

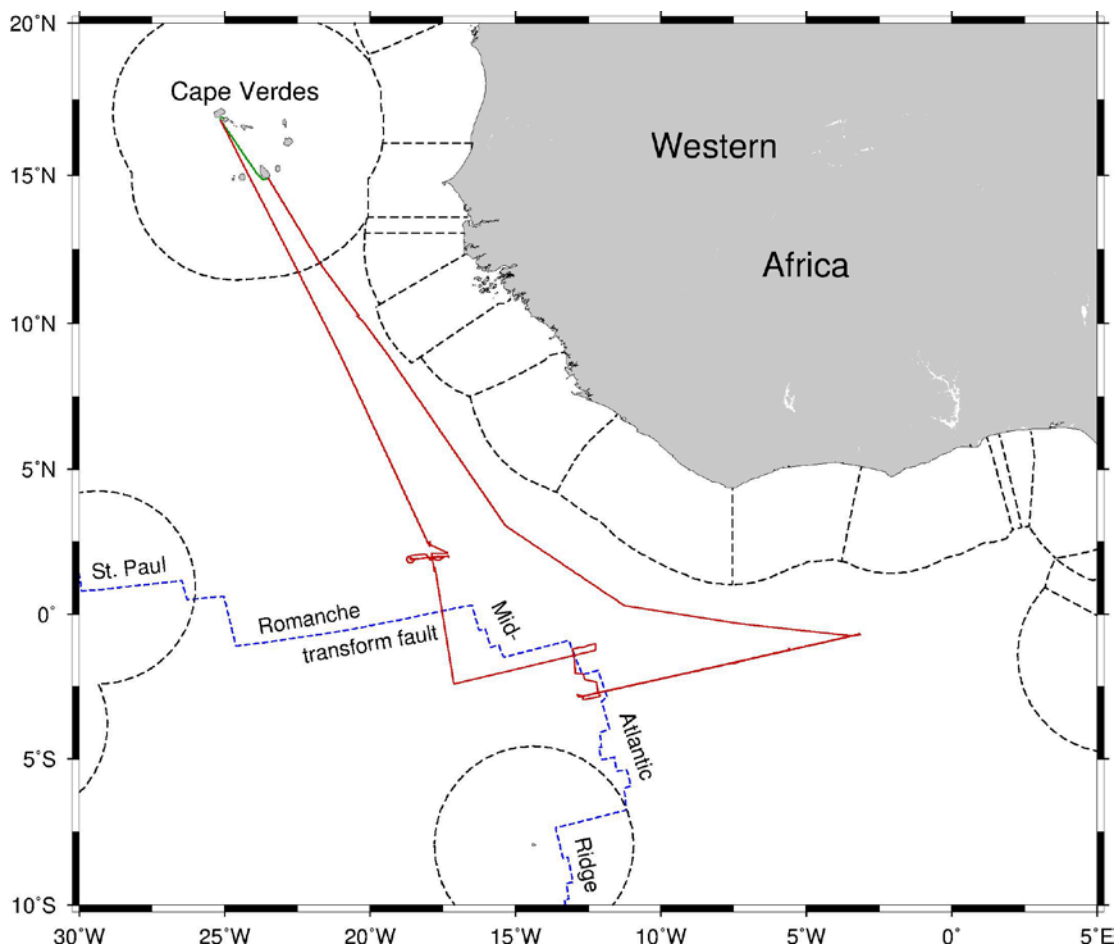
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## Short Cruise Report

### RV MARIA S. MERIAN Cruise MSM69

Mindelo/Praia, Cape Verde – Mindelo, Cape Verde  
14. November – 22. December 2017  
Chief Scientist: Ingo Grevemeyer  
Captain: Björn Maaß



## **Objectives**

The oceanic lithosphere is created by sea-floor spreading at mid-ocean ridges and covers approximately 57% of the Earth surface. Crustal thickness and lower crustal velocity are inherently related to the formation of the lithosphere and can be used to infer temporal variations in crustal accretion when moving away from the spreading ridge. After its formation, the shallow lithosphere is affected by hydrothermal circulation in the uppermost permeable crust over tens of millions of years. In turn, heat is removed from the lithosphere by circulating seawater and mineral precipitation modifies and seals open void spaces, affecting the heat loss, seismic velocity, and composition of the crust. In addition, lithosphere cools and thickens with age, resulting in the well-known subsidence of the seafloor, decreasing heat flow, and increasing seismic velocities in the rigid lithospheric mantle. In addition, the depth to the Lithosphere-Asthenosphere-Boundary (LAB) increases from approximately Moho depth to several tens of kilometres in Cretaceous crust. While the formation of crust and lithosphere at the spreading ridges is reasonably well studied, little is known about how crustal accretion changed over time and how crust and lithosphere change when carried away from the underlying heat source. Understanding how lithosphere evolves with age is thus a major challenge in Earth sciences. During MSM69, geophysical data were acquired along a 1100 km long transect in the equatorial Atlantic using seismic refraction and heat flow methods. In addition, the fossil trace of the St. Paul transform fault was surveyed. Our goal is to reveal the age-dependent features of the lithospheric structure such as crustal and mantle properties, age-dependent heat flow and major lithospheric boundaries like Moho and the LAB.

The project LITHOS-iLAB is a joint programme of German and French scientists.

## **Narrative of the Cruise**

MARIA S. MERIA left the port of Mindelo on the island of Sao Vicente on 14th of November 2017 at 23:00 local time. One day earlier, however, a sand storm on the 13th of November caused a redirection of the flight from Lisbon, changing its final destination from Sao Vicente to Praia. Thus, 16 scientists and 6 crew members were “stranded” on the island of Santiago in the southeast of the archipelago of Cape Verde. Unfortunately, it was not possible to bring all scientists and crew in time from Santiago to Sao Vicente. Thanks to Fortuna, it was possible to collect the “lost” scientists and crew in the morning of the 15th of November offshore of Praia at the pilot station. At about 11 a.m. on Wednesday the 15th of November 2017 the MERIAN left the archipelago, sailing for the next six days about 1500 nm southward and across the equator into the working area. About 3 hours after leaving Praia

the Kongsberg swath-mapping system EM122 was switched on, recording continuously bathymetric data. Mapping was only suspended during recovery of ocean-bottom-equipment as the acoustic signals of the EM122 would interfere with the acoustic release system of the gear placed onto the seafloor.

During the transit into the working area ocean-bottom-seismometers (OBS) and ocean-bottom-hydrophones (OBH) were prepared. In addition, the two airgun arrays consisting in total of 12 G-guns were setup. Preparation included two releaser tests of GEOMAR gear. During the first test on 17th of November at 9:00 a.m. the releasers were lowered down to 1000 m and communication with a hydrophone mounted into the hull of

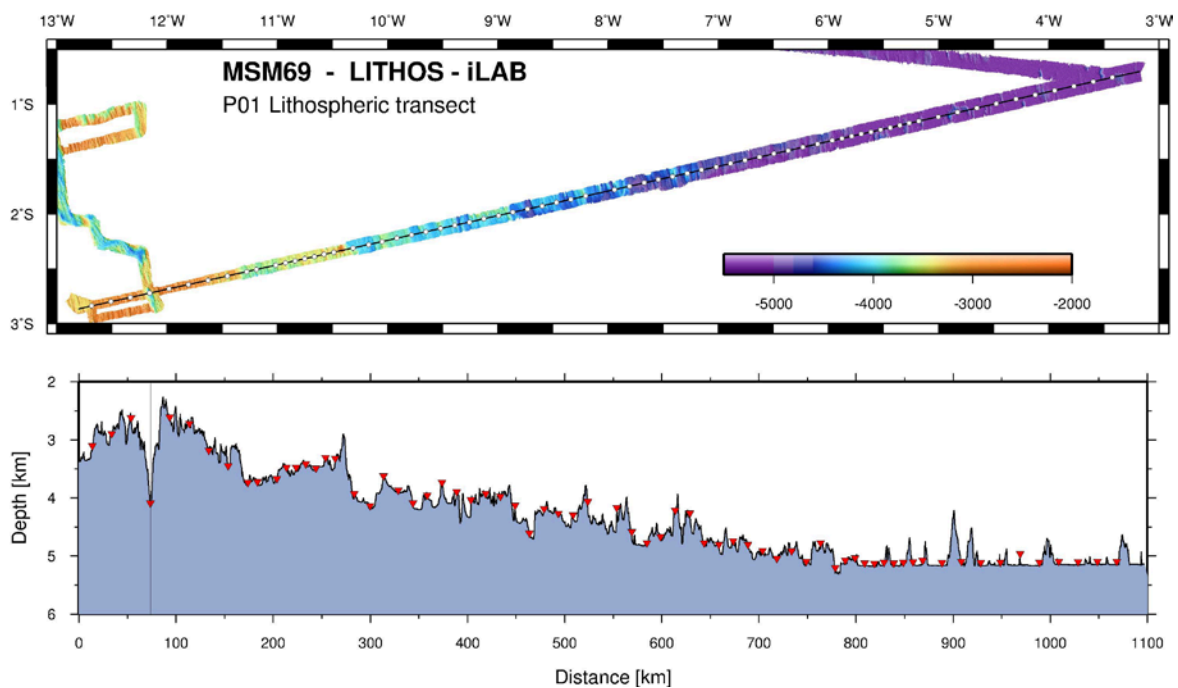


Figure 1: Seismic transect P01- deployment of 71 OBS along a 1100 km long profile

MERIAN was established. The second test was on 18th of November at 9:00 h. Releasers were lowered to 2000 m and in parallel a CTD was run, recording the sound profile for the EM122. Thereafter, French partners tested the communication between the ship's hydrophone and a French OBS lowered with the winch down to 200 m.

Approximately at midnight of Sunday 19th of November MARIA S. MERIAN crossed the equator.

On Tuesday 21st of November, the first seismic stations were deployed at 9:38 UTC along the 1100 km long seismic transect, running from approximately 50 Mio. years (Myr) old seafloor in the Guinea Abyssal Plain, across the Mid-Atlantic Ridge, into just ~1 Myr old seafloor of the South American Plate. Until Saturday 25th of November in total 71 OBS and

OBH were deployed, namely 17 GEOMAR-OBH, 24 GEOMAR-OBS, and 30 IFREMER OBS. providing 27 successful geothermal measurements.

The deployment of the two airgun arrays took place on Saturday 25th of November at 13:00 h. About one hour later, both the starboard and port arrays were in the water. The first

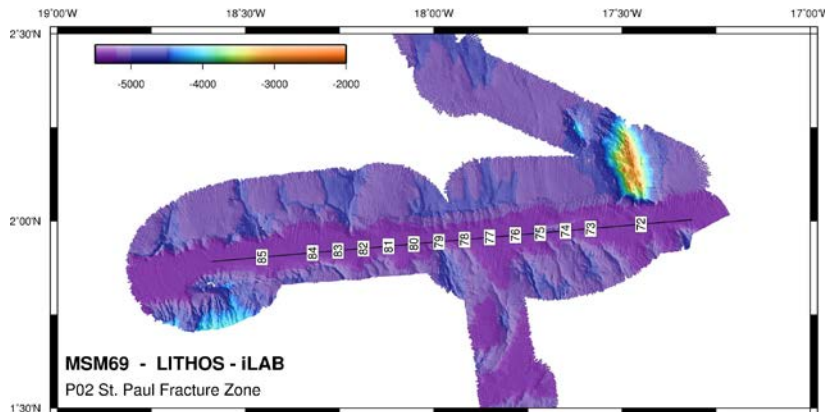


Figure 2: Seismic profile P02 along the St. Paul fracture zone

test shots were fired on 25th of November at 15:00 UTC or 14:00 local time. At 16:21:30 UTC the MERIAN was on the seismic profile and shot #1 was fired. For the next approximately 7 days shots were fired every 210 s or 3.5 min at a speed of 3.8 kn and hence resulting in a shot

spacing of about 410 m. Parallel to the airgun survey, shallow sediment stratigraphy was surveyed using the Parasound system.

On 26 of November at ~14:00 UTC a flotation of the starboard array was lost. The speed was reduced to 2 kn and the starboard array was recovered (14:25 UTC) and a new flotation added. Less than an hour later (14:59 UTC) both arrays were in operation again. After about three days of continuous airgun operation a pressure hose of a 5 litre G-gun (#1) of the port array failed. The gun was suspended on 28th of November on 16:30 UTC. Latter, at 19:26 UTC the pressure of the port array dropped from 205 to 130 bars. Gun #4 was suspended at 19:37 UTC. Another drop in pressure occurred at 19:53 UTC and gun #6 was suspended as well. Yet, the starboard array remained in full operation. However, on the next day – 29th of November – the pressured drop dramatically and we had to suspend gun #8 of the starboard array. The chief scientist therefore decided to maintain both arrays. At 9:10 UTC operation of the port array was suspended and the array was recovered. MERIAN turned around and went back to the east for approximately 2 h, returning on the profile at ~11:40 UTC. All pressure connections between the airguns and the supply hoses were changed and one electric trigger cable was maintained. At ~12:30 UTC the port array was re-deployed and operation started at 12:59:30 UTC. At 15:07 the operation of the Starboard array was stopped and the array was recovered and maintained and re-deployed. At 16:35 UTC both arrays were on duty and all 12 guns fired again.

On 30th of November gun #4 of the port array lost pressure and was suspended at 19:33 UTC. Fortunately, all remaining guns did their duty until the last shot 2nd of December 2017 at 10:21 UTC. In total 2777 shots were fired along profile p01.

After finishing the airgun shooting a daily routine established. Thus, from ca. 12:30 UTC of 2nd of December to 9th of December 2017 we either recovered the 71 OBS/H or conducted heat flow surveys, moving slowly from east to west along the seismic transect. On 9th of December at 20:45 UTC all 71 OBS/H were on deck and five additional heat flow surveys were conducted, adding another 50 successful and only one failed penetration.

On Saturday 9th to Tuesday 12th of December we conducted a multibeam mapping survey of the axis of the Mid-Atlantic Ridge between  $\sim 3^{\circ}30'S$  to  $1^{\circ}30'S$  and run parallel to the iLAB MCS profile obtained in 2015. We crossed the equator two hours after lunch of 12th of December while “diving” into the trough of the Romanche transform fault. At 23:20 UTC we left the mapping track and conducted a short Parasound profile to study the next heat flow site between Romanche and St. Paul fracture zone on approximately 60 Myr old seafloor. On 13th of December the heat probe was lowered and the Bremen Group “burned again the midnight oil” conducting another 8 successful measurements. After a short transit of just 3 hour the 10th heat flow survey was conducted in the valley of the St. Paul fracture zone. In the early morning of 14th of December at 3:31 UTC the first stations was deployed along seismic profile P02 along the St. Paul Fracture Zone. In total 14 OBS/H were deployed at 7.5 to 15 km spacing. At 12:00 UTC the airguns were deployed about 5 nm to the northwest of the profile. The first “warm-up-shot” was at 12:42 UTC and at 13:25:30 the first shot was fired along the seismic profile. Shots were fired every 90 s at a speed of 3.5 kn, resulting into a short spacing of 180 m. About 22 hours later, on Friday 15th of December at 11:20 UTC the last shot was fired. Airguns were recovered and the first OBH released. At 13:34 UTC it was on deck and until Saturday at 7:13 UTC all 14 OBS/H were recovered. After 8 hours of seafloor mapping, extending the coverage of the St. Paul fracture zone, the next heat flow survey was conducted, obtaining 11 geothermal measurements from the centre of the fracture zone towards its northern boundary. On Sunday 17th of December the heat probe was recovered at 9:30 UTC and a second short mapping programme was conducted. Latter, at  $\sim 17$  h the last heat flow station and last scientific operation in the survey area was carried out. At 22:01 UTC the heat probe was back on deck and MARIA S. MERIAN sail towards the Cape Verdes, were the vessel met four days later at 8 a.m. local time the pilot and a successful cruise ended in the harbour of Mindelo.

## **Acknowledgments**

We are thankfully to Master Björn Maas, and the crew of the RV MARIA S. MERIAN cruise MSM69 for excellent sea-going support and a great working environment. The work

conducted during this cruise was funded by the Deutsche Forschungsgemeinschaft (DFG), the OCEANS Programme of the GEOMAR Helmholtz Centre for Ocean Research, and by the European Research Council (ERC Advanced grant to S.Singh).

## Cruise participants

Name	Discipline	Institution
1. Ingo Grevemeyer, chief scientist	OBS	GEOMAR
2. Cord Papenberg, scientist	OBS	GEOMAR
3. Laura Gómez de la Peña, scientist	OBS	GEOMAR
4. Klaus-Peter Steffen, technician	Airguns	GEOMAR
5. Patrick Schröder, technician	OBS / Airguns	GEOMAR
6. Henning Schröder, scientist	OBS / Airguns	GEOMAR
7. David Lemke, student	OBS	CAU / GEOMAR
8. Kevin Growe, student	OBS	CAU / GEOMAR
9. Alexander Jüstel, student	OBS	GEOMAR
10. Lina Heine, student	OBS	CAU / GEOMAR
11. Heinrich Villinger, scientist	Heat Flow	GeoB
12. Norbert Kaul, scientist	Heat Flow	GeoB
13. Alexander Weise, student	Heat Flow	GeoB
14. Jan-Niklas Schmidt, student	Heat Flow	GeoB
15. Satish Singh, scientist	Seismics	IPGP
16. Pierre Guyavarch, technician	OBS	IFREMER
17. El Madani Aissaoui, technician	OBS	IPGP
18. Pranav Audhkhasi, scientist	Seismics	IPGP
19. Venkata Vaddineni, scientist	Seismics	IPGP

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**GeoB** FB 4 - Geowissenschaften  
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## Deployment of Ocean-Bottom-Seismometers (OBS)

Station	Position						Depth	Time drift of data loggers								
<i>P01</i>																
obh01	00°	45,2933'	S	003°	25,4118'	W	5148	2017	325	08	24	336	13	38	70	GEOMAR
obs02	00°	47,6715'	S	003°	35,8775'	W	5141	2017	325	08	10	336	15	20	0	GEOMAR
obs03	00°	50,0567'	S	003°	46,3762'	W	5150	2017	325	10	41	336	16	57	84	GEOMAR
obs04	00°	52,4373'	S	003°	56,8570'	W	5145	2017	325	20	45	336	19	28	0	GEOMAR
obh05	00°	54,8320'	S	004°	07,4030'	W	5158	2017	325	21	24	337	08	21	87	GEOMAR
obs06	00°	57,2300'	S	004°	17,9663'	W	5012	2017	325	21	04	337	10	18	2	GEOMAR
obs07	00°	59,6307'	S	004°	28,5432'	W	5159	2017	326	02	43	337	12	20	0	GEOMAR
obs08	01°	02,0538'	S	004°	39,2205'	W	5165	2017	325	21	39	337	14	24	-119	GEOMAR
obs09	01°	04,4210'	S	004°	49,6560'	W	5144	2017	325	14	34	337	16	47	21	lfremer
obs10	01°	06,8098'	S	005°	00,1923'	W	5163	2017	325	14	57	337	19	05	-216	lfremer
obs11	01°	09,1868'	S	005°	10,6763'	W	5127	2017	325	15	18	337	21	31	-55	lfremer
obs12	01°	10,3737'	S	005°	15,9123'	W	5150	2017	325	15	38	337	23	43	-267	lfremer
obs13	01°	11,5545'	S	005°	21,1230'	W	5156	2017	325	15	59	338	02	02	-4154	lfremer
obs14	01°	12,7448'	S	005°	26,3758'	W	5172	2017	325	16	15	338	04	23	-74	lfremer
obs15	01°	13,9348'	S	005°	31,6275'	W	5160	2017	325	16	30	338	06	41	-84	lfremer
obh16	01°	15,1238'	S	005°	36,8765'	W	5179	2017	326	19	20	338	20	34	-2	GEOMAR
obs17	01°	16,2942'	S	005°	42,0422'	W	5170	2017	326	21	03	338	21	27	304	GEOMAR
obs18	01°	17,4967'	S	005°	47,3528'	W	5081	2017	326	22	07	338	22	39	-139	GEOMAR
obs19	01°	18,6945'	S	005°	52,6455'	W	5128	2017	326	19	44	338	22	14	59	GEOMAR
obh20	01°	19,9037'	S	005°	57,9870'	W	5250	2017	327	02	19	339	00	48	-189	GEOMAR
obs21	01°	21,6937'	S	006°	05,8943'	W	4823	2017	327	03	27	339	02	16	-1310	GEOMAR
obs22	01°	23,4883'	S	006°	13,8265'	W	5146	2017	326	20	04	339	03	41	0	GEOMAR
obs23	01°	25,2900'	S	006°	21,7902'	W	4964	2017	327	02	42	339	14	24	0	GEOMAR
obs24	01°	27,0650'	S	006°	29,6417'	W	5094	2017	326	16	00	339	06	45	1	lfremer
obs25	01°	28,8483'	S	006°	37,5275'	W	4959	2017	326	16	14	339	08	49	5	lfremer
obs26	01°	30,6222'	S	006°	45,3788'	W	4846	2017	326	16	27	339	10	25	81	lfremer
obs27	01°	32,4052'	S	006°	53,2698'	W	4789	2017	326	16	41	339	12	29	28	lfremer
obs28	01°	34,1822'	S	007°	01,1355'	W	4850	2017	326	16	53	339	14	40	-71	lfremer
obs29	01°	35,9603'	S	007°	09,0112'	W	4824	2017	326	17	06	339	16	53	-169	lfremer
obs30	01°	37,7458'	S	007°	16,9215'	W	4300	2017	326	17	21	339	19	02	-218	lfremer
obh31	01°	39,5295'	S	007°	24,8262'	W	4256	2017	327	04	02	339	19	57	274	GEOMAR
obs32	01°	41,3040'	S	007°	32,6898'	W	4717	2017	327	04	32	339	21	19	0	GEOMAR
obs33	01°	42,9970'	S	007°	40,1968'	W	4820	2017	327	04	56	339	22	25	-16	GEOMAR
obs34	01°	44,8173'	S	007°	48,2693'	W	4627	2017	327	12	40	340	14	05	29	GEOMAR
obh35	01°	46,6612'	S	007°	56,4525'	W	4210	2017	327	05	10	340	15	12	4	GEOMAR
obs36	01°	48,422'	S	008°	04,368'	W	4272							no	data	GEOMAR
obs37	01°	50,1865'	S	008°	12,1060'	W	4104	2017	327	15	07	340	18	29	41	GEOMAR
obs38	01°	52,0040'	S	008°	20,1788'	W	4339	2017	328	07	04	340	19	31	-6	GEOMAR
obs39	01°	53,7717'	S	008°	28,0337'	W	4309	2017	327	08	15	340	21	18	-332	lfremer
obs40	01°	55,5350'	S	008°	35,8707'	W	4227	2017	327	09	09	340	23	25	-49	lfremer
obs41	01°	57,3085'	S	008°	43,7588'	W	4653	2017	327	16	34	341	01	27	75	lfremer
obs42	01°	59,0925'	S	008°	51,6945'	W	4170	2017	327	16	18	341	03	40	-46	lfremer

obs43	02°	00,8665'	S	008°	59,5890'	W	4011	2017	327	16	48	341	05	46	164	lfremer
obs44	02°	02,6422'	S	009°	07,4952'	W	3968	2017	327	17	01	341	07	36	-64	lfremer
obs45	02°	04,4225'	S	009°	15,4243'	W	4077	2017	327	17	10	341	09	36	-36	lfremer
obh46	02°	06,2035'	S	009°	23,3605'	W	3935	2017	328	10	21	341	10	47	-93	GEOMAR
obs47	02°	07,9713'	S	009°	31,2408'	W	3775	2017	328	10	34	341	11	47	261	GEOMAR
obh48	02°	09,7522'	S	009°	39,1833'	W	3992	2017	328	10	22	341	12	37	0	GEOMAR
obs49	02°	11,5160'	S	009°	47,0513'	W	4130	2017	328	10	53	341	13	54	0	GEOMAR
obs50	02°	13,3047'	S	009°	55,0365'	W	3905	2017	328	15	12	342	14	44	1	GEOMAR
obh51	02°	15,0727'	S	010°	02,9297'	W	3655	2017	328	15	29	342	05	50	-141	GEOMAR
obs52	02°	16,7118'	S	010°	10,2527'	W	4178	2017	328	15	42	342	06	46	-2	GEOMAR
obs53	02°	18,6248'	S	010°	18,8033'	W	3970	2017	328	15	51	342	07	46	107	GEOMAR
obs54	02°	20,9467'	S	010°	29,1882'	W	3353	2017	328	10	29	342	09	46	-73	lfremer
obs55	02°	22,1303'	S	010°	34,4792'	W	3338	2017	328	11	04	342	10	53	53	lfremer
obs56	02°	23,3007'	S	010°	39,7143'	W	3521	2017	328	11	17	342	12	00	-66	lfremer
obs57	02°	24,4780'	S	010°	44,9875'	W	3445	2017	328	11	58	342	13	17	406	lfremer
obs58	02°	25,6568'	S	010°	50,2637'	W	3509	2017	328	12	20	342	14	38	-70	lfremer
obs59	02°	26,8318'	S	010°	55,5315'	W	3510	2017	328	13	38	342	15	44	40	lfremer
obs60	02°	28,0100'	S	011°	00,8095'	W	3707	2017	328	13	51	342	17	08	-51	lfremer
obs61	02°	29,185'	S	011°	06,150'	W	3706								no data	GEOMAR
obh62	02°	30,3690'	S	011°	11,3827'	W	3758	2017	328	22	21	342	19	20	158	GEOMAR
obs63	02°	31,5460'	S	011°	16,6628'	W	3772	2017	328	20	10	342	19	43	-3	GEOMAR
obh64	02°	33,8987'	S	011°	27,2190'	W	3481	2017	328	21	35	342	21	06	608	GEOMAR
obh65	02°	36,2515'	S	011°	37,7835'	W	3209	2017	328	14	35	342	22	23	282	GEOMAR
obh66	02°	38,6028'	S	011°	48,3545'	W	2745	2017	328	21	19	343	13	00	1 ms	GEOMAR
obh67	02°	40,9518'	S	011°	58,9098'	W	2636	2017	328	22	26	343	14	14	2 ms	GEOMAR
obh68	02°	43,3010'	S	012°	09,4840'	W	4128	2017	328	21	57	343	16	03	-178	GEOMAR
obh69	02°	45,6422'	S	012°	20,0287'	W	2650	2017	328	22	26	343	14	14	2	GEOMAR
obs70	02°	47,9822'	S	012°	30,5760'	W	2924	2017	328	22	34	343	19	05	-100	lfremer
obs71	02°	50,3227'	S	012°	41,1265'	W	3128	2017	328	22	51	343	21	09	82	lfremer
<b>P02</b>																
obh72	01°	59,4650'	N	017°	26,9640'	W	5147	2017	347	20	01	349	13	48	9	GEOMAR
obs73	01°	58,7620'	N	017°	35,0280'	W	5141	2017	347	20	57	349	15	16	0	GEOMAR
obs74	01°	58,4090'	N	017°	39,0660'	W	5150	2017	347	21	03	349	16	09	-16	GEOMAR
obs75	01°	58,0570'	N	017°	43,0980'	W	5147	2017	347	21	24	349	17	19	-22	GEOMAR
obs76	01°	57,7050'	N	017°	47,1300'	W	5141	2017	347	19	51	349	18	39	-6	lfremer
obs77	01°	57,3530'	N	017°	51,1680'	W	5150	2017	347	20	07	349	20	06	-11	lfremer
obs78	01°	57,0000'	N	017°	55,2000'	W	5147	2017	347	20	17	349	21	32	4	lfremer
obs79	01°	56,6470'	N	017°	59,2320'	W	5141	2017	347	20	30	349	23	19	54	lfremer
obs81	01°	56,2940'	N	018°	03,2700'	W	5150	2017	347	20	41	350	00	51	-10	lfremer
obs81	01°	55,9410'	N	018°	07,3020'	W	5147	2017	347	20	55	350	02	15	-4	lfremer
obs82	01°	55,5880'	N	018°	11,3340'	W	5141	2017	347	21	16	350	02	00	0	GEOMAR
obs83	01°	55,2340'	N	018°	15,3720'	W	5150	2017	347	21	29	350	04	45	0	GEOMAR
obs84	01°	54,8810'	N	018°	19,4040'	W	5150	2017	347	21	42	350	05	56	0	GEOMAR
obh85	01°	54,1730'	N	018°	27,4680'	W	5147	2017	347	21	50	350	07	24	0	GEOMAR



**MSM69 – LITHOS-iLAB:  
Airgun shooting**

Profile	No. Shots	Latitude 1		Longitude 1		Latitude 2		Longitude 2	
P01	2777	2.865	S	12.800	W	0.700	S	3.175	W
P02	870	1.917	N	18.598	W	2.003	N	17.312	W

**Heat flow stations (HF)**

ID	Latitude		Longitude		Water Depth [m]	Date	Penetration Time (UTC)
	DD	MM.MMM	DDD	MM.MMM			
<b>HF1760 - MSM69_6</b>							
HF1760P01	-0	52.338	-3	56.417	5130	21.11.2017	14:16:50
HF1760P02	-0	52.22	-3	55.89	5134	21.11.2017	15:28:45
HF1760P03	-0	52.1	-3	55.36	5139	21.11.2017	16:34:00
HF1760P04	-0	51.984	-3	54.836	5138	21.11.2017	17:35:05
HF1760P05	-0	51.858	-3	54.306	5138	21.11.2017	18:52:10
HF1760P06	-0	51.737	-3	53.780	5139	21.11.2017	20:06:25
HF1760P07	-0	51.618	-3	53.254	5136	21.11.2017	21:18:35
HF1760P08	-0	51.5	-3	52.73	5138	21.11.2017	22:33:55
<b>HF1761 - MSM69_19</b>							
HF1761P01	-1	15.712	-5	39.898	5161	22.11.2017	13:04:50
HF1761P02	-1	15.592	-5	39.372	5162	22.11.2017	14:25:00
HF1761P03	-1	15.471	-5	38.845	5168	22.11.2017	15:33:44
HF1761P04	-1	15.351	-5	38.317	5166	22.11.2017	16:45:59
HF1761P05	-1	15.234	-5	37.787	5176	22.11.2017	17:46:40
HF1761P06	-1	15.108	-5	37.254	5173	22.11.2017	18:56:30
HF1761P07	-1	14.987	-5	36.727	5172	22.11.2017	20:01:50
HF1761P08	-1	14.868	-5	36.200	5168	22.11.2017	21:14:40
HF1761P09	-1	14.750	-5	35.672	5176	22.11.2017	22:19:20
HF1761P10	-1	14.629	-5	35.145	5165	22.11.2017	23:15:30
<b>HF1762 - MSM69_42</b>							
HF1762P01	-1	52.182	-8	22.041	4504	23.11.2017	23:14:20

HF1762P02	-1	52.064	-8	21.514	4498	24.11.2017	00:19:00
HF1762P03	-1	51.943	-8	20.886	4338	24.11.2017	01:33:00
HF1762P04	-1	51.829	-8	20.465	4329	24.11.2017	02:45:50
HF1762P05	-1	51.710	-8	19.937	4365	24.11.2017	04:02:10
HF1762P06	-1	51.590	-8	19.410	4395	24.11.2017	05:11:00
HF1762P07	-1	51.468	-8	18.874	4400	24.11.2017	06:14:40
HF1762P08	-1	51.350	-8	18.348	4390	24.11.2017	07:10:20
HF1762P09	-1	51.230	-8	17.819	4284	24.11.2017	08:01:50

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**HF1763 - MSM69\_78**

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HF1763P02	-0	53.050	-3	59.660	5115	02.12.2017	22:08:10
HF1763P03	-0	52.930	-3	59.130	5137	02.12.2017	23:11:20
HF1763P04	-0	52.818	-3	58.600	5138	03.12.2017	00:14:20
HF1763P05	-0	52.700	-3	58.070	5149	03.12.2017	01:26:50
HF1763P06	-0	52.586	-3	57.542	5133	03.12.2017	02:50:00
HF1763P07	-0	52.478	-3	57.017	5135	03.12.2017	04:00:20
HF1763P08	-0	52.363	-3	56.487	5130	03.12.2017	05:11:30

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**HF1764 - MSM69\_79**

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HF1764P01	-1	14.452	-5	34.593	5107	04.12.2017	08:15:20
HF1764P02	-1	13.895	-5	34.723	5161	04.12.2017	09:26:20
HF1764P03	-1	13.337	-5	34.855	5169	04.12.2017	11:03:50
HF1764P04	-1	12.781	-5	34.989	5171	04.12.2017	12:27:00
HF1764P05	-1	12.224	-5	35.125	5170	04.12.2017	13:44:50
HF1764P06	-1	11.669	-5	35.259	5171	04.12.2017	15:09:00
HF1764P07	-1	11.115	-5	35.403	5164	04.12.2017	16:16:20
HF1764P08	-1	10.559	-5	35.536	5163	04.12.2017	17:28:10

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**HF1765 - MSM69\_80**

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HF1765P01	-1	43.001	-7	40.172	4821	05.12.2017	23:51:20
HF1765P02	-1	42.878	-7	39.634	4796	06.12.2017	00:58:10
HF1765P03	-1	42.760	-7	39.105	4651	06.12.2017	02:10:10
HF1765P04	-1	42.648	-7	38.578	4635	06.12.2017	03:16:40
HF1765P05	-1	42.530	-7	38.047	4594	06.12.2017	04:22:00
HF1765P06	-1	42.413	-7	37.514	4550	06.12.2017	05:43:40
HF1765P07	-1	42.288	-7	36.979	4635	06.12.2017	06:53:10
HF1765P08	-1	42.169	-7	36.447	4656	06.12.2017	08:06:30
HF1765P09	-1	42.051	-7	35.917	4595	06.12.2017	09:23:20
HF1765P10	-1	41.932	-7	35.386	4512	06.12.2017	10:22:50

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**HF1766 - MSM69\_81**

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HF1766P01	-2	14.111	-9	58.680	3823	07.12.2017	16:15:35
HF1766P02	-2	13.991	-9	58.154	3826	07.12.2017	17:17:50
HF1766P03	-2	13.868	-9	57.620	3859	07.12.2017	18:23:45
HF1766P04	-2	13.750	-9	57.084	3871	07.12.2017	19:24:00
HF1766P05	-2	13.632	-9	56.567	3887	07.12.2017	20:34:50
HF1766P06	-2	13.514	-9	56.040	3890	07.12.2017	21:37:30
HF1766P07	-2	13.395	-9	55.513	3894	07.12.2017	22:43:15
HF1766P08	-2	13.276	-9	54.985	3896	07.12.2017	23:51:50
HF1766P09	-2	13.158	-9	54.459	3907	08.12.2017	00:49:10
HF1766P10	-2	13.043	-9	53.939	3901	08.12.2017	01:47:20
HF1766P11	-2	12.926	-9	53.412	3902	08.12.2017	02:49:00

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**HF1767 - MSM69\_82**

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HF1767P01	-2	35.360	-11	33.811	3215	08.12.2017	23:57:30
HF1767P02	-2	35.295	-11	33.541	3227	09.12.2017	00:37:20
HF1767P03	-2	35.241	-11	33.284	3229	09.12.2017	01:30:20
HF1767P04	-2	35.182	-11	33.021	3211	09.12.2017	02:09:40
HF1767P05	-2	35.123	-11	32.757	3242	09.12.2017	02:48:10
HF1767P06	-2	35.064	-11	32.494	3285	09.12.2017	03:37:30
HF1767P07	-2	35.003	-11	32.230	3391	09.12.2017	04:28:27
HF1767P08	-2	34.944	-11	31.966	3386	09.12.2017	05:13:55
HF1767P09	-2	34.882	-11	31.696	3378	09.12.2017	06:02:00
HF1767P10	-2	34.822	-11	31.431	3240	09.12.2017	06:34:25
HF1767P12	-2	34.702	-11	30.906	3112	09.12.2017	08:12:55
HF1767P13	-2	34.644	-11	30.641	3191	09.12.2017	08:56:40
HF1767P14	-2	34.584	-11	30.378	3200	09.12.2017	09:41:00

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**HF1768 - MSM69\_85**

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HF1768P01	1	28.803	-17	47.395	5043	13.12.2017	02:34:40
HF1768P02	1	29.339	-17	47.490	5069	13.12.2017	03:47:30
HF1768P03	1	29.876	-17	47.575	5100	13.12.2017	05:04:10
HF1768P04	1	30.415	-17	47.653	5123	13.12.2017	06:13:10
HF1768P05	1	30.954	-17	47.739	5164	13.12.2017	07:20:40
HF1768P06	1	31.491	-17	47.825	5160	13.12.2017	08:36:25
HF1768P07	1	32.028	-17	47.912	5201	13.12.2017	09:44:20
HF1768P08	1	32.564	-17	47.996	5256	13.12.2017	10:54:30

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**HF1769 - MSM69\_86**

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HF1769P01	1	54.049	-17	51.428	5263	13.12.2017	16:07:10
HF1769P02	1	54.587	-17	51.515	5267	13.12.2017	17:12:30
HF1769P03	1	55.123	-17	51.599	5280	13.12.2017	18:31:30
HF1769P04	1	55.660	-17	51.685	5278	13.12.2017	19:38:20
HF1769P05	1	56.197	-17	51.771	5281	13.12.2017	20:51:40
HF1769P06	1	56.734	-17	51.857	5291	13.12.2017	22:00:00
HF1769P07	1	57.272	-17	51.943	5292	13.12.2017	23:08:00

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**HF1770 - MSM69\_106**

HF1770P01	1	57.805	-17	52.029	5299	16.12.2017	19:29:50
HF1770P02	1	58.343	-17	52.115	5288	16.12.2017	20:41:55
HF1770P03	1	58.880	-17	52.200	5294	16.12.2017	21:59:40
HF1770P04	1	59.417	-17	52.285	5292	16.12.2017	23:09:40
HF1770P05	1	59.954	-17	52.371	5268	17.12.2017	00:29:20
HF1770P06	2	0	-17	52.457	5179	17.12.2017	01:41:45
HF1770P07	2	1.028	-17	52.544	5122	17.12.2017	02:56:00
HF1770P08	2	1.565	-17	52.629	5077	17.12.2017	04:23:10
HF1770P09	2	2.104	-17	52.715	4952	17.12.2017	05:32:00
HF1770P10	2	2.642	-17	52.800	4963	17.12.2017	06:45:50
HF1770P11	2	3.177	-17	52.888	4980	17.12.2017	07:59:55

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**HF1771 - MSM69\_108**

HF1771P01	2	24.123	-17	56.243	5044	17.12.2017	18:09:50
HF1771P02	2	24.659	-17	56.321	5033	17.12.2017	19:19:50
HF1771P03	2	25.196	-17	56.405	5012	17.12.2017	20:37:50

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