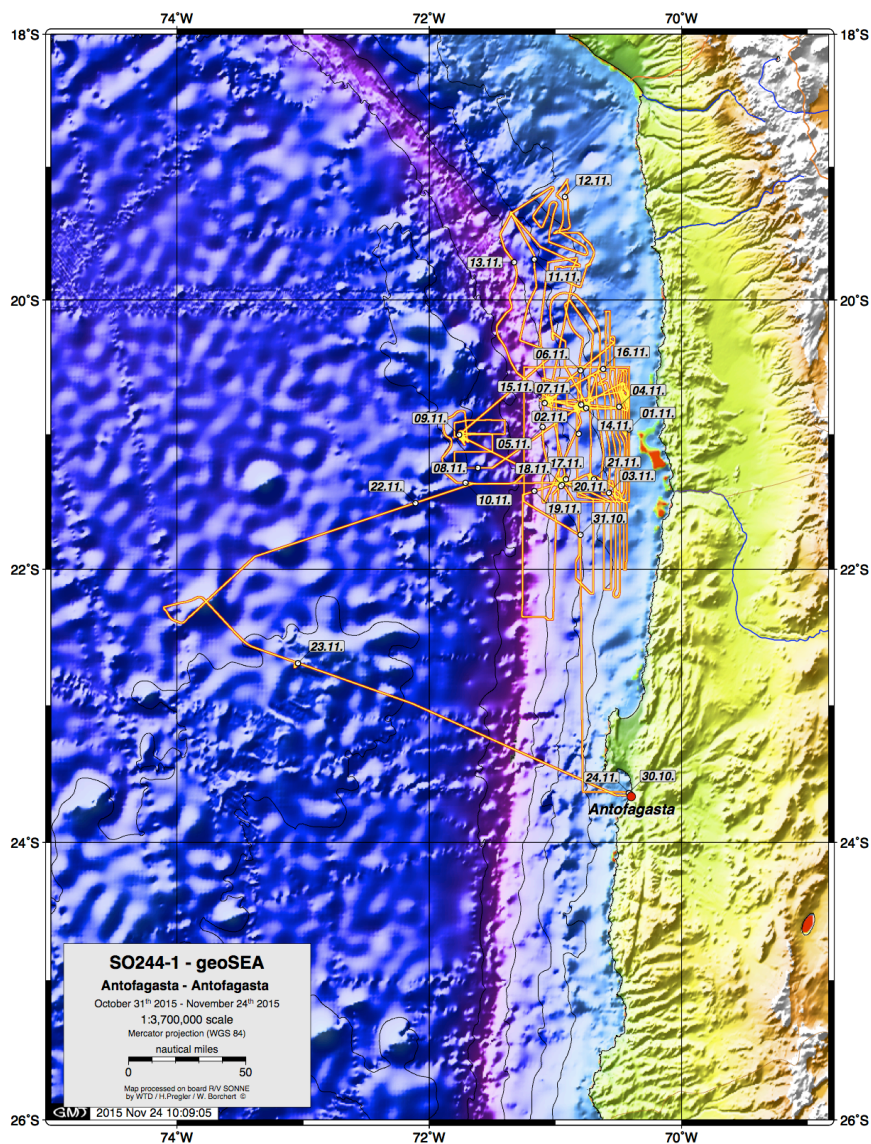


Prof. Dr. Jan H. Behrmann
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
Wischhofstr. 1-3
24148 Kiel, Germany

Tel.: +494316002272
Fax: +494316002922
email: jbehrmann@geomar.de

Short Cruise Report
TFS SONNE, SO244 Leg 1
Antofagasta - Antofagasta
30.10.2015 – 24.11.2015
Chief Scientist: Jan H. Behrmann
Captain: Lutz Mallon



Objectives

About one third of the global release of seismic energy in the twentieth century occurred at the Pacific Plate boundary of South America. This happened in catastrophic thrust earthquakes of magnitudes $M_w > 8$. Recurrence periods are among the shortest on our planet. The so-called Iquique segment between Antofagasta and Arica is a prime candidate for the next large rupture. The last heavy earthquake seaward of Iquique occurred in 1877 (reconstructed magnitude 8.8), caused a large tsunami and has a recurrence time of 122 ± 22 years. The historical record over the last 500 years shows that earthquakes in the Iquique segment occur in close temporal association with the seismic activation of neighbouring seismotectonic segments. In the southerly and northerly neighbourhood large earthquakes occurred in the past decades (Antofagasta 1995, South Peru 2001, Pisagua 2014). All this has led to an increase in seismicity in the Iquique segment. Since the rupture of the two directly adjoining segments (Antofagasta, Pisagua) the character of active deformation in the overriding plate in the Iquique segment has changed. Several previously inactive faults showed seismic activity since then, with magnitudes up to $M_w 6.3$ and ruptures up to the land surface. The seismogenic part of the plate boundary itself has increased activity, and a major earthquake (Tarapaca earthquake of 13.06.2005) was localized in the subducting plate at a focal depth of about 100 km.

All this indicates that an end of the present interseismic cycles is near or has been reached. Cruise SO244/Leg 1 is dedicated to the marine geological exploration of those parts of the Iquique segment that have not been studied so far. Firstly, the geomorphological and geophysical base for long-term geodetic observation is to be laid. Secondly, the identification and mapping of active tectonic faults and submarine slumps and slides will give an overview of past movements of the seafloor. Thirdly, the high-resolution bathymetric mapping with the ship-based multibeam echosounder and with AUV ABYSS will provide a reference frame of the seafloor topography. After a future earthquake repeat surveys could then be used to quantify the mass movements during the event.

Almost the complete zone of seismic coupling between the Nazca and South American Plates is covered by the sea. To assess interseismic and permanent deformation, high-resolution mapping and observation of deformation and seismicity at the plate boundary, and the adjoining rock complexes is mandatory, and requires seagoing equipment. In contrast to the further progressed geological, geophysical and (satellite) geodetic exploration onshore, the trench and forearc in the Iquique segment is basically unstudied, requiring a timely, exploratory approach.

The proposed high-resolution bathymetric mapping in the Iquique segment between $20^{\circ}30'S$ and $21^{\circ}30'S$ for the first time documents the surface structure of the deep sea trench, and that of the lower and middle continental slope. Firstly, this is necessary to constrain the position and width of the outcrop of the zone of compression at the base of the continental slope, in comparison to the findings further south. This will reveal how contact deformation between the downgoing and overriding plates is localized and how it is partitioned. Together with seismic information, bathymetry holds crucial information for geomorphological and tectonic interpretation. Secondly those parts of the lower and middle continental slopes will be mapped, which are dominated by submarine mass wasting, be it caused by earthquakes or not. Based on the data obtained, the volumes of the displaced materials may be quantified. Possibly, a relative chronology of larger mass wasting events can be established. This is important to estimate tsunamigenic potential by submarine sliding and slumping for the Iquique segment.

Narrative

TFS SONNE left the port of Antofagasta around 20:30 h local time on the 30th October 2015 to start the northward transit to the working area of SO244 Leg 1. The decision to leave port about 12 hours early was due to a swell warning issued by the port authorities, which would likely have forced the ship to leave port anyway.

Transit overnight was to the first station at 21°44.99'S/70°48.16'W, to retrieve the first of 15 Ocean Bottom Seismometers (OBS in the following) that had been deployed on the seafloor in the area in December 2014 (see Fig. 1 for locations). Retrieval of this OBS was successful, and after a short transit we arrived at the SW corner (21°30.00'S/71°15.00'W) of the designated mapping area for the ship-based Multibeam Echosounder EM122 (Fig. 1). Mapping started at a speed of 8 knots immediately after having completed a CTD to 2500 m water depth, to determine an acoustic velocity profile for the evaluation of the seabed mapping data. Parasound data were continuously recorded along with the EM122 data. Mapping was on a predefined grid within a rectangular box described by the 20°30'S and 21°30'S meridians and the longitudes 70°25'W and 71°15'W. During the mapping, the ship stopped at six locations to retrieve OBS, and, by the end of the mapping in the predefined quadrangle, seven instruments had been collected successfully. Initial mapping was successfully completed in the evening of 4th November.

During the night between 4th and 5th November, the first area (Area 1 Midslope; see Fig. 1) was designated for AUV mapping, following discussions over the Internet with the chief scientists of SO244 Leg 2. The first area is located in a zone of suspected normal faulting at 20°50'S/70°48'W, with major structures and escarpments trending N-S. Additional criteria for choosing Area 1 were water depth (>2000 m), absence of large mass wasting structures, and fault scarps sufficiently low to facilitate the setting up of a local geodetic array. Two transponders were dropped and surveyed, followed by the first launch of the AUV. An area of approximately 40 km² was covered by four consecutive dives, and yielded data sufficiently precise to calculate a merged terrain model with a resolution of 2 m. Using its 200 kHz multibeam sonar system, AUV ABYSS can map about 1 km² per hour, flying 80 m above the seafloor at a speed of about 1.5 m/s. This secures sufficient overlap of the outer acoustic beams. We had two battery sets available, so that there was no loss of time for battery charging between deployments. The time interval between deployments and retrievals, 14 and 16 hours (depending on battery pack capacity), respectively, was used to retrieve three additional OBS located north of Area 1, and north of 20°30'S. Transits to and from the OBS locations were used to map additional parts of the Northern Chile continental slope with the EM122, at a speed of 8 knots. The four dives were successfully concluded in the night between the 7th and 8th November.

Immediately following pick-up of the transponders, TFS SONNE moved westward across the deep sea trench to re-map a part of the outer rise located on the Nazca Plate at about 21°S, to document the oceanic spreading fabric, volcanic edifices, and, most importantly, the overprinting lower plate bend faults that form in response to downbending of the plate as it moves towards the subduction zone. Mapping with the EM122 was done at a speed of 5 knots, to improve the seabed imaging at the great water depths there (in parts >8000 m). After completion of this survey on 9th November, a zone characterized by a population of N-S trending bend faults with moderately high (up to 50 m) scarps was selected for two dives by AUV mapping (within Area 2, Outer Rise; see Fig. 1) in 4000-5000 m water depth around 21°05'S/71°35'W. The AUV dives were completed successfully on 11th November.

Next, it was decided to recover the remaining five OBS located on the South American forearc slope north of 20°30'S. These instruments were too distant from AUV dive areas to permit the transits between individual dives, and some maintenance had to be done on the AUV after six dives. The cruise track was chosen to provide an almost complete EM122 coverage of the forearc and trench area up to the NW end of the permit area at approximately 19°S.

On 13th November, TFS SONNE was back in the central study area at 21°S to resume AUV mapping. The third target selected was an anticlinal structure on the lower continental slope at about 20°45'S/71°04'W, in water depths between 4500 and 6000 m (Area 3, Lower Slope in Fig. 1). A series of four consecutive dives was successfully completed, and yielded a merged grid of approximately 35 km² size covering the crestal part of the antiform. Time between dives was used to improve and complete EM122 and Parasound data coverage in the Central Study area. AUV work in Area 3 was terminated on 16th November, and the ship transited southward to Area 4, Southern Slope (Fig. 1) for the next set of AUV dives.

Transponders were dropped and surveyed from mid-day 17th November, and the AUV was deployed in late afternoon. The target chosen here was a NW-SE trending zone of potentially active strike slip faulting that dissects the forearc from the trench up to the middle slope. Target depth was 3500-4000 m. TFS SONNE then set out to carry out EM122 bathymetric mapping on the continental slope on two N-S profiles to about 22°10'S and back, to cover hitherto non-mapped terrain of the Southern Study Area (Fig. 1). To optimize use of ship time and resources this operational scheme was repeated for the second and third AUV dives in Area 4 on four more profiles. Operations at the AUV launch in Area 4 and the retrieval of the two transponders were terminated successfully at 9:00 hrs on 20th November.

Immediately afterwards we transited to Area 5, located upslope from Area 4. Area 5 (Fig. 1) is on the western slope of the marked promontory at about 21°20'S/70°50'W in about 2000 m water depth. The promontory is made up of indurated rocks, essentially without younger sediment cover, and is traversed by several N-S trending faults, which are in turn offset by a two sets of ESE-WNW and ENE-WSW trending faults. It was decided to drop transponders there and run a set of two AUV dives, with enough operational time left for retrieving all instruments from the sea floor, packing everything up, and returning to port. Return to port was done in mapping mode, with the EM122 and the Parasound turned on, to identify and verify a number of seamount structures located on the Iquique Ridge, a weakly defined bathymetric feature on the Nazca Plate impinging the subduction zone around 21°S to 22°S. With all surveying instrumentation turned off, TFS SONNE entered the port of Antofagasta in the morning of 24th November, to end a seabed surveying expedition to uncharted terrain, with fifteen successful AUV dives, zero loss of equipment and zero operational down time.

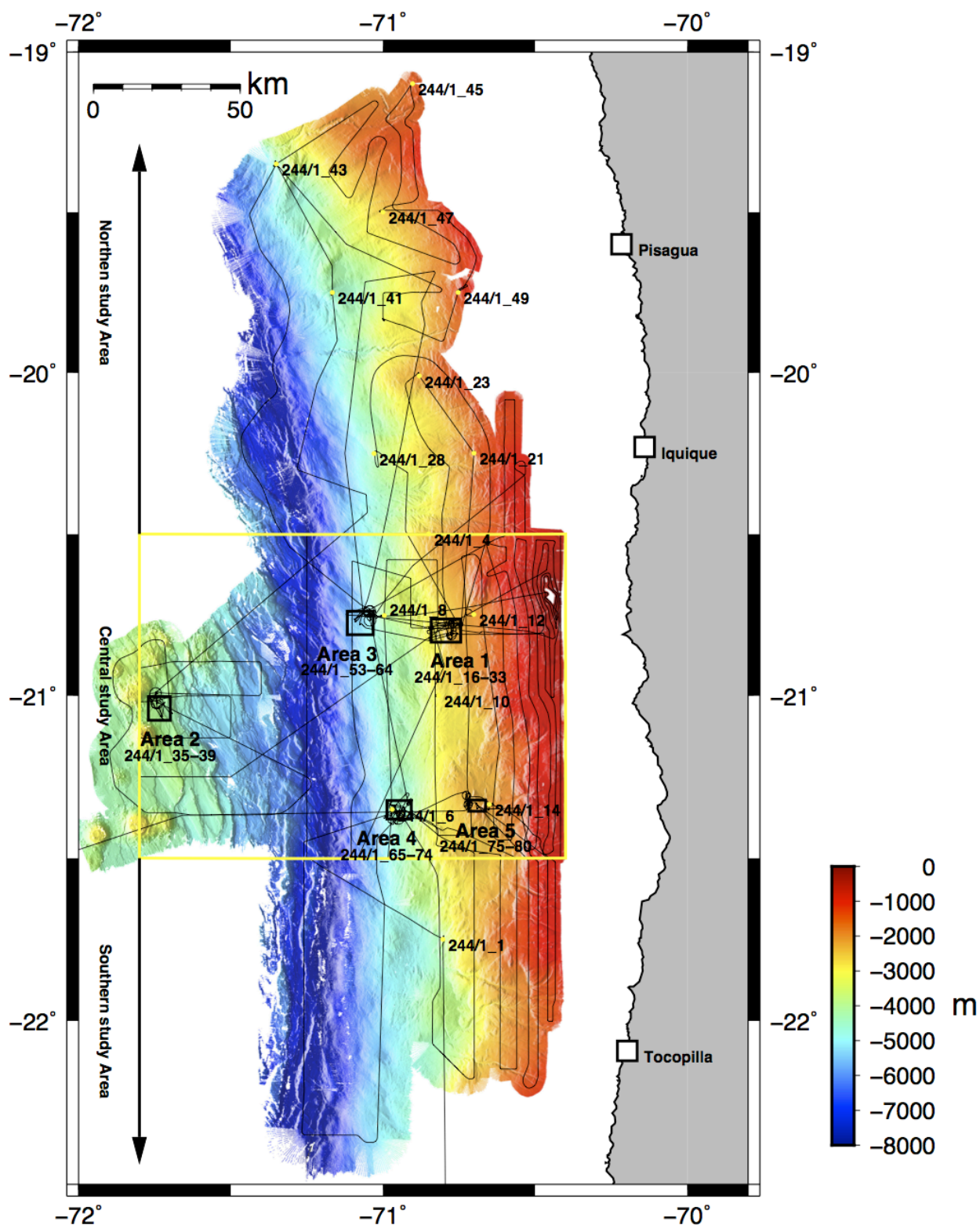


Fig. 1: Map of the Northern Chile continental margin offshore Pisagua to Tocopilla, showing mapped area with water depth from EM122 multibeam echosounder data, locations of the five AUV diving areas in the Central Study area, the ship track (thin black line) and station locations (numbered)

Acknowledgements

We thank the Master and Crew of TFS SONNE for their unrivalled support of the scientific work at sea, for their high motivation and highly professional work, which laid the foundation for a perfect expedition. The Leitstelle Deutsche Forschungsschiffe in Hamburg, the German Ministry for Education and Research (BMBF), and Briesse Schifffahrts GmbH & Co. KG are all acknowledged for the support and practical assistance that have made Cruise SO244 Leg 1 possible. We thank SHOA, Valparaiso, Chile, and the German Ministry of Foreign Affairs for seamless communication in connection with obtaining the necessary research permits.

List of Participants

Name	Task	Institution
Prof. Jan H. Behrmann	Chief scientist	GEOMAR
Dr. Ingo Klaucke	Senior Scientist Shipboard Bathymetry	GEOMAR
Dr. Isobel Yeo	Senior Scientist Microbathymetry	GEOMAR
Prof. Juan Diaz Naveas	Senior Scientist, Marine Geology	Univ. Católica Valparaiso
Dr. Michael Stipp	Senior Scientist Tectonics	GEOMAR
Marcel Rothenbeck	Engineer AUV	GEOMAR
Anja Steinführer	Engineer AUV	GEOMAR
Lars Triebe	Engineer AUV	GEOMAR
Emanuel Wenzlaff	Engineer AUV	GEOMAR
Florian Petersen	Student Assistant, GeoSEA Array	GEOMAR
Dr. Jacob Geersen	Scientist Neotectonics, Parasound	GEOMAR
Dr. Emanuel Soeding	Scientist Data Management	Uni Kiel
Margit Wieprich	PhD Student, OBS Recovery	GEOMAR
Robert Kurzawski	PhD Student, OBS Recovery	GEOMAR
Christopher Schmidt	PhD Student, Microbathymetry	GEOMAR
Simon Catalan Mendez	Observer	SHOA Valparaiso
Kim Aileen Lüneburg	Student Assistant	GEOMAR/Uni Kiel
Philipp Kreussler	Student Assistant	GEOMAR/Uni Kiel
Jasmin Moegeltoender	Scientific Assistant, Watchkeeper	GEOMAR

Institute

GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
Wischhofstr. 1-3
24148 Kiel
Germany

Christian-Albrechts-Universität Kiel
Exzellenzcluster Ozean der Zukunft
Christian-Albrechts-Platz 4
24118 Kiel
Germany

Escuela de Ciencias del Mar
Pontificia Universidad Católica de Valparaiso
Av. Altamirano 1480
Valparaiso, CHILE

List of Stations

SO244-1			Station list													
Start Date	St. No.	Instrument	Time (UTC)				Begin / on seafloor			End / off seafloor			Recovery Remarks	Rec. Stat.	Supervisor	Area
			Start Sci. Program	End Sci. Program	Duration	Latitude S	Longitude W°	Latitude S	Longitude W°	Water depth (m)						
2015	SO244-1															
31.10.2015	244/1_1-1	OBS	11:00:00	11:05:00	12:26:00	12:30:00	01:30	21° 44,585' S	70° 48,081' W	21° 44,585' S	70° 48,081' W	3890,3	rec. OBS-14-X3 from OPV Toro Cruise Nov	x	M Wieprich	
31.10.2015	244/1_2-1	CTD	15:12:05	15:17:03	17:09:01	17:33:27	02:21	21° 29,978' S	71° 14,996' W	21° 29,981' S	71° 14,995' W	6758,2			I Klaucke	
31.10.2015	244/1_3-1	EM122/Parasound	17:34:14	17:46:32	04:05:12	04:05:36	10:31	21° 29,981' S	71° 14,995' W	20° 29,955' S	70° 51,230' W	6772,1			Klaucke/	
01.11.2015	244/1_4-1	OBS	04:06:19	04:10:29	05:05:04	05:12:20	01:06	20° 29,953' S	70° 51,225' W	20° 30,099' S	70° 51,125' W	2509,1	rec. OBS-09-C4 from OPV Toro Cruise Nov	x	M Wieprich	central OBS Area
01.11.2015	244/1_5-1	EM122/Parasound	05:13:07	05:13:19	21:23:00	21:23:06	16:09	20° 30,143' S	70° 51,047' W	21° 21,007' S	70° 58,210' W	2454,7			Klaucke/	
01.11.2015	244/1_6-1	OBS	21:29:00	21:40:17	23:05:48	23:06:06	01:37	21° 20,734' S	70° 58,201' W	21° 20,838' S	70° 58,238' W	4525,7	rec. OBS-13-X1 from OPV Toro Cruise Nov	x	M Wieprich	
01.11.2015	244/1_7-1	EM122/Parasound	23:19:27	23:19:27	03:51:03	03:51:03	04:31	20° 45,447' S	70° 59,719' W	20° 44,786' S	70° 59,696' W	4109,3			Klaucke/	
02.11.2015	244/1_8-1	OBS	03:52:01	04:09:53	05:54:31	06:00:23	02:08	20° 44,757' S	70° 59,652' W	20° 45,119' S	71° 0,441' W	3891,9	rec. OBS-10-S2 from OPV Toro Cruise Nov	x	M Wieprich	southern OBS area
02.11.2015	244/1_9-1	EM122/Parasound	06:01:08	06:11:25	08:37:20	08:37:20	02:36	20° 45,141' S	71° 0,470' W	20° 59,548' S	70° 49,691' W	4195,5			Klaucke/	
02.11.2015	244/1_10-1	OBS	12:00:00	12:03:00	13:01:32	13:02:26	01:02	20° 59,668' S	70° 49,004' W	21° 0,140' S	70° 48,883' W	3002,4	rec. OBS-12-S3 from OPV Toro Cruise Nov	x	M Wieprich	southern OBS area
02.11.2015	244/1_11-1	EM122/Parasound	14:10:21	14:10:21	23:14:44	23:14:44	09:04	21° 0,054' S	70° 49,702' W	20° 45,055' S	70° 43,643' W	3140,2			Klaucke/	
02.11.2015	244/1_12-1	OBS	23:15:52	23:27:53	00:26:43	00:27:04	01:11	20° 45,055' S	70° 43,643' W	20° 44,955' S	70° 42,233' W	2138,7	rec. OBS-11-S1 from OPV Toro Cruise Nov	x	M Wieprich	southern OBS area
03.11.2015	244/1_13-1	EM122/Parasound	00:54:00	00:54:00	08:24:54	08:26:21	07:32	20° 44,662' S	70° 43,645' W	21° 20,270' S	70° 38,808' W	2153,2			Klaucke/	
03.11.2015	244/1_14-1	OBS	08:33:58	08:35:33	09:34:00	09:36:25	01:02	21° 19,916' S	70° 38,995' W	21° 21,097' S	70° 39,127' W	2059,6	rec. OBS-15-X2 from OPV Toro Cruise Nov	x	M Wieprich	
03.11.2015	244/1_15-1	EM122/Parasound	09:46:38	09:51:23	00:32:46	00:44:28	14:57	21° 20,538' S	70° 39,033' W	20° 48,611' S	70° 44,738' W	2059,6			Klaucke/	
05.11.2015	244/1_16-1	AUV	00:44:28	04:58:24	06:06:50	06:07:00	05:22	20° 48,395' S	70° 46,006' W	20° 47,592' S	70° 44,630' W	2294,8	Transponders deployed		M Rothenbeck	Area 1, middle slope
05.11.2015	244/1_17-1	EM122/Parasound	07:03:44	07:05:22	16:20:06	16:21:46	09:18	20° 47,417' S	70° 53,825' W	21° 30,277' S	71° 5,296' W	3561,1			Klaucke/	
05.11.2015	244/1_18-1	AUV	20:00:23	20:01:00	20:15:11	20:17:00	00:16	20° 47,174' S	70° 50,244' W	20° 47,028' S	70° 50,281' W	2862,2		x	M Rothenbeck	Area 1, middle slope
05.11.2015	244/1_19-1	AUV	21:18:23	23:36:20	23:36:20	23:49:00	02:30	20° 47,570' S	70° 44,627' W	20° 47,616' S	70° 44,624' W	2227,7			M Rothenbeck	Area 1, middle slope
06.11.2015	244/1_20-1	EM122/Parasound	01:20:56	01:21:33	03:14:12	03:15:25	01:54	20° 29,946' S	70° 43,231' W	20° 14,641' S	70° 42,025' W	1756,3			Klaucke/	
06.11.2015	244/1_21-1	OBS	03:16:25	03:27:37	04:14:15	04:15:06	00:58	20° 14,559' S	70° 42,007' W	20° 15,110' S	70° 42,054' W	1490,5	rec. OBS-08-C3 from OPV Toro Cruise Nov	x	M Wieprich	central OBS Area
06.11.2015	244/1_22-1	EM122/Parasound	04:16:35	04:23:06	06:34:34	06:35:41	02:19	20° 15,109' S	70° 42,053' W	20° 0,466' S	70° 52,915' W	1605			Klaucke/	
06.11.2015	244/1_23-1	OBS	06:36:33	06:45:07	07:30:08	07:32:00	00:55	20° 0,404' S	70° 52,932' W	19° 59,939' S	70° 52,979' W	2124,9	rec. OBS-06-C1 from OPV Toro Cruise Nov	x	M Wieprich	central OBS Area
06.11.2015	244/1_24-1	EM122/Parasound	07:56:25	07:57:08	13:34:49	13:36:06	05:39	20° 1,530' S	70° 54,994' W	20° 45,553' S	70° 47,540' W	2325,9			Klaucke/	
06.11.2015	244/1_25-1	AUV	13:40:35	14:08:14	15:10:43	15:11:04	01:30	20° 45,624' S	70° 47,536' W	20° 47,160' S	70° 47,893' W	2482,8		x	M Rothenbeck	Area 1, middle slope
06.11.2015	244/1_26-1	AUV	18:30:47	18:32:40	18:32:40	18:39:21	00:08	20° 47,611' S	70° 44,615' W	20° 47,608' S	70° 44,621' W	2482,8			M Rothenbeck	Area 1, middle slope
06.11.2015	244/1_27-1	EM122/Parasound	20:38:02	20:38:24	22:31:00	22:33:17	01:55	20° 27,366' S	70° 55,529' W	20° 14,762' S	71° 0,907' W	3564,7			Klaucke/	
06.11.2015	244/1_28-1	OBS	22:40:47	22:43:00	23:55:33	23:56:19	01:15	20° 14,607' S	71° 1,534' W	20° 15,176' S	71° 1,592' W	3909,6	rec. OBS-07-C2 from OPV Toro Cruise Nov	x	M Wieprich	central OBS Area
07.11.2015	244/1_29-1	EM122/Parasound	00:26:05	00:26:22	07:30:27	07:31:45	07:05	20° 17,556' S	71° 0,928' W	20° 28,594' S	70° 38,891' W	4117,1			Klaucke/	
07.11.2015	244/1_30-1	AUV	09:42:06	10:33:56	10:50:16	10:52:23	01:10	20° 47,286' S	70° 44,667' W	20° 47,820' S	70° 50,705' W	2221,5		x	M Rothenbeck	Area 1, middle slope
07.11.2015	244/1_31-1	AUV	13:59:17	14:05:34	14:05:34	14:13:02	00:13	20° 47,612' S	70° 44,626' W	20° 47,619' S	70° 44,625' W	2226,6			M Rothenbeck	Area 1, middle slope
07.11.2015	244/1_32-1	EM122/Parasound	15:50:24	15:50:35	02:05:00	02:06:36	10:16	20° 47,811' S	70° 28,455' W	20° 36,136' S	70° 27,640' W	423,1			Klaucke/	
08.11.2015	244/1_33-1	AUV	04:05:29	04:48:43	04:48:43	06:24:29	02:19	20° 46,388' S	70° 46,062' W	20° 46,132' S	70° 46,145' W	2348,1	Transponders Recovered	x	M Rothenbeck	Area 1, middle slope
08.11.2015	244/1_34-1	EM122/Parasound	10:55:03	10:56:00	03:39:27	03:40:20	16:45	21° 14,735' S	71° 29,584' W	20° 59,976' S	71° 25,108' W	5508,2			Klaucke/	
09.11.2015	244/1_35-1	AUV	05:27:36	11:04:11	12:42:09	12:43:39	07:16	21° 0,194' S	71° 45,888' W	21° 0,198' S	71° 45,875' W	4095,6	Transponders deployed	x	M Rothenbeck	Area 2, outer rise
10.11.2015	244/1_36-1	AUV	02:00:43	02:10:03	02:50:15	02:51:43	00:51	21° 3,849' S	71° 43,775' W	21° 3,850' S	71° 43,775' W	4096			M Rothenbeck	Area 2, outer rise
10.11.2015	244/1_37-1	AUV	04:49:19	04:51:20	05:04:37	05:04:37	00:15	21° 0,187' S	71° 45,873' W	21° 0,182' S	71° 45,874' W	4096			M Rothenbeck	Area 2, outer rise
10.11.2015	244/1_38-1	EM122/Parasound	08:25:03	08:32:17	19:10:44	19:10:44	10:45	21° 17,297' S	71° 14,561' W	21° 2,678' S	71° 41,959' W	6323,4			Klaucke/	outer rise
10.11.2015	244/1_39-1	AUV	19:11:11	19:11:30	19:35:01	22:00:16	02:49	21° 3,314' S	71° 41,499' W	21° 2,706' S	71° 41,953' W	4335,8	Transponders recovered	x	M Rothenbeck	Area 2, outer rise
10.11.2015	244/1_40-1	EM122/Parasound	22:10:00	22:10:16	09:57:40	09:58:00	11:48	20° 59,114' S	71° 44,403' W	19° 45,140' S	71° 9,990' W	4146,8			Klaucke/	
11.11.2015	244/1_41-1	OBS	10:04:22	10:09:27	11:16:47	11:19:50	01:15	19° 44,770' S	71° 9,994' W	19° 45,086' S	71° 10,007' W	4437,4	rec. OBS-04-N4 from OPV Toro Cruise Nov	x	M Wieprich	northern OBS Area
11.11.2015	244/1_42-1	EM122/Parasound	11:27:56	11:31:17	14:55:32	14:55:32	03:27	19° 45,376' S	71° 10,214' W	19° 21,291' S	71° 20,853' W	4467,4			Klaucke/	

SO244-1				Station list															
				Time (UTC)				Begin / on seafloor				End / off seafloor							
Start Date	St. No.	Instrument	Begin	Start Sci. Program	End Sci. Program	End	Duration	Latitude S	Longitude W°	Latitude S	Longitude W°	Water depth (m)	Recovery Remarks	Rec. Stat.	Fail. Stat.	Supervisor	Area		
11.11.2015	SO244-1	OBS	15:05:15	15:07:30	16:27:15	16:30:28	01:25	19° 20,421' S	71° 21,205' W	19° 21,428' S	71° 21,410' W	2411	rec. OBS-02-N2 from OPV Toro Cruise Nov	x		M Wieprich	northern OBS Area		
11.11.2015	244/i_44-1	EM122/Parasound	16:31:07	16:39:27	10:13:09	10:14:22	17:43	19° 21,424' S	71° 21,421' W	19° 6,031' S	70° 54,445' W	4535,2				Klaucke/			
12.11.2015	244/i_45-1	OBS	10:20:33	10:25:09	10:53:58	10:56:02	00:35	19° 5,775' S	70° 54,247' W	19° 6,015' S	70° 54,322' W	1497,9	rec. OBS-01-N1 from OPV Toro Cruise Nov	x		M Wieprich	northern OBS Area		
12.11.2015	244/i_46-1	EM122/Parasound	11:00:41	11:00:56	14:36:29	14:36:44	03:36	19° 6,270' S	70° 54,503' W	19° 29,010' S	70° 59,279' W	1560,6				Klaucke/			
12.11.2015	244/i_47-1	OBS	14:42:26	14:51:32	15:42:21	15:49:44	01:07	19° 29,479' S	70° 59,918' W	19° 29,968' S	71° 0,419' W	2352,1	rec. OBS-03-N3 from OPV Toro Cruise Nov	x		M Wieprich	northern OBS Area		
12.11.2015	244/i_48-1	EM122/Parasound	15:50:16	16:00:02	19:45:05	19:46:27	03:56	19° 29,962' S	71° 0,437' W	19° 44,507' S	70° 44,928' W	2584,4				Klaucke/			
12.11.2015	244/i_49-1	OBS	19:48:02	19:50:25	20:16:50	20:18:03	00:30	19° 44,511' S	70° 44,929' W	19° 44,907' S	70° 45,156' W	1171,3	rec. OBS-05-N5 from OPV Toro Cruise Nov	x		M Wieprich	northern OBS Area		
12.11.2015	244/i_50-1	EM122/Parasound	21:00:00	21:00:55	23:40:35	23:41:25	02:41	19° 45,403' S	70° 45,316' W	19° 49,914' S	70° 59,992' W	1333,1				Klaucke/			
12.11.2015	244/i_51-1	CTD	23:43:45	00:52:49	01:40:16	01:42:37	01:58	19° 49,964' S	71° 0,091' W	19° 49,925' S	71° 0,081' W	3217				I Klaucke			
13.11.2015	244/i_52-1	EM122/Parasound	01:57:40	01:57:51	18:48:12	18:48:40	16:51	19° 50,141' S	70° 59,960' W	20° 32,218' S	71° 18,498' W	3156,4				Klaucke/			
13.11.2015	244/i_53-1	AUV	20:55:52	01:30:22	03:37:29	03:37:29	06:41	20° 44,848' S	71° 3,737' W	20° 44,310' S	71° 2,576' W	4930				M Rotherbeck	Area 3, lower slope		
14.11.2015	244/i_54-1	EM122/Parasound	04:53:54	04:54:12	14:49:16	14:49:16	09:55	20° 47,310' S	70° 51,623' W	20° 49,890' S	70° 48,470' W	3201,7				Klaucke/			
14.11.2015	244/i_55-1	AUV	16:20:49	16:36:35	16:40:32	16:40:32	00:19	20° 46,868' S	71° 4,535' W	20° 46,628' S	71° 4,375' W	5308,9		x		M Rotherbeck	Area 3, lower slope		
14.11.2015	244/i_55-2	Waveglider	17:21:00	17:21:15	19:17:00	19:17:40	01:56	20° 44,845' S	71° 3,714' W	20° 44,839' S	71° 3,692' W	5354,1	Navigation test. Added station at end of cruise			F Petersen			
14.11.2015	244/i_56-1	AUV	19:54:59	19:58:17	20:07:30	20:07:30	00:12	20° 44,848' S	71° 3,746' W	20° 44,849' S	71° 3,747' W	5354,1				M Rotherbeck	Area 3, lower slope		
14.11.2015	244/i_57-1	EM122/Parasound	22:57:13	22:58:18	06:00:05	06:00:19	07:03	20° 15,382' S	71° 7,452' W	19° 51,620' S	70° 51,867' W	5838,6				Klaucke/			
15.11.2015	244/i_58-1	AUV	11:45:51	12:12:27	12:17:40	12:17:40	00:31	20° 46,165' S	71° 5,292' W	20° 45,885' S	71° 4,933' W	5438,2		x		M Rotherbeck	Area 3, lower slope		
15.11.2015	244/i_59-1	AUV	16:06:48	16:12:01	16:22:01	16:22:01	00:15	20° 44,845' S	71° 3,741' W	20° 44,851' S	71° 3,743' W	5338,6				M Rotherbeck	Area 3, lower slope		
15.11.2015	244/i_60-1	EM122/Parasound	20:06:31	20:10:20	02:30:52	02:30:52	06:24	20° 49,291' S	70° 26,979' W	20° 40,973' S	70° 28,477' W	490,9				Klaucke/			
16.11.2015	244/i_61-1	AUV	06:00:00	06:20:46	06:21:17	06:21:17	00:21	20° 45,845' S	71° 5,483' W	20° 45,456' S	71° 5,061' W	5543,8		x		M Rotherbeck	Area 3, lower slope		
16.11.2015	244/i_62-1	AUV	08:54:12	09:00:11	09:10:34	09:10:34	00:16	20° 44,784' S	71° 3,795' W	20° 44,829' S	71° 3,757' W	5508,7				M Rotherbeck	Area 3, lower slope		
16.11.2015	244/i_63-1	EM122/Parasound	12:00:00	12:12:14	20:34:57	20:35:26	08:35	20° 30,823' S	70° 37,355' W	20° 18,219' S	70° 31,902' W	1296,5				Klaucke/			
17.11.2015	244/i_64-1	AUV	00:38:50	01:15:03	01:49:58	03:35:40	02:56	20° 45,188' S	71° 2,521' W	20° 46,019' S	71° 2,461' W	5009,6	Transponders Recovered	x		M Rotherbeck	Area 3, lower slope		
17.11.2015	244/i_65-1	AUV	16:05:05	20:44:49	20:48:07	22:24:12	06:19	21° 22,555' S	70° 56,884' W	21° 21,018' S	70° 55,848' W	4499	Transponders Deployed			M Rotherbeck	Area 4, southern slope		
18.11.2015	244/i_66-1	EM122/Parasound	00:04:17	00:04:49	09:26:29	09:27:01	09:22	21° 29,591' S	70° 41,976' W	21° 34,329' S	70° 49,163' W	2504,7				Klaucke/			
18.11.2015	244/i_67-1	AUV	10:50:10	10:53:35	11:21:44	11:22:26	00:32	21° 22,298' S	70° 56,138' W	21° 22,621' S	70° 57,037' W	4476,4		x		M Rotherbeck	Area 4, southern slope		
18.11.2015	244/i_68-1	AUV	19:47:53	19:49:53	19:53:28	20:00:10	00:12	21° 21,018' S	70° 55,849' W	21° 21,019' S	70° 55,854' W	4488,7				M Rotherbeck	Area 4, southern slope		
18.11.2015	244/i_69-1	EM122/Parasound	20:54:48	20:56:26	11:25:24	11:26:14	14:31	21° 26,596' S	71° 1,198' W	21° 27,141' S	71° 15,586' W	5581,1				Klaucke/			
19.11.2015	244/i_70-1	AUV	13:20:04	13:52:04	14:17:58	14:18:23	00:58	21° 21,218' S	70° 56,534' W	21° 22,538' S	70° 59,504' W	4510,1		x		M Rotherbeck	Area 4, southern slope		
19.11.2015	244/i_71-1	EM122/Parasound	15:21:58	15:22:11	17:50:12	17:50:18	02:28	21° 18,798' S	70° 55,098' W	21° 20,413' S	70° 57,520' W	4353,3				Klaucke/			
19.11.2015	244/i_72-1	AUV	18:15:07	18:47:21	18:54:07	18:54:07	00:39	21° 20,992' S	70° 55,860' W	21° 21,016' S	70° 55,845' W	4483,4				M Rotherbeck	Area 4, southern slope		
19.11.2015	244/i_73-1	EM122/Parasound	21:16:04	21:17:07	06:41:54	06:42:06	09:26	21° 29,675' S	70° 36,771' W	21° 30,043' S	70° 33,640' W	2370,3				Klaucke/			
20.11.2015	244/i_74-1	AUV	09:04:33	09:49:05	10:23:34	12:13:16	03:08	21° 21,352' S	70° 56,765' W	21° 23,071' S	70° 57,443' W	4508,4	Transponders Recovered	x		M Rotherbeck	Area 4, southern slope		
20.11.2015	244/i_75-1	AUV	13:54:39	17:23:24	18:25:26	18:25:46	04:31	21° 17,890' S	70° 43,517' W	21° 19,937' S	70° 41,611' W	2343,3	Transponders Deployed			M Rotherbeck	Area 5, upper slope		
20.11.2015	244/i_76-1	EM122/Parasound	20:04:35	20:06:18	06:03:14	06:03:24	09:58	21° 30,044' S	70° 31,697' W	21° 30,826' S	70° 29,404' W	1444,2				Klaucke/			
21.11.2015	244/i_77-1	AUV	07:55:31	07:57:17	08:21:01	08:22:36	00:27	20° 29,883' S	70° 40,057' W	21° 20,873' S	70° 41,366' W	1824,3		x		M Rotherbeck	Area 5, upper slope		
21.11.2015	244/i_78-1	AUV	11:00:25	11:48:54	11:51:33	12:00:30	01:00	21° 19,933' S	70° 40,673' W	21° 19,938' S	70° 41,613' W	2184,6				M Rotherbeck	Area 5, upper slope		
21.11.2015	244/i_79-1	EM122/Parasound	13:52:59	13:53:36	21:01:13	21:02:55	07:09	21° 29,933' S	70° 27,913' W	21° 30,279' S	70° 26,649' W	872,1				Klaucke/			
21.11.2015	244/i_80-1	AUV	23:00:04	23:51:15	00:21:44	01:58:28	02:58	21° 18,659' S	70° 42,623' W	21° 20,400' S	70° 43,178' W	2316	Transponders Recovered	x		M Rotherbeck	Area 5, upper slope		
22.11.2015	244/i_81-1	EM122/Parasound	02:14:15	02:15:32	04:00:00	04:00:00	48:07	21° 21,170' S	70° 43,613' W	22° 59,181' S	72° 8,079' W	2356,9				Klaucke/			
End of SO244-1																			