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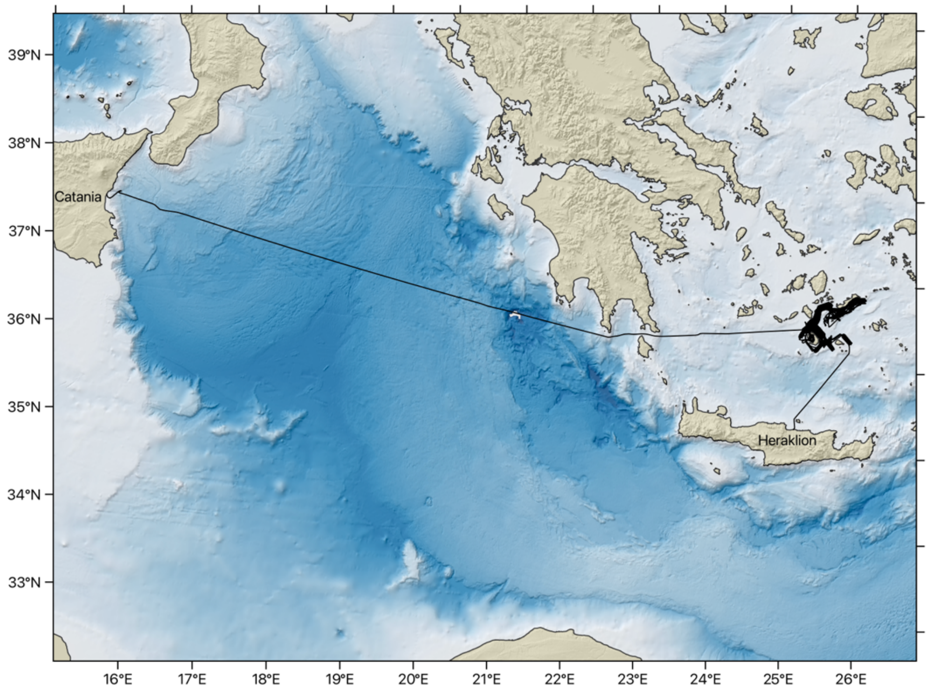
Short Cruise Report
Maria S. Merian MSM132

Catania - Heraklion
3.12.2024 – 2.1.2025
Chief Scientist: Prof. Dr. Christian Berndt
Captain: Björn Maaß



Objectives

Expedition MSM132 is the first of three cruises of the collaborative project MULTI-MAREX under the umbrella of the German Alliance of Marine Research D.A.M.'s mission mareXtreme. The aim of the project is to develop new monitoring technology towards an early warning system for natural hazards in the Aegean Sea. In the past this region has experienced the most explosive volcanic eruptions that occurred in Europe in historical times, such as the Minoan eruption in 1600 BCE and the 1650 AD eruption of Kolumbo. It is also the most seismogenic region in Europe including the 1956 magnitude 7.7 earthquake of Amorgos. Both volcanic eruptions and earthquakes have caused tsunami waves in the past. MSM132 was supposed to set the scene by acquiring geophysical and video data to fill crucial gaps in the current understanding of the region and to provide a baseline for assessing geological change during the duration of the eight year-long D.A.M. mission.

The specific objectives of the expedition were to survey the Kolumbo volcano east of Santorini to investigate to what extent hydrothermal activity is altering the volcanic edifice and how this would affect its stability. Secondly, we investigated how the tectonic activity in the Santorini Amorgos Tectonic Zone influences the volcanism and vice versa. Particular attention was paid to the nature of the seismogenic Amorgos fault and the Kolumbo fault that dissects the edifice of Santorini. For this it was crucial to tie the existing seismic data to the recently drilled boreholes of IODP expedition 398. The third objective was to determine a suitable target along the Amorgos fault for a geodesy deployment during the third MULTI-MAREX cruise which is scheduled for December 2025. The fourth objective was to test two new pieces of scientific infrastructure: the MOLA landers and the MOMO video system. Finally, we attempted to retrieve two geodesy stations that were lost off Mount Etna in Sicily during a previous campaign.

Narrative

Maria S. Merian left the port of Catania in Sicily at 0800 on December 3rd 2024 to start on its voyage MSM132. After only one hour we reached the first working area on the flanks of Mt. Etna where we attempted to recover two geodesy stations that had not surfaced during a recent deployment. After running a sound velocity profile and calibrating the Sonardyne USBL system we deployed a new video-guided launch system on the fiber optic cable. Immediately when reaching the seafloor, we found the first instrument in 1038 m water depth. It took about 30 min to navigate the recovery system right over it. When we were only about 1 m away the lights of the video system broke and the attempt had to be abandoned as the system was not repairable with the spare parts we had on board. In the evening, we set out on the 500 nm-long transit to Greece.

In the evening of December 5, we arrived in the study area off Santorini. After casting a sound velocity profile, we calibrated the multi-beam echosounder and tested a new kind of ocean bottom lander system before deploying a combined pressure, temperature and seismic observatory in the crater of Kolumbo. Throughout the night we acquired multi-beam and Parasound data between Santorini, Ios, and Amorgos. OBS deployments carried on during the next day. Three OBS were deployed in Kolumbo crater away from the active hydrothermal vent fields and two more OBS NW and SE of the crater. Afterwards we tested the newly developed MOMO video sledge and carried out electronic tests of the MOLA landers.

After successful completion of the tests, we moved to the second study area off the coast of Amorgos where we first deployed 2 OBS in the region of the planned 3D seismic block and then took a sound velocity profile. In the evening of the 8th, we deployed the 2D seismic system which we have been using since to acquire reflection seismic lines starting from Amorgos and back to Santorini.

2D Seismic acquisition continued without interruptions until December 12. We then retrieved the system at 6 in the morning and sailed into Santorini caldera where we carried out tests with the new Mola landers. At 10 am we collected spare parts for the broken lamps of the OBS launching system that will used for placing the landers in Kolumbo later on during the cruise. In the afternoon we sailed to Kolumbo volcano where we surveyed the hydrothermal vent field using the new MOMO system. The system worked perfectly and produced impressive video and stills imagery of the active hydrothermal springs. The evening and night were used to collect multi-beam bathymetry data close to Santorini’s east coast and in the northwest of Santorini.

On the morning of December 13, we sailed back into the caldera to conduct the first autonomous tests with the Mola landers. Three landers were deployed and successfully recovered after about 2 hours demonstrating that the release mechanism works and it was also possible to test their communication capabilities. Final adjustments will have to be made to the software before the next deployment on Kolumbo volcano. After these tests we started the transect to the study area off Amorgos collecting multibeam and Parasound data underway.

In the morning of December 14, we began to deploy the 3D seismic system. This was completed by 11 am and we steamed towards the first sail line of the planned 3D seismic survey. Unfortunately, the starboard paravane’s GPS antenna broke after about one hour and we had to recover the starboard paravane and dismantle the GPS system. It was not easily repaired and by 16:00 we decided to continue the survey without this GPS during the night. So, everything was redeployed. It will be possible to use the collected data albeit with a lower navigation accuracy. We used the night to repair the GPS antenna. In the morning of the 15 we again recovered the starboard paravane and mounted the repaired antenna with some extra shock absorbers to avoid another damage. It had turned out that the Tromsø paravanes that we are using for this survey have slightly different mount points for the GPS antenna than the GEOMAR ones which allowed the antennas to be shaken more than usual which caused damage in the electronics.

3D seismic surveying continued without interruptions until the evening of the 16th when the GPS on the port side paravanes also failed. Because of safety concerns it was agreed to wait with the replacement of this GPS antenna until the noon on the next day when the winds had sufficiently abated to hoist the paravane and replace the GPS antenna and surveying continued. During the 3D seismic experiment, we only ran Parasound apart from the night from the 17th to the 18th when we filled in gaps in the multibeam coverage.

During the afternoon of December 19, the MOMO team established a direct link between MOMO and the Arena visualization dome at GEOMAR using the starlink internet connection. This will allow remote involvement of onshore scientists in the future and can be used for outreach activities.

3D seismic acquisition continued until 3:30 on December 20, when we had to recover the system because of a medical emergency. After retrieval of the system, we headed for Santorini where a sailor was taken ashore. Work continued at noon with the recovery of the previously deployed ocean bottom seismometers at Kolumbo that had been equipped with temperature and pressure sensors. All instruments had been safely recovered by 16:30 and we continued with the deployment of six Mola landers around Kolumbo. At 17:00 we began a second MOMO dive starting at the northern rim of Kolumbo volcano and diving into the crater along its steep wall and into the hydrothermal vent field at the crater floor. The dive showed significant incising by erosion, a muddy seafloor on the crater wall with signs of bioturbation. The vent field consists of individual chimneys and rough material in between. White discoloration perhaps indicating bacteria mats are widespread throughout the vent field. MOMO operations lasted until 5 am on December 21. We then continued multi-beam mapping as the sea state did not allow other work.

In the early morning of December 22, the weather had calmed down sufficiently to redeploy the 3D seismic system. This was accomplished by 10 am and we began to survey the last remaining sail lines of the 3D seismic cube across the Amorgos fault. 3D seismic acquisition continued without interruptions until noon on December 23 when the cube was completed. The 3D seismic data were then processed and available by evening. The afternoon was used to deploy six Mola landers around Kolumbo volcano and into its crater.

Throughout the night we collected multibeam and Parasound data on the northern limb of the Anhydros Graben as weather conditions were not conducive to other work. On Christmas morning we undertook another MOMO dive into Kolumbo crater. This time we surveyed the southern part of the crater. No active hydrothermal activity was observed on the crater floor, but we discovered one inactive vent on the crater wall. The floor of the crater was littered with massive blocks that had apparently been deposited by a rockfall from one of the dikes in the crater wall.

From noon of the 24 we carried out another Multibeam and Parasound survey in the northeastern part of the study area to investigate the continuation of the Amorgos fault to the NE. In the morning of December 25, we conducted a XBT cast to obtain a new sound velocity profile. We then passed very close to Amorgos where it was possible to inspect the onshore geology from up close. The cliff face on the northeastern most coast of Amorgos shows spectacular folds and thrust faults indicating that the basement underwent significant compression before the present rift episode. In the afternoon we collected the Mola landers that were deployed on Kolumbo on the 24th. Four of the instruments could be retrieved and their seismometer data nicely show the earthquakes that occurred in the region between the 23rd and the 25th. Unfortunately, two Mola landers did not surface. Both of them had been deployed in the crater of Kolumbo.

During the night from December 25 to the 26 we ran a twelve-hour long MOMO dive that investigated the crater rim of Kolumbo and finished with the inspection of one of the Mola landers that had not surfaced. It turned out that the instrument had sunken about 15 cm into soft sediments that cover the crater floor which prevented the release mechanism to operate. Future deployments in the crater are therefore only possible after the instruments have been modified – an important lesson for the future installation of the early warning system.

At 10 am on the 26th we redeployed the 2D seismic system starting with lines around Kolumbo volcano where we discovered a previously unknown volcanic cone and then progressed towards the deep parts of the Amorgos Basin that has not been surveyed before.

2D seismic acquisition continued until Saturday 28 without interruptions, but in less-than-ideal weather conditions. At 8 am the streamer was recovered and we proceeded to Santorini caldera to investigate the hydrothermal system in the northern part of the caldera using MOMO.

During the night from December 28 to December 29 we surveyed the south and east of Santorini, before conducting a further MOMO dive in Kolumbo crater during daytime on the 29. This was followed by more hydroacoustic mapping in the south Santorini and towards Anafi. On the morning of December 30, we redeployed the MOMO system first in the Santorini caldera where we inspected a seafloor depression in the center of the northern basin and then in Kolumbo crater to complete the video imagery of the hydrothermal vent area. This was completed by 8 pm when we retrieved the system and continued the hydro-acoustic mapping of the Anafi area.

During daytime of December 31, we conducted a test of six MOLA landers south of Santorini. The aim was to make the landers communicate and range each other in order to calculate their absolute positions. The test was successful and constitutes the first time that MOLA landers performed a joined task in open water.

During the night from December 31 to January 1, we mapped the shallow waters of Santorini caldera and the waters east of Anafi. In the afternoon of January first we deployed eight OBS with pressure and temperature sensors in and around Kolumbo. These instruments will collect data until MMC-3 next year. Afterwards surveying around Anafi continued through to the end of the scientific program at midnight.

Acknowledgements

We thank captain Björn Maaß and his crew for their excellent support during the voyage. We would also like to thank BMBF for funding this research under the umbrella of the German Alliance for Marine Research (DAM).

Cruise participants

1.	Prof. Dr. Christian Berndt	Fahrtleiter / *Chief Scientist*	GEOMAR
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7.	Maria Blanche Jover	Seismic acquisition	GEOMAR
8.	Megan Campbell	Seismic acquisition	GEOMAR
9.	Paula Luerssen	Seismic acquisition	GEOMAR
10.	Dr. Fabian Steinmetz	Mola	GEOMAR
11.	Roberto Benavides Noriega	Mola	GEOMAR
12.	Everardo Gonzales Avatos	Mola	GEOMAR
13.	Aaron Arneke	Mola	GEOMAR
14.	Swantje Wegehaupt	Mola	GEOMAR
15.	Carl von Brandis	MOMO	GEOMAR
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17.	Dr. Daniel Müller	Geology	GFZ
18.	Dr. Andrea Geipel	Outreach	GEOMAR
19.	Gero Wetzel	Seismic engineer	GEOMAR
20.	Raphael Herges	Mola engineer	GEOMAR
21.	Malte Eggersgluess	MOMO engineer	GEOMAR
22.	Prof. Dr. Paraskevi Nomikou	Greek observer	UA

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GFZ – Geoforschungszentrum Potsdam
UA - University of Athens

Station list

Station N°	Date	Device	Time	Latitude	Longitude	Depth	Comment
	2024		[UTC]	[°N]	[°E]	[m]	
MSM132_0_Underway-1	30.11.	Weatherstation aboard RV Maria S. Merian	08:35	37° 29,782'	015° 05,773'	0	
MSM132_1-1	03.12.	SVP: Sound velocity profiler	09:27	37° 32,962'	015° 17,208'	0	
MSM132_0_Underway-2	05.12.	Multibeam echosounder	21:24	36° 33,034'	025° 27,456'	362	
MSM132_3-1	05.12.	SVP: Sound velocity profiler	22:18	36° 35,458'	025° 27,679'	424	
MSM132_4-1	06.12.	OBS (Ocean Bottom Seismometer)	16:44	36° 31,359'	025° 29,219'	499	
MSM132_0_Underway-3	06.12.	Parametric sediment echo sounder	17:28	36° 31,309'	025° 29,297'	498	
MSM132_4-2	07.12.	OBS (Ocean Bottom Seismometer)	08:37	36° 31,379'	025° 29,053'	495	
MSM132_4-3	07.12.	OBS (Ocean Bottom Seismometer)	09:39	36° 31,537'	025° 29,330'	501	
MSM132_4-4	07.12.	OBS (Ocean Bottom Seismometer)	10:58	36° 33,816'	025° 25,851'	409	
MSM132_4-5	07.12.	OBS (Ocean Bottom Seismometer)	11:56	36° 28,820'	025° 32,721'	356	
MSM132_5-1	07.12.	MOMO Ocean Floor Observation System	13:22	36° 28,816'	025° 32,723'	356	USBL
MSM132_5-1	07.12.	MOMO Ocean Floor Observation System	13:25	36° 28,816'	025° 32,723'	356	MOMO Test
MSM132_6-1	08.12.	SVP: Sound velocity profiler	09:54	36° 42,882'	025° 54,118'	475	
MSM132_4-6	08.12.	OBS (Ocean Bottom Seismometer)	11:18	36° 43,616'	025° 47,535'	394	
MSM132_4-7	08.12.	OBS (Ocean Bottom Seismometer)	11:40	36° 41,770'	025° 46,590'	445	
MSM132_7-1	08.12.	Single-Channel Streamer (SCS) 2D data	12:08	36° 41,483'	025° 46,793'	418	350 m cable
MSM132_8-1	12.12.	MOMO Ocean Floor Observation System	10:53	36° 31,364'	025° 29,194'	500	USBL
MSM132_8-1	12.12.	MOMO Ocean Floor Observation System	11:06	36° 31,364'	025° 29,196'	500	MOMO
MSM132_9-1	13.12.	Miniaturized lander device (MOLA)	08:21	36° 26,596'	025° 23,264'	383	MOLA nr 1
MSM132_9-2	13.12.	Miniaturized lander device (MOLA)	08:32	36° 26,547'	025° 23,264'	379	MOLA nr 2
MSM132_9-3	13.12.	Miniaturized lander device (MOLA)	08:43	36° 26,547'	025° 23,184'	379	MOLA nr 3
MSM132_10-1	14.12.	Multi-Channel Streamer (MCS) (3D data)	06:59	36° 32,929'	025° 38,126'	310	Stb
MSM132_11-1	16.12.	Expendable sound velocity profiler	09:06	36° 41,415'	025° 45,479'	438	
MSM132_4-8	20.12.	OBH (Hydrophone)	10:25	36° 31,349'	025° 29,241'	493	
MSM132_4-9	20.12.	OBS (Ocean Bottom Seismometer)	11:17	36° 31,379'	025° 29,064'	488	
MSM132_4-10	20.12.	OBS (Ocean Bottom Seismometer)	11:53	36° 31,541'	025° 29,357'	482	
MSM132_4-11	20.12.	OBH (Hydrophone)	12:49	36° 33,812'	025° 25,593'	401	
MSM132_4-12	20.12.	OBH (Hydrophone)	14:09	36° 28,842'	025° 32,791'	355	
MSM132_12-1	20.12.	Miniaturized lander device (MOLA)	15:01	36° 29,697'	025° 29,139'	291	MOLA 21
MSM132_12-2	20.12.	Miniaturized lander device (MOLA)	15:31	36° 31,133'	025° 31,188'	329	MOLA 111
MSM132_12-3	20.12.	Miniaturized lander device (MOLA)	16:00	36° 31,352'	025° 29,259'	492	MOLA 113
MSM132_12-4	20.12.	Miniaturized lander device (MOLA)	16:13	36° 31,418'	025° 29,101'	494	MOLA 115
MSM132_12-5	20.12.	Miniaturized lander device (MOLA)	16:36	36° 31,624'	025° 27,153'	288	MOLA 107
MSM132_12-6	20.12.	Miniaturized lander device (MOLA)	17:00	36° 33,196'	025° 28,020'	369	MOLA 118
MSM132_13-1	20.12.	MOMO Ocean Floor Observation System	17:39	36° 31,997'	025° 29,580'	141	USBL
MSM132_13-1	20.12.	MOMO Ocean Floor Observation System	18:04	36° 31,996'	025° 29,580'	147	MOMO
MSM132_10-2	22.12.	Multi-Channel Streamer (MCS) 3D data	04:32	36° 40,244'	025° 47,531'	334	
MSM132_4-13	23.12.	OBS (Ocean Bottom Seismometer)	13:35	36° 43,619'	025° 47,539'	0	
MSM132_4-14	23.12.	OBH (Hydrophone)	14:17	36° 41,916'	025° 46,621'	0	
MSM132_14-1	24.12.	MOMO Ocean Floor Observation System	04:18	36° 31,479'	025° 29,187'	0	USBL
MSM132_14-1	24.12.	MOMO Ocean Floor Observation System	04:55	36° 31,507'	025° 29,127'	500	MOMO

MSM132_15-1	25.12.	SVP: Sound velocity profiler	06:10	36° 52,732'	026° 08,127'	223	Disposable
MSM132_12-7	25.12.	Miniaturized lander device (MOLA)	11:19	36° 33,218'	025° 28,215'	369	Hydrophon e
MSM132_12-8	25.12.	Miniaturized lander device (MOLA)	12:04	36° 31,646'	025° 27,293'	0	Hydrophon e
MSM132_12-8	25.12.	Miniaturized lander device (MOLA)	12:08	36° 31,646'	025° 27,292'	0	MOLA 107
MSM132_12-9	25.12.	Miniaturized lander device (MOLA)	13:53	36° 31,090'	025° 31,361'	0	Hydrophon e
MSM132_12-9	25.12.	Miniaturized lander device (MOLA)	13:57	36° 31,094'	025° 31,361'	0	MOLA 111
MSM132_12-10	25.12.	Miniaturized lander device (MOLA)	14:44	36° 29,736'	025° 29,350'	0	Hydrophon e
MSM132_12-10	25.12.	Miniaturized lander device (MOLA)	14:46	36° 29,736'	025° 29,349'	0	MOLA 21
MSM132_16-1	25.12.	MOMO Ocean Floor Observation System	16:26	36° 32,096'	025° 29,232'	183	USBL
MSM132_16-1	25.12.	MOMO Ocean Floor Observation System	16:35	36° 32,097'	025° 29,232'	186	MOMO
MSM132_17-1	26.12.	Single-Channel Streamer (SCS) 2D seismic	08:12	36° 25,969'	025° 29,268'	112	150 m
MSM132_18-1	28.12.	MOMO Ocean Floor Observation System	08:19	36° 27,211'	025° 24,192'	284	USBL
MSM132_18-1	28.12.	MOMO Ocean Floor Observation System	08:19	36° 27,211'	025° 24,192'	284	MOMO
MSM132_19-1	29.12.	MOMO Ocean Floor Observation System	06:16	36° 32,006'	025° 29,423'	150	USBL
MSM132_19-1	29.12.	MOMO Ocean Floor Observation System	06:18	36° 32,006'	025° 29,424'	152	MOMO
MSM132_20-1	29.12.	SVP: Sound velocity profiler	19:45	36° 28,317'	025° 34,445'	389	
MSM132_21-1	30.12.	MOMO Ocean Floor Observation System	08:33	36° 26,852'	025° 22,952'	382	USBL
MSM132_21-1	30.12.	MOMO Ocean Floor Observation System	08:48	36° 26,736'	025° 23,199'	385	MOMO
MSM132_21-1	30.12.	MOMO Ocean Floor Observation System	11:38	36° 27,243'	025° 24,400'	469	MOMO
MSM132_22-1	31.12.	Miniaturized lander device (MOLA)	06:39	36° 18,515'	025° 25,718'	59	MOLA 102
MSM132_22-2	31.12.	Miniaturized lander device (MOLA)	06:53	36° 18,527'	025° 25,779'	58	MOLA 13
MSM132_22-3	31.12.	Miniaturized lander device (MOLA)	07:02	36° 18,497'	025° 25,804'	58	MOLA Tests
MSM132_22-4	31.12.	Miniaturized lander device (MOLA)	07:15	36° 18,471'	025° 25,771'	59	MOLA 101
MSM132_22-5	31.12.	Miniaturized lander device (MOLA)	07:30	36° 18,506'	025° 25,702'	59	MOLA Tests
MSM132_23-1	01.01.	OBS (Ocean Bottom Seismometer)	11:31	36° 21,079'	025° 54,948'	275	USBL
MSM132_23-1	01.01.	OBS (Ocean Bottom Seismometer)	11:35	36° 21,055'	025° 54,975'	279	USBL
MSM132_23-1	01.01.	OBS (Ocean Bottom Seismometer)	11:59	36° 31,406'	025° 29,275'	501	OBS rel
MSM132_23-1	01.01.	OBS (Ocean Bottom Seismometer)	12:17	36° 31,406'	025° 29,275'	501	Transp. rec
MSM132_23-1	01.01.	OBS (Ocean Bottom Seismometer)	12:31	36° 31,406'	025° 29,275'	496	
MSM132_24-1	01.01.	OBS (Ocean Bottom Seismometer)	12:38	36° 31,410'	025° 29,278'	496	USBL
MSM132_24-1	01.01.	OBS (Ocean Bottom Seismometer)	12:59	36° 31,410'	025° 29,278'	496	USBL
MSM132_24-1	01.01.	OBS (Ocean Bottom Seismometer)	13:15	36° 31,576'	025° 29,183'	493	OBS rel.
MSM132_24-1	01.01.	OBS (Ocean Bottom Seismometer)	13:32	36° 31,578'	025° 29,183'	495	Transp. rec
MSM132_24-1	01.01.	OBS (Ocean Bottom Seismometer)	13:35	36° 31,578'	025° 29,184'	489	
MSM132_25-1	01.01.	OBS (Ocean Bottom Seismometer)	13:35	36° 31,578'	025° 29,184'	488	USBL
MSM132_25-1	01.01.	OBS (Ocean Bottom Seismometer)	14:12	36° 31,578'	025° 29,184'	492	USBL
MSM132_25-1	01.01.	OBS (Ocean Bottom Seismometer)	15:58	36° 31,455'	025° 29,086'	495	OBS rel.
MSM132_25-1	01.01.	OBS (Ocean Bottom Seismometer)	16:21	36° 31,454'	025° 29,086'	495	Transp. rec
MSM132_25-1	01.01.	OBS (Ocean Bottom Seismometer)	17:12	36° 31,454'	025° 29,086'	495	
MSM132_26-1	01.01.	OBS (Ocean Bottom Seismometer)	14:41	36° 31,454'	025° 28,924'	306	OBS depl.
MSM132_27-1	01.01.	OBS (Ocean Bottom Seismometer)	15:07	36° 31,454'	025° 31,030'	673	OBS depl.
MSM132_28-1	01.01.	O OBS (Ocean Bottom Seismometer)	15:59	36° 29,200'	025° 26,366'	397	OBS depl.
MSM132_29-1	01.01.	OBS (Ocean Bottom Seismometer)	16:22	36° 32,750'	025° 29,194'	309	OBS depl.
MSM132_30-1	01.01.	OBS (Ocean Bottom Seismometer)	16:46	36° 31,303'	025° 26,492'	342	OBS depl.