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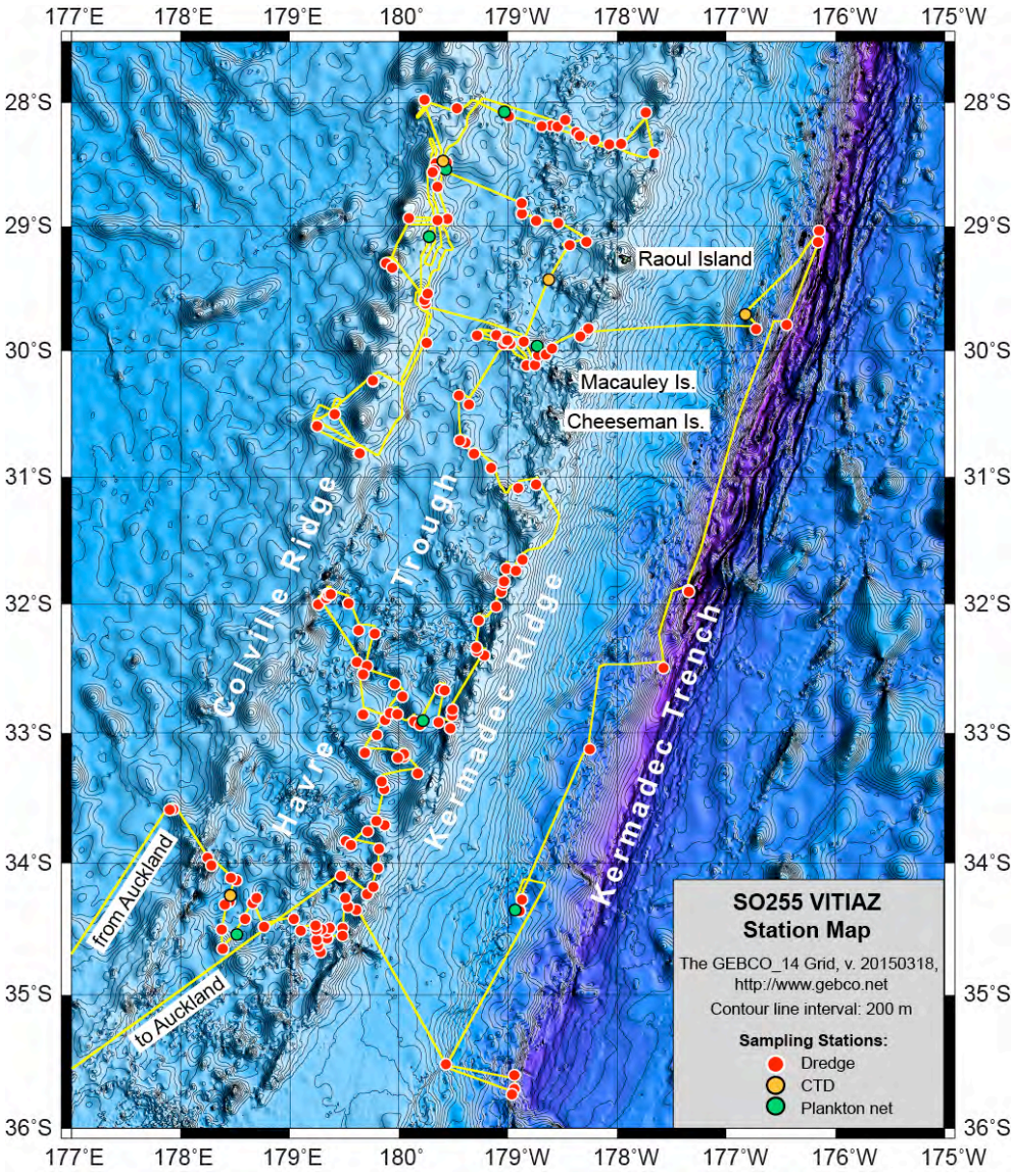
Short Cruise Report
R/V SONNE cruise SO255

Auckland (New Zealand) - Auckland (New Zealand)
02.03.2017 - 14.04.2017
Chief Scientist: Prof. Kaj Hoernle
Captain: Lutz Mallon



Objectives

Increasing international interest is drawn to the initiation and evolution of the older Vitiaz Arc of New Zealand, which split to form the Kermadec and Colville Ridges, that gave rise to the presently active Kermadec Arc and the Havre Trough Backarc systems. In collaboration with New Zealandic, Japanese, and U.S. American colleagues, R/V Sonne cruise SO255 conducted extensive bathymetric mapping (Kongsberg EM122 and EM710), sub-bottom profiling (Atlas Parasound DS P70), and hard-rock sampling (via dredging) to investigate physical and chemical conditions that control the development of subduction zones, including subduction initiation, evolution of mature arc systems, and the transition from arc splitting to backarc basin generation. More specific scientific questions of SO255 include:

I. Arc Initiation (Kermadec Ridge: eastern and western margins):

1) Did the southern Vitiaz Arc initiation occur during the Pacific-wide plate tectonic reorganization between c. 52-47 Ma in which Tonga and Izu-Bonin-Marianas (IBM), and possibly Kurile and Aleutian, Arcs and the Hawaiian-Emperor bend formed. Answering this question will contribute to understanding the magnitude of the Early Eocene plate tectonic event.
2) Were similar distinctive magma types (MORB-type tholeiites, boninites and arc tholeiites and calc-alkaline compositions) formed at the initiation of the southern Vitiaz Arc as throughout the Izu-Bonin-Marianas system and in the Fiji-Lau system?
3) How long did it take after arc initiation before “normal” arc-type magmas were produced?

II. Arc Evolution (Colville and Kermadec Ridges and Havre Trough floor):

1) Does the Fiji/Lau Ridge geochemical evolution model apply to the evolution of the Colville Ridge? It is important to establish if this model has large-scale significance or if there are major differences within a single arc system.
2) Can the timing (not well-constrained at c. 6 Ma) and geochemical evolution preceding arc splitting be constrained better?
3) The Colville Ridge provides the opportunity to evaluate the role of deep slab melts in crustal evolution free from potential crustal-level contamination that often complicates interpretation of the slab signal.

III. Backarc Basin Formation (Havre Trough):

1) Rifting an arc differs geodynamically from rifting a continent because the crust is thinner and the mantle is wetter. Comparing the two regimes may clarify rifting mechanisms in general.
2) During the rifting stage, there is a change from corner flow in the mantle wedge of a subduction zone to focused mantle flow beneath a spreading center. This is an essential but thus-far poorly studied stage in the evolution of arcs and backarc basins since chronological and magmatic constraints on current models are absent.
3) Will sampling of the chains of large volcanoes and isolated flows in the basins in the Havre Trough confirm the “hot fingers” model by Tamura et al. (2002, EPSL 197/1)?
4) Is exposed volcanic rock foundered old arc or young (backarc basalt or arc-like)?
5) Can “disorganized spreading” pave most of the basin with <1 Ma rocks, or even create 5-10 km-thick, <5 Ma “oceanic crust” without conventional ocean-ridge surface morphology or magnetic fabric?
6) Is the Havre Trough a new kind of spreading that characterizes decompression of wet mantle?

Integration of the results of these studies with those of previous and ongoing investigations (e.g. SO249 BERING, GeoPRISMS initiative) will substantially improve our understanding of the magmatic and tectonic evolution of arc systems in general. This is not only an important topic in basic research contributing to a better understanding of the Earth system but also provides important data for an assessment of natural hazards caused by subduction systems (volcanism, earthquakes, slope failure etc.).

The geological program of the cruise has been completed by minor biological investigations intending (1) to collect planktonic gastropod specimens with a plankton net for morphological and molecular analysis to understand their taxonomy, biogeography and evolution; (2) to use water samples taken with the CTD rosette water sampler to study degradation processes in the deep sea; and (3) to describe the benthic diversity of deep-sea invertebrates in the working area by collecting macro benthos from the dredged rocks.

Narrative

On March 01, the scientists boarded R/V SONNE, unpacked the sampling equipment and began to set up the laboratories in preparation for cruise SO255. After the boarding of some additional technical personal and a member of the funding agency, R/V SONNE sailed on the afternoon March 02 from Auckland. After a day of carrying out tests on the ship's underwater sound, SONNE returned to Auckland, to let off the technical personnel and took a last scientist on board who had to postpone her trip due to illness. Saturday afternoon SONNE again left the Auckland harbor to officially begin the SO255 cruise. On Saturday, March 04, we arrived at our first work station above the Colville Ridge and began with the scientific program around noon-time.

During the next week, we sampled a west to east profile across the Kermadec Arc/Backarc system between 34-36°S latitudes. After a two successful dredges on a block rifted from the Colville Ridge, we began dredging ridge-type and conical seamount structures in the Havre Trough. On March 06, we deployed the CTD for the first time on this cruise in order to record a sound profile through the water column. Such sound profiles are required to calibrate the Kongsberg multi-beam system used for mapping the seafloor to find appropriate sampling sites for dredging. On SO255, biological oceanographers used this opportunity to take samples with the CTD rosette water sampler to study degradation processes in the deep sea to depths of 4,000 m. On March 07, we sampled the 1,800 m high Gill Volcano, which is named after one of the American scientists on board. Afterwards we carried out the first haul with the plankton net. As SONNE progressed eastwards, we reached the Kibblewhite volcanic front stratovolcano, which yielded andesitic to dacitic lava samples and pumice. After the volcanic front, we proceeded on to the Kermadec Ridge, which million of years ago was attached to the Colville Ridge, forming the older Vitiaz volcanic arc.

From March 10 on, we worked at western wall of the Kermadec deep-sea trench carrying out dredges at depths of up to 8,800 m, being the deepest dredges carried out thus far with the new SONNE and probably also with the old SONNE. Unfortunately most of the dredges only brought up semi-consolidated mud or sedimentary rocks, reflecting sediments accreted to the forearc. Three dredges, however, recovered a variety of rocks ranging from sediments with abundant small volcanic clasts to a variety of lava samples.

On March 16, we returned to the Kermadec Arc and carried out three successful dredges on the west-facing rifted scarp of the Kermdec Ridge. Then we proceeded to the Giggenbach seamount cluster, successfully sampling five seamounts, which brought large amounts of basaltic to dacitic lavas and pumice. Some of the pumice is most likely related to the Havre eruption in 2012, which created a huge pumice raft (covering an area twice the size of New Zealand). For much of the third week of the cruise, the weather was stormy and seas rough. Almost as if planned, the winds died down, the sun came out and the seas calmed for the Bergfest (mid-term party). During the Bergfest we mapped profiles across the Havre Trough and along the Colville Ridge to identify future dredge sites.

The beginning of fourth week was spent sampling our northernmost profile of the study area between c. 28-29°S latitudes. The sampling was very successful on the Kermadec Ridge and in the eastern and younger portion of the Havre Trough. We were even able to sample the Havre Trough basement by dredging one of the fault scarps forming a graben wall. Next we sampled a fault scarp on the Colville Ridge and a seamount west of the ridge. On Tuesday, March 21, the dredging came to a halt due to problems with the deep-sea winch. As a result we spent the next 36 hours mapping areas of the Colville Ridge in preparation for dredging and deploying the plankton net. On March 22 we carried out our fifth and most successful deployment of the plankton net. A huge variety of planktonic creatures and large numbers of our target group, swimming gastropods (snails) known as pteropods and heteropods, were recovered in the net. Unfortunately it turned out that the winch cannot be fixed at sea. However, generously it was decided to continue dredging using the other deep sea winch holding an optical fiber cable. Early Thursday morning, we were able to resume sampling of the Colville Ridge and seamounts west of the ridge. Recovering relatively fresh volcanic material has proved challenging, because most of the samples are volcaniclastic, made up of small fragments of often altered glassy volcanic material. Nevertheless, we have recovered some relatively fresh lavas which can be used for age dating and geochemical analyses. The weather for most of the fourth week of SO255 week was gorgeous and the seas very calm, providing also the opportunity to test the life boats.

From Monday, March 27, until Friday, March 31, we sampled volcanic structures within the Havre Trough between 29–31°S latitudes in predominantly rainy weather conditions. All of the sampling was carried out in the eastern half of the Havre Trough due to the western half consisting primarily of a large sediment-filled basins and smooth basement morphology. In contrast the eastern half of the Havre Trough contained abundant small cone- and ridge-like structures, as well as some grabens with steep walls, that were successfully sampled by dredging. The most spectacular discovery of the week is what appears to be a volcanic structure with >2 km caldera in the middle of it. Although calderas are common on the volcanic front in this region, none have been previously discovered this far in the backarc. Two dredges were carried out on the inside caldera walls and two outside the caldera. Most samples were dacitic to rhyolitic in composition but some samples from outside the caldera appear to be andesitic. On Saturday, April 01, we began dredging on the Kermadec Ridge (between 31-33°S), in order to get older samples predating the splitting of the Vitiaz Arc into the Kermadec and Colville Ridges. We recovered a mix of volcaniclastic rocks and fresh lavas.

From Monday, April 03, to Friday, April 09, we carried out our last sampling profile across the Kermadec Arc and Havre Trough, including sampling of the Kermadec and Colville Ridges. After completing the sampling of the Hangaroa Volcano in the volcanic front early Monday morning, we spent the next two days traversing the Havre Trough along a NW-SE sampling profile. We sampled the margin of a 4,000 m deep basin, several NE-SW trending ridge-like structures and some small cones. Wednesday was spent sampling the deeper portions of a rifted scarp of the Colville Ridge. Then we crossed the Havre Trough again sampling more basin margins, ridges and small cones, ending at the Kuiwai volcanic front stratovolcano, which we sampled on Thursday. On Friday we dredged several volcanic cones south of Kuiwai and on Saturday we carried out several dredges on the Ngatoroirangi stratovolcano. Saturday night, we recovered a nice array of mafic samples from two cones on the Kermadec Ridge, as well as a nearly full dredge of fresh lavas from the Kermadec Ridge. The final dredge of the cruise was carried out Sunday at noon on the Sonne stratovolcano, named after the old R/V SONNE, which unfortunately was empty.

Of our three major goals, we were very successful at sampling the full variety of structures in the Havre Trough between 28-35°S, recovering a wide array of fresh lavas ranging from mafic basalts to rhyolites. Sampling of the Kermadec and Colville Ridges (former Vitiaz Arc) between the aforementioned latitudes was also successful, bringing up a large variety of lavas and volcaniclastic rocks. We had the least success at recovering volcanic rocks from the forearc, where most dredges contained mud and sedimentary rocks despite dredging on very steep slopes, suggesting that the southern Kermadec forearc is largely accretionary. Besides extensive multi-beam mapping and sediment echo sounder profiling, a total of 165 dredge hauls in an average water depth of 2,500 m were carried out on SO255. Of these, 137 (= 83%) delivered *in situ* samples of which 102 obtained lava or subvolcanic rocks, 69 volcaniclastics, and 30 sedimentary rocks. No equipment was lost or seriously damaged. The zooplankton sampling goals were achieved through the collection of three vertical net hauls and four oblique net tows. Over 6,900 specimens of planktonic gastropods from 37 species were collected, providing abundant material for future morphological and molecular analysis. Four CTD deployments and underway water sampling yielded sufficient water samples for the microbiological experiments. Huge amounts of sample vials were packed and prepared for shipping to Kiel. Furthermore a variety of macrofaunal specimens has been collected from the rocks. All macrofauna samples will be transferred to the Museum für Naturkunde (Berlin, Germany), where they will be re-assessed and then distributed to colleagues for species identification.

On Sunday, April 09, R/V SONNE headed towards Auckland. In the evening we celebrated the end of work program, several birthdays and the retirement of one of the ship's crew by grilling on the deck. On Tuesday, April 11, we finally reached the port of Auckland at 08:00 am. The cruise ended three days earlier than originally scheduled, so that the winch holding the deep-sea cable can be checked by a winch technician and, if possible, fixed before the next cruise. The transit to Auckland and the days in port were used by the scientists for preliminary studies of the data and samples as well as for cleaning, maintenance, and packing of the equipment. Most scientists disembarked as scheduled on April 15 in the morning.

Acknowledgements

We would especially like to thank Captain Mallon 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 very grateful to the shipping company Briese for their permission to use the optical fiber cable for dredging. This concession and the concentrated efforts of the master and the crew in this matter made it possible to continue dredging despite the problems with the deep-sea winch and to finish this cruise successfully.
We thank the Government of the New Zealand for granting permission to work within their territorial waters and we gratefully acknowledge the support of the German Foreign Office and the German Embassy in Auckland in this matter.
We are also grateful to the German Federal Ministry of Education and Research for continuing support of marine research.

Cruise Participantes

1. Hoernle, Kaj	Fahrtleiter / *Chief Scientist*	GEOMAR
2. Bauer, Elisabeth	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
3. Bush, Chelsea	Gesteinsbeprobung / *Rock Sampling*	GSU
4. Endres, Sonja	Biol. Ozeanographie / *Biol. Oceanography*	GEOMAR
5. Gill, James	Gast / *Guest*	UCSC
6. Hauff, Folkmar	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
7. Hirai, Yasuhiro	Gesteinsbeprobung / *Rock Sampling*	JAMSTEC
8. Jutzeler, Martin	Vulkanologie / *Volcanology*	UTAS
9. Koch, Steffen	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
10. Lampe, Vanessa	Biol. Ozeanographie / *Biol. Oceanography*	GEOMAR
11. McKeon, Jeffrey	Gesteinsbeprobung / *Rock Sampling*	GSU
12. Mögeltönder, Jasmin	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
13. Rahmsdorf, Charlotte	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
14. Simon, Ina	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
15. Tamura, Yoshihiko	Gast / *Guest*	JAMSTEC
16. Timm, Christian	Gesteinsbeprobung / *Rock Sampling*	GNS
17. Todd, Erin	Gast / *Guest*	USGS
18. Unger Moreno, Katharina	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
19. Wall-Palmer, Deborah	Zooplankton / *Zooplankton*	Plymouth Univ.
20. Wellschmidt, Gesine	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
21. Werner, Reinhard	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
22. Witte, Matthias	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
23. Zeppenfeld, Heiko	Gesteinsbeprobung / *Rock Sampling*	GEOMAR

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Station list R/V SONNE cruise SO255

Cruise	Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start lat °N	on bottom / start long °	off bottom / end lat °N	off bottom / end long°	depth (m) begin	depth (m) end	Mag	VC	Sed	Mn
SO255		1				*Station does not exist (computer problem)*										
SO255	DR	2	Seamount W of Colville Ridge	1/6 full	1	lava fragm., volcaniclastic and sedimentary rocks, Mn-crusts	-33,564	177,892	-33,558	177,896	2540	2180	yes	yes	yes	yes
SO255	DR	3	Seamount W of Colville Ridge	few rocks	1	lava fragm., volcaniclastic and sedimentary rocks, Mn-crusts	-33,560	177,925	-33,557	177,927	2148	1900	yes	yes	yes	yes
SO255	DR	4	Ridge E of Colville Ridge	full	1	lava fragments, intrusive and volcaniclastic rocks	-33,998	178,276	-34,004	178,268	1811	1298	yes	yes		
SO255	DR	5	Ridge E of Colville Ridge	1/4 full	1	lava fragments, solidified sediments, carbonate	-33,938	178,240	-33,944	178,246	2280	1875	yes		yes	
SO255	DR	6	Havre Trough, cone	one rock	0	pumice (probably not in situ)	-34,095	178,454	-34,101	178,449	2876	2440				
SO255	DR	7	Havre Trough, cone	few rocks	1	lava fragments	-34,115	178,505	-34,116	178,498	2991	2596	yes			
SO255	CTD	8	Havre Trough, basin			*water sampling, 3.538m*	-34,233	178,449	-34,233	178,449						
SO255	DR	9	Havre Trough, ridge-like structure	empty	0		-34,304	178,399	-34,309	178,404	3542	3134				
SO255	DR	10	Havre Trough, ridge-like structure	empty	0		-34,281	178,441	-34,281	178,433	3317	2957				
SO255	DR	11	Havre Trough, cone	empty	0		-34,499	178,370	-34,504	178,365	2665	2273				
SO255	DR	12	Havre Trough, Gill Seamount	1/6 full	1	lava fragments	-34,649	178,380	-34,643	178,375	2482	2094	yes			
SO255	NET	13	Havre Trough			*plankton sampling*	-34,537	178,509	-34,536	178,509						
SO255	DR	14	Havre Trough, cone	1/6 full	1	lava fragments	-34,536	178,509	-34,531	178,507	2779	2416	yes			
SO255	DR	15	Havre Trough, ridge-like structure	full	1	lava fragments, volcaniclastic rocks incl. breccia and pumice	-34,416	178,585	-34,412	178,579	2965	2504	yes	yes		
SO255	DR	16	Havre Trough, ridge-like structure	empty	0		-34,252	178,691	-34,248	178,687	3380	2957				
SO255	DR	17	Havre Trough, ridge-like structure	1/5 full	1	volcaniclastic rocks (pumice), Mn-crusts	-34,293	178,655	-34,286	178,652	2875	2472		yes		yes
SO255	DR	18	Havre Trough, cone	few rocks	1	lava fragments	-34,477	178,759	-34,470	178,759	2363	2049	yes			
SO255	DR	19	Havre Trough, cone	1/6 full	1	lava fragments	-34,417	179,033	-34,410	179,032	2015	1666	yes			
SO255	DR	20	Havre Trough, cone	1/4 full	1	lava fragments	-34,508	179,097	-34,502	179,096	1926	1587	yes			
SO255	DR	21	Havre Trough, Kimblewhite Complex	3/4 full	1	lava fragments	-34,467	179,233	-34,461	179,234	1795	1379	yes			
SO255	DR	22	Havre Trough, Kimblewhite Complex	few rocks	1	lava fragments	-34,498	179,239	-34,491	179,238	1782	1386	yes			
SO255	DR	23	Havre Trough, Kimblewhite Complex	few rocks	1	lava fragments, Mn-crusts	-34,497	179,288	-34,491	179,289	2476	2242	yes			yes
SO255	DR	24	Havre Trough, Kimblewhite Complex	one rock	1	lava fragment	-34,486	179,363	-34,480	179,361	3081	2732	yes			
SO255	DR	25	Havre Trough, Kimblewhite Complex	1/6 full	1	lava fragments	-34,517	179,334	-34,512	179,332	2885	2535	yes			
SO255	DR	26	Havre Trough, Kimblewhite Complex	3/4 full	1	lava fragments	-34,579	179,242	-34,579	179,251	1511	1150	yes			
SO255	DR	27	Havre Trough, Kimblewhite Complex	1/3 full	1	volcaniclastic rocks (pumice)	-34,624	179,253	-34,625	179,261	1930	1707		yes		
SO255	DR	28	Havre Trough, Kimblewhite Complex	1/2 full	1	lava fragments, volcaniclastic rocks (pumice)	-34,674	179,279	-34,675	179,286	2230	1866	yes	yes		
SO255	DR	29	Havre Trough, Kimblewhite Complex	1/4 full	1	lava fragments, volcaniclastic rocks (pumice)	-34,568	179,339	-34,572	179,345	2301	1948	yes	yes		
SO255	DR	30	Kermadec Ridge, western flank	1/4 full	1	lava fragments, volcaniclastic and sedimentary rocks	-34,547	179,481	-34,551	179,487	2235	1720	yes	yes	yes	
SO255	DR	31	Kermadec Ridge, western flank	1/4 full	1	lava fragments	-34,487	179,482	-34,483	179,487	2670	2330	yes			
SO255	DR	32	Kermadec Ridge, western flank	1/4 full	1	lava fragments, volcaniclastic rocks	-34,253	179,506	-34,257	179,512	2990	2537	yes	yes		
SO255	DR	33	Kermadec Ridge, western flank	empty	0		-34,322	179,531	-34,316	179,538	2400	2092				
SO255	DR	34	Kermadec Ridge, western flank	empty	0		-34,318	179,532	-34,313	179,537	2290	1968				
SO255	DR	35	Kermadec Ridge, western flank	2/3 full	1	lava fragments, volcaniclastic and sedimentary rocks	-34,345	179,608	-34,342	179,610	1739	1459	yes	yes	yes	
SO255	DR	36	Kermadec Fore Arc	few rocks	0	semi-consolidated sediment, mud	-35,635	181,060	-35,630	181,062	6859	6564			yes	
SO255	DR	37	Kermadec Fore Arc	1/3 full	1	sedimentary rocks, mud	-35,785	181,038	-35,777	181,038	6754	6438			yes	

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Cruise	Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start lat °N	on bottom / start long °	off bottom / end lat °N	off bottom / end long°	depth (m) begin	depth (m) end	Mag	VC	Sed	Mn
SO255	DR	38	Kermadec Fore Arc	1/5 full	1	sedimentary rocks, mud	-35,743	181,059	-35,735	181,054	7071	6708			yes	
SO255	DR	39	Kermadec Fore Arc	1/3 full	1	sedimentary rocks, mud	-35,550	180,430	-35,545	180,426	4381	4077			yes	
SO255	DR	40	Kermadec Fore Arc	empty	0		-34,354	181,108	-34,349	181,102	5526	4954				
SO255	NET	41	Kermadec Fore Arc			plankton sampling	-34,354	181,108	-34,349	181,102						
SO255	DR	42	Kermadec Fore Arc	empty	0		-34,265	181,129	-34,263	181,126	5668	5265				
SO255	DR	43	Kermadec Fore Arc	few rocks	1	sedimentary rocks, mud	-33,092	181,753	-33,087	181,746	5486	5035			yes	
SO255	DR	44	Kermadec Fore Arc	few rocks	0	semi-consolidated sediment, mud	-32,457	182,430	-32,455	182,422	8595	8202				
SO255	DR	45	Kermadec Fore Arc	few rocks	1	intrusive, volcaniclastic, and sedimentary rocks, mud	-31,862	182,663	-31,857	182,648	8774	7787	yes	yes	yes	
SO255	DR	46	Kermadec Fore Arc	few rocks	0	semi-consolidated sediment, mud	-31,853	182,659	-31,854	182,651	8477	7937				
SO255	DR	47	Kermadec Fore Arc	1/6 full	1	lava fragments, volcaniclastic and sedimentary rocks	-29,780	183,562	-29,787	183,557	8106	7737				
SO255	DR	48	Kermadec Fore Arc	empty	0		-29,135	183,850	-29,141	183,843	8500	8220				
SO255	DR	49	Kermadec Fore Arc	few rocks	0	semi-consolidated sediment, mud	-29,047	183,860	-29,052	183,854	8550	8120				
SO255	CTD	50	Kermadec Fore Arc			water sampling	-29,699	183,183	-29,699	183,182						
SO255	DR	51	Kermadec Fore Arc (seamount)	1/6 full	1	volcaniclastic and sedimentary rocks	-29,814	183,281	-29,820	183,280	4450	4150		yes	yes	
SO255	DR	52	Kermadec Ridge, western flank	few rocks	1	volcaniclastic rocks	-29,870	181,666	-29,879	181,671	1608	1100		yes		
SO255	DR	53	Kermadec Ridge, western flank	few rocks	1	volcaniclastic rocks	-29,809	181,740	-29,813	181,743	1210	958		yes		
SO255	DR	54	Kermadec Ridge, western flank	1/3 full	1	volcaniclastic and sedimentary rocks	-29,833	181,711	-29,836	181,717	1477	1165		yes	yes	
SO255	DR	55	Havre Trough, Giggenbach volcanic field	2/3 full	1	lava fragments	-29,965	181,406	-29,968	181,412	1550	1230	yes			
SO255	DR	56	Havre Trough, Giggenbach volcanic field	1/2 full	1	lava fragments	-30,012	181,349	-30,016	181,356	1050	694	yes			
SO255	NET	57	Havre Trough, Giggenbach volcanic field			plankton sampling, 4000m	-29,945	181,270	-29,945	181,270						
SO255	DR	58	Havre Trough, Giggenbach volcanic field	1/2 full	1	lava fragments, volcaniclastic rocks	-29,945	181,270	-29,950	181,277	874	639	yes	yes		
SO255	DR	59	Havre Trough, Giggenbach volcanic field	full	1	volcaniclastic rocks (pumice)	-30,017	181,279	-30,023	181,283	590	244		yes		
SO255	DR	60	Havre Trough, Giggenbach volcanic field	full	1	volcaniclastic rocks (pumice)	-30,093	181,249	-30,097	181,253	783	583		yes		
SO255	EM	61	Havre Trough and Colville Ridge			EM122 and Parasound profiling										
SO255	DR	62	Kermadec Ridge, crest	1/6 full	1	lava fragments, volcaniclastic rocks	-28,442	182,343	-28,447	182,348	1512	1161	yes	yes		
SO255	DR	63	Kermadec Ridge, western flank	1/4 full	1	lava fragments, sedimentary rocks	-28,123	182,268	-28,128	182,273	2204	1770	yes		yes	
SO255	DR	64	Havre Trough, major scarp	1/3 full	1	lava fragments, volcaniclastic and sedimentary rocks	-28,367	182,041	-28,372	182,042	1921	1646	yes	yes	yes	
SO255	DR	65	Havre Trough, cone	full	1	lava fragments	-28,371	181,932	-28,377	181,934	1193	877	yes			
SO255	DR	66	Havre Trough, cone	few rocks	1	volcaniclastic rocks (pumice)	-28,336	181,794	-28,340	181,796	1784	1642		yes		
SO255	DR	67	Havre Trough	1/4 full	1	volcaniclastic rocks (pumice)	-28,306	181,661	-28,313	181,663	1634	1263		yes		
SO255	DR	68	Havre Trough, ridge-like structure	1/4 full	1	lava fragments	-28,277	181,628	-28,283	181,631	1500	1158	yes			
SO255	DR	69	Havre Trough, ridge-like structure	1/3 full	1	lava fragments, volcaniclastic and sedimentary rocks	-28,181	181,527	-28,188	181,528	1856	1435	yes	yes	yes	
SO255	DR	70	Havre Trough, cone	1/3 full	1	volcaniclastic rocks (pumice)	-28,233	181,456	-28,241	181,460	1758	1441		yes		
SO255	DR	71	Havre Trough, cone	one rock	0	volcaniclastic rock (pumice)	-28,230	181,310	-28,236	181,316	2458	2072				
SO255	DR	72	Havre Trough, cone	empty	0		-28,225	181,397	-28,231	181,399	1673	1305				
SO255	NET	73	Havre Trough			plankton sampling	-28,125	180,983	-28,133	180,995						
SO255	DR	74	Havre Trough, cone	few rocks	1	volcaniclastic rocks (pumice)	-28,136	180,996	-28,142	181,002	2066	1794		yes		

Station list R/V SONNE cruise SO255

Cruise	Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start lat °N	long °	off bottom / end lat °N	long°	depth (m) begin	end	Mag	VC	Sed	Mn
SO255	DR	75	Colville (Lau) Ridge, seamount	1/3 full	1	volcaniclastic rocks	-28,091	180,532	-28,097	180,534	995	676		yes		
SO255	DR	76	Colville (Lau) Ridge, seamount	1/3 full	1	lava fragments, volcaniclastic rocks	-28,024	180,234	-28,026	180,234	1018	877	yes	yes		
SO255	CTD	77	Colville (Lau) Ridge			water sampling, 200m	-28,502	180,405	-28,502	180,404						
SO255	DR	78	Colville (Lau) Ridge	few rocks	1	lava fragments, volcaniclastic rocks	-28,502	180,404	-28,510	180,402	1372	1002	yes	yes		
SO255	DR	79	Colville (Lau) Ridge, cone			aborted due to brocken winch										
SO255	NET	80	Colville (Lau) Ridge			plankton sampling	-29,100	180,279	-29,108	180,283						
SO255	EM	81	Colville (Lau) Ridge			EM122 and Parasound profiling										
SO255	DR	82	Colville (Lau) Ridge, cone	1/5 full	1	volcaniclastic rocks	-30,783	179,638	-30,789	179,637	817	585		yes		
SO255	DR	83	Seamount W of Colville (Lau) Ridge	one rock	1	lava fragment (?), Mn-crust	-30,570	179,248	-30,575	179,249	2158	1849	yes			yes
SO255	DR	84	Seamount W of Colville (Lau) Ridge	few rocks	1	sedimentary rocks, Mn-crusts	-30,478	179,409	-30,471	179,406	1891	1547			yes	yes
SO255	DR	85	Colville (Lau) Ridge, seamount	few rocks	1	lava fragments, volcaniclastic rocks	-30,215	179,760	-30,207	179,760	1200	755	yes	yes		
SO255	DR	86	Colville (Lau) Ridge, seamount	empty	0		-30,220	179,762	-30,215	179,762	1510	1163				
SO255	DR	87	Colville (Lau) Ridge	one rock	1	sedimentary rock	-29,920	180,254	-29,914	180,250	1562	1352			yes	
SO255	DR	88	Colville (Lau) Ridge, seamount	two rocks	0	volcaniclastic rocks (pumice)	-29,536	180,263	-29,534	180,257	1785	1533				
SO255	DR	89	Colville (Lau) Ridge, seamount	few rocks	1	volcaniclastic and sedimentary rocks	-29,586	180,233	-29,586	180,231	1013	844		yes	yes	
SO255	DR	90	Colville (Lau) Ridge	1/5 full	1	volcaniclastic and sedimentary rock, semi-consolidated mud	-29,614	180,243	-29,610	180,239	1487	1180		yes	yes	
SO255	DR	91	Colville (Lau) Ridge, seamount	1/3 full	1	volcaniclastic rocks (pumice)	-29,335	179,937	-29,328	179,940	1111	787		yes		
SO255	DR	92	Colville (Lau) Ridge	empty	0	glass sponges	-29,300	179,881	-29,298	179,887	1120	982				
SO255	DR	93	Colville (Lau) Ridge	1/5 full	1	lava fragments, volcaniclastic rocks	-28,948	180,091	-28,945	180,095	1369	995	yes	yes		
SO255	DR	94	Colville (Lau) Ridge, seamount	few rocks	1	sedimentary rocks	-28,964	180,354	-28,959	180,357	1103	783			yes	
SO255	DR	95	Colville (Lau) Ridge	1/4 full	1	volcaniclastic and sedimentary rocks	-28,954	180,445	-28,949	180,442	1402	968		yes	yes	
SO255	DR	96	Colville (Lau) Ridge, seamount	empty	0	small pieces of pumice	-28,703	180,353	-28,701	180,353	1426	1285				
SO255	DR	97	Colville (Lau) Ridge	few rocks	1	lava fragments	-28,589	180,309	-28,587	180,308	1210	1013	yes			
SO255	DR	98	Colville (Lau) Ridge	1/4 full	1	lava fragments, volcaniclastic rocks	-28,571	180,326	-28,566	180,326	1034	710	yes	yes		
SO255	DR	99	Colville (Lau) Ridge, seamount	few rocks	1	volcaniclastic rocks	-28,533	180,396	-28,531	180,396	1217	1097		yes		
SO255	NET	100	Colville (Lau) Ridge				-28,520	180,406	-28,512	180,414						
SO255	DR	101	Colville (Lau) Ridge, seamount	few rocks	1	volcaniclastic rocks	-28,550	180,351	-28,546	180,353	879	708		yes		
SO255	DR	102	Havre Trough, ridge-like structure	empty	0	small pieces of pumice	-28,831	181,127	-28,826	181,128	2131	1843				
SO255	DR	103	Havre Trough, ridge-like structure	few rocks	1	lava fragments	-28,912	181,129	-28,907	181,133	2168	1825	yes			
SO255	DR	104	Havre Trough, cone	1/3 full	1	lava fragments	-28,968	181,261	-28,961	181,263	1609	1291	yes			
SO255	DR	105	Havre Trough, major scarp	few rocks	1	lava fragments	-28,986	181,463	-28,982	181,464	2211	1921	yes			
SO255	DR	106	Havre Trough, cone	1/3 full	1	lava fragments, volcaniclastic and sedimentary rocks	-29,132	181,723	-29,126	181,725	1153	844	yes	yes	yes	
SO255	DR	107	Havre Trough, ridge-like structure	few rocks	1	lava fragments	-29,158	181,568	-29,154	181,568	1791	1505	yes			
SO255	CTD	108	Havre Trough				-29,427	181,376	-29,427	181,375						
SO255	DR	109	Havre Trough, ridge-like structure	3/4 full	1	lava fragments	-29,427	181,376	-29,420	181,377	2330	1860	yes			
SO255	DR	110	Havre Trough, ridge-like structure	1/2 full	1	volcaniclastic rocks (pumice)	-29,911	181,146	-29,907	181,142	1806	1516		yes		
SO255	DR	111	Havre Trough, caldera volcano	few rocks	1	lava fragments	-29,900	180,995	-29,895	180,995	1452	1180	yes			

Station list R/V SONNE cruise SO255

Cruise	Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start lat °N	long °	off bottom / end lat °N	long°	depth (m) begin	end	Mag	VC	Sed	Mn
SO255	DR	112	Havre Trough, caldera volcano	1/2 full	1	lava fragments	-29,903	180,978	-29,898	180,975	1319	1040	yes			
SO255	DR	113	Havre Trough, cone	few rocks	1	lava fragments, volcaniclastic rocks (pumice)	-29,861	180,895	-29,855	180,892	1567	1227	yes	yes		
SO255	DR	114	Havre Trough, ridge-like structure	1/5 full	1	volcaniclastic rocks (pumice)	-29,863	180,717	-29,858	180,715	2410	2110		yes		
SO255	DR	115	Havre Trough, caldera volcano	1/2 full	1	lava fragments, volcaniclastic rocks (pumice)	-29,930	180,958	-29,923	180,959	1618	1260	yes	yes		
SO255	DR	116	Havre Trough, caldera volcano	1/5 full	1	lava fragments	-29,929	181,021	-29,923	181,019	1516	1103	yes			
SO255	DR	117	Havre Trough, Giggenbach volcanic field	3/4 full	1	lava fragments, volcaniclastic rocks (pumice)	-30,097	181,171	-30,091	181,169	1432	1069	yes	yes		
SO255	DR	118	Havre Trough, Giggenbach volcanic field	1/5 full	1	lava fragments	-30,402	180,642	-30,395	180,641	1715	1373	yes			
SO255	DR	119	Havre Trough, cone	few rocks	1	lava fragments, volcaniclastic rocks (pumice)	-30,332	180,550	-30,327	180,550	2168	1833	yes	yes		
SO255	DR	120	Havre Trough	few rocks	1	lava fragments	-30,682	180,559	-30,676	180,560	2085	1777	yes			
SO255	DR	121	Havre Trough, cone	few rocks	1	lava fragments	-30,699	180,610	-30,699	180,618	1734	1353	yes			
SO255	DR	122	Havre Trough, ridge-like structure	1/5 full	1	lava fragments	-30,786	180,689	-30,786	180,696	1967	1810	yes			
SO255	DR	123	Havre Trough, cone	1/4 full	1	lava fragments	-30,897	180,846	-30,896	180,854	1669	1374	yes			
SO255	DR	124	Kermadec volcanic front	full	1	lava fragments, volcaniclastic rocks (incl. pumice)	-31,054	181,094	-31,048	181,095	1133	777	yes	yes		
SO255	DR	125	Kermadec Ridge, west. flank (volc. front?)	1/3 full	1	lava fragments, volcaniclastic and sedimentary rocks (carb.)	-31,026	181,260	-31,020	181,261	883	504	yes	yes	yes	
SO255	DR	126	Kermadec Ridge, western flank	full	1	lava fragments, volcaniclastic rocks (incl. pumice)	-31,613	181,135	-31,614	181,141	1217	872	yes	yes		
SO255	DR	127	Kermadec Ridge, western flank	full	1	volcaniclastic and sedimentary rocks	-31,699	181,074	-31,700	181,077	1300	910		yes	yes	
SO255	DR	128	Kermadec Ridge, western flank	few rocks	1	lava fragments	-31,782	180,965	-31,784	180,971	2314	1933	yes			
SO255	DR	129	Kermadec Ridge, western flank	full	1	lava fragments	-31,804	180,961	-31,805	180,967	1716	1325	yes			
SO255	DR	130	Kermadec Ridge, western flank	1/5 full	1	lava fragments	-31,683	180,985	-31,685	180,991	2395	2091	yes			
SO255	DR	131	Kermadec Ridge, western flank	1/4 full	1	lava fragments, sedimentary rocks	-31,864	180,939	-31,864	180,944	2040	1730	yes		yes	
SO255	DR	132	Kermadec Ridge, western flank	1/3 full	1	lava fragments, semi-consolidated sediment	-31,979	180,893	-31,977	180,898	1010	1635	yes			
SO255	DR	133	Kermadec volcanic front	1/3 full	1	lava fragments	-32,087	180,731	-32,087	180,740	2230	1830	yes			
SO255	DR	134	Kermadec Ridge, western flank	full	1	lava fragments, volcaniclastic rocks	-32,297	180,710	-32,297	180,717	2945	2753	yes	yes		
SO255	DR	135	Kermadec Ridge, western flank	1/4 full	1	lava fragments, volcaniclastic rocks	-32,325	180,715	-32,322	180,722	2275	1961	yes	yes		
SO255	DR	136	Kermadec Ridge, western flank	1/3 full	1	lava fragments, volcaniclastic rocks	-32,360	180,783	-32,358	180,790	1180	972	yes	yes		
SO255	DR	137	Kermadec Ridge, western flank	few rocks	1	lava fragments, volcaniclastic rocks	-32,783	180,491	-32,783	180,497	2481	2052	yes	yes		
SO255	DR	138	Kermadec Ridge, western flank	1/5 full	1	lava fragments, volcaniclastic rocks	-32,828	180,488	-32,826	180,495	1888	1473	yes	yes		
SO255	DR	139	Kermadec Ridge, western flank	3/4 full	1	lava fragments, volcaniclastic rocks	-32,929	180,472	-32,926	180,480	995	633	yes	yes		
SO255	DR	140	Havre Trough, ridge-like structure	empty	0		-32,882	180,363	-32,876	180,360	3076	2238				
SO255	DR	141	Kermadec volcanic front	1/2 full	1	lava fragments	-32,632	180,419	-32,628	180,415	1799	1544	yes			
SO255	DR	142	Kermadec volcanic front	1/5 full	1	lava fragments	-32,626	180,378	-32,620	180,376	1024	758	yes			
SO255	NET	143	Havre Trough				-32,868	180,220	-32,884	180,206						
SO255	DR	144	Havre Trough, deep basin	few rocks	0	semi-consolidated sediment, mud	-32,901	180,192	-32,896	180,192	3351	3079				
SO255	DR	145	Havre Trough, ridge-like structure	one rock	1	lava fragment	-32,875	180,140	-32,869	180,140	2905	1392	yes			
SO255	DR	146	Havre Trough, deep basin	empty	0		-32,818	179,986	-32,814	179,986	4121	4026				
SO255	DR	147	Havre Trough, deep basin	few rocks	1	lava fragments, sedimentary rocks	-32,810	179,917	-32,802	179,914	3963	3591	yes		yes	
SO255	DR	148	Havre Trough, ridge-like structure	few rocks	1	lava frag., volcaniclastic (pumice) and sedimentary rocks	-32,681	180,032	-32,675	180,031	3115	2804	yes	yes	yes	

Station list R/V SONNE cruise SO255

Cruise	Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start lat °N	long °	off bottom / end lat °N	long°	depth (m) begin	end	Mag	VC	Sed	Mn
SO255	DR	149	Havre Trough, seamount	two rocks	1	lava fragments	-32,584	179,961	-32,589	179,960	3614	3256	yes			
SO255	DR	150	Havre Trough, ridge-like structure	few rocks	1	volcaniclastic rocks (pumice)	-32,508	179,670	-32,503	179,669	3910	3650		yes		
SO255	DR	151	Havre Trough, ridge-like structure	few rocks	1	lava fragments, volcaniclastic rocks	-32,442	179,706	-32,435	179,704	3489	2850	yes	yes		
SO255	DR	152	Havre Trough, ridge-like structure	one rock	1	lava fragment	-32,190	179,777	-32,184	179,776	3112	2638	yes			
SO255	DR	153	Havre Trough, ridge-like structure	few rocks	1	volcaniclastic rocks (pumice)	-32,164	179,629	-32,160	179,631	3160	2884		yes		
SO255	DR	154	Havre Trough, ridge-like structure	two rocks	1	lava fragments	-31,954	179,536	-31,949	179,536	2708	2384	yes			
SO255	DR	155	Colville Ridge	few rocks	1	lava fragments, Mn-crusts	-31,882	179,372	-31,878	179,370	2540	2120	yes			yes
SO255	DR	156	Colville Ridge	one rock	1	volcaniclastic rock (large bloc with lava fragments)	-31,887	179,352	-31,885	179,351	2060	1860		yes		
SO255	DR	157	Colville Ridge	few rocks	1	volcaniclastic rocks (breccia)	-31,880	179,342	-31,880	179,341	1360	1350		yes		
SO255	DR	158	Colville Ridge	few rocks	1	lava fragments, volcaniclastic rocks	-31,913	179,331	-31,906	179,329	3390	2980	yes	yes		
SO255	DR	159	Colville Ridge	few rocks	1	lava frag., volcaniclastic rocks, semi-consolidated sediment	-31,962	179,257	-31,957	179,256	3439	3101	yes	yes		
SO255	DR	160	Havre Trough, ridge-like structure	few rocks	1	lava fragments	-32,412	179,613	-31,408	179,612	3461	3068	yes			
SO255	DR	161	Havre Trough, ridge-like structure	few rocks	1	lava fragments, volcaniclastic rocks	-32,821	179,670	-32,816	179,668	2610	2164	yes	yes		
SO255	DR	162	Havre Trough, deep basin	1/2 full	1	lava fragments, volcaniclastic rocks	-32,864	179,871	-32,857	179,868	4002	3469	yes			
SO255	DR	163	Havre Trough, seamount	empty	0		-32,981	179,796	-32,976	179,794	3390	2897				
SO255	DR	164	Havre Trough, cone	full	1	lava fragments, volcaniclastic rocks	-33,120	179,686	-33,126	179,686	1907	1561	yes	yes		
SO255	DR	165	Kermadec volcanic front, Kuiwai volcano	1/5 full	1	lava fragments	-33,158	179,989	-33,163	179,987	1407	1162	yes			
SO255	DR	166	Kermadec volcanic front, Kuiwai volcano	full	1	lava fragments	-33,130	180,045	-33,134	180,043	1736	1457	yes			
SO255	DR	167	Kermadec volcanic front, Kuiwai volcano	3/4 full	1	lava fragments, volcaniclastic and sedimentary rocks	-33,154	180,044	-33,159	180,043	793	555	yes	yes	yes	
SO255	DR	168	Havre Trough, cone	one rock	1	lava fragment, Mn-crust	-33,281	180,172	-33,282	180,171	2039	1953	yes			yes
SO255	DR	169	Kermadec volcanic front	1/3 full	1	lava fragments	-33,344	179,841	-33,349	179,836	2200	1791	yes			
SO255	DR	170	Kermadec volcanic front	full	1	lava fragments, Mn-crusts	-33,402	179,863	-33,408	179,869	1480	1094	yes			yes
SO255	DR	171	Kermadec volc. front, Ngatororangi volc.	few rocks	1	lava fragments	-33,651	179,792	-33,655	179,798	2318	2168	yes			
SO255	DR	172	Kermadec volc. front, Ngatororangi volc.	few rocks	1	lava fragments	-33,684	179,867	-33,688	179,867	2026	1903	yes			
SO255	DR	173	Kermadec volc. front, Ngatororangi volc.	few rocks	1	lava fragments	-33,734	179,712	-33,738	179,714	2431	2311	yes			
SO255	DR	174	Havre Trough, deep basin	two rocks	1	lava fragments	-33,839	179,558	-33,844	179,561	3630	3322	yes			
SO255	DR	175	Havre Trough, deep basin	empty	0		-33,809	179,510	-33,813	179,513	3814	3744				
SO255	DR	176	Kermadec volc. front, Ngatororangi volc.	1/5 full	1	lava fragments	-33,868	179,816	-33,875	179,819	2147	1896	yes			
SO255	DR	177	Kermadec Ridge, western flank	empty	0		-34,019	179,805	-34,032	179,806	1802	1591				
SO255	DR	178	Kermadec Ridge, western flank	1/4 full	1	lava fragments, volcaniclastic and sedimentary rocks	-34,167	179,763	-34,171	179,767	1200	838	yes	yes	yes	
SO255	DR	179	Kermadec Ridge, western flank	full	1	lava fragments, volcaniclastic rocks	-34,222	179,707	-34,226	179,710	1106	738	yes	yes		
SO255	DR	180	Kermadec volcanic front, Sonne volcano	empty	0		-34,080	179,467	-34,084	179,473	2683	2439				
					137	**dredges yielded magmatic and / or sed. rocks (83%)**							**102**	**69**	**30**	**9**

Dredge Stations (DR): 165
CTD Stations (CTD): 4
Plankton Net Stations (NET): 7
EM122 and Parasound Surveys (EM): 2

28 **dredges returned empty or yielded only soft sediment and / or Mn (17%)**

average depth (m): 2461
max. depth (m): 8774
min. depth (m): 590

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