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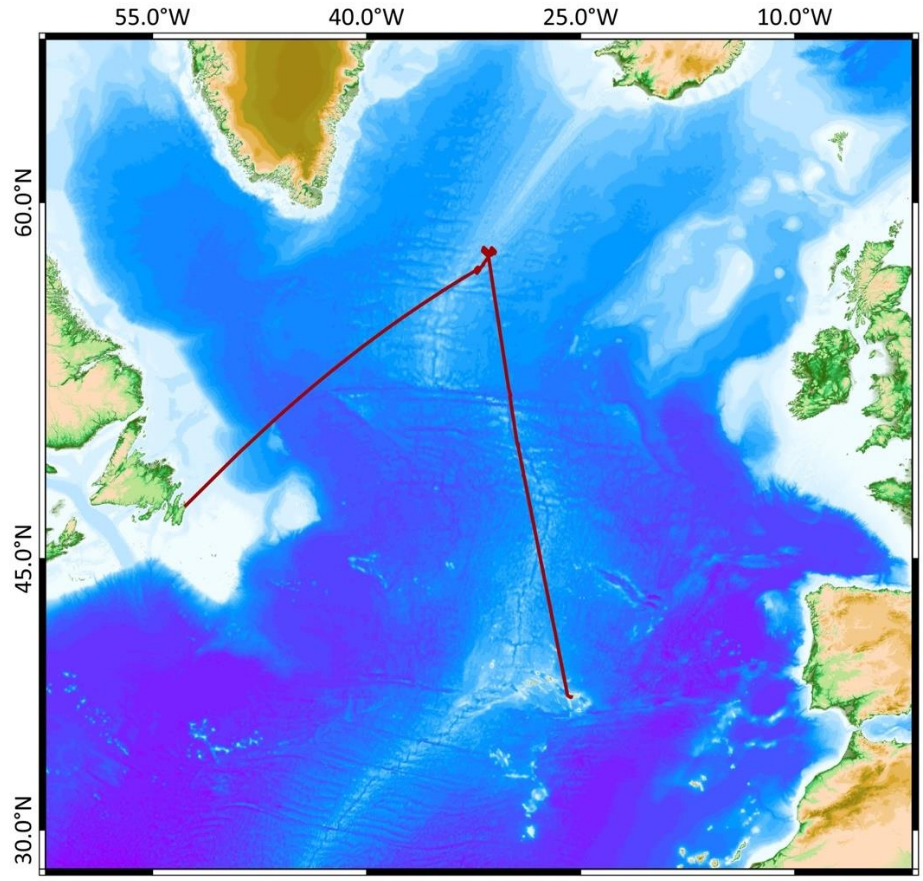
Short Cruise Report
RV Meteor, cruise M183

Ponta Delgada (Portugal) – St. John's (Canada)

July 13, 2022 – August 09, 2022

Chief Scientist: Wolfgang Bach

Captain: Rainer Hammacher



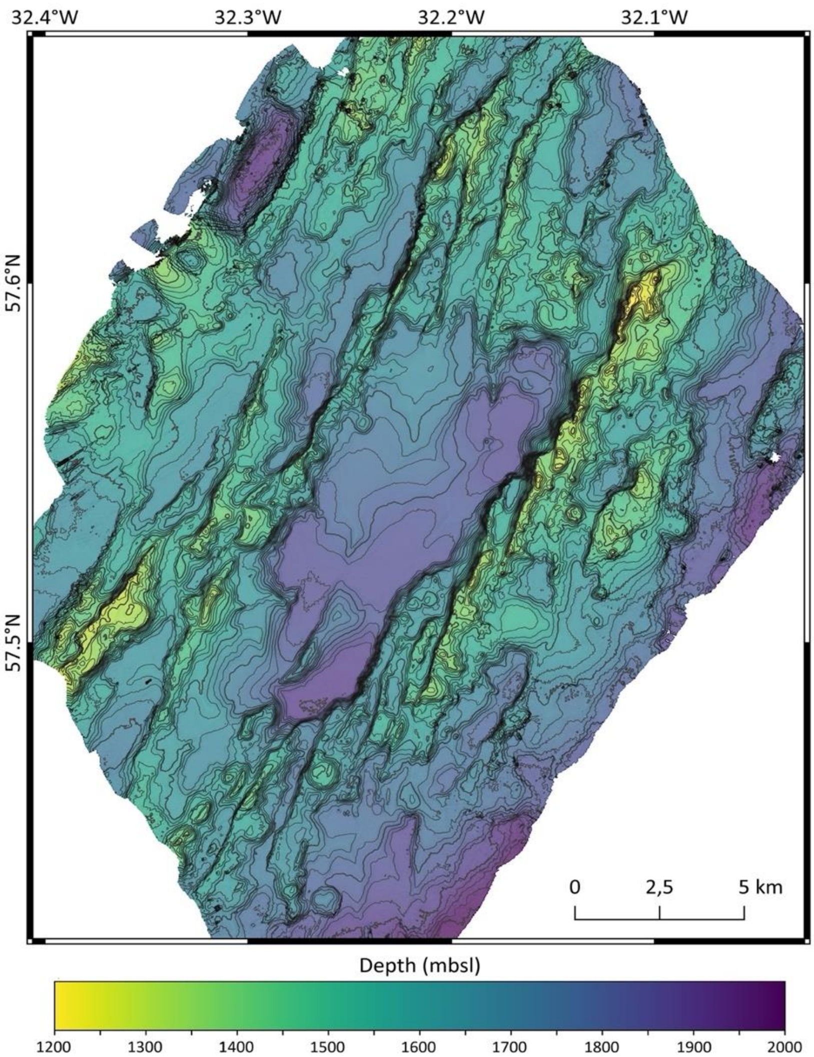
Objectives

The main goal of the cruise is to locate promising areas for future MeBo drilling and ridge flank observatory science. Sites that have sediment thickness of 30-50 m and gradients in heat flow would be perfectly suited. The work program consists of four parts: (1) ship-based echosounding and subbottom profiling, (2) ROV-based subbottom profiling, (3) measurement of conductive heat flow in the sediments, and (4) gravity coring of sediments. A nested approach was to be used to locate these sites. First, the ship's multibeam echo sounder (EM122) and subbottom profiler (PARASOUND) was used to find flat and sedimented patches of seafloor that have approximately suitable sediment thicknesses. Use of ship-based EM122 bathymetry of target ponds provided maps with 20-m gridding, i.e., higher resolution than the available 100-m grid from Martinez and Hey (2017). To establish a sediment distribution map, we used the PARASOUND sub-bottom profiling system on areas with flat seafloor. ROV surveys were conducted to provide more precise data on sediment thickness distribution in areas with rougher seafloor topography. In addition, we had hoped that temperature sensors on the AUV may help sites of elevated temperature fluid discharge, as was successfully used at the Dorado Outcrop and at North Pond. Heat flow surveys alternated with ROV survey work to make full use of the ship time 24 hrs per day. Heat flow survey lines will be selected to run parallel and perpendicular to the strike of abyssal hills (and hence the long axis of the deeper sediment ponds. Sediment samples were taken by gravity coring from areas with lowest and highest heat flow density. Soon after the core liner had been sectioned into 1-m long pieces, oxygen concentrations in the sediment porewater were measured with microelectrodes to assess sediment microbial oxygen respiration and potential for diffusive flux of oxygen from basement into the overlying sediment. The core was then split after pore water have been collected and sediments were sampled for geochemical and microbiological work. This included sampling of pore waters with Rhizon samplers and measurements of alkalinity and dissolved iron on board. The bulk of the samples were stored adequately for the analyses of nutrients, pH as well as post-cruise multi-element analysis (ICP-OES, ICP-MS). Discrete sections of the core were also sampled to examine how the microbial community (1) reflects oxidant delivery from the seafloor and the sediment-basement interface and (2) compares to sediments overlying other ridge flank systems. We anticipated that the sediment oxygen profiles will display similar profiles as have been observed in similar sediment packages over ridge flanks, where oxygen concentrations decrease with depth in the sediment until reaching a zone where concentrations increase again from oxygen diffusion from basement. Our efforts were hence focused on the seafloor-sediment and sediment-basement interfaces, with additional sampling suboxic and/or anoxic boundaries within the sediment column. In addition to the collection of sediment samples for bulk characterization of the microbial community diversity, subsamples were also taken for determining the active members of the microbial community using new fluorescence-activated cell sorting-based approaches. In addition, cell abundance estimates will be obtained by qPCR targeting the 16S rRNA gene. A potential link between variability in community structure and cell abundances with differences in heat flow between sites will also be investigated.

Narrative

RV METEOR left the port of Ponta Delgada at 9 a.m. on the 13th of July and crossed the Hirondelle Basin before leaving the archipelago of the Azores in a northwesterly direction. The 2000-km long transit was uneventful. The laboratories were set up and the working procedures were developed and discussed. We did a short test dive with the MARUM ROV SQUID in the afternoon of the 15th of July and – a day later – tested sampling of sediments with the gravity corer and trained core flow procedures during core scanning, describing, and subsampling. With decent weather and favorable currents, we were able to make good time and arrive at the work area as planned on the 18th of July (Fig. 4.1). Our initial surveying work started in the northernmost corner of our larger work area, where we had identified a series of sedimented ponds around latitude 58°10'N, which are centered roughly 11, 17, 21, and 33 km east of the spreading center. A 22-hr survey of these ponds with the ship's EM122 and PARASOUND systems was finished in the morning hours of 19th of July and was followed by a CTD station, a first heat flow transect and a gravity coring event in the largest pond, which is farthest off-axis (pond no. 1). The heat flow data indicated uniformly low heat flow values along the NW-SE transect. A second pond just 20 km ENE of the first one was surveyed with EM/PS in the night from the 19th to the 20th before we did a ROV dive and gravity coring on top of a small knoll in pond no. 1. The second pond was then also cursory investigated on the 21st of July by a nightly heat flow survey, followed by an ROV dive and a gravity coring event. This station work in pond no. 2 did also not turn out any indications of heat flow gradients. The ROV was operated in subseafloor profiling mode for those first two dives. While the ECHOES system worked, it did not appear to provide data that were significantly superior to what could be recorded by the ship-based PARASOUND system. It was hence decided to use the ROV in an observation and sampling mode for the remainder of the cruise. A six-hour transit got us – in the early morning hours of the 22nd – to our third pond around 57°33'N, 32°13'W. It was surveyed by EM/PS before a heat flow transect crossing the center of the pond from NW to SE was conducted. That transect yielded a very strong gradient in heat flow, from values as high as 560 mW/m^2 in the NW to very low values (< 30 mW/m^2) in the SE. Going on a hunch, we had already deployed the AIMS³-Lander, did a single-dip CTD station on the lander location in the SW part of the pond and had taken a gravity core from the slope of the ridge bordering the pond to the NW. Additional PS data were collected during July 23 and a gravity core was taken from the NE part of the pond. For the following four days we ran a uniform program of nightly heat flow surveys, followed by an ROV dive and a gravity corer station during the day. We did over 40 heat flow measurements covering much of the relatively flat bottom of the pond and sedimented areas up on the ridges bounding the pond, which we later named *Squid Pond*. We had three ROV dives up the slopes of the NW ridge and one on the opposite side of Squid Pond, where heat flow was lower. During these dives, we collected samples of rocks and sponges, as well as sediments by push coring. We also used a miniature temperature logger to measure temperatures in the sediments. The sea state did not permit ROV dives on the 28th and 29th of July. We did a 22-hr long EM/PS survey to extend the survey grid to the periphery of Squid Pond and increase the density of the survey grids within the area. On the 29th of July, we did a 24-hr CTD-yoyo cast with 20 lowering and hoisting events to detect diurnal changes in the water column. Between July 30 and August 1, we were able to return to our successful mode of heat flow surveys during the night and ROV dives followed by a gravity coring station during the day. The ROV dive on August 1 was dedicated to scout out a site for MeBo drilling on a knoll in the center of the pond. The summit area of the pond is extremely flat and fully sediment covered. The flanks of the knoll are also fully covered by sediments. The knoll does not represent a discharge sites, as indicated by very low heat flow density established during a heat flow deployment immediately after the dive has ended. Poor sea state on August 2 and 3 prevented the use of the ROV during the day, and two deep-tow

CTD deployments were conducted during those days, first along a NE-SW transect, and a shorter one on the second day along an E-W transect. A few hours of low wind speeds in the morning hours of August 3 were used to retrieve the AIMS[3]-Lander, which was acoustically released at 6 a.m. and safely on board 90 minutes later. Later on August 3, two gravity cores were taken from locations of high heat flow close to and on the ridge bounding the pond to the NW. During the last of our 18 working days, the 4th of August, we dove with the ROV in a location near the base of the NW-bounding ridge and looked for flat and sediment-covered areas for another MeBo drill site there. After a short dive, the ROV was hoisted on deck and the transit to St. John's began at 16:00 on August 4. The transit to St. John's went well and we arrived on time to dock the ship and unload our gear in the morning hours of August 9.



Bathymetric map of Squid Pond acquired with the Multibeam echosounder EM122.

Acknowledgements

We thank Captain Rainer Hammacher and the entire crew for superb support of all science operations throughout the entire expedition. We thank the German Research Fleet Coordination Centre for varied advice and organizational support. Funding was provided by the German Research Foundation (DFG,) under Germany´s Excellence Strategy – EXC-2077 – 390741603.

Participant List

	Name	Discipline	Institution
1.	Bach, Wolfgang, Prof. Dr.	Geology / Chief Scientist	UHB
2.	Kaul, Norbert, Dr.	Heat Flow / Deputy Chief Scientist	UHB
3.	Albers, Aike	Hydroacoustics	UHB
4.	Berndt, Paul	Hydroacoustics	UHB
5.	Engelen, Bert, PD Dr.	Microbiology	ICBM
6.	Esposito, Mario, Dr.	Oceanography	GEOMAR
7.	Henn, Ramona	Geology	UHB
8.	Klar, Steffen	ROV	UHB
9.	Kremin, Isabel	Hydroacoustics	UHB
10.	Lange, Isabel	Geology	UHB
11.	Moutard, Kim	Geochemistry	GEOMAR
12.	Nadolsky, Christina	Geochemistry	UHB
13.	Nowald, Nicolas, Dr.	ROV	UHB
14.	Raeke, Andreas	Weather technician	DWD
15.	Röhler, Aaron	Geology	UHB
16.	Schewe, Felix	Core technician	UHB
17.	Schillai, Sophia, Dr.	ROV	UHB
18.	Schmidt, Christopher, Dr.	Geochemistry	GEOMAR
19.	Seeliger, Julian	Heat Flow	UHB
20.	Vittori, Vincent	ROV	UHB
21.	Volz, Jessica, Dr.	Geochemistry	AWI
22.	Warnken, Niklas	Heat Flow	UHB

Participating Institutions

UHB	University of Bremen
GEOMAR	Helmholtz-Zentrum für Ozeanforschung, Kiel
AWI	Alfred-Wegener-Institut für Polarforschung, Bremerhaven
ICBM	Institut für Chemie und Biologie des Meeres, Universität Oldenburg
DWD	Deutscher Wetterdienst, Geschäftsfeld Seeschifffahrt

Station List

Station No.		Date	Gear	Time	Latitude	Longitude	Water Depth	Remarks
METEOR	MARUM	2022		[UTC]	[°N]	[°W]	[m]	
M183_1-1	25101	15.07	ROV	16:07	47° 20,704'	028° 28,991'	2760	Test
M183_2-1	25102	16.07	GC	11:55	50° 23,961'	029° 22,050'	4129	Test
M183_3-1	25103	18.07	PS/EM	09:57	58° 03,069'	031° 27,441'	1639	Start
M183_3-1	25103	19.07	PS/EM	06:28	58° 11,359'	031° 22,245'	1936	End
M183_4-1	25104	19.07	CTD	08:12	58° 07,359'	031° 12,900'	2171	Single dip
M183_5-1	25105	19.07	HF	11:21	58° 11,416'	031° 22,403'	1938	Start
M183_5-1	25105	19.07	HF	18:33	58° 12,802'	031° 25,265'	1907	End
M183_6-1	25106	19.07	GC	20:47	58° 12,070'	031° 23,758'	1914	
M183_7-1	25107	19.07	PS/EM	23:27	58° 10,150'	031° 01,404'	1577	Start
M183_7-1	25107	20.07	PS/EM	06:25	58° 22,640'	031° 13,276'	1418	End
M183_8-1	25108	20.07	ROV	15:54	58° 11,774'	031° 23,202'	1910	ECHOES
M183_9-1	25109	20.07	GC	17:19	58° 11,923'	031° 23,452'	1896	
M183_10-1	25110	20.07	HF	20:36	58° 14,685'	031° 00,117'	1775	Start
M183_10-1	25110	21.07	HF	08:15	58° 17,974'	031° 05,581'	1498	End
M183_11-1	25111	21.07	ROV	14:30	58° 16,381'	031° 02,902'	1840	ECHOES
M183_12-1	25112	21.07	GC	19:41	58° 17,334'	031° 04,498'	1478	
M183_13-1	25113	22.07	PS/EM	03:13	57° 33,695'	032° 07,601'	1518	Start
M183_13-1	25113	22.07	PS/EM	13:34	57° 28,287'	032° 14,743'	1683	End
M183_14-1	25114	22.07	Lander	15:18	57° 31,425'	032° 16,220'	1846	Deployment
M183_15-1	25115	22.07	CTD	16:47	57° 31,425'	032° 16,219'	1846	Single dip
M183_16-1	25116	22.07	GC	18:50	57° 34,437'	032° 14,794'	1575	
M183_17-1	25117	22.07	HF	21:20	57° 35,021'	032° 15,466'	1710	Start
M183_17-1	25117	23.07	HF	08:14	57° 32,002'	032° 11,782'	1812	End
M183_18-1	25118	23.07	PS/EM	09:40	57° 32,792'	032° 10,244'	1678	Start
M183_18-1	25118	23.07	PS/EM	16:04	57° 32,832'	032° 10,223'	1739	End
M183_19-1	25119	23.07	GC	17:16	57° 32,862'	032° 10,215'	1862	
M183_20-1	25120	23.07	HF	19:24	57° 33,587'	032° 09,968'	1862	Start
M183_20-1	25120	24.07	HF	05:57	57° 36,518'	032° 13,131'	1470	End
M183_21-1	25121	24.07	ROV	11:36	57° 34,686'	032° 15,038'	1595	Sampling
M183_22-1	25122	24.07	GC	19:12	57° 34,400'	032° 15,155'	1574	
M183_23-1	25123	24.07	HF	20:56	57° 33,712'	032° 17,588'	1544	Start
M183_23-1	25123	25.07	HF	06:57	57° 30,544'	032° 12,656'	1632	End
M183_24-1	25124	25.07	ROV	10:48	57° 30,100'	032° 13,219'	1600	Sampling
M183_25-1	25125	25.07	GC	19:23	57° 34,460'	032° 14,819'	1566	
M183_26-1	25126	25.07	HF	21:39	57° 33,687'	032° 14,581'	1640	Start
M183_26-1	25126	26.07	HF	06:55	57° 29,396'	032° 16,076'	1881	End
M183_27-1	25127	26.07	ROV	11:03	57° 32,535'	032° 16,419'	1570	Sampling
M183_28-1	25128	26.07	GC	19:14	57° 34,692'	032° 15,018'	1600	
M183_29-1	25129	26.07	HF	21:20	57° 33,644'	032° 15,650'	1642	Start
M183_29-1	25129	27.07	HF	07:10	57° 31,620'	032° 11,583'	1732	End
M183_30-1	25130	27.07	ROV	11:03	57° 33,493'	032° 15,625'	1595	Sampling
M183_31-1	25131	27.07	PS/EM	19:12	57° 32,071'	032° 13,887'	1811	Start
M183_31-1	25131	28.07	PS/EM	15:27	57° 29,884'	032° 19,320'	1519	End
M183_32-1	25132	28.07	CTD	16:47	57° 31,439'	032° 16,220'	1842	Single dip
M183_33-1	25133	28.07	GC	18:27	57° 32,895'	032° 16,803'	1493	
M183_34-1	25134	28.07	HF	20:31	57° 33,138'	032° 15,022'	1747	Start
M183_34-1	25134	29.07	HF	07:08	57° 31,073'	032° 13,203'	1838	End
M183_35-1	25135	29.07	CTD	08:43	57° 32,690'	032° 13,561'	1774	Start yoyo
M183_36-1	25136	30.07	ROV	12:17	57° 34,373'	032° 15,179'	1600	Sampling
M183_37-1	25137	30.07	GC	19:39	57° 32,866'	032° 16,779'	1489	
M183_38-1	25138	30.07	HF	21:35	57° 33,516'	032° 16,405'	1734	Start
M183_38-1	25138	31.07	HF	07:10	57° 35,146'	032° 12,926'	1634	End

Station No.		Date	Gear	Time	Latitude	Longitude	Water Depth	Remarks
METEOR	MARUM	2022		[UTC]	[°N]	[°W]	[m]	
M183_39-1	25139	31.07	ROV	10:48	57° 32,942'	032° 16,851'	1500	Sampling
M183_40-1	25140	31.07	GC	19:27	57° 30,503'	032° 12,551'	1629	
M183_41-1	25141	31.07	HF	21:58	57° 35,031'	032° 13,559'	1689	Start
M183_41-1	25141	01.08	HF	06:49	57° 30,855'	032° 09,462'	1631	End
M183_42-1	25142	01.08	ROV	12:01	57° 31,792'	032° 14,811'	1745	Sampling
M183_43-1	25143	01.08	GC	16:44	57° 31,777'	032° 14,816'	1750	
M183_44-1	25144	01.08	HF	18:45	57° 31,775'	032° 14,816'	1753	Start
M183_44-1	25144	02.08	HF	07:43	57° 31,728'	032° 12,006'	1828	End
M183_45-1	25145	02.08	CTD	10:01	57° 33,951'	032° 10,313'	1856	Start deep tow
M183_45-1	25145	02.08	CTD	18:02	57° 30,838'	032° 16,042'	1847	End deep tow
M183_46-1	25146	02.08	GC	20:15	57° 31,151'	032° 13,637'	1843	
M183_47-1	25147	02.08	HF	22:54	57° 33,229'	032° 14,182'	1745	Start
M183_47-1	25147	03.08	HF	05:56	57° 30,603'	032° 14,769'	1809	End
M183_48-1	25148	03.08	Lander	07:35	57° 31,180'	032° 16,428'	1868	Recovery
M183_49-1	25149	03.08	CTD	10:40	57° 32,643'	032° 10,840'	1859	Start deep tow
M183_49-1	25149	03.08	CTD	16:22	57° 32,658'	032° 15,367'	1770	End deep tow
M183_50-1	25150	03.08	GC	18:00	57° 33,205'	032° 15,140'	1725	
M183_51-1	25151	03.08	GC	19:57	57° 32,888'	032° 16,779'	1500	
M183_52-1	25152	03.08	HF	22:32	57° 31,109'	032° 15,345'	1843	Start
M183_52-1	25152	04.08	HF	03:52	57° 30,214'	032° 16,137'	1840	End
M183_53-1	25153	04.08	ROV	13:39	57° 33,441'	032° 15,395'	1696	Sampling