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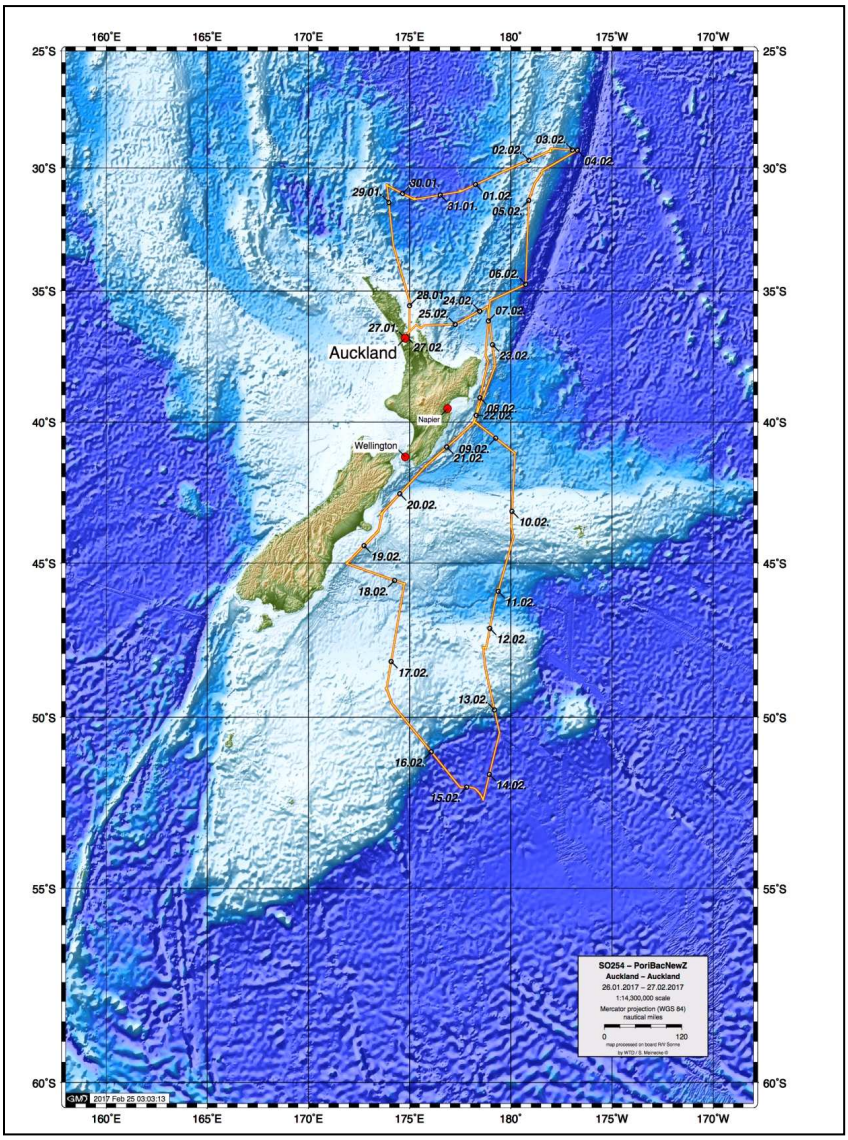
Short Cruise Report RV Sonne SO254
PoriBacNewZ
Auckland, New Zealand – Auckland, New Zealand
January 26 – February 27, 2017
Chief Scientist: Meinhard Simon
Captain: Lutz Mallon



Objectives

The south-west Pacific around New Zealand (NZ) between the subtropic and subantarctic region stretches over distinct biogeographic provinces which are separated by oceanic fronts and differ with respect to water masses, hydrography, nutrients and plankton communities: South Pacific Subtropical Gyre (SPSG), New Zealand coastal province (NEWZ) mixing partly with the South Subtropical Convergence (SSTC), Subantarctic Water Ring (SANT) and the Southern Polar Frontal Region merging partly with the Antarctic Polar Province (ANTA, Fig. 1). The Subtropical (STF), Subantarctic (SAF) and Polar Front (PF) separate these provinces. The sea floor in these regions exhibits a very diverse structure with soft sediments, remains of volcanic activities, greatly varying depths and mostly hard surfaces in the Kermadec Plateau and Trench north of NZ. A steep continental slope exist east of the NZ north and south island, Chatham Rise and Campbell Plateau (see map on the front page).

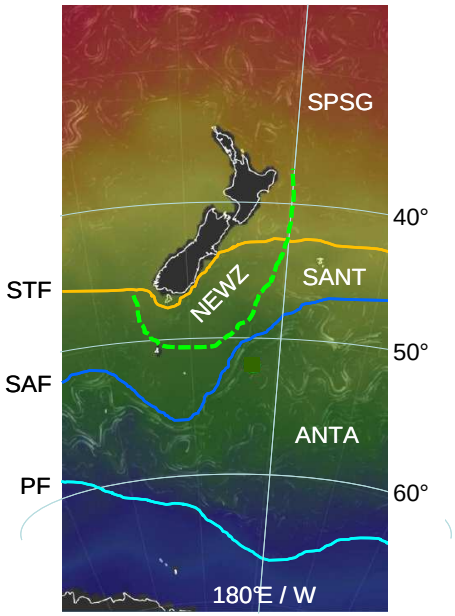


Fig. 1: Biogeographic provinces in the Pacific visited. For abbreviations see text.

The aims of the investigation were twofold: 1) A comprehensive and detailed assessment and understanding of the structural and functional biodiversity and biogeochemical role of the *Roseobacter* clade in the context of the total bacterioplankton communities and their growth characteristics in the water column and surface sediment of this region of the Pacific. 2) An assessment of the microbial biodiversity associated with sponges as well as the chemical ecology of sponge-associated bacteria and the sponge holobiont itself and among different sponge hosts and of other invertebrates (e.g. Octocorals) in this region from shallow reefs over the twilight zone down to abyssal depths. Therefore, the PoriBacNewZ cruise undertook a comprehensive sampling campaign between 29° and 52°S and 173°E and 176°W including 27 stati ons, 10 CTD stations for water column work and 19 stations for work at the sea floor by using the Remotely Operated Vehicle of Geomar (ROV Kiel 6000).

Sampling included extensive CTD-casts throughout the water column, bio-optical characterization of the euphotic water column, vertical plankton net tows, in situ pump deployments in near surface waters, sediment sampling with a Multi Corer (MUC) at five stations, ROV operations to survey and collect sponges and other invertebrates and two Agazzis trawls. A special focus was on assessing the differences in the functional properties and the composition of the bacterial and archaeal communities and their main players in the different biogeographic provinces in the water column and as a function of the composition of the pool of dissolved organic matter (DOM). Therefore, samples were collected for later analyses of the metagenome, metatranscriptome and metaproteome of the bacterial communities. Further, samples were collected for a refined assessment of the population genomics of two distinct phylogenetic lineages of the *Roseobacter* clade. In order to embed the assessments of the prokaryotic communities into functional processes, radio-labeled tracers were used to experimentally examine key microbiological and biogeochemical processes. The investigations were complemented by two mesocosm experiments on board, one with water of the SPSG and one with water of SANT. The aims of the mesocosm experiments were to examine the growth response of the ambient bacterioplankton communities to additions of diatom-derived labile DOM, alginate and vitamin B12 and B1 and precursors. These manipulations allow a more refined insight into the functional properties and substrate preferences of the bacterial communities.

A substantial part of the investigations were carried out in the frame work of the DFG-funded Collaborative Research Center Roseobacter (TRR51).

Narrative

On Saturday, January 28th around 5 pm local time Research Vessel Sonne with the embarked 40 scientists and 31 crew members left the port of Auckland for the PoriBacNewZ cruise to head to the first station at 30° 43' S, 1 73° 53' E, where we arrived in the morning of January 30th. Three 20 foot-containers and air fright boxes with scientific equipment and cooled and frozen goods and the five ROV-containers had arrived in time so that everything we needed was on board. However, due to a broken control valve of the cooling water system for two of the four Diesel engines and waiting for its replacement by a flown-in valve from the company in the UK the ship left the port with a delay of 55 hours. The scientists had come on board already on January 24th because of a very successful open ship day on January 25th organized by the German embassy in New Zealand. Hence we had plenty of time to set up the labs and get ready for work. At the rather shallow station 1 we started with a CTD sound profile for the calibration of the depth profiling of the ROV and subsequently launched the ROV for the first survey and collection of sponges and other invertebrates. Bio-optics work (Secchi-depth, hyperspectral und multispectral light field measurements (UV/VIS)) in the upper 200 m and the deployment of the McLane in situ pump at 20 m followed. We worked our way towards the east around 30°S by visiting stations 2 to 5 across the Kermadec Plateau to the trench at 29° 16' S, 17 6° 42' W where we reached our easternmost location, station 6. At each station the ROV was launched for benthic work and at station 1, 4 and 6 we also carried out water column work. At station 4 we collected only near surface water to set up our first mesocosm experiment. At station 6 as the northernmost location of the north-south transect across the biogeographic provinces we carried out the entire program of the water column and sediment work (CTD hydrography and water samples from 10 m to the sea floor, in situ pump, vertical plankton net haul, MUC). Thanks to the ICBM-owned large volume CTD (24 x 20 liter Niskin bottles) we usually needed only two casts, one 5 to 300 m and one 500 to 10 m above sea floor. At every station with ROV and water column/sediment work we sampled the water column/sediment before and after the ROV work which needed to be done during daylight. Due to this constraint we could perform bio-optic measurements only at fewer stations than planned. From station 6 the cruise track went south. Stations 7 to 15 at 45° 57' S included five stations for surveys of the benthic habitats and sponge and invertebrate collection by ROV, one of them near Raoul Island and one near Maccauley Island, three stations for water column/sediment work and one station for bio-optics measurements. This schedule followed rather the original plan. For details on the station work see attached list. At station 15, however, we had to retrieve the ROV earlier than planned due to increasing swell above 2.8 m and strong currents. The wave heights of more than 3 m and wind strengths of Beaufort scale 6 to 10 forced us to cancel all planned ROV operations further south. Unfortunately, stormy weather and wave heights of more than 5 m also forced us to stop our transect at 52° 07' S at station 18. Originally we had planned to continue the transect to 60°S. The shortage of t he cruise time by 55 hours did not allow us to wait for better weather in ANTA. Hence we returned to regions further north and visited nine more stations fairly close to the coast of the NZ south and north islands mainly concentrating on investigating and collecting sponges and other invertebrates by ROV. Only one more station in SANT was visited for more water column/sediment work (station 20) and two more stations in the SPSG in the last two days of the cruise (stations 26 and 27).

The water column stations along the transect were selected such that we aimed at visiting at least two stations in each biogeographic province. This aim was achieved in all provinces even though we had wished to visit more stations in ANTA. The stations for ROV operations had been selected according to the structure of the sea floor and continental slope and to previous records on sponge biodiversity patterns, when available, and following the transect. This was because two originally different cruise proposals had to be merged to one cruise which made it sometimes difficult to fulfill the diverging wishes of the water column/sediment and ROV work.

According to temperature and salinity in the near-surface layer we could clearly identify the biogeographic provinces. Water temperatures decreased from 23° in the SPSG to 9℃ in ANTA (Fig. 2) and salinity from >35.8 to <34.6 (Fig. 3). The different provinces and the warm surface, Antarctic intermediate und Pacific deep water masses were clearly identified from the T-S plot (Fig. 4). The location of the major fronts separating the three biogeographic provinces visited (STF, SAF) with strong drops in temperature were identified by the ship's built in temperature and salinity recordings and could clearly be extrapolated to the entire southwestern Pacific on the basis of the current temperature distribution (Fig. 5).

In the permanently stratified SPSG the deep chlorophyll maximum was located around 100 m depth and shoaled towards the south with a bloom in SANT around 50 m which we just hit in its southern outreach (Fig. 2). A pronounced bloom in the upper 60 m with a chlorophyll maximum at 30 m depth was present in ANTA.

The microbial parameters assessed reflected the different water masses and partially the biogeographic provinces. Final interpretation of the data, however, is only possible when we will have analyzed all the samples for the prokaryotic community and the DOM composition.

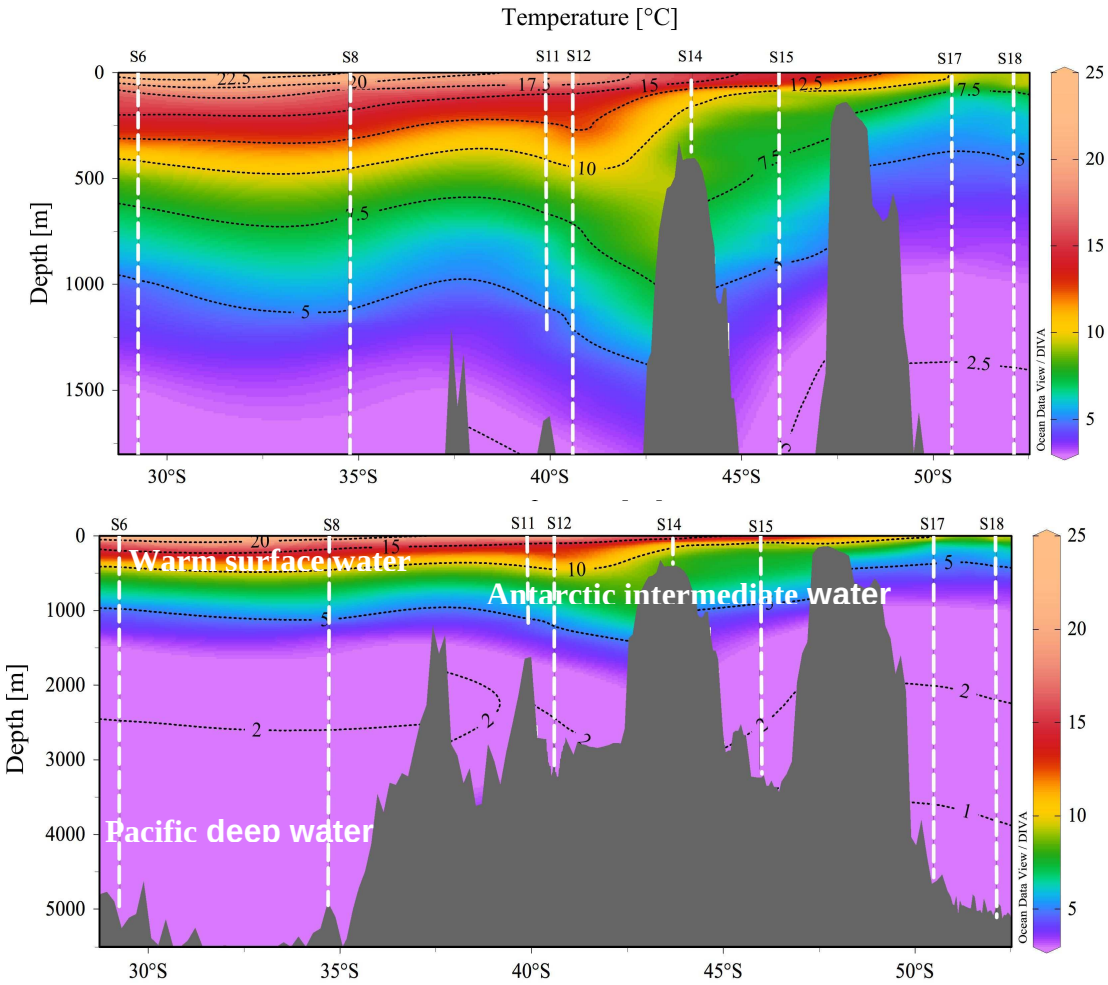


Figure 2 Contour plot of the potential temperature distribution along the meridional transect of cruise SO254 between 29°and 52℃S in the southwestern Paci fic and biogeographic provinces (top) and water masses. Black lines indicate the isopycnals and white vertical lines the locations of the stations. Upper panel: contour plot between the surface and 1800 m depth; lower panel: contour plot between the surface and the sea floor.

SPSG SANT ANTA

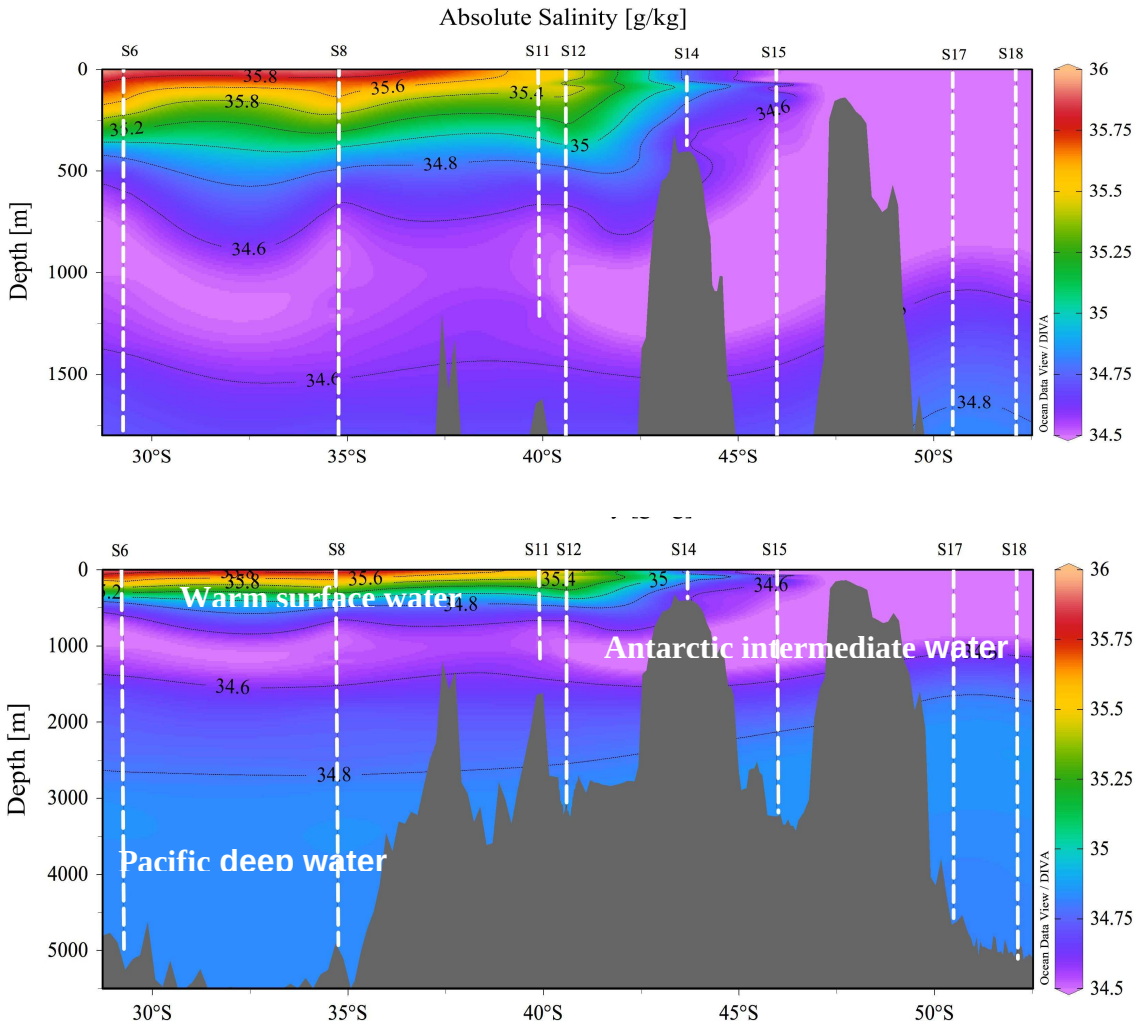


Figure 3: Contour plot of the absolute salinity distribution along the meridional transect of cruise SO254 between 29°and 52℃S in the southwestern Paci fic and biogeographic provinces (top) and water masses. Black lines indicate the isopycnals and white vertical lines the locations of the stations. Upper panel: contour plot between the surface and 1800 m depth; lower panel: contour plot between the surface and the sea floor.

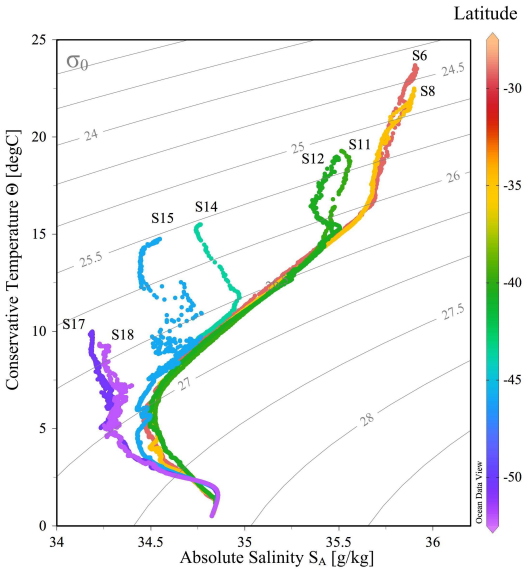


Figure 4:
T-S-Diagram (potential temperature versus absolute salinity) of all deep stations of cruise SO254

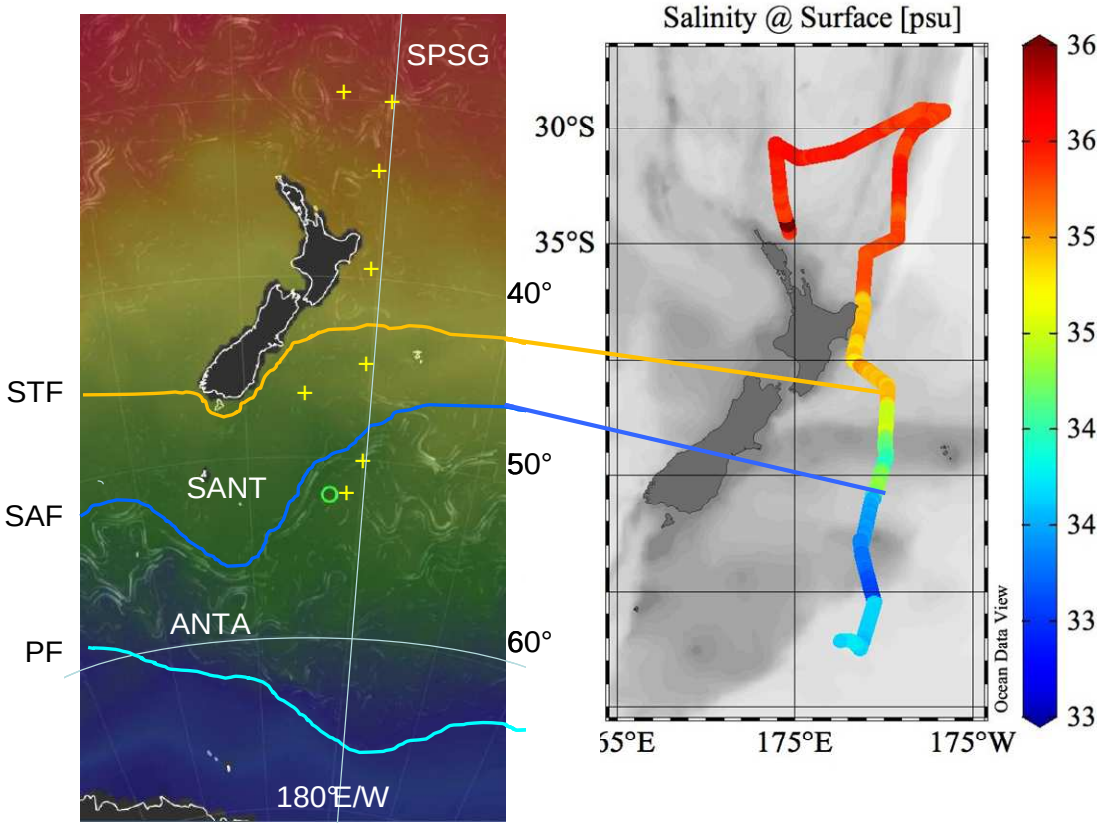


Figure 5: Sea surface temperature (www.earthnullschool.net), location of stations with water column work and of the subtropical (STF), subantarctic (SAF) and southern Polar Front (PF) in the southwestern Pacific (left panel). Right panel: Sea surface temperature of along the track of cruise SO254 and location of STF and SAF.

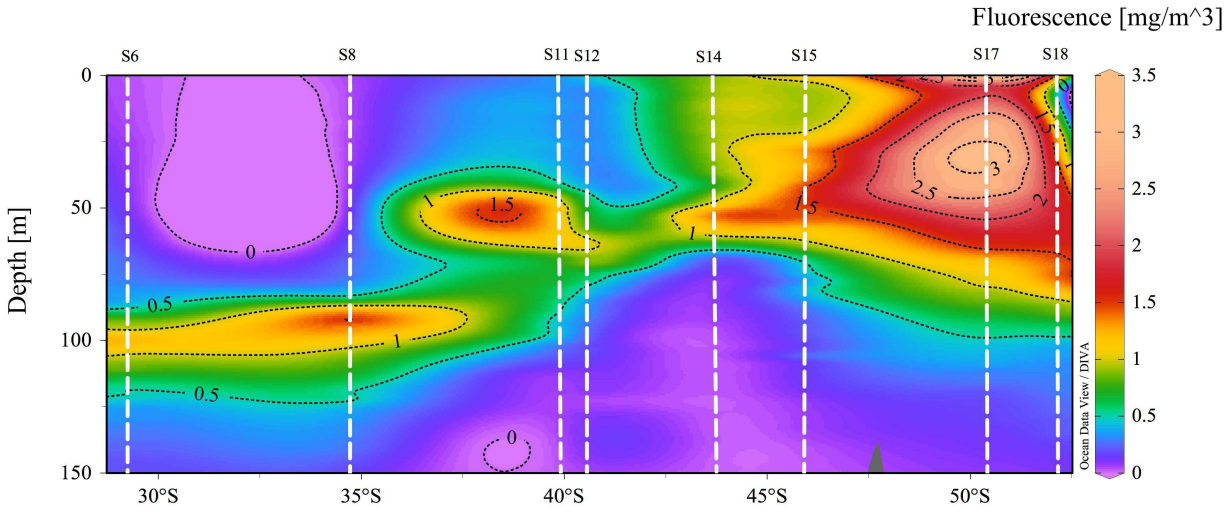


Figure 5: : in situ fluorescence translated into uncalibrated units of chlorophyll *a* along the meridional transect of cruise SO254 between 29° and 52°S in th e southwestern Pacific.

Prokaryotic abundance in the upper 100 m, assessed by flow cytometry on board, ranged between 4 and 50x10^5 cells ml^{-1}. Lowest values of <10x10^5 cells ml^{-1} were recorded in the SPSG and at 60 and 100 m along the transect to station 17 in the northern ANTA whereas

highest values occurred at the southernmost station in ANTA at 52°S. At 20 m depth elevated numbers of 15-30x10^5 cells ml^{-1} were also recorded at stations 12, 14 and 15 in the southern SPSG and SANT. Bacterial biomass production, assessed by incorporation of ^{14}C-labelled leucine, varied greatly at 20 m depth along the transect with a trend of lower values towards ANTA. Rates at 60 and 100 m depth were systematically lower and did not show any latitudinal trend. Community growth rates ranged between <0.1 and 1.25 per day. Highest and lowest values were recorded in the SPSG whereas values in SANT and ANTA did not exceed 0.33 per day. Turnover rates of dissolved free amino acids, glucose and acetate basically covaried among each other but not with bacterial biomass production. Lowest rates occurred in the SPSG, except for amino acids, and highest rates at the four southernmost stations in SANT and ANTA. The maximum of all three parameters was detected at station 20 in SANT which was further west and more on the Campbell Plateau than the other transect stations (Fig. 5, list of stations).

The mesocosm experiments at the station in the SPSG (station 4) and SANT (station 15) exhibited strikingly different growth responses of the ambient bacterial communities to the various substrate and vitamin B1 and B12 additions. At station 4 the responses were slower than at station 15.

The surface sediment along the transect exhibited quite variable structures and textures. This was already obvious from the color (Fig. 6). Bacterial abundance at the sediment surface decreased from station 6 in the SPSG to station 18 in ANTA from 4x10^8 to 4x10^7 cells cm^{-3} whereas at 20 cm below the seafloor cell numbers remained constant around 3x10^7 cells cm^{-3}. Alkaline phosphate activities were very low from station 6 to 15 and peaked at station 18 whereas aminopeptidase activities did not show a systematic trend over the biogeographic provinces.

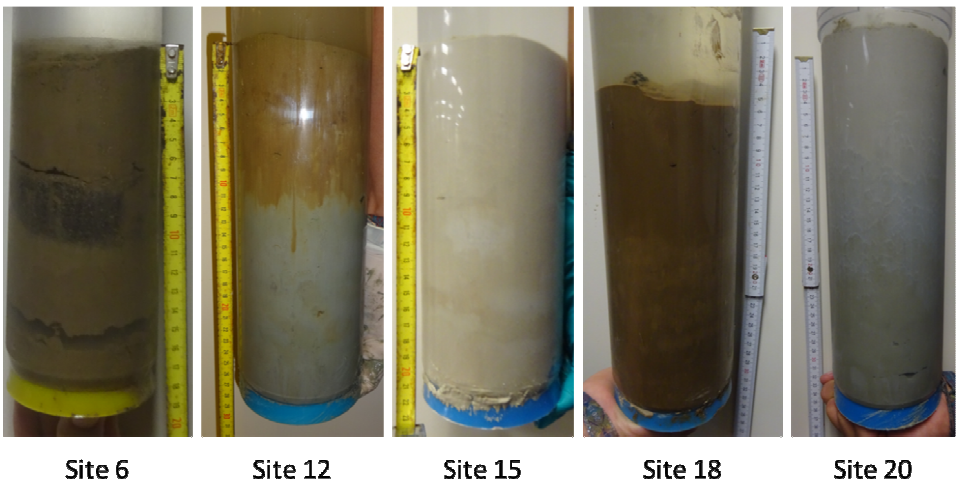


Figure 6. Representative sediment cores from cruise SO254. At station 17 no sediment was sampled as the seafloor was too hard and rocky.

During 19 ROV dives between 29° and 49°S water samp les, sediments and invertebrates were collected at a depth range of 100 to 4800 m (for exact locations and depths see attached list of stations). In addition to the ROV dives we also conducted one shallow water collection by snorkeling from a small boat near Raoul Island on the Kermadec Plateau. A total of 359 target specimens (sponges, corals, sea cucumbers etc., Fig. 7, Tab. 1) were collected. The target specimens were attributed to 183 Operational Taxonomic Units (OTUs, nominal “species”) and including 111 sponge (Porifera) OTUs. Additionally, 262 small non-target-specimens that were associated with the target organisms were collected for the NIWA Invertebrate Collection and preliminarily attributed to 73 taxonomic families (Tab. 2). Taxonomic identifications using traditional microscopy as well as DNA barcoding and amplicon sequencing of the microbiome are ongoing.

Figure 7. stalked sponge (left) and soft coral cf. *Anthomastus* sp. (right)

Tab. 1: Number of collected specimens and OTUs on potential family level of target species.

Taxonomic group	No. of OTUs 'species'	No. of specimens
Ascidiacea [Tunicates]	1	2
Anthozoa	35	91
Asteroidea	12	19
Echinoidea	1	1
Holothuroidea (Class)	17	27
Ophiuroidea	11	12
Demospongiae	62	103
Hexactinellida	44	104
Total	183	359

Tab. 2: Number of collected specimens and OTUs on potential family level of non-target species. NA: not analyzed.

Taxonomic group	No. of OTUs 'families'	No. of specimens
Ascidiacea [Tunicates]	2	27
Anthozoa	7	8
Asteroidea	3	3
Crinoidea	1	7
Echinoidea	2	6
Holothuroidea (Class)	2	2
Ophiuroidea	9	42
Malacostraca	7	59
Polychaeta	4	20
Bivalvia	4	10
Gastropoda	3	11
Cephalopoda	2	3
Hydrozoa	3	20
Demospongiae	3	6
Hexactinellida	5	11
NA	27	27
Total	84	262

A preliminary analysis revealed that the northern, deepest stations, from 29° to 39° S, were

dominated by Hexactinellida (total of 102 specimens, 7.3 per site) with Demospongiae being less abundant (total of 45 specimens, 3.2 per site). The southern stations from 41° to 45° S on the other hand were dominated by Demospongiae (54 specimens, 13.5 per site), with only a low abundance of Hexactinellida (2 specimens, 0.5 per site). Sponges in general were more common on hard substrate, i.e., volcanic bed rock, while they were rare to absent on slopes dominated by muddy sediment with occasional pumice rocks. Several of the northern sites were also geologically active (e.g. Raoul Island, Maccauley Island), and had much higher abundances of octocorals compared to sponges. Since most octocorals also require hard substrate for attachment, it appears that sponges prefer different hard substrate compared to the octocorals, which seemed rather abundant on the pumice substrate.

According to the preliminary data we were able to collect already during the cruise we are very confident that the PoriBacNewZ cruise was very successful and that we can reach the goals we set for this comprehensive study. However, to achieve them all the samples stored frozen in the home labs need to be analyzed.

On February 18th we finished the last CTD station (station 20) with the full program and on February 23rd the last ROV station (station 26). At the last station we just carried out bio-optics work and deployed the in situ pump which could not be operated as we had wished due to unfavorable weather conditions further south. This schedule left us enough time to finish the last incubations, pack all material and equipment before we reached again the port of Auckland in the morning of February 27th.

During the first two weeks in the SPSG and northern SANT we experienced good weather so that we were able to pursue our original plans to a large extent. Thereafter, in the southern region of SANT and ANTA, we experienced storms and high waves so that we had to re-schedule our plans frequently, cancel all ROV stations and even to cancel the planned stations from 55° to 60°S. Even after returning to the regions closer to the coast near the NZ south and north islands we still experienced fairly strong wind but wave heights which allowed operating the ROV. Returning to the SPSG for the last stations brought us back to fine and sunny weather. During all these weather conditions including high waves and storms up to Beaufort scale 10 the ship operated reliably so that we could process all samples collected without any problem. We did not experience any malfunctioning of instrumentation or ship equipment during the cruise after the replacement of the broken control valve at the beginning of the cruise. Even though our cruise suffered from the two initially lost days it is remarkably that these were the very first days lost since the ship was delivered to science in November 2014.

Acknowledgements
We would like to thank very much Captain Lutz Mallon, his crew and the ROV team for their excellent, always present and very friendly support of our research activities on board RV Sonne. The German Federal Ministry of Education and Research (BMBF) generously provided the main funding of this expedition. As a substantial part of this research cruise was a core project of the Transregional Collaborative Research Center *Roseobacter* (TRR51) in its second funding phase Deutsche Forschungsgemeinschaft also contributed substantially to funding of this cruise. Further support came from the German State of Lower Saxony and the Swiss National Fund.

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35	CUNO, Patrick	ROV	Geomar
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List and details of stations

Station	Start Day / Time UTC	End Day / Time UTC	Latitude	Longitude	Type of work	Depth (m)
SO254-01	29.01.2017 17:57:05	30.01.2017 07:50:23	30°43,507' S	173°53,017' E	ROV, Bio-optics, in si tu pump, plankton net	569
SO254-02	30.01.2017 19:39:17	31.01.2017 06:37:34	31°18,010' S	175°11,839' E	ROV	1255
SO254-03	31.01.2017 16:09:46	01.02.2017 08:24:47	30°59,283' S	177°30,825' E	ROV	4110
SO254-04	01.02.2017 19:47:36	02.02.2017 07:07:34	30°05,727' S	179°49,320' E	ROV, CTD, Bio-optics	5 65
SO254-05	02.02.2017 20:09:31	02.02.2017 20:09:31	29°17,521' S	178°01,866' W	ROV	409
SO254-06	03.02.2017 13:46:47	04.02.2017 11:54:22	29°16,136' S	176°42,142' W	ROV, CTD, Bio-optics, MUC, in situ pump, plankton net	4788
SO254-07	04.02.2017 22:00:36	05.02.2017 06:23:17	30°13,863' S	178°27,676' W	ROV	398
SO254-08	06.02.2017 03:37:55	06.02.2017 11:56:29	34°44,527' S	179°15,769' W	Bio-optics, CTD, in si tu pump, plankton net	4645
SO254-09	06.02.2017 20:13:10	07.02.2017 07:37:33	35°22,694' S	178°58,458' E	ROV	5237
SO254-10	07.02.2017 20:00:01	08.02.2017 01:47:06	37°29,828' S	178°45,917' E	ROV	539
SO254-11	08.02.2017 17:00:04	09.02.2017 03:26:53	39°54,738' S	178°14,237' E	ROV	1201
SO254-12	09.02.2017 09:20:02	09.02.2017 22:26:01	40°35,352' S	179°15,359' E	CTD, in situ pump, pla nkton net, MUC	3088
SO254-13	09.02.2017 21:28:42	09.02.2017 22:26:01	41°08.480' S	179°47.520' W	Bio-optics	1713
SO254-14	10.02.2017 15:46:57	10.02.2017 16:30:08	43°42,911' S	179°58,282' W	CTD	389
SO254-15	11.02.2017 08:35:12	12.02.2017 19:21:05	45°57,000' S	179°22,803' E	ROV, CTD, Bio-optics, MUC, in situ pump, plankton net	3102
SO254-16	12.02.2017 19:21:05	12.02.2017 23:14:52	47°47,809' S	178°37,757' E	Agazzis trawl	5625
SO254-17	13.02.2017 17:24:21	14.02.2017 04:09:18	50°28,826' S	179°26,742' E	CTD, in situ pump, MUC	4456

SO254-18	15.02.2017 19:38:40	16.02.2017 05:03:11	52°07,414' S	177°31,675' E	CTD, plankton net, MUC	5012
SO254-19	17.02.2017 01:07:18	17.02.2017 07:41:13	49° 5,754' S	173°52,263' E	ROV	537
SO254-20	18.02.2017 00:42:07	18.02.2017 09:47:18	45°43,071' S	174°43,866' E	CTD, in situ pump, pla nkton net, Agazzis trawl	1448
SO254-21	18.02.2017 21:06:42	19.02.2017 07:33:46	45°01,605' S	171°54,167' E	ROV	677
SO254-22	19.02.2017 20:30:18	20.02.2017 06:51:42	43°17,633' S	173°36,376' E	ROV	888
SO254-23	20.02.2017 19:36:19	21.02.2017 06:48:26	41°37,065' S	175°47,330' E	ROV	1416
SO254-24	21.02.2017 19:02:03	22.02.2017 10:14:25	40°02,988' S	178°08,236' E	ROV, Bio-optics, in sit u pump	913
SO254-25	22.02.2017 21:30:38	23.02.2017 07:56:09	37°55,296' S	179°13,519' E	ROV	1707
SO254-26	23.02.2017 19:38:39	24.02.2017 09:45:03	35°36,670' S	178°51,141' E	ROV, in situ pump	1144
SO254-27	24.02.2017 18:05:39	25.02.2017 04:44:53	36°19,177' S	177°14,143' E	Bio-optics, in situ pu mp, CTD	3140