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Short Cruise Report

R/V SONNE cruise SO258 Leg 1

Fremantle (Australia) - Colombo (Sri Lanka)

07.06.2017 - 09.07.2017

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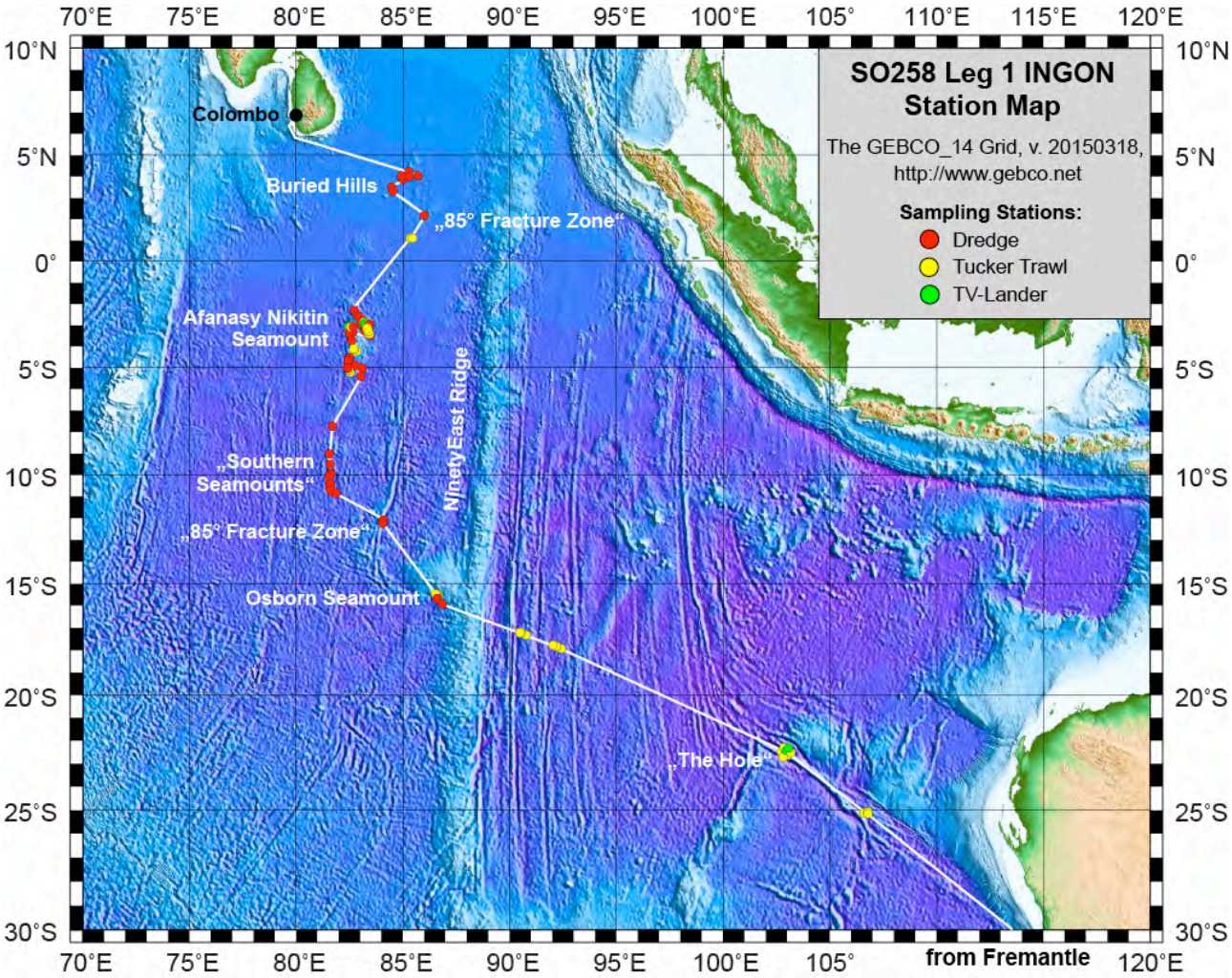
Captain: Oliver Meyer



Objectives

Geology:
R/V SONNE cruise SO258 is part of the research project INGON, which is a collaboration between the Alfred Wegener institute Helmholtz centre for polar and marine research (AWI) and the GEOMAR Helmholtz centre for ocean research Kiel. Using the example of the Indian-Antarctic Breakup c. 130 m.y. ago, SO258 INGON aims to investigate magmatic and tectonic processes that trigger the breakup of continents and the formation of ocean basins. This is not only an important topic in basic research contributing to a better understanding of the Earth system but also provides important data on the relations between magmatic and volcanic activity and their influence on environment, climate, and ecological systems. Many questions remain concerning the Indian/Sri Lanka separation from Antarctica during the break-up of Gondwana. When was the initiation of the breakup? Was it triggered by a hotspot, which generated the Rajmahal Trap basalts (plume head) and 85°E ridge (plume tail), one of in total three prominent basement ridges in the Indian Ocean? Did the extremely rapid Indian drift begin at breakup or instead at ~67 Ma triggered by a different process? Published kinematic models vary by more than 30 m.y. and therefore the related magmatic processes are unknown. To date, only a single locality along the 85°E Ridge (Afanasy Nikitin) has been sampled, but only two age dates (67 Ma, Krishna et al. 2014, J. Earth Syst. Sci. 123-1) are available and its origin is unclear. The samples from Afanasy Nikitin, however, show the most enriched (continental-like) isotopic ratios of any rocks analyzed from the ocean basins thus far. The origin of this geochemical anomaly, however, is still unclear. Thus, the major goal of SO-258 Leg 1 INGON is to answer these questions by geochronological-geochemical studies of the 85°E Ridge. These investigations will be continued on SO258 Leg 2 by complementary geophysical (seismic, magnetic, gravity) studies conducted by the AWI.

Biology:
The visual images created by bioluminescence are much different from the general, scenic illumination resulting from sunlight and therefore have lead to the evolution of special adaptations in the visual systems, and the eyes in particular. The eyes of mesopelagic cephalopods, crustaceans and teleosts are studied to investigate their morphological and physiological adaptations and specialisations for the perception of bioluminescence. In fish, traditional concepts on the function of tubular eyes are tested in conjunction with the role of optical devices such as mirrors, optical folds, lens pads and diverticula. These projects with a phylogenetic perspective are supplemented by molecular-genetic studies in order to clarify the cladistics relationships between the various species. Novel electrophysiological experiments directly demonstrate the motion- and intensity sensitivity as well as the spatial resolution of mesopelagic visual systems in fish and crustaceans,- parameters that have previously only be indirectly inferred from morphological observations. Finally, autonomic floater and lander systems have been deployed to study the mesopelagic and demersal fauna in situ. This part of the Indian Ocean has not previously been studied in this respect.

Narrative

R/V SONNE Cruise SO258 leg 1 started in Fremantle, Australia. On Monday, June 5, in the course of an Open Ship the citizens of Perth and Fremantle had the opportunity to visit the SONNE and get an insight into current research. The vessel, as well as the presentations of the different scientific working groups, met very good response among the 3.200 (!) visitors and Australian media.

In the morning of June 6, the SO258 leg 1 scientific party embarked R/V SONNE. After the arrival of all containers on board, the vessel left Fremantle in the evening of June 7 to head to its first working area. The first priority on the transit was to set up all biological laboratories since the first part of the cruise was, besides underway mapping, exclusively dedicated to biological work. Soon enough the new Trucker-Trawl net (with an opening area of 45 m^2) was mobilized and tested. A special feature of the net is that the opening can be opened and closed at depths by a control box. Although dry runs with the opening system were successful, the control box did not work during the first trawl as the net was still closed when it came on board. On June 10th, two more trawls were carried out approximately 500 nautical miles (nm) off the west coast of Australia.

To avoid previous problems, from now on the net was deployed open. Both catches were highly successful and yielded different and rare species of fish, squid, octopus and shrimp. The last trawl was brought in after sunset, avoiding bleaching of the fish and shrimp eyes in order to allow biochemical and physiological experiments on the visual systems. During the first week of the cruise, the weather has been mostly sunny and warm.

The second week was characterized by different biological experiments and the long transit to the first working area of the geologists. The series of trawls was continued with nine further deployments. Catches were brought on board during darkness. All trawls contained numerous and diverse species of fish and also an unexpected richness in squids, octopuses, and shrimp. From Sunday to Wednesday, the Newcastle University fleet of 5 benthic lander was deployed 11 times between 4,700 and 6,500 m in the vicinity of a deep seafloor depression at 22˚S by 110˚E. The lander are a combination of baited video and still camera lander and baited traps. The team successfully collected specimens of amphipods from all baited trap stations. The lander were also used to characterize the benthic scavenging fauna. Interestingly, on the video systems second deployment, the footage revealed that the seafloor was in fact a manganese nodule field. This week the weather was unsettled and occasionally rainy and windy. However, not least thanks to the efforts of the master and the crew of R/V SONNE we were able to conduct almost all deployments as scheduled despite wind and waves.

At the beginning of the third week, cruise SO258 leg 1 conducted further trawls before the series of Tucker-Trawl deployments was discontinued until reaching the Afanasy Nikitin Complex. During the night from Sunday, June 18, of Monday, we arrived at Osborn Seamount which is located at ~15°S directly west of the Ninetyeast Ridge. The first two dredge hauls of this journey have been conducted at its southern flank. Our dredges indeed returned the first rocks ever sampled from this feature but unfortunately they comprised only altered volcaniclastic rocks. En route to our first major dredge area, we stopped at the "85° Fracture Zone". Despite difficult weather conditions, we were able to recover magmatic rocks from this feature.

In the evening of Friday, June 21, R/V SONNE reached a completely unexplored area. Here the predicted bathymetry shows seamounts and ridges scattered between 8°30´S and 11°S, which have been named "Southern Seamounts" by the cruise participants. They represent the southern tip of a chain of geomorphological features called "85° Ridge", which extends from Sri Lanka to the south and includes the Afanasy Nikitin Complex. Our survey of the "Southern Seamounts" revealed that they comprise at least 10 circular or oval, up to 2,000 m high seamounts and numerous smaller volcanic structures. Sampling of these volcanoes proved difficult because obviously they are covered with manganese crusts and volcaniclastic material. Nevertheless we managed to obtain lava fragments from seven of the larger seamounts. Surprisingly fresh volcanic glass persisted on some of the lava fragments, which is particular suitable for geochemical analyses. When R/V SONNE headed towards the Afanasy Nikitin Complex on Saturday, June 24, we realized astonished, that a chain of somewhat smaller, up to 1.500 m high seamounts emanates from the "Southern Seamounts" at least 150 km in northern direction. These seamounts are not displayed by the predicted bathymetry. An attempt to sample one of these newly discovered volcanoes unfortunately yielded only crusts and heavily altered lava fragments. On Sunday, June 25, we reached the Afanasy Nikitin Complex. This submarine mountain consists of a ~400 km long and up to 140 km wide basal ridge, which rises from ~5,000 m below sea level (b.s.l.) to 2,000 m b.s.l. Several seamounts up to 2,000 m high are located on the northern portion of this ridge. One of these seamounts has been named after the Russian explorer Afanasy Nikitin. Until Friday, June 30, we have carried out altogether 11 deep dredge hauls at fault scarps and the flanks of the basal ridge, of which nine recovered lava fragments and often also volcaniclastic rocks. Fortunately we frequently found unaltered volcanic glass in the dredges. On Saturday, July 1, we reached the seamounts on the ridge. Afanasy Nikitin Seamount and a nearby seamount on the eastern flank of the ridge are so-called guyots, i.e. seamounts that have steep sides and a relatively flat summit and usually represent volcanoes that once formed ocean islands. Unfortunately two dredge hauls at the guyot on the eastern flank yielded only semi-consolidated limestone. By contrast a dredge haul at a fault scarp at the base of the northern part of the ridge returned lava and volcaniclastic rocks with fresh glassy margins. Dredging at the Afanasy Nikitin Seamount was also successful. Here the dredge recovered vesicular lava with partly fresh glassy rims from a volcanic cone on its western flank. Finally three dredge hauls at its northern tip of the Afanasy Nikitin Complex delivered lava fragments and volcaniclastic rocks.

The biologists carried out ten more trawls at the Afanasy Nikitin Complex. In this area of complex seafloor topography there are upwelling currents that improve the supply of nutrients for the macrofauna. Indeed the most successful nets contained more than 500 fish, squid, and shrimp, with numerous large specimens, in very good condition, and sometimes alive. On Thursday, June 27, and Saturday night three lander each were deployed for 12 hours at the base and the top of the Afanasy Nikitin Seamount in order to study the effects of depth/pressure on the fish and amphipod communities. The weather remained variable in the past two weeks with a mixture of clouds, sun, and partly heavy rain showers.

On Monday, July 31, in the evening SONNE headed towards a thus far largely unexplored area ~300 nm southeast off Sri Lanka. Bathymetric maps based on satellite altimetry reveal a NE-SW-striking chain of seamounts and ridges, which are referred to as Buried Hills. En route we have carried out one dredge at S-shaped, E-W-trending ridge. This feature is located on the "85° Fracture Zone" which we had already sampled ~2,000 km further south on our journey. A dredge haul at this feature turned out to be one of the best of the cruise. The dredge returned mafic and trachytic (?) lava as well as large amounts of volcanic glass. On Wednesday morning we finally arrived at the Buried Hills. Unfortunately deep sea cables hindered us to sample the south-westernmost seamount of this chain. However, a dredge haul at a seamount located slightly further northeast yielded lava fragments. The following five dredges have been conducted at an S-shaped SW-NE-trending ridge. Four of them recovered aphyric lava fragments. The last dredge of the journey aimed at a seamount located ~40 km east of the ridge but unfortunately returned empty. Besides extensive multi-beam mapping and sediment-echosounder profiling, a total of 39 dredge hauls in an average water depth of 4,150 m were carried out on SO258 leg 1. Of these, 32 (= 82%) delivered *in situ* samples of which 29 obtained volcanic rocks, 15 volcaniclastics, and five sedimentary rocks. No equipment was lost or seriously damaged.

The last Tucker trawl was carried out on Tuesday, July 4th, during transit to the Buried Hills. As before the net contained a high number of specimens allowing the successful completions of ongoing experiments. In summary, the catches during the cruise SO258 leg 1 were much better than we had hoped. In total the number of specimens by far exceeds 2,000. Over 150 species of fish from 81 genera and 38 families were caught. These were typical of the mesopelagic assemblage but included interesting abundancies and exclusions. For example, only 3 juvenile *Anoplogaster* were caught and no *Diretmus sp*, while many *Stylephorous* (11) were caught along with stomiiforms from at least 22 genera including hundreds of hatchetfish (Stenoptix and Argyropelecus), viperfish (Chauliodus), bristlemouth (Gonostoma) and the rare *Malacosteus niger* or *australis* (22 individuals) and *Eustomias* sp (28 Individuals). The diversity of cephalopods, too, was unexpectedly large with 33 cephalopod species (225 specimens from 17 Families and 27 Genera) brought on board. Crustaceans included many decapod shrimp, hyperiid amphipods, ostracods and an assortment of other isopods and amphipods. The catch, like fish, was again in some ways typical of what was to be expected in mesopelagic trawls but with some gaps.

On Friday, July 7th, we left our working area and R/V SONNE headed towards Colombo. Among others, the transit was used for preliminary studies of the data and samples as well as for cleaning, maintenance, and packing of our equipment. On Sunday, July 9th, we finally reached the port of Colombo according to schedule at 08:00 am.

Acknowledgements

We would especially like to thank Captain Meyer and the crew of R/V SONNE. Their hard work, high level of experience, great flexibility and willingness to help, as well as the pleasant working atmosphere on board, contributed directly to the success of the SO255 expedition.
We are also grateful to the German Federal Ministry of Education and Research for continuing support of marine research. Additional funding was provided by GEOMAR, the University of Tübingen, the Museum für Naturkunde Berlin, the University of Queensland, the University of Western Australia, Newcastle University, Nova Southeastern University, and University College London.

Cruise Participants

1. Reinhard Werner	Chief Scientist	GEOMAR
2. Hans-Joachim Wagner	Deputy PSO/Head Biology	UT
3. Fanny de Busserolles	Myctophid brains	UQ
4. Lucille Chapuis	Fish Brains	UWA
5. Wensung Chun	Net & Medusa Floater	UQ
6. Shaun Collin	Fish Visual System	UWA
7. Fabio Cortesi	Myctophid Mol. Biol.	UQ
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9. Tamara Frank	Crustcean ERG	NOVA
10. Nina Furchheim	Rock Sampling /Macro Benthos	MfN
11. Folkmar Hauff	Shift Leader Geology	GEOMAR
12. Silke Hauff	Rock Sampling	GEOMAR
13. Alan Jamieson	Landers	NCL
14. Anna-Lee Jessop	Fish ERG	UWA
15. Karin Junge	Rock Sampling	GEOMAR
16. Stephan Homrighausen	Shift Leader Geology	GEOMAR
17. Nora Krebs	Rock Sampling	GEOMAR
18. Oleg Levchenko	Guest Geology	IO RAS
19. Thomas Linley	Landers	NCL
20 Thomas Lisney	Fish Brains	CEFE
21. Alastair Mac Even	TV Crew	Silverback TV
22. Julia Marinova	Guest Geology	IO RAS
23. Justin Marshall	Net & Medusa Floater	UQ
24. Ulrich Mattheus	Chemicals Resp.; Histology	UT
25. Katharina Pank	Rock Sampling	GEOMAR
26. Julian Partridge	Pigment Regeneration	UWA
27. Olly Scholey	TV Crew	Silverback TV
28. Maxim Portnyagin	Shift Leader Geology	GEOMAR
29. Inga Steindal	Biological Rhythms	UCL
30. Anne Völsch	Rock Sampling	GEOMAR
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Appendix I (SO258 Leg 1 Station Summary)

Type	Stat.	Location	total volume	Rec. DR	Station summary	start / on bottom		end / off bottom		depth (m)		Rock sampling			
						lat °N	long °	lat °N	long°	begin	end	Mag	VC	Sed	Mn
T T	1	en route to working area A			*duration of haul: 6.0 hours,1000m, trawl did not open*	-27,143	108,951	-27,026	108,807	5405	5488				
T T	2-1	en route to working area A			duration of haul: 4.0 hours, 700-650-550-500m	-25,115	106,194	-25,052	106,186	4013	2887				
T T	2-2	en route to working area A			duration of haul: 7.0 hours, 700-650-550-500m	-25,041	106,158	-25,085	106,003	2973	3951				
TVL	3 to 7	N-slope of deep trough in working area A			TV-lander transect 1 (launch of 5 lander)	-22,198	102,503	-22,266	102,443	4737	6550				
T T	8	deep trough in working area A			duration of haul: 6.0 hours, 1200-1000-800-600-400-200m	-22,268	102,437	-22,429	102,330	6551	4492				
TVL	9	N-slope of deep trough in working area A			TV-lander transect 1 (recovery of 5 lander)	-22,195	102,506	-22,275	102,451	4687	6549				
T T	10	deep trough in working area A			duration of haul: 4.0 hours, 500-300m	-22,279	102,446	-22,343	102,414	6537	6611				
TVL	11	N-slope of deep trough in working area A			TV-lander transect 2 (launch of 4 lander)	-22,198	102,504	-22,248	102,425	4740	4735				
T T	12	deep trough in working area A			duration of haul: 7.0 hours, 1000-800-600-400m	-22,246	102,424	-22,351	102,340	6542	5964				
TVL	13	N-slope of deep trough in working area A			TV-lander transect 2 (recovery of 4 lander)	-22,196	102,516	-22,249	102,434	4740	6500				
T T	14	deep trough in working area A			duration of haul: 5.5 hours, 400-300-200m	-22,249	102,434	-22,313	102,425	6493	6552				
TVL	15	bottom of deep trough in working area A			TV-lander transect 2 (launch of 2 lander))	-22,249	102,459	-22,246	102,465	6237	6109				
T T	16	deep trough in working area A			duration of haul: 8.5 hours, 1000-800-200m	-22,246	102,465	-22,381	102,401	6101	5967				
TVL	17	bottom of deep trough in working area A			TV-lander transect 2 (recovery of 2 lander)	-22,244	102,461	-22,247	102,471	6103	6091				
T T	18	en route to Osborn Seamount			duration of haul: 5.0 hours, 1200-200-100m	-17,626	91,727	-17,685	91,870	5434	5407				
T T	19	en route to Osborn Seamount			duration of haul: 9.3 hours, 800-200-100m	-17,695	91,893	-17,789	92,116	5586	5407				
T T	20	en route to Osborn Seamount			duration of haul: 3.4 hours, 400-200m	-17,054	90,199	-17,081	90,245	5487	5136				
T T	21	en route to Osborn Seamount			duration of haul: 11.0 hours, 200m	-17,081	90,246	-17,174	90,497	5477	5136				
DR	22	Osborn Seamount	few rocks	1	volcaniclastic rocks	-15,900	86,760	-15,730	86,768	3412	3088		yes		
DR	23	Osborn Seamount	empty	0		-15,633	86,520	-15,625	86,520	3523	3071				
T T	24	Osborn Seamount			duration of haul: 3.3 hours	-15,427	86,439	-15,450	86,491	2740	2970				
T T	25	Osborn Seamount			duration of haul: 4.7 hours	-15,451	86,495	-15,495	86,569	2727	2404				
DR	26	85° Fracture Zone, southern section	few rocks	1	lava fragments, volcaniclastic rocks	-12,127	83,910	-12,127	83,917	3987	3550	yes	yes		
DR	27	85° Fracture Zone, southern section	few rocks	1	lava fragments, intrusive and sedimentary rocks, Mn-crusts	-11,981	83,943	-11,978	83,949	4120	3743	yes		yes	yes
CTD	28	Southern Seamounts			*failed because of technical defect*	-10,776	81,756	-10,776	81,756	4941	4936				
DR	28	Southern Seamounts	few rocks	1	lava fragments	-10,628	81,520	-10,628	81,528	4480	4010	yes			
DR	30	Southern Seamounts	1/4 full	1	lava fragments, semi-consolidated sediment, Mn-crusts	-10,671	81,525	-10,664	81,530	4714	4306	yes		yes	yes
DR	31	Southern Seamounts	one rock	0	one piece of Mn-crust	-10,368	81,508	-10,363	81,511	4959	4501				yes
DR	32	Southern Seamounts	few rocks	1	lava fragments, volcaniclastic rock (punice)	-10,423	81,466	-10,416	81,469	4490	4213	yes	yes		
DR	33	Southern Seamounts	few rocks	1	lava fragments, volcaniclastic rocks	-10,037	81,428	-10,033	81,434	4423	3895	yes	yes		
DR	34	Southern Seamounts	2 rocks	1	*lava fragment, Mn-crust+sediment*	-9,919	81,523	-9,912	81,526	4330	3900	yes			yes
CTD	35	Southern Seamounts			only sound profile for EM122 (2.500 m)	-9,912	81,526	-9,912	81,526	3913	3891				
DR	36	Southern Seamounts	few rocks	1	lava fragments	-9,475	81,493	-9,471	81,497	4300	3950	yes			
DR	37	Southern Seamounts	few rocks	1	lava fragments	-9,002	81,464	-8,997	81,485	4928	4510	yes			
DR	38	Seamount north of Southern Seamounts	few rocks	1	lava fragments, volcaniclastic rocks	-7,755	81,599	-7,756	81,605	4724	4300	yes	yes		
DR	39	Afanasi Nikitin Ridge	1/2 full	1	lava fragments	-5,387	82,902	-5,382	82,906	4957	4545	yes			
DR	40	Afanasi Nikitin Ridge	1/3 full	1	lava fragments, Mn-crusts	-5,026	82,971	-5,022	82,975	4750	4430	yes			yes
DR	41	Afanasi Nikitin Ridge	1/3 full	1	lava fragments	-4,894	82,665	-4,901	82,670	4180	3777	yes			
DR	42	Afanasi Nikitin Ridge	few rocks	0	Mn-nodules	-5,009	82,301	-5,009	82,307	5020	4650				yes
TT	43	Afanasi Nikitin Ridge			duration of haul: 3.3 hours, 400-250m	-5,017	82,295	-5,093	82,356	4997	4607				
TT	44	Afanasi Nikitin Ridge			duration of haul: 4.0 hours, 400-250-150m	-5,095	82,357	-5,211	82,413	4590	4441				

Appendix I (SO258 Leg 1 Station Summary)

Type	Stat.	Location	total volume	Rec. DR	Station summary	start / on bottom lat °N	start / on bottom long °	end / off bottom lat °N	end / off bottom long°	depth (m) begin	depth (m) end	Rock sampling Mag	VC	Sed	Mn
DR	45	Afanasi Nikitin Ridge	1/4 full	1	lava fragments, volcaniclastic rocks	-4,662	82,315	-4,662	82,323	4992	4396	yes	yes		
DR	46	Afanasi Nikitin Ridge	1/4 full	1	lava fragments, volcaniclastic rocks	-4,554	82,378	-4,551	82,383	3740	3340	yes	yes		
TT	47	Afanasi Nikitin Ridge			duration of haul: 2.5 hours, 400-250m	-4,139	82,566	-4,178	82,610	3657	3319				
TT	48	Afanasi Nikitin Ridge			duration of haul: 5.0 hours, 400-250m	-4,179	82,611	-4,253	82,708	3325	3221				
DR	49	Afanasi Nikitin Ridge	few rocks	1	lava fragments, volcaniclastic rocks	-4,179	82,582	-4,178	82,590	3879	3364	yes	yes		
DR	50	Afanasi Nikitin Ridge	few rocks	1	lava fragments, volcaniclastic rocks	-3,780	82,489	-3,777	82,494	4459	4181	yes	yes		
DR	51	Afanasi Nikitin Ridge	empty	0		-3,448	82,359	-3,446	82,365	4939	4527				
DR	52	Afanasi Nikitin Ridge	half full	1	lava fragments, volcaniclastic rocks, carbonate	-3,405	82,524	-3,401	82,529	4325	4050	yes	yes	yes	
DR	53	Afanasi Nikitin Ridge	half full	1	lava fragments, volcaniclastic rocks	-3,143	82,483	-3,142	82,488	4469	4203	yes	yes		
TVL	54	Afanasi Nikitin Ridge			TV-lander transect 4 (launch of 3 lander))	-3,149	82,433	-3,159	82,433	4720	4738				
TT	55	Afanasi Nikitin Ridge			duration of haul: 8.0 hours, 1200-800-150m	-3,159	82,437	-3,379	82,442	4724	4505				
TVL	56	Afanasi Nikitin Ridge			TV-lander transect 4 (recovery of 3 lander)	-3,157	82,436	-3,165	82,428	4725					
TT	57	Afanasi Nikitin Ridge			duration of haul: 3.5 hours, 700-150m	-3,234	83,195	-3,353	83,236	3638	2383				
TT	58	Afanasi Nikitin Ridge			duration of haul: 4.0 hours, 800-150m	-3,367	83,242	-3,475	83,288	2897	4596				
DR	59	Afanasi Nikitin Ridge, guyot	empty	0		-3,358	83,228	-3,352	83,233	2912	2367				
DR	60	Afanasi Nikitin Ridge, guyot	few rocks	1	limestones	-3,348	83,177	-3,341	83,182	3030	2610			yes	
DR	61	Afanasi Nikitin Ridge	few rocks	1	lava fragments, volcaniclastic rocks, semi-consolidated sed.	-3,090	83,277	-3,087	83,284	4370	4070	yes	yes		
TVL	62	Afanasi Nikitin Seamount			TV-lander transect 5 (launch of 3 lander)	-3,037	83,094	-3,030	83,088	1593	1550				
TT	63	Afanasi Nikitin Seamount			duration of haul: 8,7 hours, 1000-300m	-2,963	83,060	-3,165	83,176	3202	3897				
TVL	64	Afanasi Nikitin Seamount			TV-lander transect 5 (recovery of 3 lander)	-3,043	83,100	-3,029	83,088	1662	1554				
DR	65	Afanasi Nikitin Seamount	few rocks	1	lava fragments	-3,046	83,016	-3,050	83,020	2690	2280	yes			
TT	66	Afanasi Nikitin Seamount			duration of haul: 5,4 hours, 1200m (overheating of winch)	-2,997	83,048	-3,108	83,100	2570	3250				
TT	67	Afanasi Nikitin Seamount			duration of haul: 3,1 hours, 200m	-3,108	83,100	-3,177	83,131	3251	3670				
DR	68	Afanasi Nikitin Ridge	full	1	lava fragments, volcaniclastic rocks, Mn-crusts	-2,701	82,826	-2,708	82,813	3077	2637	yes			
DR	69	Afanasi Nikitin Ridge	one bloc	1	lava fragment	-2,643	82,720	-2,643	82,720	3272	2880	yes			
DR	70	Afanasi Nikitin Ridge	few rocks	1	lava fragment, Mn-crust+sediment	-2,415	82,595	-2,421	82,598	4073	3660	yes			
TT	71	en route to working area D (Buried Hills)			duration of haul: 4.0 hours, 800-200m	1,219	85,387	1,198	85,287	4461	4466				
DR	72	85° Fracture Zone, northern section	1/6 full	1	lava fragments	2,119	86,099	2,116	86,091	4073	3777	yes			
DR	73	Buried Hills	few rocks	1	volcaniclastic rocks with Mn-crusts	3,449	84,508	3,440	84,505	4059	3570		yes		
DR	74	Buried Hills	empty	0		3,383	84,523	3,379	84,516	4078	3709				
DR	75	Buried Hills	few rocks	1	lava fragments, volcaniclastic rocks, limestone	3,966	84,966	3,958	84,966	4041	3600	yes	yes	yes	
DR	76	Buried Hills	few rocks	1	lava fragments, volcaniclastic rocks	3,967	84,985	3,963	84,985	3760	3528	yes	yes		
DR	77	Buried Hills	few rocks	1	lava fragments	4,113	85,247	4,109	85,243	3971	3736	yes			
DR	78	Buried Hills	one rock	1	lava fragment, Mn-crust+sediment	4,176	85,236	4,172	85,230	3770	3489	yes			
DR	79	Buried Hills	empty	0	(soft sediments)	4,063	85,671	4,062	85,663	4115	3850				
				32	**dredges yielded magmatic and / or sed. rocks 82,1%)**							**29**	**15**	**5**	**7**
				7	**dredges returned empty or yielded only soft sediment and / or Mn and / or dropstones (17,9%)**										

Dredge Stations (DR): 39
Tucker Trawl Stations (TT): 25
TV-Lander Transects (TVL): 5 Transect
CTD Stations (CTD): 2

Mag: magmatic rocks
VC: volcaniclastic rocks
Sed: sedimentary rocks
Mn: Mn-crusts, - nodules