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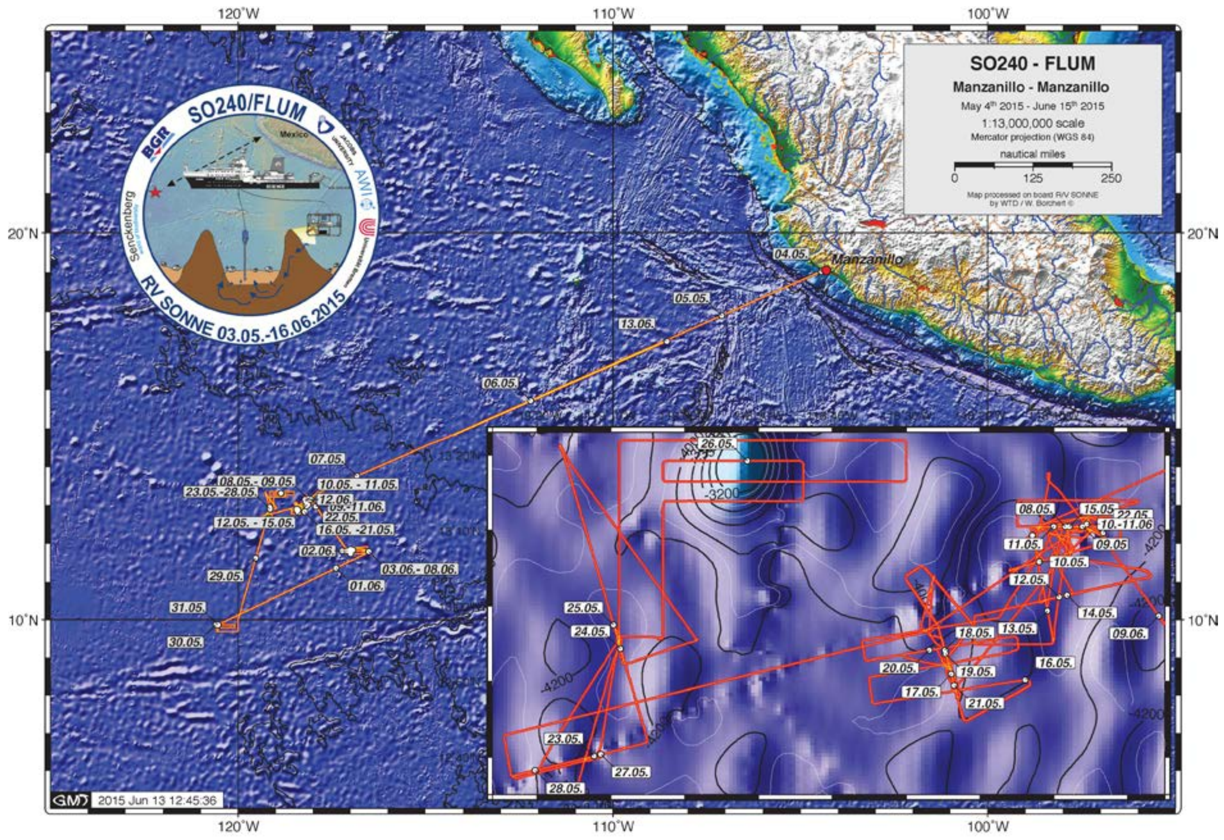
Short Cruise Report
R.V. Sonne Cruise SO-240

Manzanillo – Manzanillo
03.05. – 15.06.2015
Chief Scientist: Thomas Kuhn
Captain: Lutz Mallon



Objectives

Hydrothermal fluids can withdraw significant amounts of heat from the oceanic lithosphere by lateral fluid flow through permeable basaltic crust of an age of up to 65 Ma. Basement outcrops in-between impermeable pelagic sediments permit seawater recharge and discharge of altered and slightly heated seawater. A recharge site has been detected on the flank of one of the numerous seamounts in the working area in the equatorial E-Pacific during earlier investigations. Moreover, successions of small basins typical for “hydrothermal pits” occur which could be interpreted as fossil discharge sites.

The objective of this project will be to investigate the regional pattern of seawater circulation within the basaltic seafloor based on seismic surveys, heat flow measurements and pore-water geochemistry. Recharge of oxic seawater causes upward oxygen diffusion into the sediments overlying the permeable basalt in areas proximal to the recharge sites (seamounts or basalt outcrops). The prolonged oxygen exposure time is suggested to have a strong impact on biogeochemical processes in the sediments and the element inventory of Manganese nodules. The quantitative investigation of such processes and element enrichments and their range of influence around recharge sites is thus the second objective of this project. An additional goal will be to investigate whether fluid circulation through 21 Million years old crust can mobilize metals and affect metal flux rates into sediments and nodules at possible discharge sites.

Narrative of the cruise

Cruise SO-240 started on May 3rd, 2015 with the embarkation of the scientific crew and the unloading of our containers in the port of Manzanillo, which is situated on the Pacific coast of Mexico. The new research vessel SONNE set sail on Monday afternoon, May 4th; the departure being delayed by half a day due to the late pickup of frozen samples from the previous cruise. During the 900-nm-long transit to the working area, which is situated to the southwest of Manzanillo, our seismic gear was successfully tested and the scientists were busy installing their equipment in the laboratories. On May 5th, scientists were introduced to the hydro-acoustic systems onboard and were made familiar with security systems of the vessel. In a first science meeting, the scientific objectives and the technical approaches of this cruise were discussed. We arrived at working area 1 on May 7th at noon, starting with a first CTD for the calibration of the swath echo-sounding system EM 122.

During SO-240, four working areas were investigated, generally starting with a seismic and bathymetric survey in each area, and following up with heat flow profiles. The results of these geophysical measurements formed the basis for deciding on suitable locations for sediment sampling, which included taking long piston or gravity cores, multicores, and box cores. The long cores were split into 1 m segments immediately after recovery and stored in the cool room (at 4°C) for at least 12 hours so that the sediments could re-equilibrate to the temperature conditions prevailing at the seafloor. After 12 hours, the oxygen content of the pore water was measured along high-resolution profiles along all core segments using oxygen micro-electrodes. This procedure was followed up by pore water sampling, sedimentological description, and sub-sampling. One core from the multicorer was treated in the same way, the other 11 cores being used for biological and geochemical analyses. The near-bottom seawater was also sub-sampled from the multicorer. The box corer provides a seafloor sample with a pre-defined surface area (50 x 50 cm) and 40 to 50 cm sediment thickness. Manganese nodules were collected from the sediment surface and sub-samples from the sediments were taken at 3 cm intervals. Working areas were further investigated using a video sledge equipped with video and photo cameras, Niskin bottles, a CTD, oxygen, chlorophyll, and turbidity sensors, a 5-function manipulator for rock sampling as well as three thrusters for enhancing the small-scale maneuverability of the sledge.

Working areas 1 to 3 are situated to the east (WA-1), south (WA-2), and southwest (WA-3) of a large seamount complex. The center of WA-1 is a small seamount named Teddy Bare due to its topographic features, and we investigated the fluid flux in the vicinity of this and other seamounts until May 16th by carrying out three seismic surveys, six heat flow profiles, 15 sediment stations, two video stations and one dredge station.

WA-2 is characterized by a group of small seamounts to the north that rises up to 800 m above the surrounding seafloor with a basal radius of 1 to 2 km, and by NNW-SSE oriented basins and ridges to the south. We investigated this area with a size of 35 km x 30 km between May 17th and May 21st by carrying out three seismic surveys, three heat flow profiles, 12 sediment stations, and three video stations.

WA-3 is situated about 50 to 90 km to the southwest of the largest seamount in this area, a structure with a basal diameter of 25 km rising more than 3000 m above its surroundings. Between May 22nd and May 28th, we investigated small basins oriented parallel to the general basin and ridge structures of the seafloor and carried out heat flow profiles perpendicular to them. In the meantime, hurricane “Andres” developed a few hundred kilometers east-southeast of our position. As it started moving in our direction, we had to leave the working area early on May 29th and sailed to 10°N and 120°W.

We used the time in this refuge area (working area X; WA-X) to carry out heat flow measurements far away from the influence of seamounts. In order to do this, we had to map the area first, which took place between May 29th and 30th. One heat flow profile and a box core station were carried out on May 30th and 31st, after which we could transit to working area 4 (WA-4) on June 1st.

WA-4 is located about 200 to 300 km to the southeast of WAs 1-3. The so-called “Prospective Area #1” of the BGR Manganese nodule exploration campaign forms the central part of WA-4. In the latter area, two lander systems (DOS, BoBo) equipped with oceanographic measuring devices and a 400 m long thermistor mooring were deployed during the previous cruise SO-239. These systems were successfully recovered on June 2nd and 3rd together with four BGR moorings. The latter moorings have measured near-bottom current strengths and directions for more than one year. All data were downloaded, the instruments maintained and the four BGR moorings were re-deployed on June 6th. In the meantime, one CTD tow-yo and two CTD yo-yo stations, each 14 hours long, were carried out. All this work (3.5 days) took place as part of the project “EcoResponse” within the framework of the European “Joint Programming Initiative – Oceans” (JPI-O), which deals with the potential ecological impacts of future Manganese nodule mining. Amongst others, the data gathered during SO-240 will be used to model the hydrodynamic behavior of a sediment plume that may develop during Manganese nodule mining.

In addition to the JPI-O work in this area, we investigated small depressions (about 200 m x 400 m) that occur within a 10 km wide (E-W), 35 km long (N-S), and 100 to 150 m deep basin which marks the eastern boundary of WA-4. The seafloor in these depressions is characterized by a very low backscatter intensity, implying a soft sediment that may be typical for water escape structures. Our investigations furthermore show that the basaltic crust under the sediment cover is heavily faulted and that many of these faults even reach to the seafloor and lead to an offset of the sediments, thus enabling fluid circulation in the basaltic crust far away from seamounts. Such conditions have also been detected in the western part of WA-4. In total, we carried out 100 km of seismic and 200 km of bathymetric survey, three heat flow profiles, nine sediment stations, and one station for the *in-situ* shear strength measurement of deep-sea sediments between June 1st and 8th in WA-4.

Finally, on June 9th, we returned to WA-1 in order to investigate a temperature anomaly which we had found after the analysis of CTD data in the water column immediately above the Teddy Bare seamount. Between June 9th and June 11th, we carried out additional heat flow profiles, four sediment stations, one CTD cast and one dredge drag in this area.

As a new hurricane “Carlos” was shaping up to the southeast of Manzanillo, R/V SONNE had to start her transit back to Manzanillo in the late afternoon of June 11th, where she arrived safely on Sunday morning at 8:30 local time. On the transit back to Manzanillo, the labs were cleaned, containers were packed, and a first synthesis of the cruise was presented during a final science meeting.

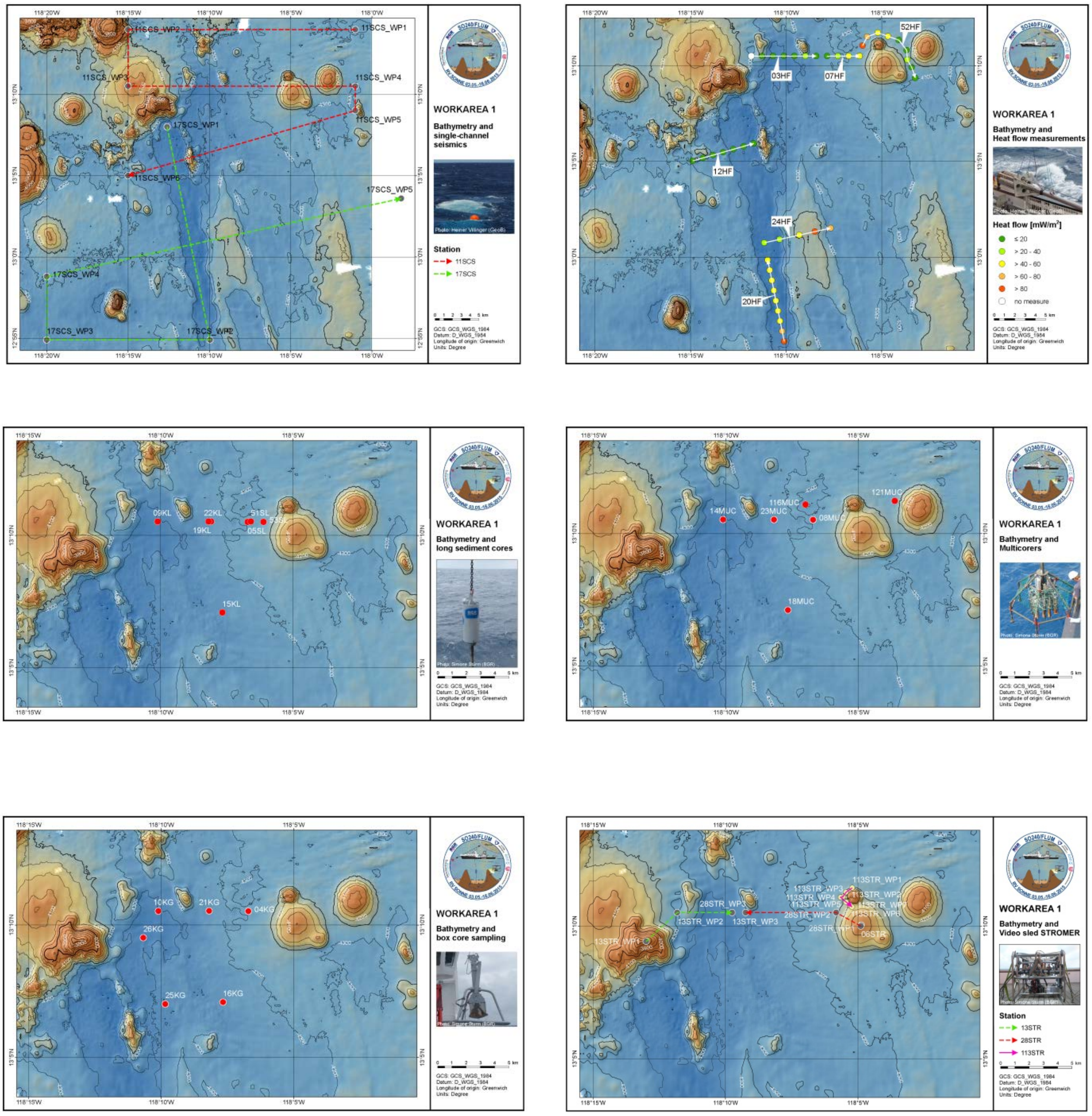


Figure 1. *Maps of working area 1 of cruise SO-240.*

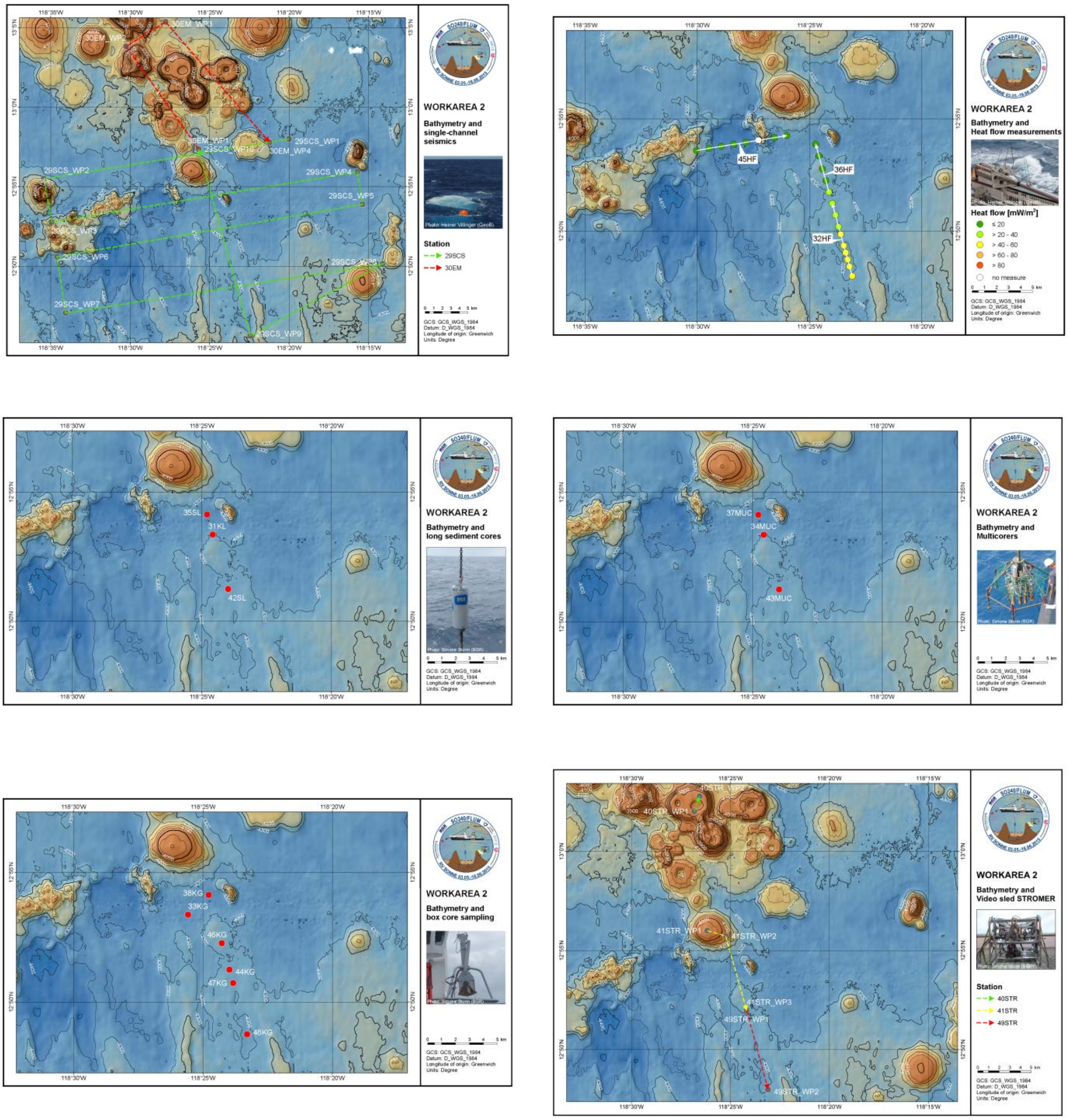


Figure 2. *Maps of working area 2 of cruise SO-240.*

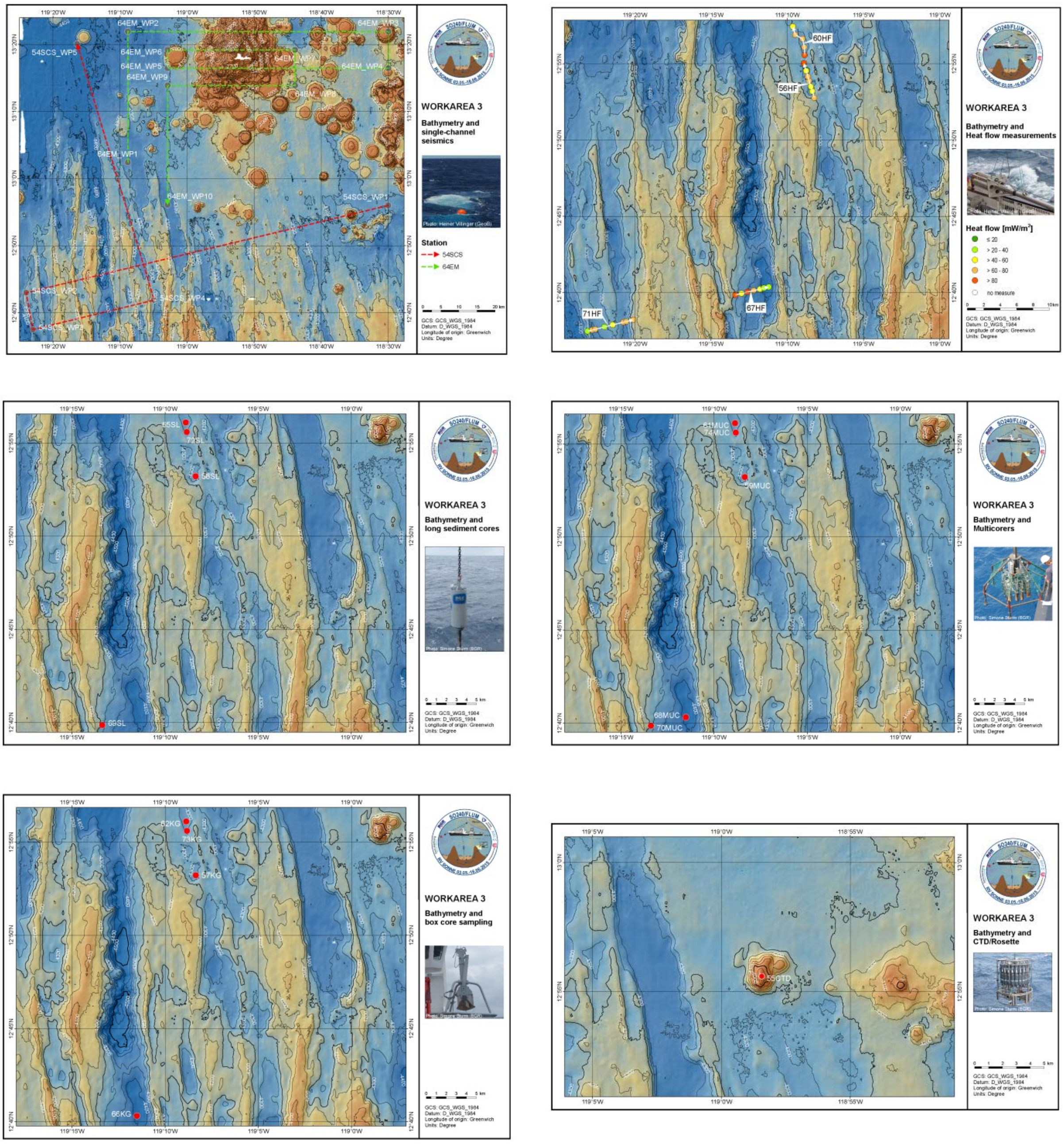


__Figure 3.__ Maps of working area 3 of cruise SO-240.

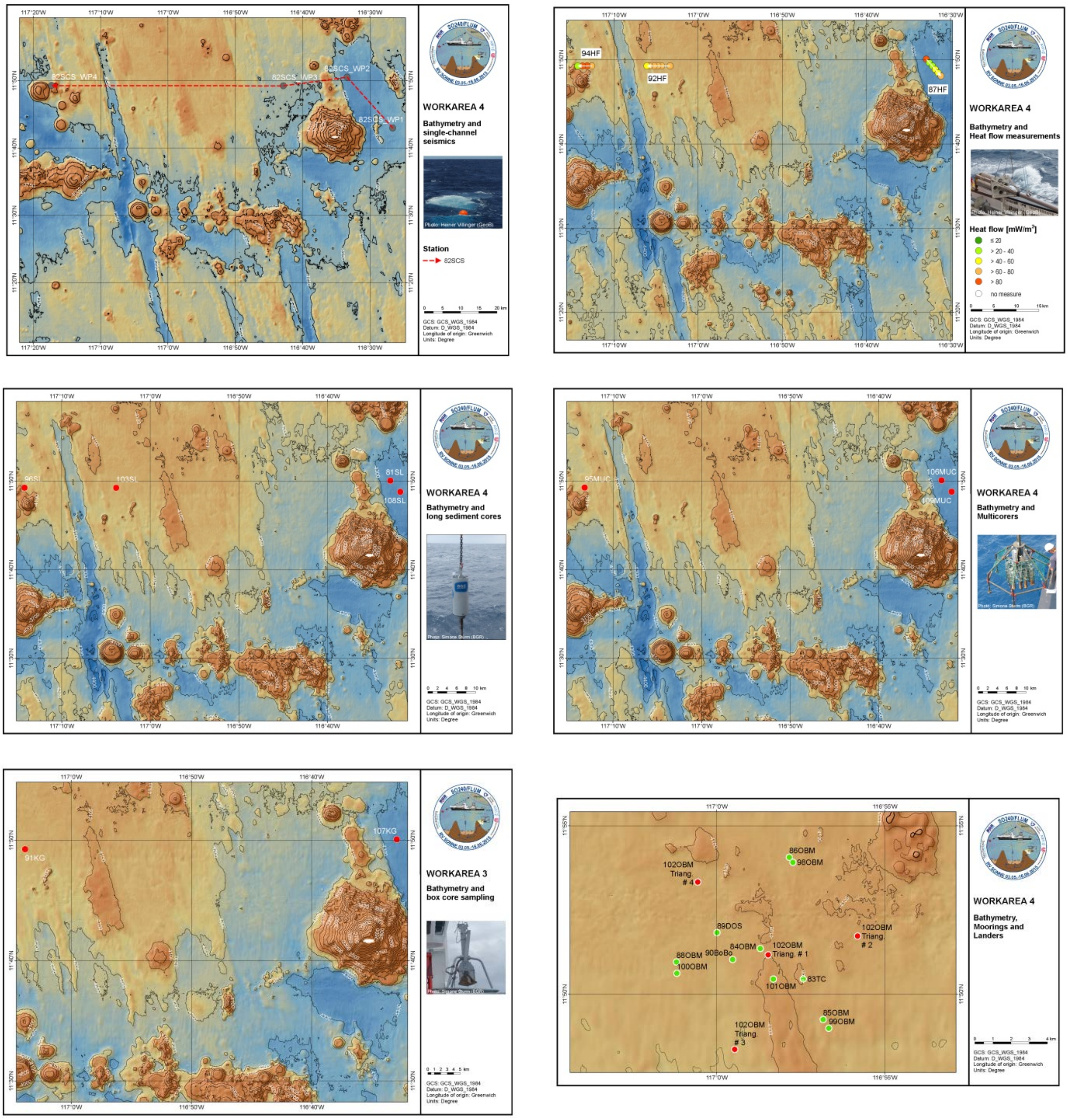


__Figure 4.__ Maps of working area 4 of cruise SO-240.

Acknowledgements

We thank Capt. Lutz Mallon and his crew for the excellent support during the SO-240 cruise - we really enjoyed working with them. The cruise was financed through BMBF grant 03G0240.

Cruise Participants

Nr.	Teilnehmer / Participant	Aufgabe / Task	Institution
1	Kuhn, Thomas, Dr.	Fahrtleitung / *Chief Scientist*	BGR
2	Heller, Christina, Dr.	Knollen, Sedimente / *nodules, sediments*	BGR
3	Lückge, Andreas, Dr.	Knollen, Sedimente / *nodules, sediments*	BGR
4	Rühlemann, Carsten, Dr.	Knollen, Sedimente, stellv. Fahrtleiter / *nodules, sediments, Co-Chief Scientist*	BGR
5	Stegger, Ulrich	Knollen, Sedimente, GIS / *nodules, sediments, GIS*	BGR
6	Vink, Anemiek, Dr.	Knollen, Sedimente, JPI-O / *nodules, sediments, JPI-O*	BGR
7	Wegorzewski, Anna, Dr.	Knollen, Sedimente / *nodules, sediments*	BGR
8	Heyde, Ingo, Dr.	Wärmestrom, Gravimetrie / *heat flow, gravimetry*	BGR
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10	Kevel, Oliver	Gerätetechnik / *technician*	BGR
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12	Sturm, Simone	Logistik, Labor / *logistics, lab. technician*	BGR
13	Villinger, Heiner, Prof. Dr.	Wärmestromsonde, Seismik / *heat flow, seismics*	GeoB
14	Kaul, Norbert, Dr.	Wärmestromsonde, Seismik / *heat flow, seismics*	GeoB
15	Schwab, Arne	Wärmestromsonde, Seismik / *heat flow, seismics*	GeoB
16	Heesemann, Bernd	Gerätetechnik / *technician*	GeoB
17	Bösel, Janine	Bathymetrie, Sedimentecholot / *bathymetry sediment echosounding*	GeoB
18	Müller, Paulina	Bathymetrie, Sedimentecholot / *bathymetry sediment echosounding*	GeoB
19	Singh, Rasphal	Bathymetrie, Sedimentecholot / *bathymetry sediment echosounding*	GeoB
20	Kasten, Sabine, PD Dr.	Porenwasser, Sedimente */ pore water, sediments*	AWI
21	Dohrmann, Ingrid	Laborantin / *lab technician*	AWI
22	Hartmann, Jan F.	Porenwasser, Sedimente */ pore water,*	AWI

		sediments	
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24	Ritter, Simon	Porenwasser, Sedimente / *pore water, sediments*	AWI
25	Preuss, Inken-Marie, Dr.	Porenwasser, Sedimente / *pore water, sediments*	AWI / JUB
26	Filsmair, Christoph	Porenwasser, Sedimente / *pore water, sediments*	JUB
27	Kleint, Charlotte	Porenwasser, Sedimente / *pore water, sediments*	JUB
28	Gerken, Jan	Hydrodynamik JPI O / *hydrodynamics JPI-O*	IUP
29	Purkiani, Kaveh	Hydrodynamik JPI O / *hydrodynamics JPI-O*	IUP
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List of stations during cruise SO240-FLUM. *"UTC" indicates Universal Time Coordinated of bottom contact or max. depth of the respective device, affixes "B" and "E" after UTC for STROMER and dredge operations indicate beginning and end of bottom visibility or contact. Position and water depth refer to time of bottom contact or visibility, respectively. For moorings recovery, the release position is given. Water depth is from EM 122 if not noted otherways.*

Station SO240-	Date 2015	UTC			Position		Water depth [m]	Remarks
		start	bottom	end	latitude (N)	longitude (W)		
01CTD	07.05.	18:50		22:13	13° 10.52'	118° 12.19'	4262	24 bottles filled with water samples
02PS	07.05.	22:37			13° 10.359'	118° 11.673'	4272	Parasound profile with 8 knots
	08.05.			00:02	13° 11.872'	118° 02.544'	4255	
03HF	08.05.	01:03			13° 10.479'	118° 11.870'	4179	Six (6) heat flow stations along profile,
	08.05.			14:15	13° 10.512	118° 07.855'	4284	each ca. 1 km apart
04KG	08.05.	14:51	16:12	17:48	13° 10.519'	118° 06.706'	4278	37 cm sediment, 12.6 kg/m^2 small nodules
05SL	08.05.	18:06	19:29	21:34	13° 10.525'	118° 06.705'	4287	756 cm sediment core
06STR	08.05.	22:20	00:51B		13° 10.060'	118° 04.858'	4024	Test of new video sledge STROMER
	09.05.		02:21E	03:50	13° 10.060	118° 04.560'	4075	
07HF	09.05.	05:11			13° 10.525'	118° 07.862'	4313	Four (4) heat flow stations along profile,
	09.05.			13:35	13° 10.528'	118° 06.741'	4273	each ca. 1 km apart
08MUC	09.05.	13:53	15:36	17:30	13° 10..524'	118° 06.708'	4289	12/12 tubes filled, 29 cm sediment
09KL	09.05.	18:11	19:53	22:01	13° 10.524'	118° 10.104'	4335	1187 cm core length
10KG	09.05.	22:13	23:31	01:00	13° 10.525'	118° 10.107'	4333	43 cm core length, 14.8 kg/m^2 large nodules
11SCS	10.05.	02:16			13° 13.974'	117° 59.111'	4259	Three single-channel seismic profiles
				13:00	13° 04.672'	118° 15.913'	4288	Total length: 85 km
12HF	10.05.	13:43			13° 05.043'	118° 14.891'	4291	Seven (7) heat flow profiles, each ca. 1 km apart
	11.05.			02:08	13° 05.962'	118° 11.684'	4360	Posidonia transponder 100 m over HF lance
13STR	11.05.	03:01	04:19B		13° 09.441'	118° 12.985'	3725	Transect along NE slope of seamount
	11.05.		12:56E	14:23	13° 10.519'	118°09.751'	4313	
14MUC	11.05.	15:13	16:51	18:46	13° 10.528'	118°10.108'	4332	11/12 tubes filled, 35 cm sediment
15KL	11.05.	19:23	21:04	22:55	13° 07.101'	118° 07.657'	4319	1161 cm core length
16KG	11.05.	23:21	00:43	02:14	13° 07.098'	118° 07.655'	4319	43 cm core recovery, no nodules
17SCS	12.05.	03:01			13° 01.080'	118° 13.031'	4140	Four single-channel seismic profiles
	12.05.			15:00	13° 03.610'	118° 57.992'	4241	Total length: 90 km
18MUC	12.05.	16:12	17:48	19:32	13° 07.109'	118° 07.657'	4318	12/12 tube filled, 36 cm sediment
19KL	12.05.	20:10	21:46	23:32	13° 10.527'	118° 08.083'	4307	All steel pipes were lost, only head weight recovered
20HF	13.05.	00:43			12° 55.688'	118° 09.971'	4599	Nine (9) heat flow stations along profile,
	13.05.			15:17	12° 59.862'	118° 10.946'	4375	each ca. 1 km apart
21KG	13.05.	16:48	18:07	19:37	13° 10.529'	118° 08.187'	4288	43 cm core length, 18.6 kg/m^2 large nodules
22KL	13.05.	19:52	21:30	23:15	13° 10.527'	118°08.184'	4302	1301 cm core length; repetition of 19KL
23MUC	13.05.	23:51	01:33	03:19	13° 10.526'	118° 08.186'	4305	10/12 tubes filled, 31 cm sediment
24HF	14.05.	04:35			13° 00.743'	118° 11.175'	4374	Five (5) heat flow stations along profile,
	14.05.			14:44	13° 01.527'	118° 07.660	4296	each ca. 1 km apart
25KG	14.05.	15:45	17:04	18:42	13° 07.013'	118° 09.845	4331	43 cm core length, 18.2 kg/m^2 large nodules
26KG	14.05.	19:11	20:33	22:09	13° 09.517'	118° 10.676'	4343	43 cm core length, 20.8 kg/m^2 large nodules
27GDS	14.05.	22:47	00:03B		13° 09.227'	118° 05.594'	4251	Five Mn nodules, one indurated sediment with
	15.05.		01:51E	03:15	13° 09.630'	118° 05.240'	4122	2 cm thick Fe-Mn crust
28STR	15.05.	03:42	05:14B		13° 10.007'	118° 04.869'	4035	Transect along west slope of Teddy Bare SMt.
			14:02E	15:50	13° 10.527'	118° 08.936'	4298	and E-W over sampling stations
29SCS	15.05.	17:20			12° 58.358'	118° 17.655'	4219	Five (5) seismic profiles over working area 2
	16.05			17:15	12° 58.414'	118° 26.409'	4238	Total length: 200 km
30EM	16.05.	17:17			12° 58.540'	118° 26.490'	4186	Hydroacoustic mapping (EM 122) of seamounts
				19:46	12° 57.760'	118° 21.204'	4289	In the north of WA-2; length: 40 km
31KL	16.05.	20:31	22:02	23:55	12° 53.355'	118° 24.572'	4289	1174 cm core length with slump deposits?
32HF	17.05.	01:06			12° 48.015'	118° 23.136'	4292	Eight (8) heat flow stations along profile,
				14:38	12° 51.223'	118° 23.967'	4274	each ca. 1 km apart
33KG	17.05.	15:12	16:30	18:10	12° 53.365'	118° 25.576'	4292	37 cm core length, 12.6 kg/m^2 small nodules
34MUC	17.05.	18:24	20:00	21:48	12° 53.358'	118° 24.569'	4287	11/12 tubes filled, 22 cm sediment
35SL	17.05.	22:04	23:27	01:40	12° 54.128'	118° 24.791'	4319	982 cm core length
36HF	18.05.	01:56			12° 51.777'	118° 24.144'	4296	Continuation of 32HF; five heat flow stations
				10:54	12° 54.123'	118° 24.778'	4307	each ca. 1 km apart
37MUC	18.05.	10:57	12:32	14:20	12° 54.131'	118° 24.782'	4319	10/12 tubes filled, 28 cm sediment

SO-240, List of stations continued

Station SO240-	Date 2015	UTC start	bottom	end	Position latitude (N)	longitude (W)	Water depth [m]	Remarks
38KG	18.05.	14:36	15:58	17:33	12° 54.129'	118° 24.777'	4320	41 cm core length, 15.8 kg/m^2 small nodules
39PS	18.05.	18:16			12° 57.344'	118° 27.966'	4296	Short profile over donut seamounts to map
				19:33	13° 03.891'	118° 26.244'	4188	Sediment thickness in their craters
40STR	18.05.	18:05	22:05B		13° 02.020'	118° 26.744	3712	Video mapping in seamount crater, 4 MAPRS at
			00:59E	02:22	13° 02.912'	118° 26.515'	3718	100, 200, 300, 400m; 2 water samples
41STR	19.05.	03:25	05:00B		12° 56.018'	118° 26.157'	3884	Video mapping of seamount flank and along
			14:00E	15:40	12° 51.978'	118° 24.180'	4275	32/36 HF profile
42SL	19.05.	16:09	17:38	19:20	12° 51.249'	118° 23.976'	4290	1036 cm core length
43MUC	19.05.	19:21	21:04	22:53	12° 51.247'	118° 23.980'	4289	12/12 tube filled, 33 cm sediment
44KG	19.05.	23:01	00:22	02:03	12° 51.243'	118° 23.978'	4289	43 cm core length, 17.8 kg/m^2 medium nodules
45HF	20.05.	02:57			12° 53.519'	118° 30.163'	4226	Seven (7) heat flow stations along profile,
				15:53	12° 54.266'	118° 26.008'	4290	each ca. 1 km apart; 1 station failed
46KG	20.05.	16:33	17:53	19:31	12° 52.266'	118° 24.271'	4275	39 cm core length, 18.4 kg/m^2 small-med. nods
47KG	20.05.	19:59	21:15	22:53	12° 50.727'	118° 23.834'	4290	43 cm core length, 23.4 kg/m^2 large nodules
48KG	20.05.	23:25	00:43	02:22	12° 48.749'	118° 23.295'	4313	42 cm core length, 23.0 kg/m^2 med.-large nods.
49STR	21.05.	03:00	04:40B		12° 51.980'	118° 24.170'	4273	Continuation of station 41STR
			13:04E		12° 49.056'	118° 23.374'	4292	
50CTD	21.05	17:21	19:30	21:14	13° 10.020'	118° 04.949'	4026	CTD profile & water samples at Teddy Bare Smt
51SL	21.05.	21:42	23:08	01:07	13° 10.526'	118° 06.584'	4286	537 cm core length
52HF	22.05.	01:13			13° 10.698'	118° 06.400'	4287	Nine (9) heat flow stations around Teddy Bare
				14:26	13° 09.367'	118° 03.230'	4283	each ca. 1 km apart
53SL	22.05.	15:09	16:33	18:30	13° 10.508'	118° 06.110'	4273	482 cm core length, closest to Teddy Bare Smt.
54SCS	22.05.	20:54			12° 56.437'	118° 28.025'	4327	Three (3) seismic profiles over working area 3
	23.05.			22:00	13° 20.258'	119° 16.466'	4407	Total length: 220 km
55CTD	24.05.	00:31	02:18	03:45	12° 55.596'	118° 58.433'	3870	CTD profile to calibrate EM 122
56HF	24.05.	05:09			12° 52.802'	119° 08.344'	4292	Seven (7) heat flow stations in pits of suspected
				14:39	12° 54.545'	119° 08.745'	4286	hydrothermal origin; each ca. 1 km apart
57KG	24.05.	15:19	16:41	18:12	12° 53.217'	119° 08.352'	4310	43 cm core length, no nodules
58SL	24.05.	18:19	19:39	21:30	12° 53.216'	119° 08.351'	4309	1244 cm core length
59MUC	24.05.	21:31	23:43	01:28	12° 53.216'	119° 08.344'	4306	12/12 tubes filled, 38 cm sediment
60HF	25.05.	02:22			12° 55.007'	119° 08.965'	4280	Continuation of profile 56HF; five (5) heat flow
				13:10	12° 57.457'	119° 09.626'	4273	Stations, each ca. 1 km apart
61MUC	25:05	13:36	15:16	17:01	12° 56.109'	119° 08.871'	4293	12/12 tubes filled, 42 cm sediment
62KG	25.05.	17:16	18:40	20:13	12° 56.107'	119° 08.870'	4294	44 cm core length, no nodules
63PS	25.05.	21:05			12° 55.635'	119° 08.998'	4294	Short profile over small depression to
				22:34	13° 02.965'	119° 08.829'	4348	identify sediment structures
64EM	25.05.	22:35			13° 02.440'	119° 08.820'	4360	EM 122 mapping of large, dominating seamount
	26.05.			18:11	12° 55.760'	119° 03.130'	4363	NW of working area 3
65SL	26.05.	19:07	20:29	22:19	12° 56.107'	119° 08.884'	4293	1275 m core length
66KG	27.05.	00:06	01:24	02:59	12° 40.311'	119° 11.520'	4406	41 cm core length, 4.1 kg/m^2 small nodules
67HF	27.05.	03:37			12° 39.800'	119° 13.480'	4244	Seven (7) heat flow stations over tectonically
				14:21	12° 40.376'	119° 11.203'	4399	controlled basin structure; each ca. 1 km apart
68MUC	27.05.	14:50	16:33	18:29	12° 40.307'	119° 11.514'	4408	12/12 tubes filled, 36 cm sediment
69SL	27.05.	18:54	20:16	22:00	12° 39.855'	119° 13.374'	4275	1265 cm core length
70MUC	27.05.	22:00	23:34	01:16	12° 39.857	119° 13.385'	4270	12/12 tubes filled, 35 cm sediment
71HF	28.05.	02:22			12° 37.460'	119° 23.158'	4283	Eight (8) heat flow stations over tectonically
				14:17	12° 38.219'	119° 20.085'	4207	controlled basin structure; each ca. 1 km apart
72SL	28.05.	18:51	20:15	22:00	12° 55.597'	119° 08.833'	4294	853 cm core length
73KG	28.05.	22:03	23:22	00:56	12° 55.601'	119° 08.829'	4295	41 cm core length, no nodules
74MUC	29.05.	01:07	02:44	04:25	12° 55.601'	119° 08.830'	4295	12/12 tubes filled, 37 cm sediment
Leaving the working area due to hurricane "Andres", sail to 10° N / 120° W, principally to wait for the hurricane to pass by								
75EMPS	29.05.	20:39			09° 59.366'	119° 59.990'	4359	EM 122 mapping to select area without
	30.05.			11:45	09° 52.020'	120° 35.110'	4379	seamount for HF calibration
76HF-	30.05.	19:01			09° 52.027'	120° 32.098'	4420	Test of BGR-Heat Flow Lance; aborted due to
BGR				20:00	09° 52.036'	120° 32.101'	4420	technical problems
77HF	30.05.	20:37			09° 52.033'	120° 32.104'	4405	Four (4) heat flow stations for calibration
	31.05.			03:23	09° 52.034'	120° 31.197'	4360	without seamount influence; ea. ~ 0.5 km apart
78KG	31.05.	13:41	15:08	16:51	09° 52.017'	120° 32.010'	4414	~20 cm indurated sediment, 1 crust, no nodules

SO-240, List of stations continued

Station SO-240	Date 2015	UTC start	UTC bottom	UTC end	Position latitude (N)	Position longitude (W)	Water depth [m]	Remarks
Transit	31.05.	17:00			09° 52.017’	120° 32.010’		Transit to working area 4
	01.06			17:00	11° 45.997’	116° 32.005’		
79CTD	01.06.	17:26	18:26	19:09	11° 45.997’	116° 32.005’	4327	CTD to 2000 m for EM122 calibration
80EM	01.06.	19:34			11° 45.584’	116° 31.839’		EM 122 mapping of basin in WA-4 to identify
				22:38	11° 46.000’	116° 29.000’		small pits (black spots in side-scan sonar)
81SL	01.06.	23:21	00:45	02:13	11° 50.064’	116° 32.890’	4355	1346 cm core length
82SCS	02.06.	03:50			11° 42.977’	116° 26.596’		Three (3) seismic profiles over working area 4 &
				14:29	11° 49.285’	117° 17.284’		5, total length: 95 km
83TC	02.06.	17:59		20:27	11° 50.450’	116° 57.427’	4098	Recovery of thermistor chain of SO239 # 2
84OBM	02.06.	20:19		21:27	11° 51.355’	116° 58.704’	4093	Recovery of mooring KM14-037OBM
85OBM	02.06.	22:11		23:08	11° 49.245’	116° 56.837’	4112	Recovery of mooring KM14-035OBM
86OBM	02.06.	23:42		00:30	11° 54.064’	116° 57.842’	4107	Recovery of mooring KM14-034OBM
87HF	03.06.	02:36			11° 50.078’	116° 32.868’	4351	Six (6) heat flow stations over small basins with
				13:00	11° 48.063’	116° 31.135’	4313	with black spots; each ca. 1 km apart
88OBM	03.06.	15:27		16:29	11° 50.954’	117° 01.195’	4135	Recovery of mooring KM14-036OBM
89DOS	03.06.	17:00		18:53	11° 51.826’	116° 59.992’	4112	Recovery of SO239 # 44 DOS-2 lander
90BoBo	03.06.	19:18		21:30	11° 51.029’	116° 59.526’	4121	Recovery of SO239 # 4 BoBo lander
91KG	03.06.	22:04	23:18	00:54	11° 49.263’	117° 03.835’	4131	42 cm core length, 21.3 kg/m2 small-med. nod.
92HF	04.06.	01:15			11° 49.251’	117° 03.344’	4129	Six (6) heat flow stations over distinct fault
				12:31	11° 49.265’	117° 06.068’	4138	structures; each ca. 1 km apart
93CTD	04.06.	13:35			11° 53.850’	116° 57.783’	4101	CTD tow-yo station for JPI-O, tow yo between
Tow-Yo	05.06.			06:31	11° 49.089’	117° 02.971’	4132	50 and 500 m above bottom @ 0.5 m/s, 0.5 kn
94HF	05.06.	07:43			11° 49.262’	117° 12.673’	4153	Five (5) heat flow stations over distinct fault
				15:14	11° 49.277’	117° 14.288’	4157	structure near seamounts; each ca. 1 km apart
95MUC	05.06.	16:49	18:24	20:11	11° 49.262’	117° 13.197’	4150	12/12 tubes filled, 31 cm sediment
96SL	05.06.	20:11	21:37	23:20	11° 49.260’	117° 13.195’	4145	980 cm core length
97CTD	06.06.	00:45			11° 51.490’	117° 00.233’	4118	JPI-O station, vessel at station, 4 cycles through
Yo-Yo	06.06.			14:34	11° 51.493’	117° 00.188’	4116	complete water column @ 0.7 m/s
98OBM	06.06.	15:13		15:16	11° 53.915’	116° 57.733’	4108	Redeployment of mooring KM14-034OBM
99OBM	06.06.	16:01		16:04	11° 48.987’	116° 56.669’	4120	Redeployment of mooring KM14-035OBM
100OBM	06.06.	17:12		17:16	11° 50.619’	117° 01.184’	4122	Redeployment of mooring KM14-036OBM
101OBM	06.06.	18:25		18:32	11° 50.447’	116° 58.317’	4088	Redeployment of mooring KM14-037OBM
102OBM	06.06.	19:03		22:21	11° 50.673’	116° 58.324’	4087	Triangulation of mooring positions
103SL	06.06.	23:08	00:26	02:14	11° 49.253’	117° 03.847’	4137	977 cm core length; for permeability analysis
104LIR	07.06.	02:22	03:52	10:18	11° 49.272’	117° 03.840’	4133	In situ shear strength of sediments @4 locations
105EM	07.06.	10:24			11° 49.332’	117° 04.546’	4134	EM 122 mapping of central working area 4
				15:11	11° 45.426’	116° 34.230’	4073	
106MUC	07.06.	15:49	17:27	19:18	11° 50.079’	116° 32.900’	4351	12/12 tubes filled, 40 cm sediment
107KG	07.06.	19:20	20:49	22:20	11° 50.070’	116° 32.907’	4351	43 cm core length, nodule layers at 16, 32 cm
108SL	07.06.	22:57	00:20	02:04	11° 48.796’	116° 31.767’	4326	1038 cm core length
109MUC	08.06.	02:12	03:46	05:35	11° 48.791’	116° 31.760’	4327	12/12 tubes filled, 37 cm sediment
110EM	08.06.	06:27			11° 55.723’	116° 33.200’	4017	EM 122 mapping of central working area 4
				09:22	11° 54.374’	116° 56.731’	4107	
111CTD	08.06.	09:57			11° 50.393’	116° 56.673’	4131	JPI-O station, vessel at station, 4 cycles through
Yo-yo	09.06.			02:10	11° 49.670’	116° 56.331’	4115	complete water column @ 0.7 m/s
112EM	09.06.	02:47			11° 54.370’	116° 56.500’	4100	EM 122 mapping of central working area 4
				04:16	11° 54.540’	117° 08.709’	4114	
Transit to working area 1 (Teddy Bare Seamount) at 13° 11.116’ N / 118° 05.137’ W								
113STR	09.06.	14:04	15:35B		13° 11.453’	118° 05.231’	4222	Video mapping along western basis of small
			19:43E	21:30	13° 10.723	118° 05.216’	4161	seamount north of Teddy Bare SMt.
114HF	09.06.	22:08			13° 11.092’	118° 06.004’	4266 m	Heat flow station at Teddy Bare Seamount;
-BGR				02:05	13° 11.106’	118° 05.772’	4258 m	aborted at first waypoint due to tech. problems
115HF	10.06.	02:44			13° 11.103’	118° 05.770’	4256	Eight(8) heat flow stations along foot of small
-BGR				15:30	13° 10.710’	118° 05.300’	4214	seamount north of Teddy Bare SMt.
116MUC	10.06.	15:58	17:40	19:21	13° 11.098’	118° 06.003’	4270	12/12 tubes filled, 31 cm sediment
117SL	10.06.	19:30	20:56	22:42	13° 11.103’	118° 05.992’	4271	Ca. 6 m core length, steel pipe bent
118KG	10.06.	22:52	00:12	01:46	13° 11.102’	118° 05.996’	4272	40 cm core length, 12.6 kg/m^2 small nodules
119CTD	11.06.	02:45		05:25	13° 17.488’	118° 10.806’	3502	CTD station over larger seamount

SO-240, List of stations continued

Station SO-240	Date 2015	UTC start	bottom	end	Position latitude (N)	longitude (W)	Water depth [m]	Remarks
120 GDS	11.06.	06:41	07:55B		13° 09.077’	118° 12.660	4010	Sampling at seamount in WA-1
			11:01E	12:27	13° 09.349’	118° 12.894’	3786	only Fe-Mn crusts sampled, no rocks
121MUC	11.06.	13:24	15:00	16:50	13° 11.235’	118° 03.623’	4268	12/12 tubes filled, 23 cm sediment

EM: EM 122 swath echosounder mapping
SCS: single channel seismics
PS: parasound mapping
HF: heat flow sensor, University Bremen
HF-BGR: heat flow sensor, BGR:
LIR: *in-situ* shear strength of sediments
KL: piston corer
SL: gravity corer
KG: box corer
MUC: multiple corer
GDS: rock dredge
STR: video sledge STROMER
CTD: CTD/rosette water sampler
OBM: ocean bottom oorings