profile start	23° 00,253'	014° 02,937'	139
M157_14-8	22.08.	10:46	MC	on ground	22° 59,983'	014° 02,983'	137
M157_14-9	22.08.	11:12	MC	on ground	22° 59,984'	014° 02,983'	139
M157_14-10	22.08.	11:27	MC	on ground	22° 59,985'	014° 02,981'	139
M157_14-11	22.08.	11:45	MC	on ground	22° 59,984'	014° 02,982'	138
M157_14-12	22.08.	12:04	MC	on ground	22° 59,986'	014° 02,986'	137
M157_16-2	22.08.	17:11	Lander	deployed	23° 00,006'	014° 13,016'	118
M157_16-3	22.08.	17:53	CTD	max depth	23° 00,000'	014° 12,943'	119
M157_16-4	22.08.	18:27	AC-S	max depth	23° 00,000'	014° 12,942'	115
M157_16-5	22.08.	18:55	MSS	in water	22° 59,526'	014° 12,954'	114
M157_16-6	22.08.	19:51	P-CTD	in water	22° 59,991'	014° 12,932'	114
M157_12-11	23.08.	06:27	Lander	released	22° 59,844'	013° 51,881'	151
M157_12-12	23.08.	08:34	Dredge	on ground	23° 00,037'	013° 52,026'	150
M157_12-13	23.08.	09:53	VVG	on ground	23° 00,035'	013° 52,125'	151
M157_12-14	23.08.	10:15	VVG	on ground	23° 00,034'	013° 52,124'	152
M157_12-15	23.08.	10:35	VVG	on ground	23° 00,035'	013° 52,124'	151
M157_12-16	23.08.	10:46	VVG	on ground	23° 00,035'	013° 52,125'	151
M157_12-17	23.08.	11:26	MC	on ground	23° 00,035'	013° 52,123'	149
M157_12-18	23.08.	12:06	MC	on ground	23° 00,034'	013° 52,124'	150
M157_14-13	23.08.	15:05	Mooring	deployed	23° 00,019'	014° 03,061'	135
M157_15-2	23.08.	16:39	MC	on ground	23° 00,007'	014° 08,008'	136
M157_15-3	23.08.	16:55	MC	on ground	23° 00,009'	014° 08,009'	135
M157_15-4	23.08.	17:28	MC	on ground	23° 00,001'	014° 08,007'	140
M157_15-5	23.08.	17:56	MC	on ground	23° 00,002'	014° 08,007'	139
M157_15-6	23.08.	18:22	Dredge	on ground	23° 00,003'	014° 08,032'	140
M157_15-7	23.08.	19:02	MC	on ground	23° 00,002'	014° 08,079'	140
M157_15-8	23.08.	19:24	MC	on ground	23° 00,003'	014° 08,081'	139
M157_15-9	23.08.	19:46	VVG	on ground	23° 00,003'	014° 08,080'	139
M157_15-10	23.08.	20:00	VVG	on ground	23° 00,002'	014° 08,078'	136
M157_15-11	23.08.	20:14	VVG	on ground	23° 00,002'	014° 08,078'	138
M157_15-12	23.08.	20:33	VVG	on ground	23° 00,002'	014° 08,079'	138
M157_15-13	23.08.	20:46	VVG	on ground	23° 00,002'	014° 08,079'	133
M157_15-14	23.08.	21:22	CTD	max depth	23° 00,002'	014° 08,079'	138
M157_15-15	23.08.	22:00	AC-S	max depth	23° 00,002'	014° 08,081'	140
M157_17-2	23.08.	23:31	CTD	max depth	23° 00,009'	014° 18,999'	76
M157_17-3	24.08.	00:03	AC-S	max depth	23° 00,008'	014° 19,000'	80
M157_17-4	24.08.	00:16	VVG	on ground	23° 00,008'	014° 19,001'	79
M157_17-5	24.08.	00:27	VVG	on ground	23° 00,008'	014° 19,002'	77
M157_17-6	24.08.	00:38	VVG	on ground	23° 00,008'	014° 19,001'	77
M157_17-7	24.08.	00:43	VVG	on ground	23° 00,009'	014° 19,000'	76
M157_17-8	24.08.	00:49	VVG	on ground	23° 00,009'	014° 19,002'	77
M157_17-9	24.08.	01:21	Dredge	on ground	23° 00,040'	014° 19,105'	76

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_2-3	24.08.	02:53	Dredge	on ground	23° 00,027'	014° 22,206'	85
M157_2-4	24.08.	03:45	VVG	on ground	23° 00,011'	014° 22,006'	45
M157_2-5	24.08.	03:55	VVG	on ground	23° 00,012'	014° 22,008'	46
M157_2-6	24.08.	04:06	VVG	on ground	23° 00,011'	014° 22,009'	46
M157_2-7	24.08.	04:28	AC-S	max depth	23° 00,011'	014° 22,008'	46
M157_2-8	24.08.	04:52	CTD	max depth	23° 00,010'	014° 22,005'	46
M157_16-7	24.08.	07:10	Mooring	recovered	23° 00,332'	014° 13,475'	112
M157_16-8	24.08.	08:04	Lander	recovered	23° 00,039'	014° 12,940'	113
M157_16-9	24.08.	19:27	MC	on ground	23° 00,039'	014° 12,942'	115
M157_16-10	24.08.	10:46	MC	on ground	23° 00,038'	014° 12,942'	114
M157_16-11	24.08.	11:05	MC	on ground	23° 00,039'	014° 12,941'	114
M157_16-12	24.08.	11:19	MC	on ground	23° 00,039'	014° 12,942'	113
M157_16-13	24.08.	11:34	MC	on ground	23° 00,038'	014° 12,942'	114
M157_16-14	24.08.	12:29	CTD	max depth	23° 00,037'	014° 12,942'	116
M157_14-14	24.08.	14:33	CTD	max depth	22° 59,999'	014° 03,196'	132
M157_14-15	24.08.	15:47	P-CTD	in water	22° 59,998'	014° 03,196'	139
M157_12-19	24.08.	17:59	MSS	in water	23° 00,021'	013° 52,006'	151
M157_12-20	24.08.	19:11	P-CTD	in water	22° 59,997'	013° 51,989'	152
M157_12-21	25.08.	03:35	CTD	max depth	22° 59,997'	013° 52,000'	150
M157_10-2	25.08.	06:02	VVG	on ground	22° 59,997'	013° 29,917'	242
M157_10-3	25.08.	06:32	VVG	on ground	22° 59,997'	013° 29,916'	242
M157_10-4	25.08.	07:00	VVG	on ground	22° 59,997'	013° 29,916'	242
M157_10-5	25.08.	07:38	Dredge	on ground	22° 59,997'	013° 30,023'	241
M157_10-6	25.08.	08:54	AC-S	max depth	22° 59,996'	013° 30,009'	240
M157_10-7	25.08.	09:15	CTD	max depth	22° 59,995'	013° 30,009'	241
M157_10-8	25.08.	10:01	MC	on ground	22° 59,995'	013° 30,010'	241
M157_10-9	25.08.	19:37	MC	on ground	22° 59,996'	013° 30,010'	241
M157_10-10	25.08.	11:06	MC	on ground	22° 59,995'	013° 30,010'	241
M157_10-11	25.08.	11:24	MC	on ground	22° 59,995'	013° 30,009'	241
M157_12-22	25.08.	17:10	Lander	deployed	22° 59,999'	013° 52,008'	149
M157_9-2	25.08.	20:43	CTD	max depth	22° 59,990'	013° 18,988'	361
M157_9-3	25.08.	21:20	AC-S	max depth	23° 00,004'	013° 19,004'	361
M157_9-4	25.08.	21:56	VVG	on ground	23° 00,004'	013° 19,002'	362
M157_9-5	25.08.	22:14	VVG	on ground	23° 00,004'	013° 19,004'	362
M157_9-6	25.08.	22:33	VVG	on ground	23° 00,003'		362
M157_9-7	25.08.	23:16	Dredge	on ground	23° 00,054'	013° 19,305'	360
M157_11-2	26.08.	02:21	VVG	on ground	22° 59,988'	013° 40,992'	154
M157_11-3	26.08.	02:40	VVG	on ground	22° 59,988'	013° 40,994'	154
M157_11-4	26.08.	03:36	CTD	max depth	22° 59,988'	013° 40,994'	158
M157_11-5	26.08.	04:20	AC-S	max depth	22° 59,987'	013° 40,994'	154
M157_16-15	26.08.	08:53	BTP	on ground	23° 00,001'	014° 12,992'	114
M157_16-16	26.08.	10:36	MC	on ground	23° 00,003'	014° 12,995'	114
M157_16-17	26.08.	11:03	MC	on ground	23° 00,002'	014° 12,998'	117
M157_16-18	26.08.	11:32	MC	on ground	23° 00,003'	014° 12,999'	114
M157_16-19	26.08.	11:46	MC	on ground	23° 00,004'	014° 12,999'	113
M157_16-20	26.08.	11:56	MC	on ground	23° 00,003'	014° 13,000'	114
M157_16-21	26.08.	17:06	Lander	released	23° 00,025'	014° 12,988'	114

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_17-10	26.08.	20:11	MSS	in water	22° 58,796'	014° 19,110'	76
M157_12-23	27.08.	11:45	Lander	released	23° 00,029'	013° 52,089'	149
M157_12-24	27.08.	13:36	Drifter	deployed	22° 59,933'	013° 51,954'	150
M157_12-25	27.08.	14:33	GC	on ground	22° 59,935'	013° 51,980'	151
M157_14-16	27.08.	18:00	GC	on ground	22° 59,884'	014° 02,885'	138
M157_16-22	28.08.	06:52	GC	on ground	22° 59,825'	014° 12,970'	119
M157_17-11	28.08.	08:53	GC	on ground	22° 59,980'	014° 18,964'	77
M157_17-12	28.08.	09:34	GC	on ground	22° 59,994'	014° 18,986'	78
M157_17-13	28.08.	10:43	MC	on ground	23° 00,000'	014° 19,005'	77
M157_17-14	28.08.	11:12	MC	on ground	23° 00,000'	014° 19,000'	77
M157_17-15	28.08.	11:33	MC	on ground	22° 59,966'	014° 19,006'	79
M157_16-23	28.08.	12:42	Lander	released	23° 00,022'	014° 13,037'	114
M157_16-24	28.08.	13:25	CTD	max depth	22° 59,995'	014° 12,962'	113
M157_14-17	28.08.	15:25	MC	on ground	22° 59,989'	014° 03,011'	139
M157_12-26	28.08.	17:04	MC	on ground	22° 59,990'	013° 52,003'	149
M157_12-27	28.08.	17:28	MC	on ground	22° 59,968'	013° 52,007'	149
M157_8-2	28.08.	22:12	CTD	max depth	22° 59,963'	013° 08,967'	321
M157_8-3	28.08.	22:48	AC-S	max depth	22° 59,965'	013° 08,968'	321
				Transect at 17,5°S			
M157_18-1	30.08.	00:54	Mooring	released	17° 59,863'	011° 39,199'	132
M157_18-2	30.08.	13:23	Mooring	deployed	18° 00,006'	011° 39,086'	131
M157_19-1	30.08.	13:47	MSS	in water	18° 00,250'	011° 41,803'	112
M157_20-1	30.08.	15:18	MSS	in water	17° 59,928'	011° 42,990'	93
M157_21-1	30.08.	16:39	MSS	in water	17° 59,936'	011° 37,947'	131
M157_22-1	30.08.	17:53	MSS	in water	17° 59,761'	011° 34,891'	187
M157_23-1	30.08.	19:22	MSS	in water	17° 59,938'	011° 30,898'	234
M157_24-1	31.08.	02:23	CTD	max depth	17° 16,023'	011° 43,445'	34
M157_24-2	31.08.	02:38	AC-S	max depth	17° 16,022'	011° 43,445'	34
M157_24-3	31.08.	03:25	VVG	on ground	17° 16,023'	011° 43,443'	33
M157_24-4	31.08.	03:36	VVG	on ground	17° 16,022'	011° 43,445'	33
M157_24-5	31.08.	03:52	VVG	on ground	17° 16,023'	011° 43,444'	34
M157_24-6	31.08.	04:19	Dredge	on ground	17° 16,014'	011° 43,552'	32
M157_24-7	31.08.	06:23	MC	on ground	17° 16,013'	011° 43,437'	33
M157_24-8	31.08.	06:42	MC	on ground	17° 16,014'	011° 43,436'	33
M157_24-9	31.08.	07:54	Scanfish	profile start	17° 16,155'	011° 41,841'	62 / 419
M157_25-1	31.08.	14:11	CTD	max depth	17° 16,017'	011° 04,006'	1520
M157_25-2	31.08.	15:14	AC-S	max depth	17° 16,017'	011° 04,004'	1515
M157_25-3	31.08.	16:29	CTD	max depth	17° 16,017'	011° 04,005'	1517
M157_25-4	31.08.	17:55	BC	on ground	17° 16,016'	011° 04,006'	1523
M157_26-1	31.08.	20:45	BC	on ground	17° 16,020'	011° 08,998'	1101
M157_26-2	31.08.	22:14	CTD	max depth	17° 16,020'	011° 08,999'	1105
M157_26-3	31.08.	23:00	AC-S	max depth	17° 16,020'	011° 09,000'	1102
M157_27-1	01.09.	01:07	CTD	max depth	17° 16,014'	011° 16,496'	507
M157_27-2	01.09.	01:47	AC-S	max depth	17° 16,014'	011° 16,497'	508
M157_27-3	01.09.	02:23	BC	on ground	17° 16,013'	011° 16,494'	508
M157_28-1	01.09.	05:56	CTD	max depth	17° 16,016'	011° 30,058'	151

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_28-2	01.09.	06:41	AC-S	max depth	17° 16,017'	011° 30,058'	152
M157_28-3	01.09.	07:07	VVG	on ground	17° 16,017'	011° 30,059'	151
M157_28-4	01.09.	07:27	VVG	on ground	17° 16,017'	011° 30,059'	151
M157_28-5	01.09.	07:48	VVG	on ground	17° 16,017'	011° 30,059'	145
M157_28-6	01.09.	08:12	Dredge	in water	17° 16,017'	011° 30,091'	151
M157_28-7	01.09.	09:21	MC	on ground	17° 16,014'	011° 30,067'	150
M157_29-1	01.09.	11:24	CTD	max depth	17° 15,721'	011° 43,026'	41
M157_29-2	01.09.	11:37	AC-S	max depth	17° 15,722'	011° 43,026'	41
M157_29-3	01.09.	11:46	VVG	on ground	17° 15,721'	011° 43,026'	42
M157_29-4	01.09.	11:58	VVG	on ground	17° 15,721'	011° 43,025'	40
M157_29-5	01.09.	12:10	VVG	on ground	17° 15,721'	011° 43,025'	40
M157_29-6	01.09.	12:25	Dredge	in water	17° 15,725'	011° 43,034'	41
M157_29-7	01.09.	13:43	MC	on ground	17° 15,729'	011° 43,024'	41
M157_30-1	01.09.	15:33	CTD	max depth	17° 20,387'	011° 36,120'	117
M157_30-2	01.09.	15:55	AC-S	max depth	17° 20,389'	011° 36,121'	117
M157_30-3	01.09.	16:12	VVG	on ground	17° 20,389'	011° 36,121'	117
M157_30-4	01.09.	16:26	VVG	on ground	17° 20,390'	011° 36,122'	116
M157_30-5	01.09.	16:43	VVG	on ground	17° 20,389'	011° 36,121'	119
M157_30-5	01.09.	16:47	VVG	on ground	17° 20,388'	011° 36,122'	115
M157_30-6	01.09.	16:58	Dredge	in water	17° 20,390'	011° 36,129'	117
M157_30-7	01.09.	17:29	Dredge	in water	17° 20,524'	011° 36,300'	118
M157_30-8	01.09.	18:11	MC	on ground	17° 20,613'	011° 36,380'	116
				Transect at 23°S			
M157_16-25	03.09.	04:16	CTD	max depth	22° 59,998'	014° 13,010'	114
M157_14-18	03.09.	06:15	CTD	max depth	23° 00,023'	014° 03,005'	140
				Transect at 25°S			
M157_31-1	03.09.	19:18	CTD	max depth	25° 00,002'	012° 59,836'	1803
M157_31-2	03.09.	20:18	AC-S	max depth	25° 00,001'	012° 59,835'	1805
M157_31-3	03.09.	20:33	MSS	in water	25° 00,013'	012° 59,828'	1801
M157_32-1	03.09.	22:42	MSS	in water	24° 58,970'	013° 11,526'	1373
M157_33-1	04.09.	02:38	MSS	in water	24° 59,265'	013° 22,359'	985
M157_34-1	04.09.	06:12	MSS	in water	24° 59,184'	013° 33,370'	603
M157_34-2	04.09.	07:30	MC	on ground	25° 00,001'	013° 32,947'	627
M157_34-3	04.09.	08:51	GC	on ground	24° 59,999'	013° 32,948'	626
M157_35-1	04.09.	10:51	MSS	in water	24° 59,056'	013° 38,836'	436
M157_36-1	04.09.	13:09	MSS	in water	24° 59,060'	013° 43,604'	509
M157_37-1	04.09.	15:31	MSS	in water	24° 59,277'	013° 49,174'	243
M157_38-1	04.09.	18:04	MSS	in water	24° 59,322'	013° 54,960'	186
M157_39-1	04.09.	20:00	MSS	in water	24° 59,170'	014° 06,169'	176
M157_40-1	04.09.	21:54	MSS	in water	24° 59,123'	014° 17,154'	165
M157_41-1	04.09.	23:28	MSS	in water	24° 59,024'	014° 22,678'	142
M157_42-1	05.09.	01:04	MSS	in water	24° 59,117'	014° 28,125'	122
M157_43-1	05.09.	02:59	MSS	in water	24° 59,280'	014° 33,638'	109
M157_44-1	05.09.	04:18	MSS	in water	24° 59,268'	014° 39,194'	89
M157_45-1	05.09.	05:39	MSS	in water	24° 59,279'	014° 44,706'	54
M157_46-1	05.09.	06:46	MSS	in water	24° 59,281'	014° 47,938'	32

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_41-2	05.09.	09:41	GC	on ground	25° 00,001'	014° 22,647'	139
M157_41-3	05.09.	10:47	MC	on ground	25° 00,003'	014° 22,649'	139
M157_41-4	05.09.	14:04	VVG	on ground	25° 00,003'	014° 22,648'	139
M157_41-5	05.09.	14:57	VVG	on ground	25° 00,003'	014° 22,649'	139
M157_41-6	05.09.	15:15	VVG	on ground	25° 00,004'	014° 22,649'	139
M157_41-7	05.09.	15:43	Dredge	in water	25° 00,112'	014° 22,887'	141
M157_41-8	05.09.	17:45	Lander	deployed	25° 00,002'	014° 22,652'	140
M157_43-2	05.09.	19:31	CTD	max depth	25° 00,002'	014° 33,662'	106
M157_43-3	05.09.	20:04	AC-S	max depth	25° 00,002'	014° 33,663'	110
M157_43-4	05.09.	20:24	P-CTD	in water	25° 00,003'	014° 33,664'	107
M157_43-5	05.09.	21:35	MSS	in water	25° 00,003'	014° 33,664'	108
M157_43-6	06.09.	05:00	P-CTD	in water	24° 59,999'	014° 33,662'	104
M157_43-7	06.09.	08:52	VVG	on ground	25° 00,003'	014° 33,663'	107
M157_43-8	06.09.	09:07	VVG	on ground	25° 00,003'	014° 33,663'	107
M157_43-9	06.09.	09:21	VVG	on ground	25° 00,001'	014° 33,665'	105
M157_43-10	06.09.	09:41	Dredge	in water	25° 00,002'	014° 33,712'	109
M157_43-11	06.09.	10:48	MC	on ground	25° 00,006'	014° 33,669'	106
M157_43-12	06.09.	11:13	MC	on ground	25° 00,007'	014° 33,670'	106
M157_44-2	06.09.	12:50	CTD	max depth	24° 59,999'	014° 39,171'	83
M157_44-3	06.09.	13:15	AC-S	max depth	24° 59,998'	014° 39,170'	88
M157_44-4	06.09.	13:30	VVG	on ground	24° 59,999'	014° 39,171'	85
M157_44-5	06.09.	13:50	VVG	on ground	24° 59,998'	014° 39,170'	83
M157_44-6	06.09.	14:05	VVG	on ground	24° 59,999'	014° 39,171'	88
M157_44-7	06.09.	14:21	Dredge	in water	25° 00,011'	014° 39,188'	87
M157_43-13	06.09.	16:51	Lander	deployed	25° 00,005'	014° 33,662'	108
M157_34-4	06.09.	22:55	CTD	max depth	24° 59,992'	013° 32,936'	633
M157_34-5	06.09.	23:31	AC-S	max depth	24° 59,994'	013° 32,934'	626
M157_34-6	07.09.	00:22	BC	on ground	24° 59,993'	013° 32,936'	627
M157_36-2	07.09.	03:23	CTD	max depth	25° 00,002'	013° 43,968'	317
M157_36-3	07.09.	04:09	AC-S	max depth	25° 00,002'	013° 43,968'	317
M157_36-4	07.09.	04:29	VVG	on ground	25° 00,002'	013° 43,968'	317
M157_36-5	07.09.	04:59	VVG	on ground	25° 00,002'	013° 43,968'	317
M157_36-6	07.09.	05:31	VVG	on ground	25° 00,002'	013° 43,969'	317
M157_36-7	07.09.	06:00	Dredge	in water	25° 00,003'	013° 43,884'	318
M157_41-9	07.09.	10:09	Lander	at surface	24° 59,988'	014° 22,468'	137
M157_41-10	07.09.	11:07	MC	on ground	25° 00,022'	014° 22,644'	140
M157_41-11	07.09.	11:28	MC	on ground	25° 00,022'	014° 22,644'	141
M157_41-12	07.09.	12:11	GC	on ground	25° 00,022'	014° 22,643'	140
M157_41-13	07.09.	12:34	GC	on ground	25° 00,022'	014° 22,644'	140
M157_43-14	07.09.	13:53	GC	on ground	25° 00,004'	014° 33,855'	107
M157_47-1	07.09.	16:00	GC	on ground	25° 00,181'	014° 17,771'	161
M157_38-2	07.09.	19:18	CTD	max depth	24° 59,998'	013° 55,003'	186
M157_38-3	07.09.	19:45	AC-S	max depth	24° 59,997'	013° 55,010'	186
M157_38-4	07.09.	20:06	VVG	on ground	24° 59,997'	013° 55,010'	187
M157_38-5	07.09.	20:26	Dredge	in water	24° 59,997'	013° 55,038'	186
M157_39-2	07.09.	22:50	CTD	max depth	25° 00,010'	014° 06,165'	177
M157_39-3	07.09.	23:18	AC-S	max depth	25° 00,013'	014° 06,163'	177

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_39-4	07.09.	23:34	VVG	on ground	25° 00,015'	014° 06,164'	176
M157_39-5	07.09.	23:50	VVG	on ground	25° 00,014'	014° 06,164'	187
M157_39-6	08.09.	00:05	VVG	on ground	25° 00,019'	014° 06,160'	177
M157_39-7	08.09.	00:19	VVG	on ground	25° 00,018'	014° 06,151'	176
M157_39-8	08.09.	00:33	VVG	on ground	25° 00,018'	014° 06,150'	177
M157_39-9	08.09.	00:46	Dredge	in water	25° 00,034'	014° 06,167'	177
M157_43-15	08.09.	06:02	Lander	at surface	25° 00,039'	014° 33,604'	105
M157_43-16	08.09.	08:46	MC	on ground	25° 00,000'	014° 33,671'	108
M157_43-17	08.09.	09:08	MC	on ground	25° 00,002'	014° 33,670'	105
M157_46-2	08.09.	12:12	Scanfish	profile start	25° 00,004'	014° 47,946'	34 / 1802
M157_41-14	09.09.	11:54	CTD	max depth	24° 59,997'	014° 22,647'	140
M157_41-15	09.09.	11:39	MSS	in water	24° 59,997'	014° 22,645'	140
M157_41-16	09.09.	12:37	AC-S	max depth	24° 59,999'	014° 22,647'	141
M157_41-17	09.09.	13:54	Lander	released	24° 59,999'	014° 22,648'	140
M157_41-18	09.09.	16:24	BTP	max depth	24° 59,998'	014° 22,706'	139
M157_41-19	09.09.	17:40	P-CTD	in water	25° 00,000'	014° 22,710'	139
M157_41-20	09.09.	18:27	MSS	in water	24° 59,998'	014° 22,707'	140
M157_41-21	09.09.	19:42	MSS	in water	24° 59,998'	014° 22,707'	140
M157_40-2	10.09.	03:32	CTD	max depth	24° 59,992'	014° 17,133'	163
M157_40-3	10.09.	04:10	AC-S	max depth	24° 59,993'	014° 17,134'	162
M157_48-1	10.09.	06:02	VVG	on ground	25° 00,275'	014° 12,391'	173
M157_48-2	10.09.	06:22	VVG	on ground	25° 00,274'	014° 12,390'	172
M157_48-3	10.09.	06:42	VVG	on ground	25° 00,272'	014° 12,391'	172
M157_48-4	10.09.	07:00	Dredge	in water	25° 00,290'	014° 12,399'	175
M157_48-4	10.09.	07:32	Dredge	on deck			173
M157_48-5	10.09.	07:57	MC	on ground	25° 00,353'	014° 12,319'	173
M157_39-10	10.09.	09:20	OFOS	max depth	25° 00,008'	014° 06,173'	177
M157_39-11	10.09.	09:51	Dredge	in the water	25° 00,025'	014° 06,190'	177
M157_42-2	10.09.	13:41	CTD	max depth	24° 59,984'	014° 28,161'	124
M157_42-3	10.09.	14:24	AC-S	max depth	24° 59,984'	014° 28,161'	123
M157_43-18	10.09.	15:39	Lander	deployed	25° 00,003'	014° 33,666'	105
M157_43-19	10.09.	16:23	CTD	max depth	25° 00,001'	014° 33,666'	104
M157_45-2	10.09.	18:05	CTD	max depth	25° 00,005'	014° 44,677'	52
M157_45-3	10.09.	18:31	AC-S	max depth	25° 00,006'	014° 44,679'	53
M157_45-4	10.09.	18:38	VVG	on ground	25° 00,005'	014° 44,678'	54
M157_45-5	10.09.	18:54	VVG	on ground	25° 00,006'	014° 44,681'	56
M157_45-6	10.09.	19:08	VVG	on ground	25° 00,005'	014° 44,678'	54
M157_45-7	10.09.	19:22	Dredge	in water	25° 00,012'	014° 44,693'	53
M157_46-3	10.09.	20:49	CTD	max depth	25° 00,009'	014° 47,987'	33
M157_46-4	10.09.	21:08	AC-S	max depth	25° 00,001'	014° 48,011'	32
M157_46-5	10.09.	21:15	VVG	on ground	25° 00,001'	014° 48,011'	33
M157_46-6	10.09.	21:25	VVG	on ground	25° 00,002'	014° 48,011'	33
M157_46-7	10.09.	21:33	VVG	on ground	25° 00,002'	014° 48,011'	33
M157_46-8	10.09.	21:40	Dredge	in water	25° 00,015'	014° 48,026'	33
M157_41-22	11.09.	05:50	MC	on ground	24° 59,997'	014° 22,719'	140
M157_41-23	11.09.	06:11	MC	on ground	24° 59,995'	014° 22,718'	140
M157_41-24	11.09.	06:34	Lander	at surface	25° 00,023'	014° 22,689'	141

Station No.	Date 2019	Time (UTC)	Device	Action	Latitude (S)	Longitude (E)	Water Depth (m)
M157_49-1	11.09.	08:42	MSS	in water	25° 05,038'	014° 30,353'	121
M157_49-2	11.09.	10:09	Mooring	released	25° 05,019'	014° 31,987'	113
M157_49-3	11.09.	11:04	CTD	max depth	25° 05,017'	014° 32,086'	113
M157_49-4	11.09.	11:33	AC-S	max depth	25° 05,017'	014° 32,087'	113
M157_44-8	11.09.	12:48	MC	max depth	25° 00,007'	014° 39,160'	85
M157_44-9	11.09.	13:28	P-CTD	in water	25° 00,007'	014° 39,159'	84
M157_44-10	11.09.	14:08	MSS	in water	25° 00,007'	014° 39,160'	85
M157_43-20	12.09.	07:03	BTP	max depth	25° 00,042'	014° 33,701'	109
M157_43-21	12.09.	08:38	Lander	at surface	25° 00,042'	014° 33,700'	103
Transect at 23°S							
M157_17-16	12.09.	19:28	CTD	max depth	23° 00,007'	014° 19,005'	76
M157_17-17	12.09.	19:57	AC-S	max depth	23° 00,008'	014° 19,006'	76
M157_17-18	12.09.	20:12	P-CTD	in water	23° 00,007'	014° 19,007'	76
M157_17-19	12.09.	20:50	MSS	in water	23° 00,008'	014° 19,006'	76
M157_17-20	12.09.	21:38	MSS	in water	23° 00,008'	014° 19,005'	77
M157_16-26	13.09.	03:34	CTD	max depth	22° 59,993'	014° 12,977'	113
M157_16-27	13.09.	04:09	AC-S	max depth	22° 59,999'	014° 13,003'	113
M157_16-28	13.09.	06:10	MC	on ground	22° 59,999'	014° 13,001'	113
M157_16-29	13.09.	06:28	MC	on ground	22° 59,998'	014° 13,002'	114
M157_2-9	13.09.	10:49	CTD	max depth	22° 59,988'	014° 22,014'	46
M157_2-10	13.09.	11:25	AC-S	max depth	22° 59,988'	014° 22,012'	46
M157_2-11	13.09.	11:42	P-CTD	in water	22° 59,988'	014° 22,013'	46
M157_2-12	13.09.	14:40	MSS	in water	22° 59,988'	014° 22,013'	46
M157_2-13	14.09.	09:00	Scanfish	profile start	23° 00,002'	012° 34,482'	47 / 2069

Abbreviations

Water column

AC-S In situ absorption spectrophotometer
CTD water sampling rosette equipped with sensors
P-CTD Pump-CTD for ultra-high-resolution sampling
Mooring anchored sensor chains for long- and short-term deployments
MSS Microstructure profiler for turbulence and mixing study
Scanfish towed undulating CTD for the upper water column
Drifter Drifting sensor string for surface observations
BTP Benthic Trace Profiler for sampling the benthic nepheloid layer
OFOS Ocean Floor Observation System

Benthic interface and sediments

Lander Biogeochemical Observatories (BIGO-1/-2) for benthic in-situ measurements and sampling
Dredge Trawl of chains to sampling biota and coarse material at the sea floor
VVG Van-Veen-Grab sampler for sediment surface samples
MC Multiple corer video-guided (8 tubes)
BC Box corer
GC Gravity corer (6-12 m steel tubing)