Short Cruise Report

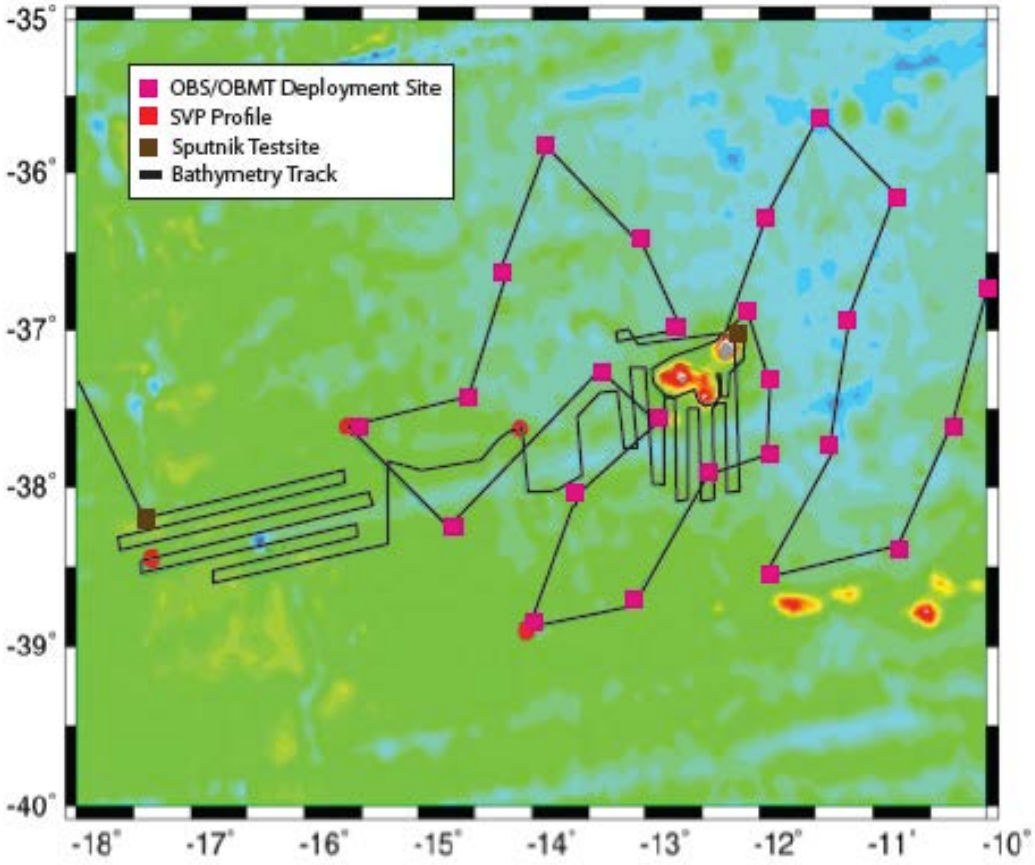
Maria S. Merian; Cruise No. MSM 20/2

Walvis Bay – Recife

January 17th, 2012 – February 22th, 2012

Chief Scientist: Marion Jegen-Kulcsar

Captain: Ralf Schmidt



Objectives

According to classical plume theory, the Tristan da Cunha hotspot is thought to have played a major role in the rifting of the South Atlantic margins and the creation of the aseismic Walvis Ridge by impinging at the base of the continental lithosphere shortly before or during the breakup of the South Atlantic margins. However, Tristan da Cunha is enigmatic as it cannot be clearly identified as a hot-spot but may also be classified as a more shallow type of anomaly that may actually have been caused by the opening of the South Atlantic. The equivocal character of Tristan is largely due to lack of geophysical data in this region. It is of central importance to characterize the region around Tristan da Cunha with geophysical data in a more coherent way to understand the tectonic processes of the opening of the South Atlantic and the formation of the Walvis Ridge, i.e. to understand whether Tristan da Cunha is the cause or the consequence of the rifting. We, therefore, staged a multi-disciplinary geophysical study of the region by acquiring passive marine electromagnetic and seismic data, bathymetric data as well as gravity data from which we will derive an electrical resistivity, velocity and density model down to a depth of several hundred kilometers. These models will be interpreted in the context of geochemical data and tectonic models developed within the SPP1375 ,**S**outh **A**tlantic **M**argin **P**rocesses and **L**inks with onshore **E**volution (SAMPLE).

On the cruise MSM 20-2 we acquired bathymetric and gravity data within the Tristan region and deployed 26 OBMT and 24 OBS as well as two seismic and one MT land stations on the neighbouring uninhabited Nightingale island for a year long data acquisition. The lands stations are on loan from the German geophysical instrumentation pool at the Geoforschungszentrum Potsdam. The recovery of the stations is planned for January/February 2013 during a second Merian Cruise (Capetown 28.1.2013 to Walvis Bay 22.2.2013). The cruise also offered the opportunity to invite two Geologists from GFZ/TU Berlin for a 5 day rock sampling excursion Tristan.

Short cruise description

Deployment of seafloor OBS and OBMT stations

We left Walvis Bay on the morning of the 17th of January and started our six day transit to the working area around Tristan da Cunha. The gravimeter has been running continuously after a reference measurement in Walvis Bay on the 15th of January. Bathymetry and oarasound data acquisition was initiated as soon as sufficient water depth (> 600 m) for the Kongsberg EM120 multibeam bathymetry system (191 beams) has been reached. After unpacking and setting up our work spaces the releasers, which attach the anchors through a hook to the instrument frames carrying our sensors, were tested on the 19th and 20th of January. The releaser test is essential since failure of a release, i.e. opening of the hook, results in a loss of the entire instrument and thus more than 60 000 Euro. For the test, the releasers were attached to a wire cage, which was lowered to a water depth of 4000 m. A coded acoustic signal that initiates the release mechanism for an individual releaser was sent to each receiver. Upon recovery on deck we assured that each of the releaser hooks had opened.

The remainder of the transit was used to prepare our 26 OBMT and 24 OBS stations for deployment. The OBS stations (see Figure 2) consist of 24 Lobster (**L**ongterm **O**cean **B**ottom **S**eismometer for **T**sunami and **E**arthquake **R**esearch) from the DPAS Pool manufactured by K.U.M. Umwelt- and Meerestechnik Kiel GmbH, Germany. They are equipped with a Gueralp CMG-40 T broadband seismometer incorporated in titanium pressure housing mounted on a titanium frame, which is equipped with syntactic foam floats. 18 of the OBMT have been built and designed by Geomar in corporation with Magson GmbH in Berlin, Germany and K.U.M. (see Figure 3 left). The frame and pressure housing are identical to the Lobster, however, instead of a seismometer the instruments are equipped with a highly sensitive magnetometer designed by Magson. Electric field measurements are made through to electric dipoles which are mounted between the equipment frame and the anchor and consist of 10 m long PVC pipes on whose ends electric field electrodes are mounted (fabricated by Clovertech Ltd, Japan). Six OBMT have been added by our Japanese cooperation partners from the University of Tokyo and are of in house Japanese design (see Figure 3 right).

The station grid has been designed to cover the potential plume head around Tristan da Cunha and ensure a 3D coverage of the region. It consists of 24 stations that have been occupied by OBS and OBMT stations and 2 additional OBMT stations. The distance between the stations is on the average 40 nm, with a slightly increasing distance from the centre to the edges of the working area. The mainly north-south trending profile path for deployment has been chosen according to prevailing wind and current directions. OBMT stations have been given the abbreviation TRIS1 to TRIS26, whereas the OBS stations have been abbreviated with TDC1 to TDC26, where the stations TDC13 and TDC 24 have been omitted, since stations 13 and 24 have been occupied by OBMT stations only. Prior to deployment a bathymetric search around the targeted stations has been performed in order to find sedimented seafloor to allow for better coupling of the instruments. The OBMT stations and OBS stations were separated by 2 cables (0.2 nm). Deployment of the first stations was on 22.1.2012 at 22:33 UTC and ended on 29.1.2012 at 02: 36 in the morning.

Deployment of the stations has been interrupted after deployment of station 10 by a brief visit to Tristan da Cunha on the 25th of January, where scientists M. Jegen and W. Geissler, as well as the Captain R. Schmidt, 1st officer E. Stegmaier and 1st engineer A. Schueler met the administrators and guides to prepare the land expedition to Nightingale. Subsequently, two geologists and one artist were ferried to Tristan da Cunha to stay for a duration of 4 days for geological sampling on the island.

While the release of the stations upon recovery is controlled and initiated by an acoustic signal from the ship during the recovery cruise, a back up timer release had to be set in order to assure ascend of the stations if acoustic communication failed. Given the recovery cruise dates of the RV Maria S. Merian leaving Capetown on 28.1.2013 and return to Walvis Bay on 22.2.. We identified four quadrants, for which different backup release dates and times were set. The dates are chosen to cover the last 4 days in the working region after the scheduled recovery and shown in figure 5.

On January 29th, the geologist and artist rejoined the vessel and five scientist (M. Jegen, W. Geissler, K. Baba, M. Wollatz-Vogt and H. Kirk) left the vessel to install two land seismic and 1 land MT station on Nightingale Island. Scientists and crew of the Maria S. Merian used the occasion for a day-visit of the island on January 30th. At 18:00 UTC Maria S. Merian left the island and acquired bathymetric, gravity and parasound data around the island. She returned February 1st at 10:30 UTC to pick up the scientist returning from the land expedition and to complete bathymetric mapping of the working area.

Bathymetry, Parasound and Gravity

Bathymetric measurements and parasound were conducted continuously during the whole survey. On the transit to the working area data has been acquired as soon as the water depth was sufficient for good data quality on the Kongsberg EM120 (> 600m). Recording of bathymetric, parasound and gravity data has been stopped when entering the Brasilian economic zone. During the bathymetric survey a volcano reaching approx. 300 m underneath has been found and is probably the location of a submarine eruption in August 2004 in the Tristan region. In accordance with the Island Village Council the new volcano was baptized Isolde (see figure 6).

Acknowledgement

We thank the master R. Schmidt and the crew of R/V MARIA S. MERIAN for their professional and friendly support of the scientific work at sea. Much appreciated support has been given by the “Leitstelle Meteor/Merian” in Hamburg, the “Senatskommission für Ozeanografie der DFG“ and Briese Schiffahrts GmbH & Co. KG. We thank the DFG, and especially Dr. Susanne Faulhaber, for making the sea experiments in the framework of the DFG Priority Program SAMPLE possible. Special thanks go to the Tristan the Island Village Council, the Tristan da Cunha administrator S. Burns and our local guides led by Robin Repetto and Trevor Glass. Lastly, we would also like to thank the German Ministry of Foreign Affairs for acquiring the necessary research permits.

Participants

Name	Discipline	Institution
Jegen-Kulcsar, Marion	Marine Geophysics / Chief Scientist	GEOMAR
Geissler, Wolfram	Marine Geophysics	AWI
Maia, Marcia	Marine Geophysics	UBO
Sigloch, Karin	Marine Geophysics	LMU
Vexler, Ilya	Geology	TU-BERLIN
Kleiding, Jakob	Geology	GFZ
Sommer, Malte	Marine Geophysics	GEOMAR
Hosseini, Kasra	Geophysics	LMU
Staehler, Simon	Geophysics	LMU
Baba, Kiyoshi	Marine Geophysics	TOKYO
Ota, Toyanobu	Marine Geophysics	TOKYO
Kirk, Henning	Marine Technician	AWI
Wollatz-Vogt, Martin	Marine Technician	GEOMAR
Schröder, Patrick	Marine Technician / Teamleader	GEOMAR
Schwartz, Olav	Marine Technician	GEOMAR
Rannou, Cathrine	Artist/Architect	RENNES
Bloch, Wasja	Student	TU-BERLIN
Kapp, Gerhard (passenger to Tristan da Cunha)	Civil Engineer	WSP
Retief, Marthinus (passenger to Tristan da Cunha)	Civil Engineer	WSP
Madlener, Dominik (passenger to Tristan da Cunha)	Technician	LIEBHERR

GEOMAR: Helmholtz Institute of Ocean Research, Kiel, Germany
AWI: Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany
UBO: Universite de Bretagne Occidentale, Brest, France
LMU: Ludwig Maximilians University, Munich, Germany
GFZ: Geoforschungszentrum, Potsdam, Germany
TU-BERLIN: Technical University of Berlin, Berlin, Germany
WSP: Southafrican Coastal Engineering Company
LIEBHERR: Crane Manufacturing Company, Nenzing, Austria

Figure 1: Releaser Test.

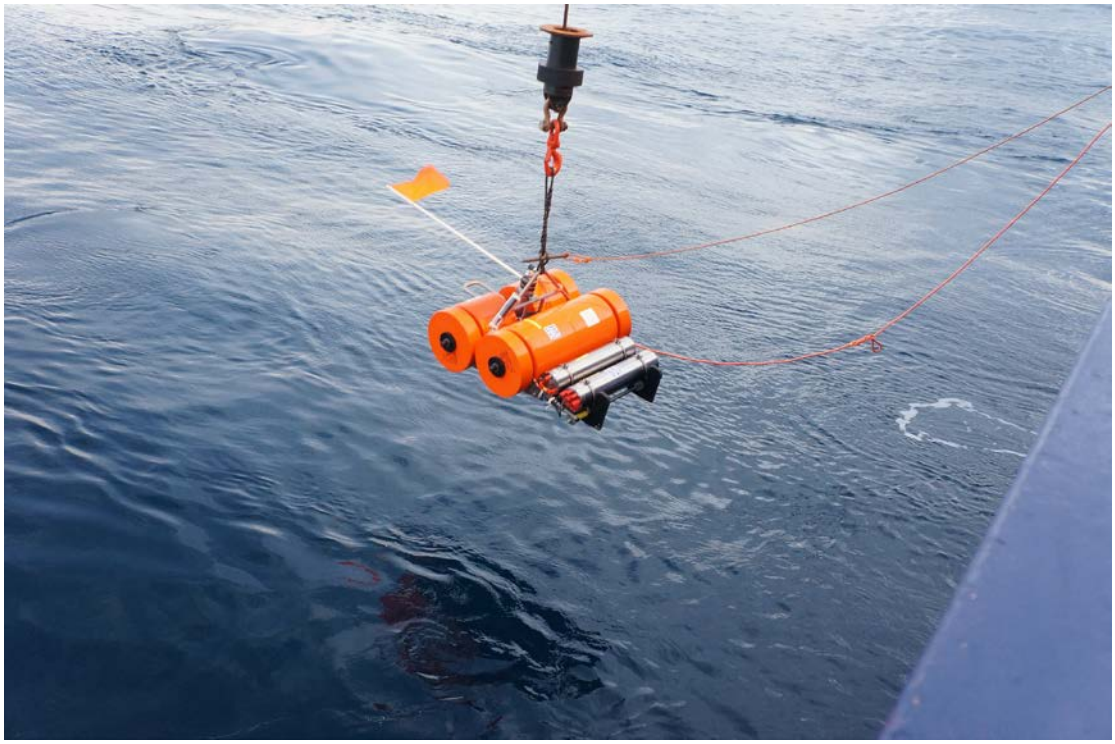


Figure 2: Lobster OBS.

Figure 3: Geomar OBMT station.

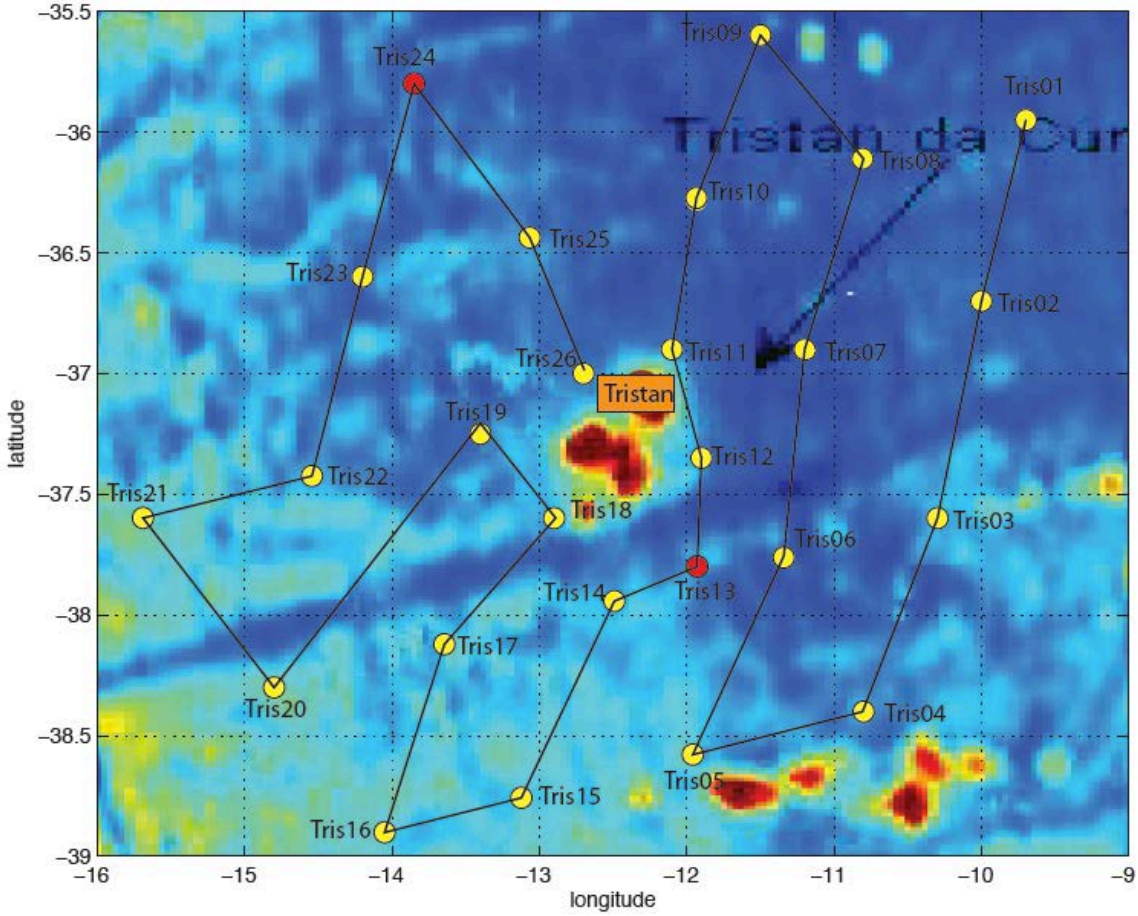


Figure 4: Station distribution for the 26 OBMT stations, abbreviated with TRIS01 to TRIS26. 24 of the stations were also occupied by Lobster OBS. The OBS station numbering follows the numbering of the OBMT sites, the abbreviation for seismic stations is TDC01 to TDC26, where TDC13 and TDC24 have been omitted.

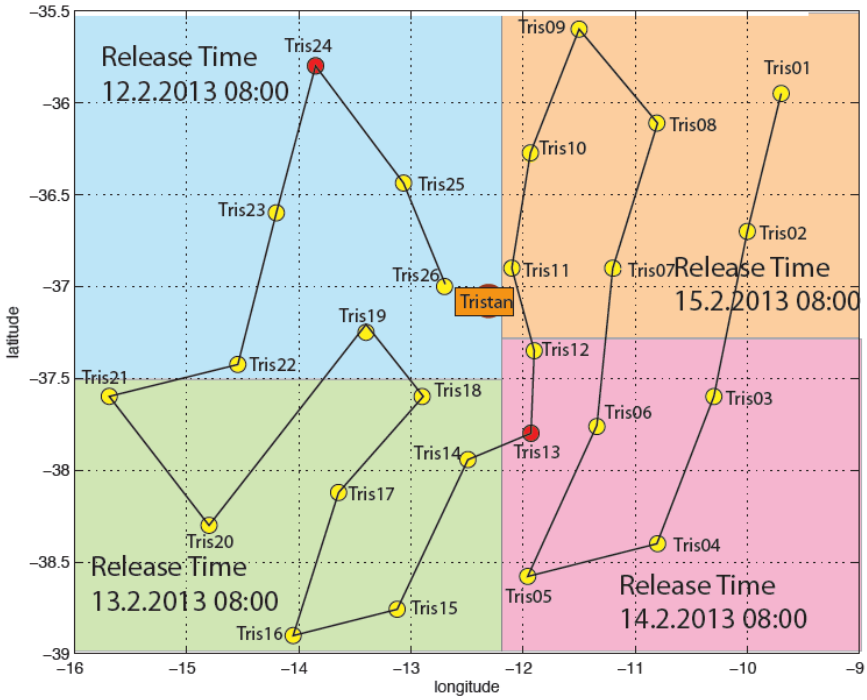


Figure 5: Backup release dates for the stations in case controlled recovery through acoustic signal fails.

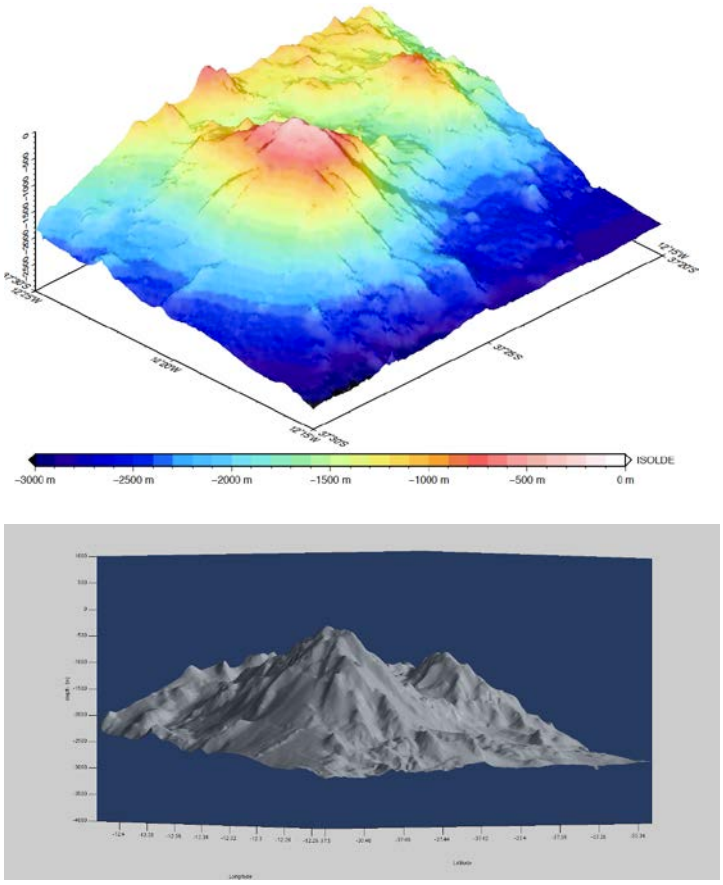


Figure 6: Bathymetric data of seafloor volcano Isolde located east of Nightingale, a probable source of a submarine eruption in 2004.

List of Stations

Magnetotelluric Stations

Station Nr	Station Name	Depl. Date	Depl. Time (UTC)	Lat	Long	Depth (m)
MSM20/020-1	TRIS01-G	23/1/16	22:33	35° 55,77' S	9° 40,90' W	3937.5
MSM20/021-1	TRIS02-G	24/1/16	5:08	36° 40,21' S	9° 59,39' W	3635.8
MSM20/022-1	TRIS03-G	24/1/16	10:49	37° 35,69' S	10° 18,14' W	3365.2
MSM20/023-1	TRIS04-T	24/1/16	17:18	38° 21,68' S	10° 46,59' W	3534.8
MSM20/024-1	TRIS05-G	25/1/16	0:30	38° 34,78' S	11° 57,55' W	3161.4
MSM20/025-1	TRIS06-G	25/1/16	5:35	37° 44,68' S	11° 22,17' W	3560.3
MSM20/026-1	TRIS07-G	25/1/16	10:08	36° 54,26' S	11° 12,13' W	3813.1
MSM20/027-1	TRIS08-T	25/1/16	15:39	36° 7,75' S	10° 48,04' W	3949.4
MSM20/028-1	TRIS09-G	25/1/16	21:44	35° 38,33' S	11° 29,62' W	4169.4
MSM20/029-1	TRIS10-G	26/1/16	1:42	36° 16,45' S	11° 56,21' W	3721.4
MSM20/030-1	TRIS11-T	26/1/16	15:51	36° 52,62' S	12° 7,09' W	3571.1
MSM20/031-1	TRIS12-G	26/1/16	20:17	37° 21,52' S	11° 53,81' W	3671.3
MSM20/032-1	TRIS13-T	26/1/16	22:56	37° 47,53' S	11° 57,27' W	3286.1
MSM20/033-1	TRIS14-G	27/1/16	3:06	37° 55,73' S	12° 26,89' W	3301.8
MSM20/035-1	TRIS15-T	27/1/16	11:03	38° 45,21' S	13° 4,58' W	3181
MSM20/036-1	TRIS16-G	27/1/16	17:19	38° 54,16' S	14° 0,27' W	3110.3
MSM20/037-1	TRIS17-G	27/1/16	23:31	38° 4,83' S	13° 38,07' W	3391.3
MSM20/038-1	TRIS18-G	28/1/16	3:57	37° 35,80' S	12° 54,52' W	3154.9
MSM20/039-1	TRIS19-T	28/1/16	7:20	37° 15,60' S	13° 24,75' W	3583.5
MSM20/040-1	TRIS20-G	28/1/16	17:59	38° 16,61' S	14° 43,04' W	3216.1
MSM20/041-1	TRIS21-T	29/1/16	0:03	37° 36,63' S	15° 36,95' W	3225.7
MSM20/042-2	TRIS22-G	29/1/16	6:20	37° 24,69' S	14° 33,17' W	3338.5
MSM20/043-1	TRIS23-G	29/1/16	10:54	36° 38,61' S	14° 16,74' W	3674.7
MSM20/044-1	TRIS24-T	29/1/16	16:06	35° 49,14' S	13° 52,93' W	3655.5
MSM20/045-1	TRIS25-G	29/1/16	22:53	36° 23,92' S	13° 2,91' W	3545.1
MSM20/046-1	TRIS26-G	30/1/16	2:29	36° 59,49' S	12° 40,72' W	3515.6
	G: Geomar T: Tokyo					

OBS Stations

Station Nr	Station Name	Depl. Date	Depl. Time (UTC)	Latitude	Longitude	Depth (m)
MSM20/020-2	TDC01	23/1/16	22:43	35° 55,47' S	9° 41,26' W	3944.5
MSM20/021-2	TDC02	24/1/16	5:16	36° 40,11' S	9° 59,63' W	3633.9
MSM20/022-2	TDC03	24/1/16	10:59	37° 35,53' S	10° 18,54' W	3357
MSM20/023-2	TDC04	24/1/16	17:25	38° 21,81' S	10° 46,92' W	3534.3
MSM20/024-2	TDC05	25/1/16	0:37	38° 34,86' S	11° 57,72' W	3162.7
MSM20/025-2	TDC06	25/1/16	5:44	37° 44,83' S	11° 22,47' W	3560.3
MSM20/026-2	TDC07	25/1/16	10:16	36° 54,49' S	11° 12,37' W	3800.3
MSM20/027-2	TDC08	25/1/16	15:45	36° 7,93' S	10° 48,14' W	3951.2
MSM20/028-2	TDC09	25/1/16	21:52	35° 38,57' S	11° 29,68' W	4168.3
MSM20/029-2	TDC10	26/1/16	1:50	36° 16,56' S	11° 56,39' W	3713.6
MSM20/030-2	TDC11	26/1/16	15:57	36° 52,66' S	12° 7,33' W	3569.6
MSM20/031-2	TDC12	26/1/16	20:26	37° 21,64' S	11° 54,12' W	3673.2
MSM20/033-2	TDC14	27/1/16	3:15	37° 55,79' S	12° 27,11' W	3307.6
MSM20/035-2	TDC15	27/1/16	11:11	38° 45,17' S	13° 4,91' W	3183.8
MSM20/036-2	TDC16	27/1/16	17:25	38° 54,10' S	14° 0,67' W	3104.2
MSM20/037-2	TDC17	27/1/16	23:38	38° 4,94' S	13° 38,33' W	3390.6
MSM20/038-2	TDC18	28/1/16	4:07	37° 35,81' S	12° 54,77' W	3159
MSM20/039-2	TDC19	28/1/16	7:29	37° 15,44' S	13° 25,08' W	3595.4
MSM20/040-2	TDC20	28/1/16	18:08	38° 16,47' S	14° 43,30' W	3225.4
MSM20/041-2	TDC21	29/1/16	0:12	37° 36,65' S	15° 37,23' W	3225.4
MSM20/042-1	TDC22	29/1/16	6:12	37° 24,88' S	14° 32,91' W	3333.9
MSM20/043-2	TDC23	29/1/16	11:01	36° 38,81' S	14° 17,05' W	3673.1
MSM20/045-2	TDC25	29/1/16	23:00	36° 24,16' S	13° 2,83' W	3548.8
MSM20/046-2	TDC26	30/1/16	2:36	36° 59,71' S	12° 40,77' W	3507.4

Sound Velocity Profiles

Station Nr		Depl. Date	Depl. Time (UTC)	Latitude	Longitude	Depth (m)
MSM20/016-1		20/1/16	6:08	27° 54,45' S	5° 34,07' E	4860.9
MSM20/017-1		21/1/16	7:08	29° 49,72' S	2° 1,28' E	3691.9
MSM20/018-1		22/1/16	8:40	32° 5,72' S	2° 13,76' W	4195.5
MSM20/019-1		23/1/16	8:11	34° 28,38' S	6° 47,55' W	4147.9
MSM20/020-3		23/1/16	22:53	35° 55,56' S	9° 41,34' W	3933.6
MSM20/022-3		24/1/16	11:06	37° 35,47' S	10° 18,49' W	3358.4
MSM20/026-3		25/1/16	10:24	36° 54,55' S	11° 12,43' W	3788
MSM20/034-2		27/1/16	5:08	38° 1,12' S	12° 31,94' W	3294.7
MSM20/036-3		27/1/16	17:32	38° 54,15' S	14° 0,74' W	3104.7
MSM20/039-3		28/1/16	7:46	37° 15,57' S	13° 24,79' W	3587.6
MSM20/041-3		29/1/16	0:23	37° 36,64' S	15° 37,29' W	3227.5
MSM20/044-2		29/1/16	16:15	35° 49,06' S	13° 52,96' W	3654.9
MSM20/049-2		4/2/16	13:19	37° 36,81' S	14° 6,56' W	3132.7
MSM20/049-3		5/2/16	12:09	38° 32,26' S	16° 49,56' W	2602
MSM20/049-4		6/2/16	13:02	38° 26,98' S	17° 20,45' W	3241.1