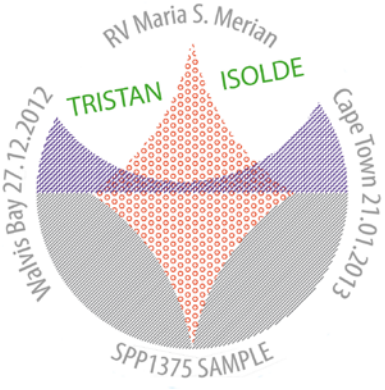
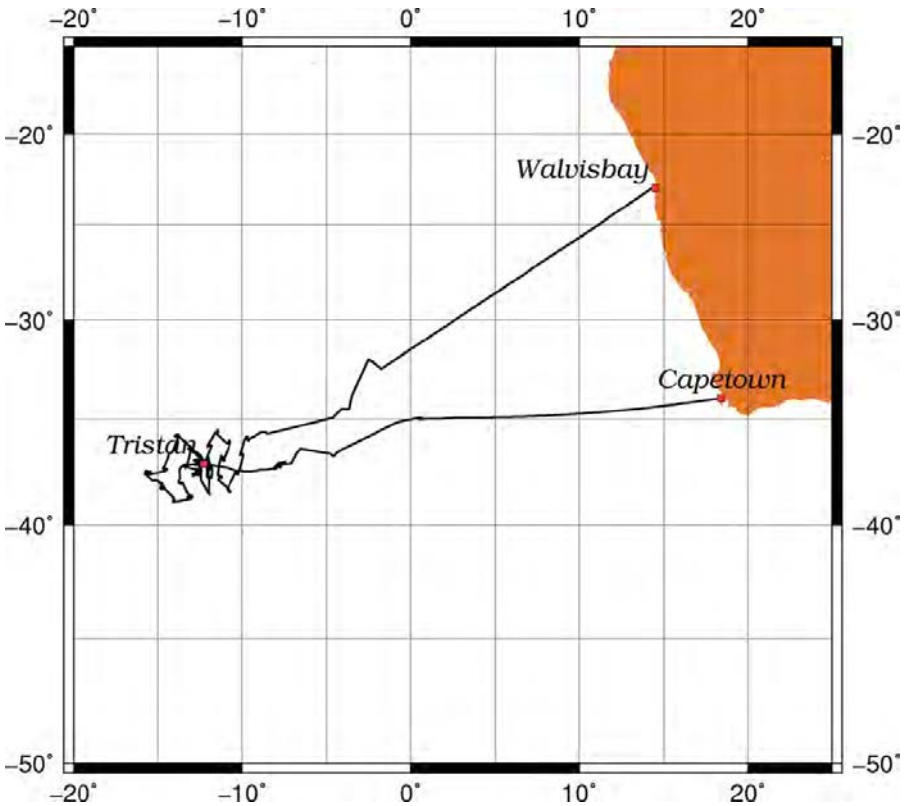
Short Cruise Report
Maria S. Merian; Cruise No. MSM 24

Walvis Bay – Cape Town
December 27th, 2012 – January 21st, 2013
Chief Scientist: Wolfram Geissler
Captain: Ralf Schmidt





Objectives (parts identical with MSM 20-2 report)

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 a 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, seismic 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 24 we acquired bathymetric data within the Tristan region and recovered 26 out of 26 ocean-bottom magnetotelluric stations (OBMT) and 22 out off 24 broadband ocean-bottom seismometers (BB-OBS) as well as two seismic and one MT land stations on the uninhabited Nightingale Island, which were deployed one year ago during cruise MSM 20-2 (Figure 1). The cruise also offered the opportunity for a colleague from the University Heidelberg to conduct geological sampling on Tristan da Cunha.

The BB-OBS stations (Figure 2) consist of 24 LOBSTER (**L**ongterm **O**cean **B**ottom **S**eismometer for **T**sunami and **E**arthquake **R**esearch) from the DEPAS Pool, manufactured by K.U.M. Umwelt- and Meerestechnik Kiel GmbH. Germany. They are equipped with a Guralp CMG-40T 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. (Figure 3). 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 taken by two electric dipoles, which are mounted between the frame and the anchor. They consist of 10 m long PVC pipes on whose ends electric field electrodes are mounted (fabricated by Clovertech Ltd. Japan). Eight OBMT of in house Japanese design have been added by our cooperation partners from the University of Tokyo (Figure 4).

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 sites that have been occupied by OBS and OBMT stations and 2 additional OBMT sites. OBMT stations are named TRIS01 to TRIS26, whereas the OBS stations have been abbreviated with TDC01 to TDC26. Sites 13 and 24 have been occupied by OBMT stations only. The OBMT stations and OBS stations were separated by about 2 cables (0.2 nm). The distance between the sites is on the average 40 nm, with a slightly increasing distance from the centre to the edges of the working area.

Short cruise description

Recovery of BB-OBS and OBMT stations

We left Walvis Bay in the afternoon of December 27th and started our five-day transit to the working area around Tristan da Cunha. Bathymetry (Kongsberg EM122) and ATLAS Parasound data acquisition was initiated as soon as we left the exclusive economic zone of Namibia on December 28th, 2012 to fill white areas in the ocean floor maps. When necessary sound velocity profiles were measured to calibrate the multibeam echo sounder EM122. During the transit the BB-OBS and OBMT groups set up the laboratories. Unfortunately, one container with essential goods for the recovery did not arrive in time to Walvis Bay. Luckily, we got a back-up system for the OBS recovery from K.U.M. Umwelt- und Meerestechnik Kiel GmbH and were supported with missing tools and material by the vessel.

In the morning of January 2nd we arrived to the first recovery station, where one BB-OBS and on OBMT had to be recovered. Arriving on site, we first got into contact with the acoustic release system of the ocean-bottom instruments. Therefore, specific acoustic codes were sent by a cabled hydrophone to wake up the release units at the seafloor, range the distance to the instruments and finally to release the complete instruments from their iron or concrete anchors.

At sites where MT stations from ERI Tokyo have been deployed, triangulation by ranging the distance to the release units were performed before the release of the instruments. Depending on the instrument type, ascend of the instruments to the sea surface took about 40 to 60 minutes (BBOBS and OBMT from GEOMAR) and 100 to 130 minutes (MT stations from ERI). After the instruments were located at sea surface by radio or visually, the actual recovery operation took about 15 to 25 minutes depending on the sea state.

On deck we synchronized the internal clocks by GPS time stamps and ended the recording. Afterwards data was downloaded, uncompressed and reformatted. Then, a first quality control of the recorded data took place. Finally, the instruments were dismantled and components were packed.

The mainly north-south trending ship tracks for recovery have been chosen according to prevailing wind and current directions as we already did last year during the deployment cruise. To allow a topographic correction of the MT data, we carried out additional bathymetric surveys around the station sites. Furthermore, we went along parallel tracks to the last year ones to get more complete bathymetry coverage of the region, even if we could not cover the area of interest totally. Coverage of nearly

100% was only achieved in the close vicinity of the Tristan da Cunha archipelago.

Recovery of stations was interrupted by short visits to Tristan da Cunha's only settlement, Edinburgh of the Seven Seas, on January 7th in the afternoon to disembark the South African coastal engineer R. Jansen. geologist S. Kollenz and artist H. Leu. Chief scientist W. Geissler as well as Captain R. Schmidt and 1st officer J.-P. Günther also went ashore to meet the administrator of Tristan da Cunha S. Burns. We discussed the geological sampling on Tristan da Cunha and the planned land expedition to Nightingale. S. Kollenz took rock samples along the coast and along a profile halfway up to the volcano's summit to study landscape evolution.

On Nightingale we had installed two seismometers and one magnetotelluric station during cruise MSM 20-2. For their recovery three local guides embarked to Maria S. Merian and their landing boat was stored on deck. During the night two more ocean bottom stations were successfully recovered. In the morning of January 8th, scientists W. Geissler, K. Baba, H. Kirk, and O. Schwartz landed together with the local guides on Nightingale for dismantling the land stations. In the early afternoon all went back onboard Maria S. Merian. In the meantime bathymetry around Nightingale Island was mapped using the shallow-water EM1002 multi-beam echo sounder. During the night from January 8th to 9th we again recovered two stations from the seafloor. On January 9th we once more headed for Edinburgh of the Seven Seas. Scientists and crew of the Maria S. Merian used the occasion for a short visit of the island. In the afternoon a delegation from Tristan da Cunha, including the administrator Sean Burns, visited Maria S. Merian.

Together with the geologist and the artist we left Tristan da Cunha in the evening and continued with the recovery of the ocean-bottom instruments. Unfortunately, the next ocean-bottom seismometer (TDC25) could not be released from the seafloor even if it answered all release commands. After several failed attempts to release the instrument the schedule forced us to head for the next recovery site. Until the morning of January 13rd we recovered the remaining BB-OBS and OBMT, with the exception of the last BB-OBS (TDC17). Again we got into contact to the release unit, but the release failed, most probably due to problems with the power supply of the manual release system. At this site we hope that the autonomous time release will bring the instrument to the surface on February 13th, 2012. In the following night we again visited the site of the first missed BB-OBS (TDC25) to try again to release it, but unfortunately, without success.

Bathymetry. Parasound and Gravity

Bathymetric and Parasound measurements were conducted continuously during the whole cruise by means of Kongsberg EM122 and ATLAS Parasound sediment echo sounders. Acquisition started on December 28th. 2012, after leaving the Namibian exclusive economic zone and lasted until January 19th, 2013 arriving close to the South African exclusive economic zone. We had to stop acquisition of Parasound data already January 13th, 2013 due to severe technical problems with the instrument. To calibrate the multibeam echo sounder we regularly measured sound velocity profiles in the water column. While staying close to Nightingale Island for the recovery of land stations, the close vicinity of the island was mapped using the Kongsberg EM1002 swath bathymetry echo sounder. Additionally, we also operated the ADCP 38 kHz system to measure currents in the ocean. Unfortunately, the ADCP-75 kHz

system was not stable. That's why, we decided to shutdown the acquisition already at the beginning of the cruise. We used the time left after the recovery of the ocean-bottom instruments to map the seafloor east of Tristan da Cunha and around some seamounts further east on the way back to Cape Town.

We arrived to Cape Town already in the morning of January 20th, 2013, one day earlier than previously planned. This was because we needed an additional day to ensure a proper packing of all scientific equipment. Since most of the boxes were stored in the missing and now to Cape Town delivered container, this could not be carried at sea.

Acknowledgement

We thank the master Ralf 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 "Senats-kommission 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. Furthermore we thank the German instrument pool for amphibian seismology (DEPAS) and Geophysical Instrument Pool Potsdam (GIPP) for providing instruments and technical support. Special thanks go to the Tristan Island Village Council, the Tristan da Cunha administrator S. Burns, and our local guides led by Robin Repetto, Trevor Glass and Simon Glass. Again, we want to thank K.U.M. Umwelt- und Meerestechnik Kiel GmbH for providing us with the back-up system that finally allowed us to leave Walvis Bay in time without our container freight. We thank all unnamed people in our institutes and somewhere else that made this cruise to a successful expedition. Lastly, we would also like to thank the German Ministry of Foreign Affairs for acquiring the necessary research permits.

Participants

Name	Discipline	Institution
Geissler, Wolfram	Marine Geophysics / Chief Scientist	AWI
Kirk, Henning	Marine Geophysics	AWI
Baba, Kiyoshi	Marine Geophysics	ERI
Ota, Toyonobu	Marine Geophysics	ERI
Schröder, Patrick	Marine Geophysics	GEOMAR
Schwartz, Olav	Marine Geophysics	GEOMAR
Barkawitz, Gesa	Marine Geophysics	Bremen
Kammann, Janina	Marine Geophysics	Hamburg
Schulten, Irena	Marine Geophysics	Kiel
Tsekhmistrenko, Maria	Marine Geophysics	Bremen
Plöger, Miriam	Marine Geophysics	GEOMAR
Stechert, Robin	Marine Geophysics	GEOMAR
Kollenz, Sebastian	Geology	U Heidelberg
Leu, Hilke	Artist	Bremerhaven
Jansen, Ruben*	Civil Engineer	WSP

AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
ERI	Earthquake Research Institute, University of Tokyo, Japan
GEOMAR	Helmholtz Institute of Ocean Research, Kiel, Germany
U Heidelberg	University of Heidelberg, Germany
WSP	Wsp Africa Coastal Engineers, Stellenbosch, South Africa
*	passenger to Tristan da Cunha

Figures

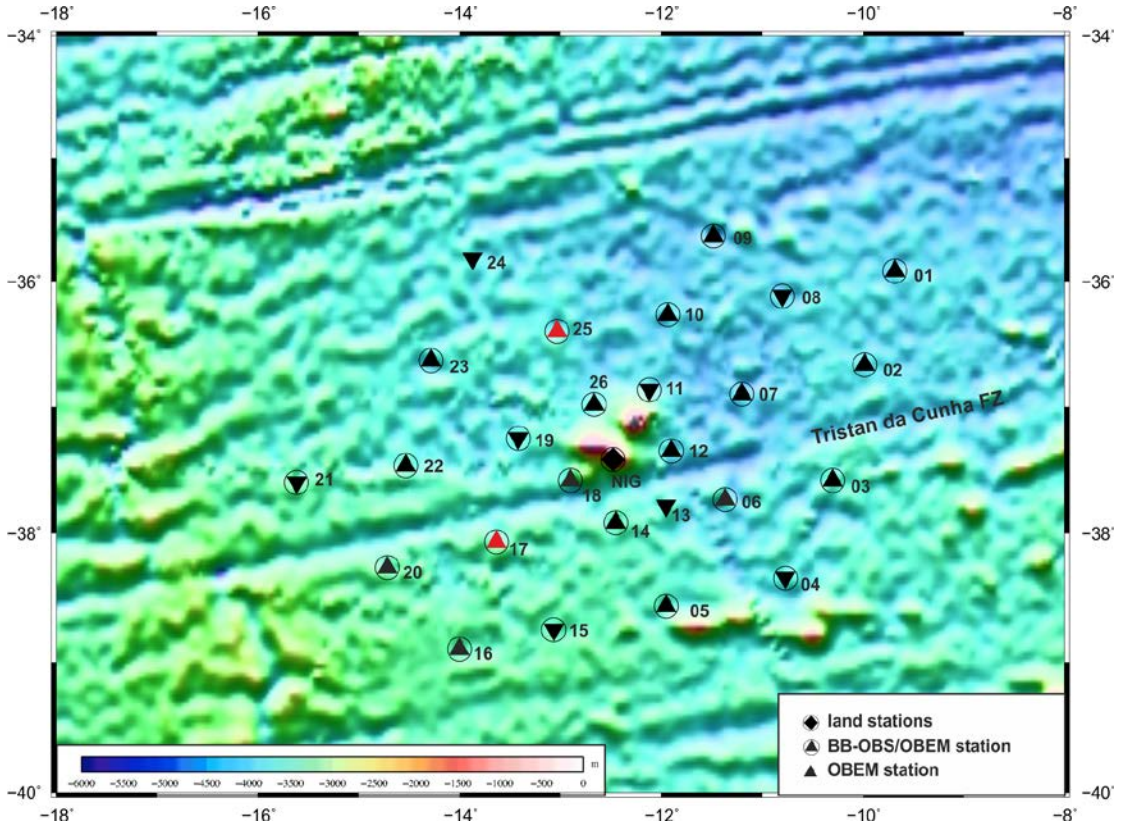


Figure 1. Station map.

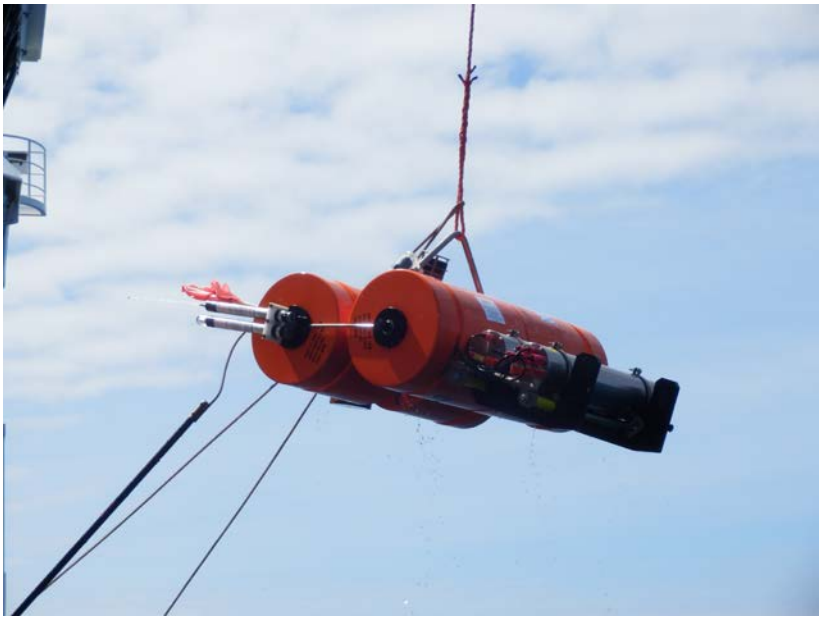


Figure 2. Recovery of DEPAS BBOBS (Photograph: K. Baba).

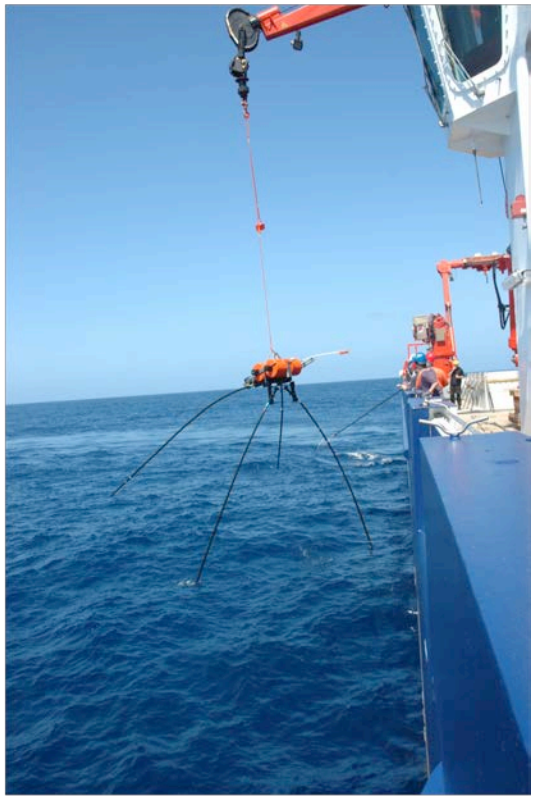


Figure 3. Recovery of GEOMAR OBMT (Photograph: K. Baba).

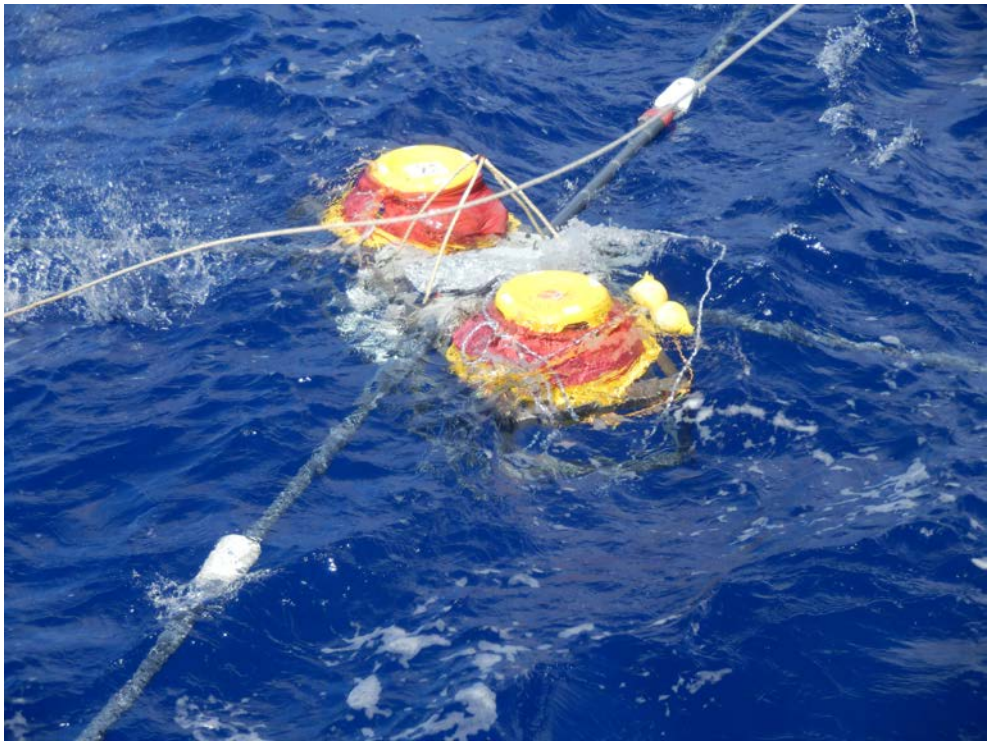


Figure 4. ERI OBMT station (photograph: K. Baba).

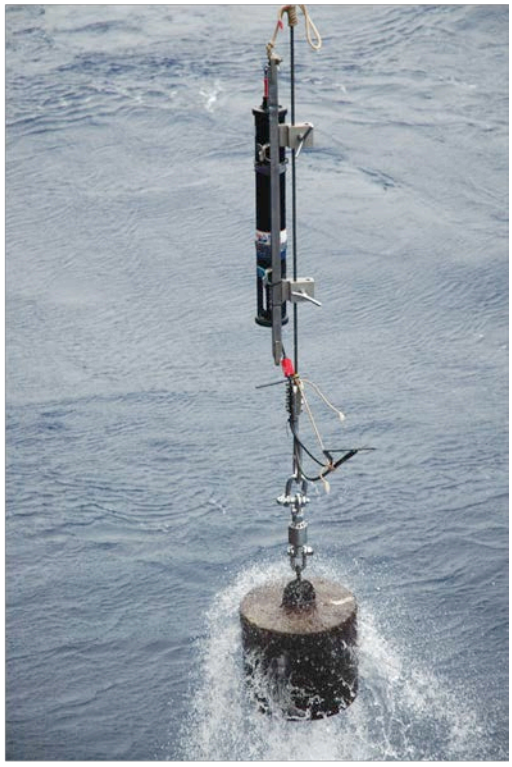


Figure 5. Sound velocity probe
(Photograph: H. Leu)

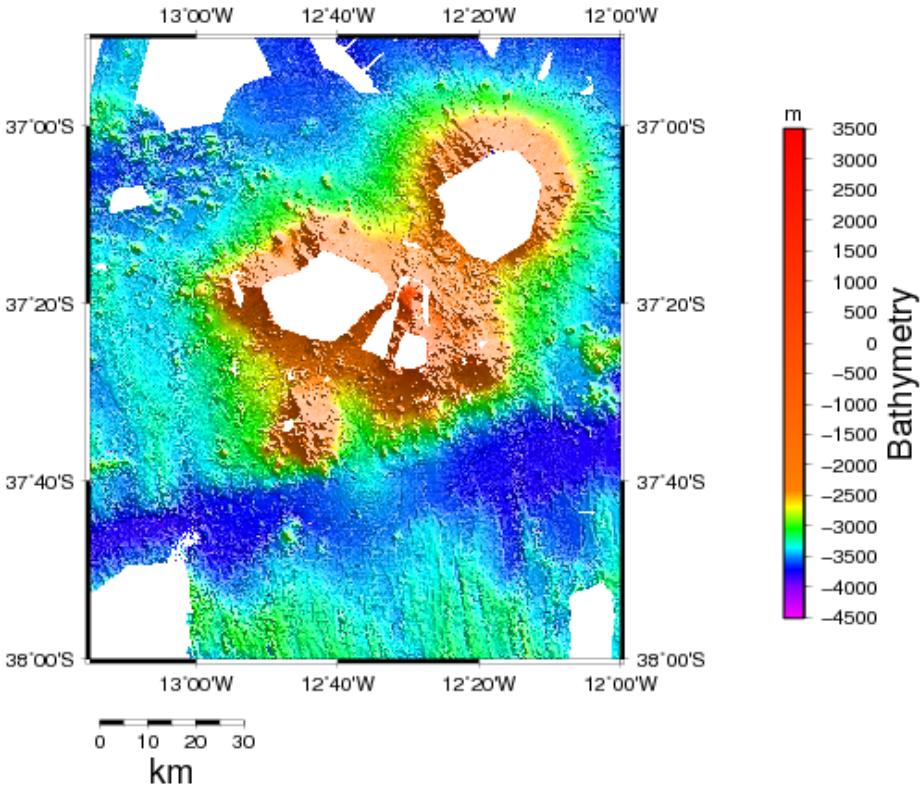


Figure 6. Bathymetric data around Tristan da Cunha acquired during cruises MSM 20-2 and MSM 24.

List of Stations

Table 1. Recovered broadband ocean bottom seismometer stations (BB-OBS).

Station No.	Date	Time [UTC]	Position Lat	Position Lon	Depth [m]	Gear
MSM24/830-1	02.01.13	05:21	35° 55.45' S	9° 41.05' W	3926	TDC01
MSM24/831-1	02.01.13	14:15	36° 40.24' S	9° 59.76' W	3645	TDC02
MSM24/832-1	02.01.13	22:17	37° 35.48' S	10° 18.23' W	3372	TDC03
MSM24/833-1	03.01.13	09:00	38° 21.76' S	10° 46.83' W	3532	TDC04
MSM24/834-2	03.01.13	19:38	37° 44.95' S	11° 22.72' W	3557	TDC06
MSM24/835-1	04.01.13	05:18	36° 54.50' S	11° 12.03' W	3808	TDC07
MSM24/836-2	04.01.13	17:20	36° 7.67' S	10° 48.16' W	3942	TDC08
MSM24/837-1	05.01.13	01:07	35° 38.51' S	11° 29.70' W	4165	TDC09
MSM24/838-1	05.01.13	10:00	36° 16.24' S	11° 56.33' W	3720	TDC10
MSM24/839-2	05.01.13	17:18	36° 52.67' S	12° 7.13' W	3576	TDC11
MSM24/840-1	06.01.13	00:06	37° 21.91' S	11° 54.19' W	3671	TDC12
MSM24/842-1	06.01.13	14:37	38° 34.71' S	11° 57.42' W	-	TDC05
MSM24/843-1	06.01.13	20:37	37° 55.70' S	12° 27.10' W	3303	TDC14
MSM24/844-1	07.01.13	05:05	37° 35.73' S	12° 54.89' W	-	TDC18
MSM24/845-2	08.01.13	02:29	37° 15.18' S	13° 25.23' W	3590	TDC19
MSM24/846-1	09.01.13	04:00	36° 59.73' S	12° 40.60' W	3504	TDC26
MSM24/849-1	10.01.13	21:41	36° 38.88' S	14° 16.81' W	3679	TDC23
MSM24/850-1	11.01.13	04:21	37° 25.35' S	14° 32.80' W	3336	TDC22
MSM24/851-1	11.01.13	15:19	37° 36.69' S	15° 37.05' W	-	TDC21
MSM24/852-1	12.01.13	06:30	38° 16.47' S	14° 43.26' W	3220	TDC20
MSM24/853-1	12.01.13	14:27	38° 53.99' S	14° 0.86' W	3101	TDC16
MSM24/854-1	13.01.13	01:55	38° 45.05' S	13° 4.73' W	3181	TDC15

Table 2. Not recovered broadband ocean bottom seismometer stations (BB-OBS).

Station No.	Date	Time [UTC]	Position Lat	Position Lon	Depth [m]	Gear
MSM24/847-1	10.01.13	06:23	36° 24.90' S	13° 3.74' W	3524	TDC25 (failed)
MSM24/855-1	13.01.13	12:11	38° 4.84' S	13° 38.01' W	-	TDC17 /failed)
MSM24/847-1	14.01.13	00:31	36° 24.35' S	13° 2.63' W	-	TDC25 (failed)

Table 3. Recovered land stations (S – seismological; MT – magneto-telluric).

Station	Recovery (UTC)	Latitude	Longitude	Elevation (m)
NIG01 (S)	8.1.2013 10:15	37° 25.061' S	12° 28.532' W	40
NIG02 (S)	8.1.2013 09:00	37° 25.095' S	12° 28.660' W	65
NIG03 (MT)	8.1.2013 09:13	37° 25.084' S	12° 28.604' W	57

Table 4. Recovered ocean bottom magneto-telluric stations (OBMT).

Station No.	Date	Time [UTC]	Position Lat	Position Lon	Depth [m]	Station Name
MSM24/830-2	02.01.13	07:01	35° 55.67' S	9° 40.60' W	3927	TRIS01
MSM24/831-2	02.01.13	14:59	36° 40.26' S	9° 58.74' W	3641	TRIS02
MSM24/832-2	02.01.13	23:01	37° 35.49' S	10° 17.52' W	3388	TRIS03
MSM24/833-2	03.01.13	10:09	38° 21.66' S	10° 46.50' W	-	TRIS04 (ERI)
MSM24/834-1	03.01.13	18:43	37° 44.67' S	11° 22.25' W	3561	TRIS06
MSM24/835-2	04.01.13	05:55	36° 54.39' S	11° 11.79' W	3808	TRIS07
MSM24/836-1	04.01.13	18:06	36° 7.58' S	10° 48.04' W	3941	TRIS08 (ERI)
MSM24/837-2	05.01.13	01:40	35° 38.24' S	11° 29.48' W	4169	TRIS09
MSM24/838-2	05.01.13	10:32	36° 16.00' S	11° 56.28' W	3722	TRIS10
MSM24/839-1	05.01.13	18:38	36° 52.68' S	12° 6.26' W	3584	TRIS11 (ERI)
MSM24/840-2	06.01.13	00:43	37° 21.77' S	11° 53.20' W	3686	TRIS12
MSM24/841-1	06.01.13	09:09	37° 47.01' S	11° 57.42' W	3207	TRIS13 (ERI)
MSM24/842-2	06.01.13	15:22	38° 34.76' S	11° 57.31' W	3144	TRIS05
MSM24/843-2	06.01.13	21:14	37° 55.63' S	12° 27.02' W	3297	TRIS14
MSM24/844-2	07.01.13	05:42	37° 35.71' S	12° 54.78' W	3158	TRIS18
MSM24/845-1	08.01.13	03:28	37° 15.22' S	13° 25.24' W	3593	TRIS19 (ERI)
MSM24/846-2	09.01.13	04:36	36° 59.36' S	12° 40.68' W	3503	TRIS26
MSM24/847-2	10.01.13	01:38	36° 23.62' S	13° 2.77' W	-	TRIS25
MSM24/848-1	10.01.13	15:48	35° 48.98' S	13° 52.49' W	3660	TRIS24 (ERI)
MSM24/849-2	10.01.13	22:23	36° 38.78' S	14° 16.41' W	3679	TRIS23
MSM24/850-2	11.01.13	06:09	37° 25.68' S	14° 32.75' W	3331	TRIS22
MSM24/851-2	11.01.13	16:06	37° 36.60' S	15° 37.04' W	-	TRIS21 (ERI)
MSM24/852-2	12.01.13	08:31	38° 16.76' S	14° 42.43' W	3185	TRIS20
MSM24/853-2	12.01.13	15:12	38° 53.95' S	14° 0.51' W	3112	TRIS16
MSM24/854-2	13.01.13	02:47	38° 45.29' S	13° 4.52' W	3172	TRIS15 (ERI)
MSM24/855-2	13.01.13	10:26	38° 4.78' S	13° 37.93' W	3387	TRIS17

Table 5. Sound velocity profiles measured by sound velocity probe (SVP).

Station No.	Date	Time [UTC]	Position Lat	Position Lon	Depth [m]	Gear
MSM24/826-1	28.12.12	11:36	25° 11.83' S	10° 48.85' E	-	SVP (1500 m)
MSM24/827-1	29.12.12	12:38	27° 57.46' S	6° 8.01' E	-	SVP (1500 m)
MSM24/828-1	30.12.12	12:29	30° 34.30' S	1° 38.80' E	-	SVP (1000 m)
MSM24/829-1	01.01.13	13:27	35° 20.28' S	6° 39.54' W	-	SVP (1200 m)
MSM24/832-3	02.01.13	23:57	37° 35.83' S	10° 17.40' W	-	SVP (1500 m)
MSM24/836-3	04.01.13	18:50	36° 7.58' S	10° 48.04' W	3944	SVP (1500 m)
MSM24/841-2	06.01.13	07:29	37° 47.61' S	11° 55.37' W	-	SVP (1500 m)
MSM24/848-2	10.01.13	14:16	35° 49.25' S	13° 52.36' W	-	SVP (1500 m)
MSM24/850-3	11.01.13	06:53	37° 25.68' S	14° 32.76' W	-	SVP (1500 m)
MSM24/853-3	12.01.13	15:52	38° 53.96' S	14° 0.51' W	3115	SVP (1500 m)
MSM24/855-3	13.01.13	11:17	38° 4.84' S	13° 38.02' W	-	SVP (1500 m)