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Short Cruise Report

RV Sonne, cruise SO289

Valparaíso (Chile) – Nouméa (New Caledonia)

February 18 – April 8 2022

Chief Scientist: Eric P. Achterberg

Captain: Tilo Birnbaum

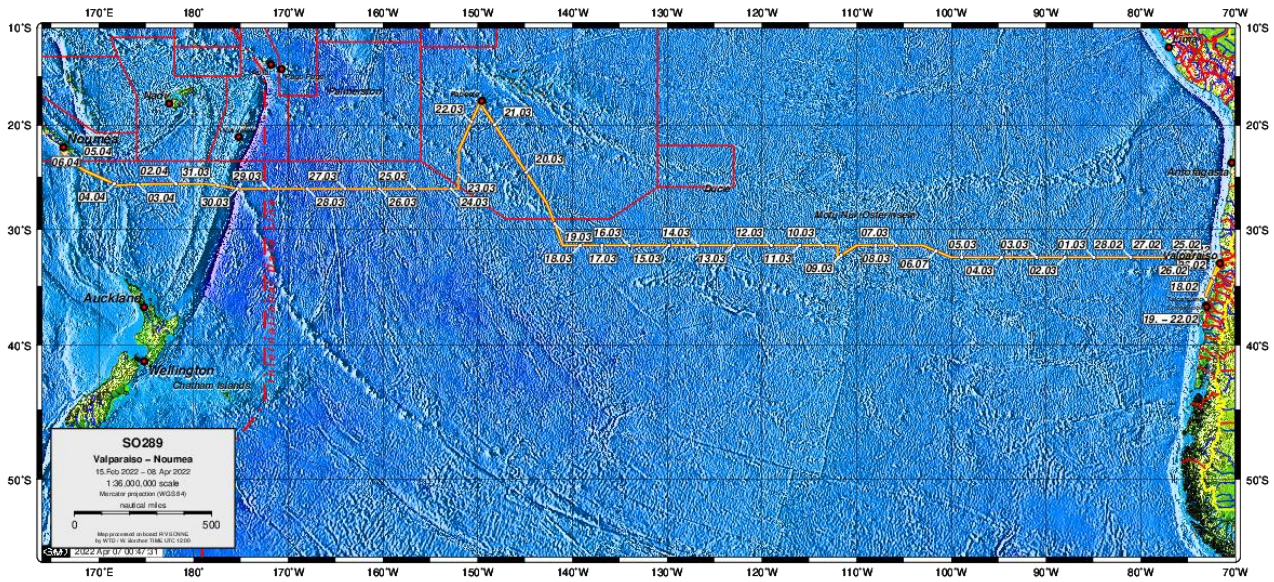

Fig. 1: Cruise track (yellow line) and stations of RV SONNE cruise SO289

Objectives

The main scientific aim of cruise SO289 is to determine the distributions of trace elements and their isotopes (TEIs), quantify their sources from the four major ocean boundaries (rivers, atmosphere, exchange with sediments, ocean crust), and determine their biogeochemical cycling and relationships to large scale ocean circulation along a cruise track in the South Pacific Ocean (SPO).

The major questions that we will address on cruise SO289 are:

1. The S Pacific gyre is ultra-oligotrophic with low concentrations of nitrate and the micro-nutrient Fe, and low to medium phosphate concentrations. What are the proximally limiting or co-limiting micro-nutrients for surface water microbiological processes in this region? How are micronutrients and nitrate supplied to support surface ocean productivity in the SPO?
2. Intermediate and deep water masses in the SPO upwell to the south and north to supply micronutrients to the Fe-starved Pacific sector of the Southern Ocean, and the productive Equatorial PO. The Fe/N ratios in these waters are very likely below those required by phytoplankton communities in surface waters, but in terms of the total Fe supply to the surface ocean, these waters play a fundamental role in setting surface productivity. Which processes control the concentration and distribution of micronutrients in intermediate and deep waters in the SPO, and therefore ultimately the supply of micronutrients to the remote surface waters?
3. The sources, sinks, and internal cycling of TEIs, including micronutrients, in the SPO are poorly understood despite its importance for the global cycling of nutrients and carbon. Which processes control the fluxes, supplies and cycling of TEIs?
4. Hydrothermal vents along the East Pacific Rise provide large deep water Fe inputs. What are the stabilisation mechanisms of vent derived Fe, and what is the length scale of the Fe plume?
5. The flow of the hydrothermal tracer ^{3}He suggests potentially substantial transport of hydrothermally derived TEIs to the Southern Ocean. Does this transport mechanism form an important supply route of Fe, and other TEIs such as Zn, to the Fe limited S. Ocean?
6. The Maipo is an important Chilean river flowing into the SPO. What are the TEI inputs of this river reaching the open ocean and how are they distributed by ocean circulation?
7. Are the Chilean shelf and slope system important sources of Fe and other elements to the SPO?
8. How does large scale ocean circulation affect the TEI distributions in water masses in the deep SPO? Is the advection of water masses from the Southern Ocean reflected in their TEI distributions, which would allow more reliable application of certain TEIs (Nd/Hf isotopes, REEs) as paleo circulation tracers recorded in sediments?

We have the following major goals that we want to achieve for the proposed cruise:

Obj 1.: Determine the distribution, as well as the physical and chemical speciation of TEIs, including micronutrients (such as Cd, Co, Cu, Fe, Mn, Mo, Ni, V, Zn, Cr), non biologically essential elements (such as Al, Pb, Hg, Ti, Zr, Hf, Nb, U, W and REEs (Rare Earth Elements)) and a range of isotope systems (including Nd, Hf, Pa/Th, Ra, Pb, Fe, Ni, Zn) in high resolution full-depth profiles.

Obj 2.: Quantify the fluxes of these TEIs and micronutrients to the ocean from the four ocean boundaries: atmosphere, continent, ocean crust and sediments and assess the role of physical and chemical speciation of TEIs for their fluxes from the different sources.

Obj 3.: Assess, using chemical tracers and physical oceanography, the mixing and advection of these TEIs away from their sources into the ocean interior, and upwards into the surface ocean.

Obj 4.: Explore the relationship between macro- and micro-nutrient concentrations and fluxes, ocean productivity, nutrient utilization and limitation, diazotrophy, and the nitrogen and carbon cycles.

Narrative

Scientists and technicians travelled from their home laboratories to Valparaíso (Chile) to join RV SONNE on February 17, 2022. A group of GEOMAR scientists and technicians had travelled already on February 14 to arrive earlier in Valparaíso to unload containers and set up the equipment for the cruise. Unfortunately, the port of Valparaíso was not able to handle containers for the SONNE. All the cruise participants of SO289 were transferred by Pilot boat to the vessel in the Bay of Valparaiso on the morning of February 17 while the Agency managed to get us a berth in Talcahuano, a port 2 days sailing south from Valparaíso. We arrived in Talcahuano on February 19, and commenced with the off-loading of containers of the previous two cruises, before we loaded the 6 containers for SO289 plus the supply containers for the cruise. The GEOMAR trace metal clean winch container with a new cable guiding deck block and our clean container for filtration were installed. The CTD sensors, UVP and other instruments were installed as well as the set-up of the laboratories.

With a delay of 4.5 days we sailed in the evening of February 22 with moderate wave conditions in the coastal waters off Chile and started sampling surface waters on February 23 with our trace metal clean tow fish for trace elements and biological variables at the first station in the outflow of the Maipo River. This sampling activity using the tow fish continued until we reached New Caledonia, but was halted for a few hours prior to reaching the international waters outside the Chilean EEZ on February 28. In addition we halted the sampling from the tow fish whilst in the EEZ of French Polynesia from March 18 to 23 and whilst in the EEZ of New Caledonia after April 4.

The surface waters were sampled for nitrogen fixation, nutrients and trace elements to establish the rates of nitrogen fixation, types of diazotrophs present (using nifH gene analysis), and the chemical environment of the diazotrophs. Nutrients and trace elements were sampled typically every 3 hours when steaming, and also upon arrival or departure at stations. The tow fish was deployed throughout the cruise and only taken out of the water for inspection once or twice. The ship's ADCP and TSG were operated whilst the vessel was in international waters. In addition, we sampled for aerosols. The aerosol collector was placed on the top deck of the Sonne and filters changed every 48 or 72 h.

We have been deploying 2 different CTDs (titanium GEOMAR CTD and stainless steel SONNE CTD) and also a set of 11 in situ pumps. The titanium GEOMAR CTD is operated by a dedicated winch system with a Kevlar cable, thereby preventing contamination of the samples during the sample collection. The deployments of the CTDs have been successful. The deployment of the in situ pumps was also very successful and greatly contributed to the success of the cruise.

At each station we sampled the full water column with the titanium GEOMAR CTD for contamination prone variables (GEO-CTD), and using the stainless steel SONNE CTD for less contamination prone variables, including isotopes like Nd (SS-CTD). An additional titanium CTD (BIO-CTD) was deployed daily to about 300 m depth for collection of samples for biological variables. Biological rate experiments of nitrification and di-nitrogen fixation were conducted using the water from the titanium CTD (and also tow fish). Phytoplankton resource limitation experiments were conducted in the ship-board laboratory and also in incubation tanks on the aft deck.

We sampled a total of 44 stations on SO289, and 14 were so-called superstations. At the superstations, we deployed an additional SS-CTD for the collection of additional waters for isotope measurements. In addition, at the superstations we deployed up to 11 in situ pumps on the stainless steel wire of the SS-CTD. The pumps and SS-CTD deployment occurred simultaneously. This operation saved us 4-5 hours at each superstation, thereby making up for lost time for the delayed departure in Chile. The stainless steel wire of the SONNE was clean and released few particles. The freshwater rinsing system of the cable facilitated a clean CTD wire.

The in situ pumps were used to collect particles for geochemical and biological investigations. Particulate Th isotopes (Th 234) obtained from the filters of the in situ pumps were measured on-board. In addition, a Mn cartridge was placed on a number of the in situ pumps, which allowed for the collection of long-lived Ra samples. We also sampled the Niskins from the SS-CTD for helium isotopes which we will use as a tracer of the hydrothermal fluid inputs to the ocean. Helium is a conservative tracer and allows us to follow the plume and determine the fluxes of elements.
The first station on February 23 (2022) was conducted in the bay right in front of the outflow of the Maipo river. The GEOMAR titanium (Ti) CTD with OTE Niskin bottles worked well, as did the stainless steel (SS) CTD from the SONNE.
The first 4 stations were conducted in waters with depths of less than 2500 m, and therefore took only a few hours to complete. Also the distance between the stations was short with only a few hours steaming between stations. Therefore, the ship had to wait on occasions at a station prior to the start of sampling activities, as the samples from the previous station had not yet been processed. We reached our intended latitude of 32°30 S at station 5, with the intention to follow this until New Zealand waters. Following station 7, the depths were about 4000 m, and steaming distances about 12-15 h, which allowed good time for sample handling and also sleep between stations.
Our last station in the EEZ of Chile was on February 28 (station 10), and the next station (station 11) was in international waters. All further stations were sampled in international waters, as we shelved our plan to work in the EEZ of New Zealand. Station distances were 2 or 3 degrees (longitude) in the region between the Chilean EEZ and the East Pacific Rise. The stations in the region of the East Pacific Rise were occupied at shorter distances (down to 1 degree) and we also moved 1 degree north to 31°25 S at station 17 in order to sample the hydrothermal plume, and we sampled a hydrothermal system right above the East Pacific Rise at 111°59 W, 31°25S (station 22).
Sailing west from the East Pacific Rise, we turned to sampling stations at a 3 or 4 degrees distance along 31°25S. Station occupation continued until station 32 on March 18, following which we sailed to Tahiti for a medical evacuation of a crew member. We returned to international waters to the south of French Polynesia on March 23, and occupied station 33. The diversion to Tahiti took about 5 days, and we decided to follow a cruise track that was even more northerly (26°10S) with a station spacing of 4 degrees in order to save steaming time on our way to New Caledonia. The transect allowed us to sample in the international waters between the EEZs of New Zealand and Tonga. The narrow gap between these EEZs allowed us to sample the Kermadec-Tonga Trench (station 39) and also an underwater volcanic system on the ridge (station 40). The last 4 stations of cruise SO289 were conducted in the South Fiji Basin, which is impacted by hydrothermal inputs in addition to a range of inputs from continental run-off and sediments. The last station (station 44) was occupied in the early morning of April 4. Following this station, we started packing up and loading our containers. The weather in the study area has been kind and we have not lost any station time as a result of poor weather but then a threat of a tropical cyclone forced us to pack swiftly and allow us to unload the container in the port of Nouméa on April 8, before flying home on April 9.

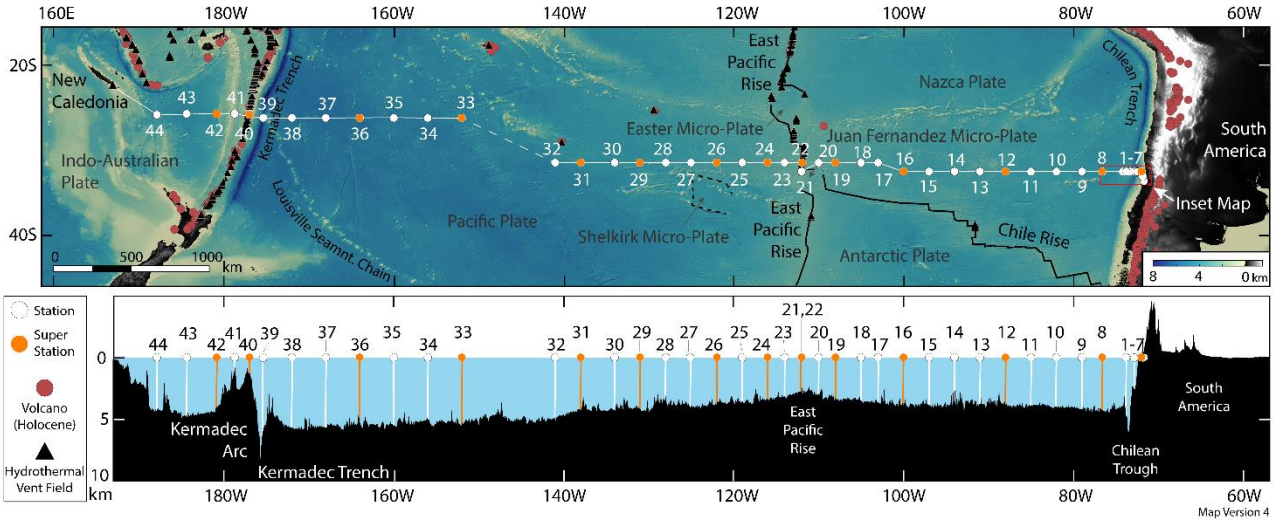

Fig. 2: Cruise track (white line) for SO289 with standard stations as white dots and superstations as orange dots. Brown dots are volcanoes and black triangle hydrothermal vent fields. Bottom: stations positioned on a bathymetry map. Figure by Chris Galley.

Acknowledgements

All the members of the SO289 GEOTRACES South Pacific team are very grateful to the Federal Ministry of Education and Research (BMBF), the German Research Fleet Coordination Centre at (Universität Hamburg), the shipping company BRIESE RESEARCH and LPL Projects + Logistics GmbH for providing their outstanding support to science and ship logistics, which made this cruise possible. The careful managing of the COVID situation was outstanding, and allowed us to conduct our successful cruise. We also like to sincerely thank the captain, officers and crew on the RV SONNE who did a fantastic job at facilitating our research and making our life as pleasant as possible on board.

Participant List

Achterberg	Eric	Chief Scientist/Chemical Oceanography	GEOMAR
Frank	Martin	Deputy Chief Scientist/Isotope Systems	GEOMAR
Vieira	Lucia	Scientist/Ra geochemistry	GEOMAR
Kleindienst	Alina	PhD student/Hg analysis	University Pau, France
Yuan	Zhongwei	PhD student/nutrient limitation	GEOMAR
Gosnell	Kathleen	Scientist/trace element cycling	GEOMAR
Li	Guanlin	PhD student/N cycling	GEOMAR
Fadeev	Eduard	Scientist/microbiology	University Vienna, Austria
Liu	Te	PhD student/Al and NH4 cycling	GEOMAR
Xu	Antao	PhD student/Nd isotopes	GEOMAR
Steiner	Zvi	Scientist/element cycles	GEOMAR
Wen	Zouzhu	Scientist/diazotrophy	GEOMAR
Tammen	Juliane Katharina	MSc student/Photophysiology	GEOMAR
Evers	Florian	Technician/winch operations	GEOMAR
Browning	Thomas	Scientist/(micro)-nutrient limitation	GEOMAR
Pöhle	Sandra	Scientist/trace element cycling	Jacobs University
Köhler	Dennis	Technician/In situ pump operations	AWI
O'Sullivan	Edel Mary	Scientist/element cycles	GEOMAR
Galley	Chris	Scientist/CTD, multibeam and ADCP operations	Memorial University, Canada
Liu	Haoran	PhD student/phytoplankton studies	GEOMAR
Fröhberg	Nico	PhD student/trace element cycles	Jacobs University
Pedre	Ignacio	Scientist/trace element cycling	Jacobs University
Blum	Lea	Hiwi/sample collection	GEOMAR
Jasinski	Dominik	Technician/trace element sampling	GEOMAR
Zhang	Zhouling	Scientist/radiogenic isotopes	GEOMAR
Mutzberg	Andre	Technician/nutrient analysis	GEOMAR
Schott	Thorsten	Technician/winch operations	GEOMAR
Battermann	Paul	Hiwi/sample collection	GEOMAR
Moriarty	Sarah	PhD student/S isotope collection	Memorial University, Canada
Hamisch	Stephan	Hiwi/sample collection	GEOMAR
Von Keitz	Tabea	Hiwi/sample collection	GEOMAR
Gürses	Can	BSc student/trace element cycling	GEOMAR
Amenabar	Maria	Chilean observer	SHOA

Station List

ISP = in situ pumps
SS CTD = SONNE stainless steel CTD
Ti BIO CTD = GEOMAR Ultra Clean Titanium CTD for biology
Ti GEOCHEM CTD = GEOMAR Ultra Clean Titanium CTD for geochemistry

Station No.	Device Operation	Event Date and Time	Event Comment	Latitude	Longitude	Depth (m)
1	SO289_1-1	2022/02/23 16:28:42	Ti GEO-BIO CTD	33° 36,455' S	071° 43,741' W	108
0	SO289_0_Underway-1	2022/02/23 16:30:12	ADCP start	33° 36,454' S	071° 43,743' W	109
0	SO289_0_Underway-2	2022/02/23 16:30:42	EM122 start	33° 36,454' S	071° 43,745' W	117
1	SO289_1-2	2022/02/23 17:08:29	SS CTD	33° 36,454' S	071° 43,742' W	111
0	SO289_0_Underway-3	2022/02/23 17:39:43	TMF	33° 36,239' S	071° 43,968' W	112
2	SO289_2-1	2022/02/23 21:00:45	Ti GEO-BIO-CTD	33° 05,403' S	071° 49,514' W	162
2	SO289_2-2	2022/02/23 22:01:49	SS CTD	33° 05,412' S	071° 49,518' W	163
3	SO289_3-1	2022/02/24 00:29:03	Ti BIO-CTD	32° 58,042' S	071° 51,840' W	840
3	SO289_3-2	2022/02/24 08:36:19	SS-CTD	32° 58,035' S	071° 51,833' W	832
3	SO289_3-3	2022/02/24 11:26:24	Ti GEO CTD	32° 58,038' S	071° 51,831' W	833
4	SO289_4-1	2022/02/24 14:07:12	SS-CTD	32° 52,394' S	071° 53,532' W	1749
5	SO289_5-1	2022/02/24 18:37:45	SS-CTD	32° 29,954' S	071° 59,906' W	2449
5	SO289_5-2	2022/02/24 20:43:43	Ti GEO CTD	32° 29,964' S	071° 59,904' W	2450
5	SO289_5-3	2022/02/25 01:29:01	SS CTD + ISP	32° 29,964' S	071° 59,902' W	2450
5	SO289_5-4	2022/02/25 06:43:01	Ti BIO-CTD	32° 29,966' S	071° 59,910' W	2451
6	SO289_6-1	2022/02/25 11:06:35	Ti GEO CTD	32° 30,004' S	072° 48,015' W	5488
6	SO289_6-2	2022/02/25 16:04:24	SS-CTD	32° 30,002' S	072° 47,990' W	5486
6	SO289_6-3	2022/02/25 22:22:02	Ti BIO CTD	32° 29,998' S	072° 47,995' W	5486
7	SO289_7-1	2022/02/26 03:14:36	TI GEO CTD	32° 29,985' S	073° 48,002' W	4060
7	SO289_7-2	2022/02/26 06:07:13	SS-CTD	32° 29,998' S	073° 47,997' W	4062
7	SO289_7-3	2022/02/26 10:00:39	Ti BIO CTD	32° 30,002' S	073° 47,996' W	4060
8	SO289_8-1	2022/02/26 21:50:24	Ti BIO CTD	32° 30,004' S	076° 36,039' W	3887
8	SO289_8-2	2022/02/26 22:28:03	SS CTD	32° 30,006' S	076° 36,026' W	3881
8	SO289_8-3	2022/02/27 01:25:12	TI GEO CTD	32° 30,002' S	076° 36,029' W	3885
8	SO289_8-4	2022/02/27 04:25:37	SS CTD + ISP	32° 30,000' S	076° 36,017' W	3886

9	SO289_9-1	2022/02/27 20:25:39	Ti BIO CTD	32° 30,001' S	079° 00,082' W	4030
9	SO289_9-2	2022/02/27 20:52:40	SS CTD	32° 29,999' S	079° 00,075' W	4030
9	SO289_9-3	2022/02/28 00:11:17	TI GEO CTD	32° 30,003' S	079° 00,057' W	4035
10	SO289_10-1	2022/02/28 16:36:52	Ti BIO CTD	32° 29,876' S	081° 59,950' W	3984
10	SO289_10-2	2022/02/28 17:00:00	SS-CTD	32° 29,884' S	081° 59,954' W	3992
10	SO289_10-3	2022/02/28 20:00:52	Ti GEO CTD	32° 29,890' S	081° 59,949' W	3992
11	SO289_11-1	2022/03/01 12:21:24	Ti BIO CTD	32° 30,015' S	085° 00,026' W	3840
11	SO289_11-2	2022/03/01 12:47:00	SS CTD	32° 30,009' S	085° 00,020' W	3824
11	SO289_11-3	2022/03/01 15:54:27	TI GEO CTD	32° 30,015' S	085° 00,031' W	3841
12	SO289_12-1	2022/03/02 07:24:48	Ti BIO-CTD	32° 29,868' S	087° 59,964' W	3713
12	SO289_12-2	2022/03/02 07:48:47	SS-CTD	32° 29,871' S	087° 59,974' W	3711
12	SO289_12-3	2022/03/02 10:46:30	Ti GEO CTD	32° 29,877' S	087° 59,970' W	3720
12	SO289_12-4	2022/03/02 13:58:45	SS CTD + ISP	32° 29,880' S	087° 59,995' W	3712
13	SO289_13-1	2022/03/03 08:20:53	Ti BIO CTD	32° 30,010' S	090° 59,900' W	3611
13	SO289_13-2	2022/03/03 08:44:27	SS CTD	32° 29,998' S	090° 59,900' W	3612
13	SO289_13-3	2022/03/03 11:42:20	Ti GEO CTD	32° 30,001' S	090° 59,896' W	3612
14	SO289_14-1	2022/03/04 02:23:10	Ti BIO CTD	32° 29,977' S	094° 00,050' W	3928
14	SO289_14-2	2022/03/04 02:49:32	SS CTD	32° 29,975' S	094° 00,049' W	3927
14	SO289_14-3	2022/03/04 05:56:38	Ti GEO CTD	32° 29,978' S	094° 00,050' W	3926
15	SO289_15-1	2022/03/04 22:15:03	Ti BIO CTD	32° 30,024' S	097° 00,049' W	3850
15	SO289_15-2	2022/03/04 22:38:08	SS CTD	32° 30,018' S	097° 00,063' W	3852
15	SO289_15-3	2022/03/05 01:56:03	Ti GEO CTD	32° 30,009' S	097° 00,054' W	3857
16	SO289_16-1	2022/03/05 16:57:12	Ti BIO CTD	32° 30,010' S	100° 00,024' W	3742
16	SO289_16-2	2022/03/05 17:18:53	SS CTD	32° 30,009' S	100° 00,025' W	3745
16	SO289_16-3	2022/03/05 20:51:14	Ti GEO CTD	32° 30,010' S	100° 00,015' W	3745
16	SO289_16-4	2022/03/05 23:31:37	SS CTD + ISP	32° 30,007' S	100° 00,012' W	3748
17	SO289_17-1	2022/03/06 18:34:05	TI BIO CTD	31° 25,650' S	102° 59,925' W	3564
17	SO289_17-2	2022/03/06 18:57:24	SS CTD	31° 25,646' S	102° 59,922' W	3563
17	SO289_17-3	2022/03/06 21:50:52	TI GEO CTD	31° 25,652' S	102° 59,927' W	3564
18	SO289_18-1	2022/03/07 12:56:44	TI BIO CTD	31° 25,829' S	106° 00,006' W	3403

18	SO289_18-2	2022/03/07 13:20:16	SS CTD	31° 25,832' S	106° 00,003' W	3401
18	SO289_18-3	2022/03/07 16:03:59	TI GEO CTD	31° 25,816' S	106° 00,009' W	3404
19	SO289_19-1	2022/03/08 03:03:53	TI BIO CTD	31° 25,794' S	107° 59,996' W	3114
19	SO289_19-2	2022/03/08 03:26:03	SS CTD + ISP	31° 25,793' S	107° 59,995' W	3114
19	SO289_19-3	2022/03/08 10:12:32	Ti GEO CTD	31° 25,793' S	107° 59,996' W	3114
19	SO289_19-4	2022/03/08 12:41:17	SS CTD	31° 25,798' S	107° 59,992' W	3113
20	SO289_20-1	2022/03/08 22:00:24	Ti BIO CTD	31° 25,808' S	110° 00,001' W	2670
20	SO289_20-2	2022/03/08 22:26:03	SS CTD	31° 25,811' S	110° 00,014' W	2667
20	SO289_20-3	2022/03/09 00:43:12	Ti GEO CTD	31° 25,811' S	110° 00,017' W	2678
21	SO289_21-1	2022/03/09 14:19:04	Ti BIO CTD	32° 30,039' S	111° 59,969' W	2703
22	SO289_22-1	2022/03/09 19:37:45	SS CTD	31° 25,826' S	111° 59,362' W	2382
22	SO289_22-2	2022/03/09 20:30:00	SS CTD	31° 25,823' S	111° 59,376' W	2387
22	SO289_22-3	2022/03/09 21:16:50	TI GEO CTD	31° 25,815' S	111° 59,388' W	2387
22	SO289_22-4	2022/03/09 23:02:00	CTD + ISP	31° 25,816' S	111° 59,382' W	2385
23	SO289_23-1	2022/03/10 13:48:25	Ti BIO CTD	31° 25,784' S	114° 00,016' W	2920
23	SO289_23-2	2022/03/10 14:13:09	SS CTD	31° 25,788' S	114° 00,015' W	2919
23	SO289_23-3	2022/03/10 16:35:10	TI GEO CTD	31° 25,799' S	114° 00,013' W	2918
24	SO289_24-1	2022/03/11 06:48:01	TI BIO CTD	31° 25,808' S	116° 00,025' W	3312
24	SO289_24-2	2022/03/11 07:19:25	SS CTD + ISP	31° 25,813' S	116° 00,012' W	3312
24	SO289_24-3	2022/03/11 14:02:52	Ti GEO CTD	31° 25,804' S	116° 00,008' W	3314
24	SO289_24-4	2022/03/11 16:24:54	SS CTD	31° 25,806' S	116° 00,009' W	3315
25	SO289_25-1	12/03/2022 06:35	TI BIO CTD	31° 25,792' S	119° 00,007' W	3719
25	SO289_25-2	12/03/2022 06:59	SS CTD	31° 25,800' S	118° 59,995' W	3719
25	SO289_25-3	12/03/2022 10:05	Ti GEO CTD	31° 25,798' S	119° 00,007' W	3719
26	SO289_26-1	13/03/2022 02:00	Ti Bio CTD	31° 25,794' S	121° 59,988' W	3676
26	SO289_26-2	13/03/2022 02:24	SS-CTD	31° 25,795' S	121° 59,987' W	3679
26	SO289_26-3	13/03/2022 05:22	TI GEO CTD	31° 25,800' S	122° 00,004' W	3677
27	SO289_27-1	13/03/2022 20:56	Ti Bio CTD	31° 25,767' S	125° 00,003' W	3848
27	SO289_27-2	13/03/2022 21:24	SS-CTD	31° 25,769' S	125° 00,013' W	3849
27	SO289_27-3	14/03/2022 00:27	Ti GEO CTD	31° 25,767' S	125° 00,002' W	3839

28	SO289_28-1	14/03/2022 17:07	TI BIO CTD	31° 25,800' S	128° 00,014' W	3705
28	SO289_28-2	14/03/2022 17:35	SS CTD	31° 25,795' S	128° 00,010' W	3764
28	SO289_28-3	14/03/2022 19:05	TI GEO CTD	31° 25,801' S	127° 59,995' W	3753
28	SO289_28-4	14/03/2022 21:39	SS CTD + ISP	31° 25,798' S	127° 59,996' W	3690
29	SO289_29-1	15/03/2022 16:31	TI BIO CTD	31° 25,816' S	131° 00,047' W	4250
29	SO289_29-2	15/03/2022 16:58	SS CTD	31° 25,813' S	131° 00,030' W	4248
29	SO289_29-3	15/03/2022 20:17	TI GEO CTD	31° 25,801' S	131° 00,023' W	4250
30	SO289_30-1	16/03/2022 11:59	TI BIO CTD	31° 25,793' S	134° 00,005' W	4172
30	SO289_30-2	16/03/2022 12:24	SS CTD	31° 25,798' S	134° 00,001' W	4167
30	SO289_30-3	16/03/2022 15:48	Ti GEO CTD	31° 25,804' S	133° 59,995' W	4184
31	SO289_31-1	17/03/2022 17:59	TI BIO CTD	31° 25,797' S	137° 59,990' W	4348
31	SO289_31-2	17/03/2022 18:20	SS CTD	31° 25,804' S	137° 59,998' W	4349
31	SO289_31-3	17/03/2022 19:41	TI GEO CTD	31° 25,798' S	137° 59,995' W	4348
31	SO289_31-4	17/03/2022 23:09	SS CTD + ISP	31° 25,809' S	137° 59,994' W	4345
32	SO289_32-1	18/03/2022 18:44	TI BIO CTD	31° 25,779' S	140° 59,999' W	4665
32	SO289_32-2	18/03/2022 19:07	SS CTD	31° 25,789' S	140° 59,995' W	4663
32	SO289_32-3	18/03/2022 22:47	Ti GEO CTD	31° 25,802' S	140° 59,996' W	4663
33	SO289_33-1	23/03/2022 18:30	TI BIO CTD	26° 10,182' S	152° 00,010' W	4658
33	SO289_33-2	23/03/2022 18:55	SS CTD	26° 10,191' S	152° 00,009' W	4654
33	SO289_33-3	23/03/2022 23:08	Ti GEO CTD	26° 10,189' S	152° 00,010' W	4661
33	SO289_33-4	24/03/2022 02:36	SS CTD + ISP	26° 10,187' S	151° 59,999' W	4656
34	SO289_34-1	25/03/2022 00:33	TI BIO CTD	26° 10,112' S	155° 59,927' W	5087
34	SO289_34-2	25/03/2022 00:59	SS CTD	26° 10,107' S	155° 59,921' W	5091
34	SO289_34-3	25/03/2022 04:42	Ti GEO CTD	26° 10,111' S	155° 59,924' W	5094
35	SO289_35-1	26/03/2022 02:27	BIO CTD	26° 10,208' S	159° 59,967' W	4952
35	SO289_35-2	26/03/2022 02:52	SS CTD	26° 10,204' S	159° 59,985' W	4959
35	SO289_35-3	26/03/2022 06:44	TI GEO CTD	26° 10,198' S	159° 59,995' W	4954
36	SO289_36-1	27/03/2022 02:07	Ti BIO CTD	26° 10,196' S	163° 59,975' W	5606
36	SO289_36-2	27/03/2022 02:30	SS CTD (shallow)	26° 10,202' S	163° 59,977' W	5606
36	SO289_36-3	27/03/2022 03:51	Ti GEO CTD	26° 10,198' S	163° 59,980' W	5606

36	SO289_36-4	27/03/2022 08:03	SS CTD + ISP	26° 10,197' S	163° 59,986' W	5607
37	SO289_37-1	28/03/2022 07:45	TI BIO CTD	26° 10,206' S	168° 00,024' W	5477
37	SO289_37-2	28/03/2022 08:07	SS CTD	26° 10,194' S	168° 00,005' W	5509
37	SO289_37-3	28/03/2022 12:30	TI GEO CTD	26° 10,213' S	168° 00,029' W	5473
38	SO289_38-1	29/03/2022 09:05	TI BIO CTD	26° 10,202' S	172° 00,003' W	5192
38	SO289_38-2	29/03/2022 09:26	SS CTD	26° 10,208' S	172° 00,005' W	5446
38	SO289_38-3	29/03/2022 13:28	TI GEO CTD	26° 10,202' S	172° 00,003' W	5192
38	SO289_38-4	29/03/2022 17:02	SS CTD (shallow)	26° 10,196' S	172° 00,000' W	5197
39	SO289_39-1	30/03/2022 08:52	TI BIO CTD	26° 09,996' S	175° 23,792' W	7681
39	SO289_39-2	30/03/2022 09:14	SS CTD + ISP	26° 10,002' S	175° 23,795' W	7680
39	SO289_39-3	30/03/2022 15:21	TI GEO CTD	26° 09,999' S	175° 23,792' W	7688
40	SO289_40-1	31/03/2022 04:37	Ti GEO CTD	25° 52,491' S	177° 10,997' W	526
40	SO289_40-2	31/03/2022 05:22	TI GEO CTD	25° 52,498' S	177° 10,998' W	526
40	SO289_40-3	31/03/2022 10:16	TI BIO CTD	25° 52,501' S	177° 11,002' W	527
41	SO289_41-1	31/03/2022 18:49	Ti BIO CTD	25° 43,093' S	178° 42,893' W	2353
41	SO289_41-2	31/03/2022 19:18	SS CTD	25° 43,093' S	178° 42,891' W	2356
41	SO289_41-3	31/03/2022 21:15	TI GEO CTD	25° 43,090' S	178° 42,895' W	2350
42	SO289_42-1	01/04/2022 11:48	TI BIO CTD	25° 43,101' S	178° 59,986' E	3763
42	SO289_42-2	01/04/2022 12:16	CTD-SS	25° 43,106' S	178° 59,987' E	3761
42	SO289_42-3	01/04/2022 13:31	TI GEO CTD	25° 43,094' S	178° 59,985' E	3760
42	SO289_42-4	01/04/2022 16:03	SS CTD + ISP	25° 43,094' S	178° 59,983' E	3763
43	SO289_43-1	02/04/2022 16:49	Ti BIO CTD	25° 43,218' S	175° 29,873' E	4492
43	SO289_43-2	02/04/2022 17:20	SS CTD	25° 43,114' S	175° 29,987' E	4488
43	SO289_43-3	02/04/2022 20:48	TI GEO CTD	25° 43,099' S	175° 30,003' E	4507
44	SO289_44-1	03/04/2022 15:36	Ti BIO CTD	25° 49,979' S	171° 59,942' E	3396
44	SO289_44-2	03/04/2022 15:59	SS CTD	25° 49,979' S	171° 59,943' E	3407
44	SO289_44-3	03/04/2022 18:43	Ti GEO CTD	25° 49,977' S	171° 59,943' E	3317
0	SO289_0_Underway-4	03/04/2022 21:33		25° 49,972' S	171° 59,941' E	0