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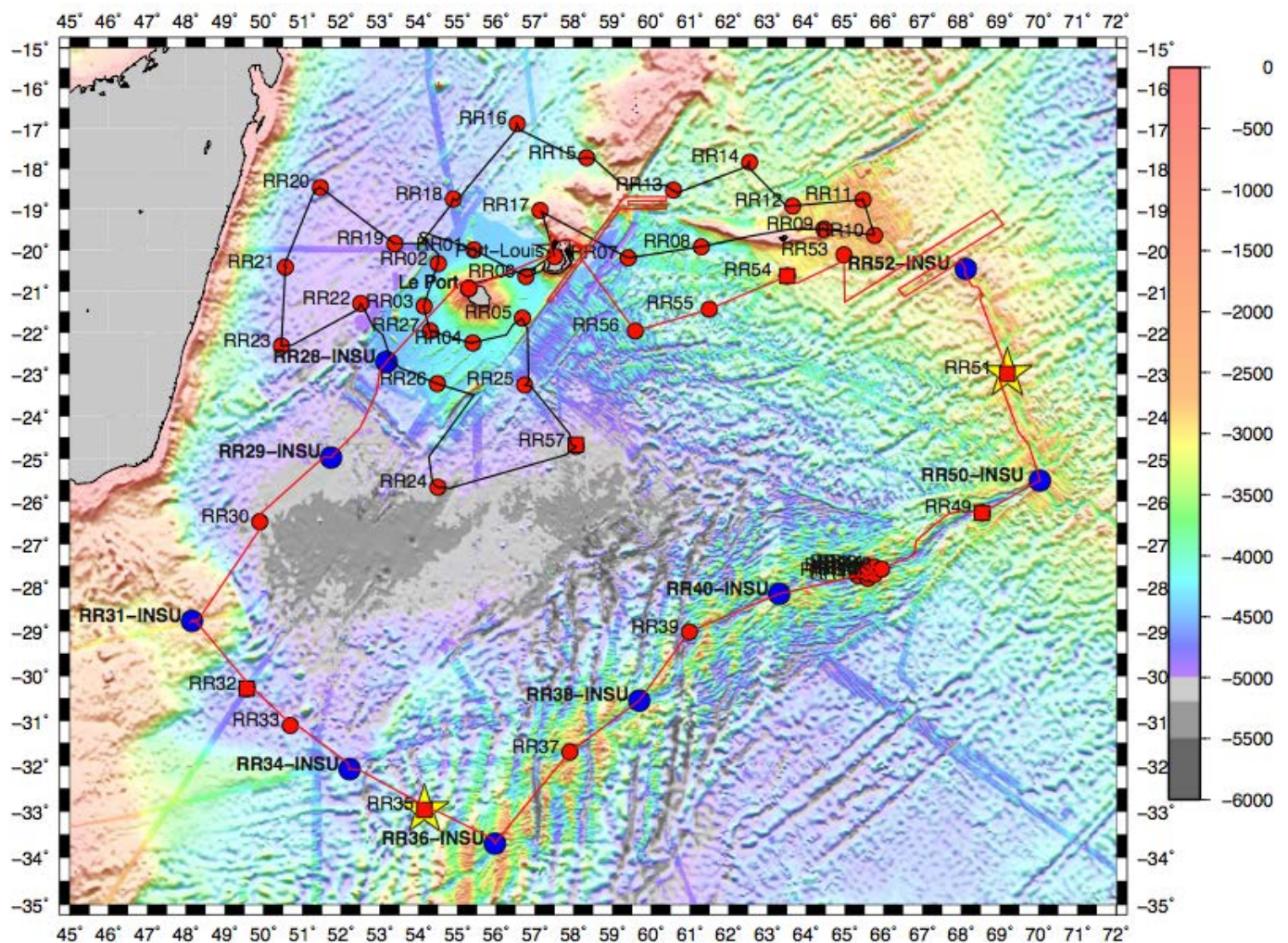
Short Cruise Report METEOR Cruise 101

Port Louis, Mauritius – Le Port, La Réunion (France)

23/10/2013 – 04/12/2013

Chief Scientist: Dr. Karin Sigloch

Captain: Michael Schneider



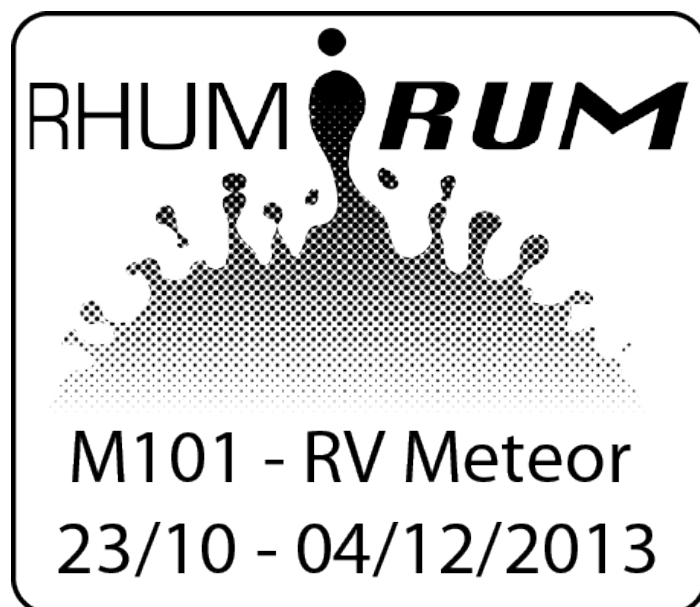
Objectives

RHUM-RUM – Seismological Imaging of a mantle plume under La Réunion, western Indian Ocean

La Réunion Island in the western Indian Ocean is among the most active volcanoes in the world and a very strong candidate for a hot spot underlain by a deep, “classical” mantle plume. The German-French project RHUM-RUM (Réunion Hotspot and Upper Mantle–Réunions Unterer Mantel) aims to seismologically image the crust and mantle under the island at all depths. We want to help settle the first-order question of whether deep mantle plumes exist and are important to the solid earth’s heat budget. RHUM-RUM the largest attempt so far to seismologically image an oceanic mantle plume.

During R/V METEOR cruise M101, we successfully recovered all 57 ocean-bottom seismometers that we had deployed over an area of 1500×2000 square kilometers one year earlier, using the Réunion-based research vessel MARION DUFRESNE. We continuously acquired multi-swath bathymetry and tow-behind magnetic data along our 15,000-km long cruise track of largely unmapped ocean floor. This included four dedicated, exploratory profiles around Mauritius and the Central and Southwest Indian spreading ridges, targeted at specific tectonic questions.

The cruise consisted of two legs (M101/1 and M101/2). On Leg 1, which lasted from 23/10 to 10/11/2013, we recovered ocean-bottom seismometers around the Mascarene Islands (La Réunion, Mauritius, Rodrigues), between Madagascar to the west and the Central Indian Ridge to the east – along the black ship track on the station map. Leg 1 ended on 11/11 with a stopover in Le Port de la Réunion, where we exchanged part of our personnel and our gear. On Leg 2 (red track), which lasted from 12/11 to 04/12/2013, we recovered ocean-bottom seismometers along an extensive loop to the south, tracking the Southwest and Central Indian spreading ridges during roughly half of the leg.



Narrative

4.1 Leg 1 (Port Louis, 23 Oct. 2013 – Le Port de la Réunion, 10 Nov. 2013)

The METEOR left Port Louis on 23 October around 9:00 as planned, heading north. Six hours later, we arrived at the first of 57 ocean-bottom seismometers (OBS) to be recovered. The station RR17, named “Le Dodo” in honor of Mauritius and its national mascot bird, returned to the surface without hesitation, and with a full data load.

The OBS recovery procedure would become the structuring pattern of the cruise. In this routine of recovering 1-3 OBS per day, we would encounter various issues, such as no reply upon calling, a flasher beacon failing in a night recovery, or realizations that certain seismometers, batteries, data loggers, or internal clocks had not worked as desired. The most basic measure of success however is that we did recover 100% of our ocean-bottom seismometers, a remarkable statistic. We had deployed 48 DEPAS broadband seismometers (the largest number of unique instruments ever deployed from the pool), plus 9 French broadband seismometers from the INSU pool, managed by IPG Paris. All in all, this was one of the largest long-term (13 month) deployments of ocean-bottom seismometers worldwide so far.

During Oct. 24-26, the cruise continued east past the island of Rodrigues. After the second OBS, RR07, we started the continuous acquisition of multi-swath bathymetry data using the METEOR’s Kongsberg EM122 sounder, and of scalar magnetic data, acquired by a SeaSpy magnetometer towed 200 meters behind the ship. An atmospheric chemistry group by the Max Planck Institute for Geochemistry in Jena continuously measured atmospheric mixing ratios of carbon dioxide, methane, and water vapor, along the entire cruise track.

We established a routine of scientific seminars and work meetings almost every evening. We also established a regular blog for outreach to the general public in English, French and German (www.rhum-rum.net/en/blog, www.rhum-rum.net/fr/blog, www.rhum-rum.net/de/blog).

On October 26, two OBS on the Central Indian Ridge were recovered (RR10 and RR11), and the METEOR. Turning back west and north, the first tropical storm of the season was forming a few hundred kilometers north of us, and would parallel our westward track for several days. This meant a number of OBS recoveries in winds of Beaufort 7 or 8 until October 30, which was unpleasant but manageable.

While the weather would be unproblematic for the remainder of the cruise, and all OBS would return to the surface, we started having some serious issues with seismological data harvest from station RR23 onward. All in all, 9 of the 48 German seismometers would fail to yield data because they had returned defective from a repair by their manufacturer, and had remained mechanically blocked once they landed on the seafloor.

With some spare time at the end of Leg 1, we could do some dedicated bathymetric mapping and targeted a major seamount (La Pérouse, located between RR02 and RR19, surveyed on 6 Nov 2013), and the steep flanks of the plateau that hosts the island of Mauritius on 7-8 Nov. 2013.

After a refueling stop in Mauritius on 09/11, Leg 1 ended as planned in the harbor of Le Port de la Réunion on the morning of 10 November. 11 scientists left the ship, 9 new colleagues joined us, and new provisions were stocked.

Leg 2 (Le Port de la Réunion, 12 Nov. 2013 – Le Port de la Réunion, 4 Dec. 2013)

The METEOR left the port of La Réunion on the morning of 12/11/2013 as planned, with the 7000-km long loop to the deep south ahead of its (red track in cruise map), taken in counterclockwise sense in order to use tailwinds both in the south (west winds prevailing) and in the north (east winds). During Leg 1, we had recovered only German OBS, but in Réunion, our colleagues from the French OBS team had joined us in order to recover 9 French OBS during Leg 2 (in addition to 20 more German OBS).

The data yield of the French OBS was quite high (around 85% of total time, all 9 stations functioned), whereas 6 of the 20 German OBS on Leg 2 unfortunately yielded no seismograms at all, due to the aforementioned defect. Their hydrophones did record. German and French stations had been deploying in alternating order (red and blue dots, respectively, on the map, so that we should be able to interpolate across data gaps).

A cluster of 8 German OBS (RR41-RR48) on “Segment 8” of the Southwest Indian Ridge had worked very well (7 out of 8 stations with good data yield). The primary purpose of this densified sub-network was to study the seismicity of this anomalously slow spreading ridge. During an around-the-clock recovery operation of this sub-array (about 36 hours on 21-23 November), we also took time to triangulate each OBS for a more precise location estimate, and optimized the ship track to yield a complete bathymetric amp of the seamount and its surroundings.

On station RR50 and RR52, we deployed two “MERMAIDS”, novel seismological Argos floats that drift passively in the SOFAR channel and rise to the surface to transmit data in real time as soon as their hydrophones have detected the hydroacoustic signal of a larger earthquake.

The non-scientific highlight of the cruise was a meeting with R/V SONNE on the Central Indian Ridge at station RR51 on Sunday, 24 November. The SONNE has been exploring for metal sulphides in this area, and we had learned of its presence about one week earlier. The scientific parties and crews of both ships were eager to spend a few hours in meeting on the open ocean and visiting the other ship, so this was scheduled for Sunday afternoon, following the recovery of RR51. The occasion was clearly special and even moving, since in 27 possible years, the METEOR and the SONNE had never met, and the SONNE, built in 1969, is currently in its final year of service.

On average, we had gained time as Leg 2 proceeded, and the weather remained favorable throughout. This allowed us to survey two more targeted bathymetric and magnetic profiles towards the end. On 25-26/11, we did an exploratory survey (three east-west profiles between RR52 and RR53) to explore the spreading history of a ridge segment that is thought to be perturbed by flow of Réunion plume material into the Central Indian Ridge.

The second dedicated bathymetric/magnetic survey of Leg 2 took place at the end of the cruise (28/11 to 03/12). We surveyed the extremely pronounced transform fault east of Mauritius on two long, SW-NE passes, and a suspected extension of Rodrigues Ridge to the northeast of Mauritius, in four E-W passes

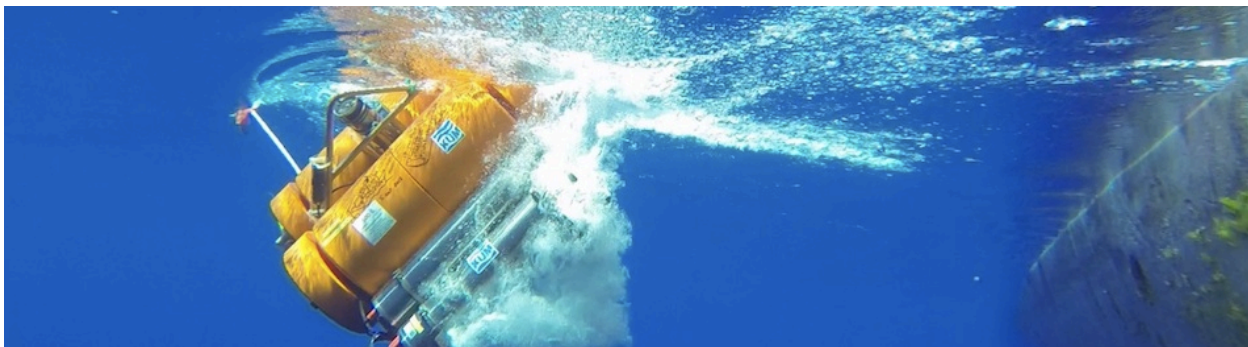
After refueling in Mauritius on 03/12, we transited to La Réunion during the night, ending the cruise in the morning of 04/12 in Le Port de la Réunion, as planned.



Recovery of ocean-bottom seismometer RR12 during the late evening of 26/10/2013.



French OBS RR40 seconds before being pulled out of the water. Hooked by the ship crane, this type of instrument swings like a double pendulum, and also needs to be approached carefully due to its protruding parts.



Recovery of a German model. Here, RR04 has been hooked by the ship crane and has to turn, seconds before being pulled out of the water.

Acknowledgements

We thank Captain Michael Schneider and the extremely professional, skilled, and friendly crew of the METEOR for their crucial role in making cruise M101 a success. We also thank the funding agencies of RHUM-RUM: in Germany, the Deutsche Forschungsgemeinschaft (DFG) and the Senatskommission für Ozeanographie of the DFG; in France, the Agence Nationale de la Recherche (ANR) and the Institut National des Sciences de l'Univers (INSU).

Participants

Colleagues who participated in both cruise legs (13 scientists and 2 meteorologists)

Name	Discipline	Institution
Sigloch, Karin, Dr.	Seismology / Chief Scientist	LMU
Barruol, Guilhem, Dr.	Seismology / Senior Scientist	ULR, IPGP
Andriampenomanana, Elamahalala	Seismology	UANT
Andrianasolo, Ramarolahy Rina	Seismology	UANT
Bissessur, Pritivi Dass, Dr.	Marine Geophysics	MOI
Hosseini, Seyed Kasra	Seismology	LMU
Korger, Edith, Dr.	Seismology, OBS Technician	AWI
Labahn, Erik	OBS Engineer	KUM
Mazzullo, Alessandro	Seismology	IPGP
Molina, Antonio	Seismology	LMU
Seifert, Thomas	Atmospheric Chemistry	MPIJ
Tsekhmistrenko, Maria	OBS Technician	AWI
Velasquez, Juan Santiago	Seismology	LMU
Hartmut Sonnabend	Meteorologist	DWD
Andreas Raeke	Weather Technician	DWD

Colleagues who participated in Leg 1 only (11 scientists)

Name	Discipline	Institution
Bronner, Adrien, Dr.	Marine Geophysics	EOST
Capdeville, Yann, Dr.	Seismology	UNAN
Coadou, Erlé	Seismology	ULR
Davy, Céline	Seismology	ULR
Deplus, Christine, Dr.	Marine Geophysics	IPGP
Dyment, Jérôme, Dr.	Marine Geophysics	IPGP
Fontaine, Fabrice, Dr.	Seismology	ULR
Igel, Heiner, Prof. Dr.	Seismology	LMU
Morgan, Jason Phipps, Prof. Dr.	Marine Geophysics	RHUL
Mouraut, Nicolas	Seismology	ULR
Stähler, Simon	Seismology	LMU

Colleagues who participated in Leg 2 only (9 scientists)

Name	Discipline	Institution
Berthod, Carole	Geology	ULR
Daniel, Romuald	OBS Engineer	IPGP
Gabriel, Anne Alice, Dr.	Seismology	LMU
Gaina, Carmen, Dr.	Marine Geophysics	UOS
Muller, Elisabeth	Marine Geophysics	UOX
Li, Xuan	OBS Engineer	IPGP
Roult, Geneviève, Dr.	Seismology	IPGP
Rümpker, Georg, Prof. Dr.	Seismology	UFR
Bonnieux, Sébastien	Marine Engineer	UNIC

LMU	Ludwig-Maximilians-Universität München
ULR	Université de La Réunion
AWI	Alfred Wegener Institut Bremerhaven
DWD	Deutscher Wetterdienst, Geschäftsfeld Seeschifffahrt
EOST	Ecole et Observatoire des Sciences de la Terre, Strasbourg
IPGP	Institut de Physique du Globe, Paris
KUM	Kiel Umwelt- und Meerestechnik, Kiel
MOI	Mauritius Oceanography Institute
MPIJ	Max Planck Institut für Biogeochemie, Jena
RHUL	Royal Holloway University London
UANT	University of Antananarivo, Institute and Observatory of Geophysics
UFR	Goethe-Universität Frankfurt am Main
UNAN	Université de Nantes
UNIC	Université de Nice
UOS	University of Oslo
UOX	University of Oxford



Station list

Station List M101/1 (Leg 1)

		Date	Time	Latitude	Longitude	Water Depth	Gear
METEOR	RHUM-RUM		[UTC]	[°S]	[°E]	[m]	
ME101-1/1990-1	RR 17	23.10.2013	12:02	19° 04,52' S	057° 10,18' E	2205	OBS+SVP
ME101-1/1993-1	RR 07	24.10.2013	4:09	20° 10,37' S	059° 21,39' E	4370	OBS
ME101-1/1996-1	RR 08	24.10.2013	17:04	19° 55,33' S	061° 16,67' E	4190	OBS
ME101-1/1999-1	RR 09	25.10.2013	13:00	19° 29,25' S	064° 26,23' E	2976	OBS
ME101-1/2002-1	RR 10	25.10.2013	22:04	19° 38,40' S	065° 44,74' E	2310	OBS
ME101-1/2005-1	RR 11	26.10.2013	4:25	18° 46,26' S	065° 27,18' E	3941	OBS
ME101-1/2009-1	RR 12	26.10.2013	16:15	18° 55,26' S	063° 38,60' E	3185	OBS+SVP
ME101-1/2012-1	RR 14	27.10.2013	2:59	17° 50,34' S	062° 31,52' E	3420	OBS
ME101-1/2015-1	RR 13	27.10.2013	16:12	18° 32,26' S	060° 33,49' E	4130	OBS
ME101-1/2018-1	RR 15	28.10.2013	7:50	17° 44,03' S	058° 19,54' E	3959	OBS
ME101-1/2021-1	RR 16	28.10.2013	20:00	16° 53,83' S	056° 32,24' E	4426	OBS
ME101-1/2025-1	RR 18	29.10.2013	13:54	18° 44,83' S	054° 52,96' E	4743	OBS+SVP
ME101-1/2028-1	RR 19	30.10.2013	3:11	19° 50,83' S	053° 22,63' E	4901	OBS
ME101-1/2031-1	RR 20	30.10.2013	17:18	18° 28,75' S	051° 26,97' E	4820	OBS
ME101-1/2034-1	RR 21	31.10.2013	7:42	20° 25,47' S	050° 33,12' E	4782	OBS
ME101-1/2037-1	RR 23	31.10.2013	20:04	22° 19,74' S	050° 26,33' E	4893	OBS
ME101-1/2040-1	RR 22	01.11.2013	11:28	21° 18,52' S	052° 29,77' E	4920	OBS
ME101-1/2043-1	RR26	02.11.2013	5:01	23° 13,90' S	054° 27,74' E	4259	OBS
ME101-1/2046-1	RR24	03.11.2013	2:12	25° 40,92' S	054° 29,07' E	5074	OBS
ME101-1/2049-1	RR57	03.11.2013	23:14	24° 44,00' S	058° 03,26' E	5200	OBS
ME101-1/2052-1	RR25	04.11.2013	12:10	23° 16,20' S	056° 43,97' E	4759	OBS
ME101-1/2055-1	RR05	05.11.2013	23:28	21° 40,24' S	056° 39,97' E	4092	OBS
ME101-1/2059-1	RR04	05.11.2013	9:00	22° 14,91' S	055° 22,98' E	4168	OBS+SVP
ME101-1/2061-1	RR27	05.11.2013	16:07	21° 57,97' S	054° 17,52' E	4277	OBS
ME101-1/2063-1	RR03	05.11.2013	20:46	21° 22,42' S	054° 07,30' E	4340	OBS
ME101-1/2065-1	RR02	06.11.2013	4:11	20° 20,40' S	054° 29,71' E	4436	OBS
ME101-1/2068-1	RR 01	06.11.2013	20:26	20° 00,17' S	055° 24,95' E	4298	OBS
ME101-1/2071-1	RR 06	07.11.2013	6:46	20° 39,25' S	056° 45,41' E	4216	OBS+SVP

Station List M101/2 (Leg 2)

		Date	Time	Latitude	Longitude	Water Depth	Gear
METEOR	RHUM-RUM		[UTC]	[°S]	[°E]	[m]	
ME101-2/2076-1	RR28-INSU	12.11.2013	21:10	22° 43,27' S	053° 09,24' E	4540	OBS+SVP
ME101-2/2080-1	RR29-INSU	13.11.2013	16:06	24° 58,12' S	051° 44,80' E	4825	OBS
ME101-2/2083-1	RR30	14.11.2013	9:10	26° 29,03' S	049° 52,83' E	5140	OBS+SVP
ME101-2/2087-1	RR31-INSU	15.11.2013	3:39	28° 46,23' S	048° 08,17' E	2710	OBS
ME101-2/2090-1	RR32	15.11.2013	17:45	30° 17,72' S	049° 33,09' E	4670	OBS
ME101-2/2093-1	RR33	16.11.2013	2:44	31° 07,32' S	050° 41,25' E	4904	OBS
ME101-2/2096-1	RR34-INSU	16.11.2013	14:49	32° 04,41' S	052° 12,61' E	4260	OBS
ME101-2/2098-1	RR 35	17.11.2013	6:27	32° 58,20' S	054° 09,03' E	4214	OBS
ME101-2/2101-1	RR 36-INSU	17.11.2013	18:31	33° 41,84' S	055° 57,19' E	3560	OBS
ME101-2/2104-1	RR 37	18.11.2013	11:38	31° 42,55' S	057° 53,10' E	4036	OBS
ME101-2/2107-1	RR 38-INSU	19.11.2013	0:24	30° 34,13' S	059° 40,95' E	4540	OBS
ME101-2/2110-1	RR 39-GM	19.11.2013	15:35	29° 01,11' S	060° 58,34' E	4700	OBS
ME101-2/2113-1	RR 40-INSU	20.11.2013	6:29	28° 09,02' S	063° 18,24' E	4750	OBS+SVP
ME101-2/2117-1	RR 41	20.11.2013	19:40	27° 44,03' S	065° 19,79' E	5430	OBS
ME101-2/2119-1	RR 46	21.11.2013	2:12	27° 47,73' S	065° 35,80' E	3640	OBS
ME101-2/2121-1	RR 42	21.11.2013	7:30	27° 36,61' S	065° 25,55' E	4776	OBS
ME101-2/2123-1	RR45	21.11.2013	12:57	27° 39,97' S	065° 36,67' E	2822	OBS

ME101-2/2125-1	RR 47	21.11.2013	15:55	27° 41,37' S	065° 46,05' E	4582	OBS
ME101-2/2127-1	RR 43	21.11.2013	20:05	27° 31,46' S	065° 34,23' E	4264	OBS
ME101-2/2129-1	RR 44	22.11.2013	0:18	27° 31,94' S	065° 45,64' E	4548	OBS
ME101-2/2131-1	RR 48	22.11.2013	4:31	27° 34,83' S	065° 57,57' E	4830	OBS
ME101-2/2134-1	RR 49	23.11.2013	0:27	26° 16,71' S	068° 31,94' E	4444	OBS
ME101-2/2137-1	RR50-INSU	23.11.2013	10:54	25° 31,63' S	070° 01,46' E	4100	OBS
ME101-2/2141-1	RR 51	24.11.2013	5:43	23° 00,05' S	069° 11,66' E	3463	OBS
ME101-2/2144-1	RR 52-INSU	25.11.2013	3:38	20° 28,43' S	068° 06,22' E	2880	OBS+SVP
ME101-2/2149-1	RR 53-GM	28.11.2013	0:51	20° 07,39' S	064° 57,65' E	2940	OBS
ME101-2/2152-1	RR 54	28.11.2013	11:30	20° 38,83' S	063° 29,84' E	2499	OBS
ME101-2/2155-1	RR 55	28.11.2013	23:38	21° 26,54' S	061° 29,68' E	4462	OBS
ME101-2/2158-1	RR56-GM	29.11.2013	10:40	21° 58,05' S	059° 35,51' E	4230	OBS
ME101-2/2161-1	--	30/11/2013	2:10	20° 23,43' S	057° 59,82' E	5089	SVP only

Gear abbreviations:

OBS: recovery of an ocean-bottom seismometer

SVP: sound velocity profile for calibrating the bathymetry system



The non-scientific highlight of the cruise was the meeting with RV SONNE on station RR51, Central Indian Ridge, on 24 November 2013.