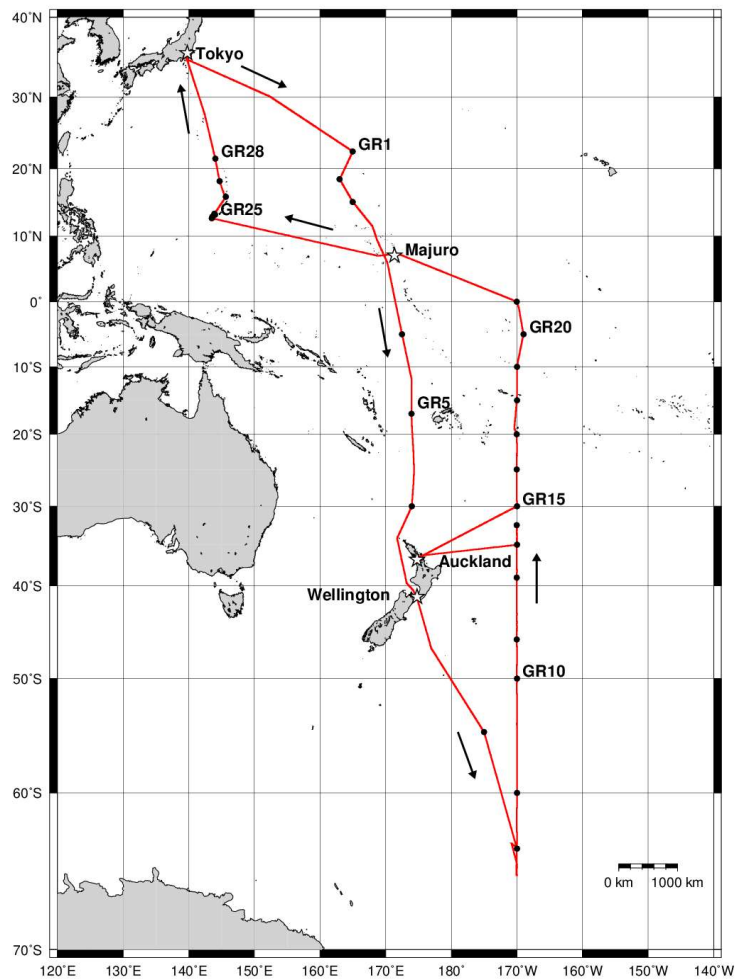


Cruise Summary Report

1. Cruise Information

- Cruise ID: KH-14-6
- Name of vessel: R/V Hakuho Maru
- Title of the cruise
Biogeochemistry of Trace Elements and Their Isotopes in the Pacific Ocean and the Antarctic Sea
(GEOTRACES section GP-19)
- Chief scientist [Affiliation]:
Toshitaka Gamo [Atmosphere and Ocean Research Institute, The University of Tokyo]
- Cruise period: From December 2, 2014 to February 26, 2015
- Ports of departure / call / arrival
Tokyo/ (Leg-1) / Wellington / (Leg-2) / Auckland / (Leg-3) / Majuro / (Leg-4) / Tokyo
- Research area: Western Pacific Ocean including the Antarctic Sea

- Research map



List of KH-14-6 stations (GRUS Expedition)

LEG	Station No.	Latitude	Longitude	Depth (m)	Seawater sampling				Sediment sampling	Argo float	In situ Filtration	Sea ice sampling
					CTD-CMS 12L x 24	CTD SSBL navigated	Separate Niskin 12L	Large Volume 250L x 4	Multiple corer			
1	GR0	27°02'N	157°32'E	5500						○		
1	GR1	22°30'N	165°00'E	5600	○			○	○			
1	GR2	18°30'N	163°00'E	5000	○			○				
1	GR3	15°10'N	165°00'E	5250	○			○	○			
1	GR4	5°00'S	172°30'E	4250	○			○	○			
1	GR5	16°59'S	173°55'E	2000	○			○	○			
1	GR6	30°00'S	174°00'E	3300	○		○	○	○			
2	GR7	55°00'S	175°00'W	5260	○			○	○			
2	GR8	64°00'S	170°00'W	2870	○			○	○		○	
2	GR-ICE	65°43'S	170°02'W	3100								○
2	GR9	60°00'S	170°00'W	3900	○		○	○	○			
2	GR10	50°00'S	170°00'W	5350	○		○	○	○		○	
2	GR11	46°00'S	170°00'W	5200	○			○	○			
2	GR12	39°00'S	170°00'W	4550	○			○	○			
2	GR13	32°30'S	170°00'W	5600	○		○	○	○			
2	GR14	35°00'S	170°00'W	5200	○			○	○			
3	GR15	30°00'S	170°00'W	5400	○			○	○			
3	GR16	25°00'S	170°00'W	5600	○		○	○	○			
3	GR17	20°00'S	170°00'W	5300	○			○	○			
3	GR18	15°00'S	170°00'W	4800	○			○	○			
3	GR19	10°00'S	170°00'W	5000	○			○	○			
3	GR20	05°00'S	169°00'W	5400	○		○	○	○			
3	GR21	00°00'S	170°00'W	5550	○		○	○	○			
4	GR22	12°43'N	143°32'E	3000	○	(○)		○	○			
4	GR23	12°56'N	143°38'E	3000	○							
4	GR24	13°15'N	144°01'E	1300	○							
4	GR25	13°24'N	143°55'E	1500	○							
4	GR26	15°56'N	145°40'E	500	○							
4	GR27	18°13'N	144°42'E	3600	○	(○)		○				
4	GR28	21°30'N	144°00'E	1700	○	○						

2. Overview of the Observation

2.1. Purposes of the cruise

The KH-14-6 cruise, nicknamed as “GRUS Expedition”, has been internationally authorized as a GEOTRACES meridional study in the South Pacific Ocean (section No. GP19). GEOTRACES is a “New Wave” of global marine geochemical studies, started in 2006 as one of the large-scale international programs sponsored by SCOR (Scientific Committee on Oceanic Research). GEOTRACES aims at an international study of the marine biogeochemical cycles of trace elements and their isotopes (TEIs) with a global point of view. Scientists from approximately 35 nations have been involved in the programme, which is designed to study all major ocean basins over the next decade. Our ability to predict future environmental changes caused by global warming depends upon our correct knowledge on the distribution of biologically controlled chemical species in the ocean and their exchange fluxes at the air-sea and sediment-water interfaces.

The determination of trace elements has recently become a central focus of many research programs that seek information on the biogeochemical processes in the ocean.

The study of TEIs has graduated from a curiosity to understand how the chemical diversity of trace elements, in their various redox and chemical states, interacts with the physical and biological processes occurring in the ocean. This is particularly important in the case of micronutrients such as Fe and Zn, whose oceanic distributions seem to be a crucial link to climatic processes. Together with other biologically required TEIs, perturbations of their cycles may have fundamental consequences for the global carbon cycle, which is firmly associated with global climate. Recent advances on highly precise analytical instruments and clean sampling techniques have just enabled us to get precise information on TEIs in the ocean. These advances are the powerful background to pursue a new international program, GEOTRACES.

The main purpose of this cruise is to establish the 2-dimensional meridional profiles of GEOTRACES trace elements and isotopes in the southern Pacific Ocean including the Antarctic Sea along the 170°W line, in order to advance ocean sciences on trace elements and isotopes as mentioned above. Little is known about the marine biogeochemical cycles on TEIs in the Pacific Ocean at the present stage. In the western Pacific Ocean, in particular, the northward Antarctic Bottom Water plays a key role in dynamic deepwater convection associated with active biogeochemical cycles. We conducted a similar cruise by R/V Hakuho Maru (KH-04-5) in the South Pacific Ocean in 2004-2005, and it should be of great interest to compare the data obtained this time with those in the past (10 years ago), revealing decadal changes in various physical, chemical and biological parameters in the western Pacific.

Another important target of the cruise will be to study the submarine hydrothermal activity in the Mariana arc-backarc zone as a significant source of trace metals from lithosphere to seawater.

2.2. Sampling

For the research objectives as above, we have taken air, seawater, and sediment samples for chemical analyses at 28 stations as listed in the above table. Water samples were collected from surface to near the bottom by using a clean CTD Carousel Multi Sampling system (24 Niskin-X (12L) bottles) attached at the end of a Ti-armored cable (No.2 winch of R/V Hakuho Maru). The system was also equipped with chemical sensors (dissolved oxygen, pH, chlorophyll Fluorometer, Turbiditymeter etc.) for *in situ* measurements.

We occupied two stations (30°S, 174°E) and (32°30'S, 170°W) for inter-comparison with the data obtained by a previous Australian GEOTRACES cruise.

Only during the Leg-4 (from Majuro to Tokyo), we applied an acoustically navigated (SSBL) CTD hydrocast for collecting bottom seawater samples just above the active venting sites as closely as possible. In situ sensors for pCO₂, ORP, Rn, and ATP were also attached to the CTD-Niskin sampling system.

For the precise measurements of trace radioactive nuclides in seawater,

large-volume water samplers with a volume of 250 L were also used for seawater sampling. Bottom sediment was taken with a multiple corer. Suspended particles were taken using an *in situ* filtering system.

Fifty-two Japanese scientists, technicians, and students, including six graduate students from foreign countries (China, Korea, Brunei, and Austria) were on board to conduct the sampling works.

2.3. Chemical analysis

Routine chemical measurements of salinity, dissolved oxygen, nutrients, pH, alkalinity and chlorophyll-a were mostly completed during the cruise. These on board data will be published in a preliminary cruise report within 6 months after the cruise. Besides these, chemical analyses on board the ship as well as those on shore-based laboratories were and will be carried out in clean conditions for trace elements, particularly GEOTRACES key parameters: Fe, Al, Zn, Mn, Cd, Cu, $\delta^{15}\text{N}$ of NO_3 , $\delta^{13}\text{C}$ of ΣCO_2 , ^{230}Th , ^{231}Pa , Pb isotopes and Nd isotopes. In addition, seawater analyses are planned for the following components by the cruise participants: sulfides, He isotopes, Ce isotopes, Pu isotopes, Bi, ^7Be , ^{10}Be , ^{134}Cs , ^{137}Cs , ^{129}I , Ba/Ca, Rare Earth Elements, Ni, W, Au, isotopes of Ni, Cu, Zn, and W, Se, ^{236}U , Cr, Perfluoro Alkyl Substances (PFASs), etc. These data will be published as part of original papers by the cruise participants within a few years.

As for the air and aerosol samples collected during the cruise, the following components will be measured by the cruise participants and their co-workers: CH_4 , CO_2 , B isotopes, Na, S, Pb isotopes, bioactive trace metals, macro-nutrients, Perfluoro Alkyl Substances (PFASs) etc.

2.4. Acknowledgement

This cruise passed through the EEZs (Exclusively Economic Zones) of several countries. Kind permissions from the Governments of U.S.A., New Zealand, Niue, Tokelau, Kiribati, Marshall Islands, Fiji and Micronesia were indispensable to pursue the cruise successfully. We are also thankful to the Environmental Protection Authority of New Zealand and the U.S. Fish and Wildlife Service for permitting our activity within the EEZ and ECS (Extended Continental Shelf) of New Zealand and within Mariana Arc of Fire National Wildlife Refuge, respectively.

It is our great pleasure to thank Captain Takatoshi Seino, the officers and crew of R.V. *Hakuho Maru* for their invaluable collaboration in the successful conduct of all shipboard works. Sincere thanks are also due to Office for Cruise Coordination of Ocean Research Institute, the University of Tokyo, and Research Vessel Operation Department of Japan Agency for Marine-Earth Science and Technology (JAMSTEC) for their great efforts to support the cruise. This cruise was partly supported by the a grant-in-aid for Scientific Research (A) (No. 23253001) from MEXT of Japan.