Prof. Dr. Heiko Pälike
MARUM / Universität Bremen
Leobener Strasse 8
28359 Bremen
Germany

Tel.: +49-421-218-65980
Fax: +49-421-218-9865980
email: hpaelike@marum.de

Short Cruise Report
RV MARIA S MERIAN cruise MSM116

Montevideo (Uruguay) – Recife (Brasil)
03.04.2023 – 07.05.2023
Chief Scientist: Heiko Pälike
Captain: Ralf Schmidt

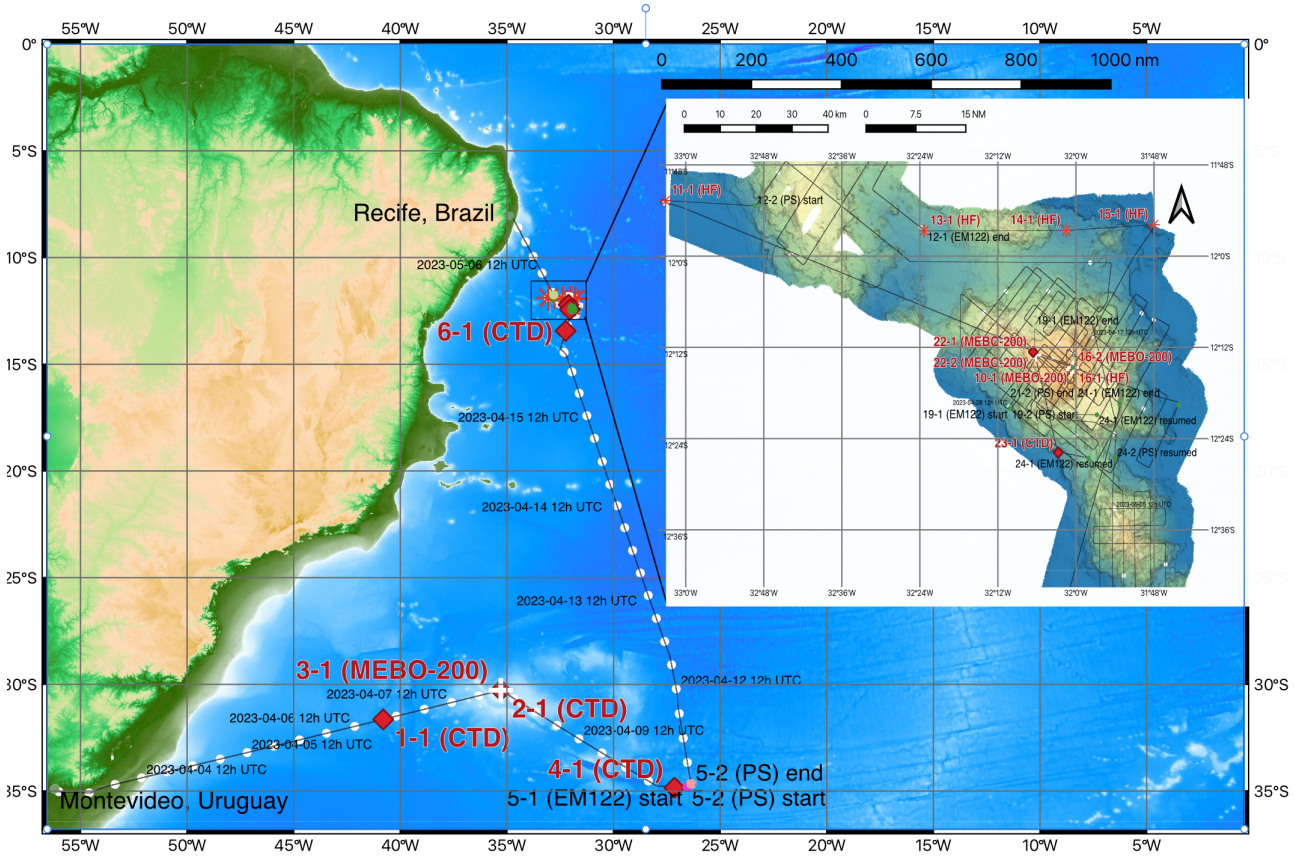

Fig. 1: Cruise track with stations of RV MARIA S. MERIAN cruise MSM116 from Montevideo to Recife.

Objectives

Over recent decades, tremendous advances have been made, primarily through scientific ocean drilling and coring, to extend our knowledge of past climatic conditions and states from the Holocene and Pleistocene back into the Paleogene and even older geological times. These advances, primarily created from spliced and patched individual records, showed that there have been strong changes in deep water temperatures throughout the Cenozoic, generally showing a cooling trend over time, with a total amplitude of about 12-15°C from the earliest Eocene through to the present, with a generally matching corresponding evolution of greenhouse gas concentrations. Yet, many of these datasets and compilations are obtained from relatively deep paleo-water depths, compromising our ability to obtain well-preserved calcareous microfossils, as some have been either diagenetically altered, or partially dissolved.

The primary objective of MSM116 was to obtain sequences of very well-preserved deposits of calcareous microfossils from relatively shallow water depths (in reach of the MeBo200 coring device) and paleo-water depths (thus with potentially good preservation), and therefore allow the study of surface and bottom water temperatures, $\delta^{18}O$-seawater, and related paleoceanographic parameters to establish climatic boundary conditions during past “warmer worlds”. The planned program consisted of coring two stations on the Rio Grande Rise (DSDP Site 72-516), each triple-cored to obtain an as complete as possible sedimentary sequence from Pliocene through at least Miocene, but possibly older, strata.

Overall, the material would serve to establish a Paleogene MeBo200 core sequence with excellent microfossil preservation and high $CaCO_3$ content, to preserve sections that could not be recovered at DSDP Site 516, and to sample enough material to allow pairwise application of traditional (e.g., Mg/Ca, alkenone) and novel (e.g., clumped isotopes) proxies to answer unresolved questions about the evolution of ocean temperatures, past CO_2 concentrations, and Earth System Sensitivity. The quality of previous rotary cores at DSDP Site 516 has been variable and incomplete. In addition, the remaining rotary-crilled and only partially recovered sediments do not provide complete archives nor the necessary resolution for state-of-the-art paleoproxy analysis. Future proxy reconstructions applied to these sediments include paleo-productivity, changes in faunal composition, and carbonate accumulation rates for the Pliocene, extended Miocene and possibly Oligocene horizons.

The ancillary aim of the cruise, which we intend to follow to avoid idle time during MeBo200 maintenance between deployments, or due to unfavorable weather conditions, was to obtain temperature gradient profile measurements using a short (3.6m) lance with attached temperature loggers to obtain *in-situ* formation temperatures, and together with measured thermal conductivity measurements, allow for calculating heat-flow fluxes in the working area. An additional objective was to conduct detailed multibeam mapping and subbottom parametric profiling to enhance our understanding of the cored sediments, and the general working area. Several CTD/Rosette measurements were planned to characterize the oceanographic conditions and properties of the water masses bathing the relatively shallow drilling sites, and therefore establish to what extent paleoceanographic proxies to be measured from the sediment cores can be used to establish past changes in, e.g. Antarctic Intermediate Water, North-Atlantic Deep Water, and potentially surface currents.

Narrative

Despite nation-wide strikes in the transport sector of Germany all scientists and the MeBo Team reached Montevideo in time. As soon as the ship arrived from the previous cruise MSM115, mobilization started for MSM116, particularly moving the eight MeBo200 containers and the cooling container (reefer) onto the ship that were helpfully already alongside the ship. After a successful harbor test of MeBo200 just after 10am local time (UTC-3h), we were able to leave the port of Montevideo, Uruguay, on 3.4.2023 just before 2pm local time. The stormier conditions of the previous day had calmed down so that we could enjoy a beautiful journey out of the port and into the South Atlantic Ocean. In the afternoon we conducted the obligatory safety drill. For the first five days of being on ship, we observed existing COVID-19 measures (daily antigen tests). As soon as we left territorial waters, we started collecting routine weather, seawater property and ADCP underway data serving our primary research. On April 6th, in international waters, we started our first official MSM116 station, a CTD/Rosette water sampler to investigate the Antarctic Intermediate Water which was supposed to bath our initial working area in the South Atlantic, as well as serving to re-calibrate our hydroacoustic sound velocity profile, which was already markedly different to those used further south during MSM115. Water samples were collected for future analysis of oxygen isotopes. We used our ~4.5 day transit to our working area to give science talks to both scientists and crew, and to plan the deployment options and configuration of MeBo200.

On the morning of the 8th April we experienced benign swell and wind conditions and were near DSDP Site 516 (30º16.59'S, 035º 17.10'W) and took another CTD/Rosette cast at 7am bord time, while onboard standard checks were conducted by the MeBo Team. We had already observed a Navy Ship several nautical miles in the distance. After we put MeBo200 into the water around 8:25 am and lowered it to 100m for a system test, the Navy ship contacted the Merian, and required all scientific activities in the seabed or subsoil to be terminated. We stopped the MeBo deployment, and it was back on deck at just before 10am. Thereafter, we went on a south-easterly course to leave the area. We left the area on the 10th April very early in the morning, and after notifying the Navy ship that had trailed us until here, resumed hydroacoustic mapping to begin scouting for potential new working areas, and casting a CTD/Rosette sampler. It turned out to be very useful to have taken the offline multi resolution GMRT bathymetric database with us, as we were now searching for working areas in water depths < 2000m to be accessible by MeBo200, with a slope of less than 6 degrees, benign swell conditions, and with potential sediment cover to reach our objectives.

At first, we investigated a series of seamounts by multibeam mapping and Parasound profiling around 34º 37.5'S, 026º 16.68'W that had previously been visited and dredged by the *Nathaniel B Palmer* cruise NBP1808. We spent around 20h mapping the most promising seamount, but in the end could not find any suitable sediment cover. Due to the easter weekend (7.-10. April), we could only receive information on some of the results from that cruise after our mapping, which confirmed our suspicion of only very little sediment cover due to a presumably geological young age of this seamount. We briefly considered investigating another seamount chain at about 38ºS, but decided that weather conditions were unlikely to be stable enough to allow any useful deployment there (an assessment that later turned out to be correct). Thus, we decided to use our transit time towards Recife to look for other options. Our research had revealed a set of accessible seamounts (the Bahia / Stocks seamounts), approximately 300 nm from our planned destination port. We thus set sail north just after 9am bord time on April 11th to commence a 1250 nm, ~ 5 day transit north towards the Bahia / Stocks Seamount chain, and turned off underway recording while passing through the EEZ around the Islas de Martin Vaz.

On April 16th, just before 2am bord time, we slowed down to 6 kn to collect underway data over the first promising seamount (at around 14º 27.46'S, 032º 17.88'W). This

seamount was at around 1000 m water depth, with an apparent soft sediment cover of around 30-40 m, as indicated by the Parasound profile. This was a first promising sign that our search for sediments, even as of yet unknown age or character, might be successful. Meanwhile we had researched existing literature about these seamounts chains, and first indications were that this particular had probably formed in the later Eocene. After casting another CTD/Rosette sampler as Station 6-1, at about 8pm board time on the same day we finally started our first profile that crossed the Stocks Seamount from south-east towards north-west. The Seamount appeared to have a relatively shallower plateau (around 1600m water depth), and we were able to identify our first MeBo200 drill site satisfying our technical constraints, as well as showing several packages of parallel laminated Parasound reflectors down to an apparent depth >100m. We optimized this site location to have the largest possible sediment cover.

We thus prepared for our first MeBo200 deployment to the seafloor, which became Station GeoB25308-1 at 12º14.945'S, 032º00.696'W, and on April 17th in the evening we were able to observe the first white drill cuttings on the rig floor, suggesting perhaps carbonate containing sediment. By 7am on April 18th, after many attempts, the MeBo200 has now drilled to a depth of 24m, with relatively easy penetration on the one hand, but a reduction in rotation speed in the lower layers, and difficulties in fishing out the core tubes below 24m. We now deployed a full-core drilling unit, which, without taking cores, should deepen the borehole further to overcome drilling difficulties that arose from apparently poorly consolidated and in layers, coarse sand grade material. However, from about 35m downwards, more and more flushing pressure was needed to continue drilling, until finally the necessary pressure became too high at about 49m borehole depth. Therefore, we decide to stop this deployment for the time being, and without borehole logging, in order to find out something about the nature of the sediments, which requires bringing the MeBo back on deck.

During the recovery of MeBo200 on deck, extracting core barrels, and preparing the rig for the next operation, we conducted further multibeam and Parasound profiling across the Stocks Seamount Plateau, in order to optimize our drill sites and to learn more about the fascinating geology here. The sediments recovered consisted of almost pure foraminiferal sands with nannofossils and smaller fractions of foraminiferal ooze with nannofossils. Thus, on the one hand we had achieved our major aim of recovering well preserved carbonate rich sediments, while on the other hand these same pure foraminiferal sands proved to be a challenge of recovery, not just for MeBo200, but probably most drilling operations that cannot deploy a casing. The nannofossil based biostratigraphy for the top 24 m sediment recovered showed a normal age succession from the Pleistocene in Core 2 (around 1.7Ma) through the Pliocene from Core 5 (~ 3.2Ma), with an oldest recovered age of ~<5 Ma in Core 7. In order to avoid the more troublesome unconsolidated foraminiferal sands at the top of the section and to more fully characterize the sediment package, we re-located the next MeBo200 deployment about 750m along the elevated ridge towards the north-east as Station GeoB25310-1 (12º 14.620'S, 032º 00.459'W). Our new plan was to first drill, without coring, to maximum depth, conduct a logging run, offset MeBo a few tens of meters without bringing it back on deck, and then start coring after flushing down through the top surface layer. By April 21st, ~7am bord time, we had washed down to 90m, and reached our initial target depth of 105.4m at just before 9am. While pulling up the drill string one by one we conducted a logging run with the SGR, CTD and magnetic susceptibility tools. At the end of logging run, just after stowing away the logging tool, unfortunately the wire core catcher broke, forcing us to postpone the activities planned for a second coring run at this deployment, and ending this deployment without coring. Before returning to this location for another try we conducted a set of five thermal gradient measurements to the north and north-west of the seamount, as well as on our coring location itself, using a 3.6m long lance with attached miniature temperature loggers (MTLs). Meanwhile MeBo200 was being

retrieved, maintained, and prepared for the next deployment. MeBo200 deployment for Site 16-2 (12º 14.629'S, 032º 00.430'W) was started on April 23th in the evening. This deployment reached down to 32.8m, but then the full-core drill became stuck. Offsetting MeBo by ca. 15m to the south-east, we started coring attempt GeoB25316-3 where the plan was to wash down to 40m, again to avoid sand grade material, and then core. At this second attempt we lost circulation at 45.8m, and had to abandon this deployment. From 16-2 two cores were retrieved from around 32m depth below seafloor, with indicative ages from the Miocene (13.5-15.5Ma), indicating that we were luckily starting to reach more of our initial science aims of recovering sediments from past warmer geological periods.

In order to further minimize the Pleistocene top cover, after more survey work, we decided to attempt our next MeBo200 deployment on the north-western side of the seamount plateau ca. 10km away from our first attempts. MeBo200 Station GeoB25318-1 (12º 13.005'S, 032º 06.174'W) was started on April 25th in the evening and at a slightly deeper water depth of 1772m. Here the sediment cover was a little thinner overall, and also again with a thinner top apparent top layer. This site was able, despite intermittent coring problems, to reach first a somewhat harder but thin layer in the middle of the succession, before encountering a hard layer at the target depth or around 75m. At this site we also completed a logging run, this time with the standard tools plus a sonic velocity tool. The biostratigraphy from this core reveals a mixed Pliocene succession in the uppermost section, followed by a poorly recovered interval, but then an interval of Late and Middle Eocene sediments with apparently very good nannofossil preservation. The oldest sediment recovered here is of Late Paleocene age (57 Ma). While at this stage the Oligocene was still missing, by now we had actually exceeded our original objectives in terms of reaching back into past periods with warmer climates, despite with still less core recovery than we had perhaps hoped for. The next MeBo deployment nearby (GeoB25320-1 at 12º 12.988'S, 032º 06.162'W) was after more mapping deployed on 29th April in the morning. This site recovered a complementary set of cores with similar ages as Site 18-1, but this time also drilled almost 1m into the underlying basalt (which literature suggested to be around 59 My old), and recovered Pliocene, Miocene, Late, Middle and Early Eocene sediments.

Our final MeBo Station (Site GeoB 25322-1 at 12º 12.625'S, 032º 06.691'W) was offset about 1km to the north-east, as our Parasound mapping had revealed a sediment package not yet retrieved, at intermediate depth levels. This site, deployed on May 2nd in the morning, washed through the top 35m, cored to depth, and after offsetting by 20m and attempting to core the coarser top interval jammed the core barrel after retrieving the first core, thus terminating Site 22-2. Again, the biostratigraphic work indicates that we recovered a similar but complimentary sequence to GeoB253-18-1, 20-1, and the enigmatic sediment package we aimed for turned out to be of Oligocene age, thus revealing an age succession from the Pleistocene, Pliocene, Miocene, Oligocene, Eocene and Paleocene, where the deepest sediment recovered at Site 22-1 appears to be very close above the Paleocene/Eocene boundary (PETM). The final MeBo deployment ended on May 4th in the morning. By now we had used up our available drilling time, and after casting two final CTD/Rosette cast on and off the plateau, and after extending our mapping effort and filling final gaps we finally ended science operations on May 6th at around 2am, and began steaming for our port call in Recife, which was reached on May 7th, 8am, completing MSM116.

Acknowledgements

We thank Captain Schmidt and the entire crew of RV MARIA S MERIAN for their excellent support during the cruise. The professional working environment and supportive atmosphere on the MERIAN are greatly appreciated. The expedition took place as part of the research program of the Cluster of Excellence "The Ocean Floor—Earth's Uncharted Interface" (EXC-2077) funded by the Germany's Excellence Strategy through the Deutsche Forschungsgemeinschaft (DFG). Additional funding is acknowledged from the "Freunde und Förderer der Goethe-Universität Frankfurt".

Participants List

1.	Heiko Pälike	Chief Scientist	MARUM
2.	Torsten Bickert	Co-Chief, CTD, HF, Sedimentology	MARUM
3.	Ursula Röhl	Sedimentology	MARUM
4.	Jens Herrle	Sedimentology + Biostratigraphy	Goethe-Uni Frankfurt
5.	Heather Johnstone	Sedimentology	MARUM
6.	Heather Jones	Biostratigraphy	MARUM
7.	Paul Berndt	Hydroacoustics	MARUM
8.	Jakob Quabeck	Sediment Sampling, Hydroacoustics	MARUM
9.	Rodrigo Nascimento	Sediment Sampling, Hydroacoustics	UFF
10.	Marcus Lerman	Sediment Sampling, Hydroacoustics	USP
11.	Christian Hilgenfeldt	Core Logging (MSCL)	MARUM
12.	Yang Zhang	Core Logging (MSCL), Thermal Cond.	MARUM
13.	Birgit Meyer-Shack	Lab Lead, Sediment Sampling	MARUM
14.	Erik Linowski	MeBo Team Leader	MARUM
15.	Siefke Fröhlich	MeBo Team	MARUM
16.	Ralf Düßmann	MeBo Team	MARUM
17.	Werner Schmidt	MeBo Team	MARUM
18.	Hoang Mai	MeBo Team	MARUM
19.	Frauke Ahrlich	MeBo Team	MARUM
20.	Ousmane Coulibaly	MeBo Team	MARUM
21.	Pooja Moore	MeBo Team	MARUM
22.	Johannes Wiener	MeBo Team	MARUM/Bauer

Institutes

MARUM Center for Marine Environmental Sciences
Universität Bremen
Leobener Straße 8
28359 Bremen, Germany

Goethe-University Frankfurt
Department of Geosciences
Altenhöferallee 1
60438 Frankfurt am Main, Germany

University of São Paulo (USP)
Paleoceanography and Paleoclimatology Laboratory
School of Arts, Sciences and Humanities
Rua Arlindo Bettio, 1000
CEP03828-000 São Paulo SP, Brazil

Universidade Federal Fluminense (UFF)
Geoscience (Geochemistry) Graduate Program
(Environmental Geochemistry)
Outeiro São João Baptista s/n – Centro
Niterói, RJ - Brazil

Station List

Device key: CTD = shipboard CTD with rosette water sampler, MEBO200 = MARUM Seafloor drilling rig MeBo200, EM122 = deep sea multibeam echosounder, HF = HeatFlow Temperature Gradient Lance, PS = Parasound. For all devices, the position and time of deployment from ship is recorded (time in the water / profile start). Bord Time = UTC-3

Station	GeoB No.	Date and Time [UTC]	Latitude	Longitude	Depth [m]	Device	Comment
MSM116_1-1	GeoB25301-1	2023-04-06 18:01:47	31° 38.548' S	040° 48.109' W	3817	CTD	
MSM116_2-1	GeoB25302-1	2023-04-08 10:04:53	30° 16.597' S	035° 17.119' W	1320	CTD	
MSM116_3-1	GeoB25303-1	2023-04-08 11:25:13	30° 16.620' S	035° 17.106' W	1320	MEBO-200	no deployment to seafloor
MSM116_4-1	GeoB25304-1	2023-04-10 12:04:10	34° 50.707' S	027° 08.364' W	4575	CTD	
MSM116_5-2	–	2023-04-10 17:46:44	34° 48.114' S	026° 32.902' W	3037	PS	recording start
MSM116_5-1	–	2023-04-10 17:46:44	34° 48.114' S	026° 32.902' W	3037	EM122	profile start
MSM116_5-2	–	2023-04-11 12:24:11	34° 40.007' S	026° 22.131' W	1944	PS	recording end
MSM116_5-1	–	2023-04-11 12:24:11	34° 40.007' S	026° 22.131' W	1944	EM122	profile end
MSM116_6-1	GeoB25306-1	2023-04-16 13:13:54	13° 26.016' S	032° 14.638' W	4829	CTD	
MSM116_7-1	–	2023-04-16 22:58:39	12° 19.431' S	031° 53.252' W	2877	EM122	profile start
MSM116_7-1	–	2023-04-17 15:23:35	12° 14.858' S	032° 00.729' W	1596	EM122	profile end
MSM116_7-2	–	2023-04-16 22:59:00	12° 19.410' S	031° 53.282' W	2846	PS	recording start
MSM116_7-2	–	2023-04-17 15:23:35	12° 14.858' S	032° 00.729' W	1596	PS	recording end
MSM116_8-1	GeoB25308-1	2023-04-17 15:56:15	12° 14.952' S	032° 00.700' W	1598	MEBO-200	
MSM116_9-1	–	2023-04-19 13:08:42	12° 14.870' S	032° 00.677' W	1596	EM122	profile start
MSM116_9-1	–	2023-04-20 13:49:56	12° 13.552' S	032° 00.490' W	1662	EM122	profile end
MSM116_9-2	–	2023-04-19 13:08:43	12° 14.869' S	032° 00.677' W	1596	PS	recording start
MSM116_9-2	–	2023-04-20 13:49:57	12° 13.550' S	032° 00.490' W	1662	PS	recording end
MSM116_10-1	GeoB25310-1	2023-04-20 16:00:31	12° 14.620' S	032° 00.459' W	1609	MEBO-200	
MSM116_11-1	GeoB25311-1	2023-04-22 12:32:21	11° 52.692' S	033° 03.095' W	4604	HF	
MSM116_12-1	–	2023-04-22 17:03:50	11° 53.369' S	032° 49.380' W	4099	EM122	profile start
MSM116_12-2	–	2023-04-22 17:03:50	11° 53.369' S	032° 49.382' W	4099	PS	recording start
MSM116_12-2	–	2023-04-23 06:08:52	11° 56.708' S	032° 23.141' W	4039	PS	recording end
MSM116_12-1	–	2023-04-23 06:08:52	11° 56.708' S	032° 23.141' W	4039	EM122	profile end
MSM116_13-1	GeoB25313-1	2023-04-23 06:20:37	11° 56.677' S	032° 23.324' W	4041	HF	
MSM116_14-1	GeoB25314-1	2023-04-23 11:13:22	11° 56.616' S	032° 01.475' W	4260	HF	
MSM116_15-1	GeoB25315-1	2023-04-23 15:13:24	11° 55.862' S	031° 47.974' W	5080	HF	
MSM116_16-1	GeoB25316-1	2023-04-23 20:35:26	12° 14.620' S	032° 00.453' W	1610	HF	
MSM116_16-2	GeoB25316-2	2023-04-23 22:16:27	12° 14.629' S	032° 00.430' W	1608	MEBO-200	
MSM116_16-3	GeoB25316-3	2023-04-24 18:22:41	12° 14.633' S	032° 00.425' W	1608	MEBO-200	station start after small offset
MSM116_17-1	–	2023-04-25 12:52:42	12° 14.643' S	032° 00.461' W	1605	EM122	profile start
MSM116_17-1	–	2023-04-25 22:03:10	12° 13.051' S	032° 06.242' W	2135	EM122	profile end
MSM116_17-2	–	2023-04-25 12:53:00	12° 14.644' S	032° 00.477' W	1604	PS	recording start
MSM116_17-2	–	2023-04-25 22:03:31	12° 13.076' S	032° 06.264' W	1778	PS	recording end
MSM116_18-1	GeoB25318-1	2023-04-25 22:22:20	12° 13.005' S	032° 06.174' W	1772	MEBO-200	
MSM116_19-1	–	2023-04-28 12:02:27	12° 20.037' S	032° 10.182' W	3931	EM122	profile start
MSM116_19-1	–	2023-04-29 10:23:30	12° 09.230' S	032° 06.355' W	2436	EM122	profile end
MSM116_19-2	–	2023-04-28 12:02:41	12° 20.054' S	032° 10.167' W	3934	PS	recording start
MSM116_19-2	–	2023-04-29 10:23:45	12° 09.261' S	032° 06.353' W	2462	PS	recording end
MSM116_20-1	GeoB25320-1	2023-04-29 11:04:48	12° 12.988' S	032° 06.162' W	1771	MEBO-200	
MSM116_21-1	–	2023-05-01 13:36:47	12° 19.564' S	031° 44.230' W	4868	EM122	profile start
MSM116_21-1	–	2023-05-02 09:19:18	12° 18.758' S	032° 00.003' W	2001	EM122	profile end
MSM116_21-2	–	2023-05-01 13:37:02	12° 19.588' S	031° 44.243' W	4880	PS	recording start
MSM116_21-2	–	2023-05-02 09:19:25	12° 18.767' S	032° 00.010' W	1980	PS	recording end
MSM116_22-1	GeoB25322-1	2023-05-02 10:58:43	12° 12.625' S	032° 06.691' W	1747	MEBO-200	
MSM116_22-2	GeoB25322-2	2023-05-04 01:32:33	12° 12.631' S	032° 06.689' W	1748	MEBO-200	station start after small offset
MSM116_22-3	GeoB25322-3	2023-05-04 13:22:51	12° 12.603' S	032° 06.576' W	1753	CTD	
MSM116_23-1	GeoB25323-1	2023-05-04 17:54:42	12° 25.841' S	032° 02.717' W	4198	CTD	
MSM116_24-1	–	2023-05-04 21:01:53	12° 26.579' S	031° 58.070' W	3674	EM122	profile start
MSM116_24-2	–	2023-05-04 21:01:58	12° 26.583' S	031° 58.065' W	3674	PS	recording start
MSM116_24-1	–	2023-05-05 17:01:00	12° 26.565' S	031° 54.014' W	4141	EM122	profile interrupted
MSM116_24-2	–	2023-05-05 17:01:00	12° 26.565' S	031° 54.014' W	4141	PS	recording paused
MSM116_24-1	–	2023-05-05 17:31:05	12° 26.565' S	031° 54.012' W	4142	EM122	recording resumed
MSM116_24-2	–	2023-05-05 17:31:05	12° 26.565' S	031° 54.012' W	4241	PS	recording resumed
MSM116_24-1	–	2023-05-05 19:41:21	12° 20.870' S	031° 56.771' W	2259	EM122	profile resumed
MSM116_24-2	–	2023-05-05 19:41:21	12° 20.871' S	031° 56.759' W	2261	PS	profile resumed
MSM116_24-1	–	2023-05-06 05:14:00	11° 45.147' S	032° 47.972' W	3643	EM122	profile end
MSM116_24-2	–	2023-05-06 05:14:00	11° 45.147' S	032° 47.972' W	3643	PS	recording end