Cruise Summary

1. Cruise Information

● Cruise ID: KH-19-6 Leg 4

● Name of vessel: R/V Hakuho-maru

● Title of cruise: Integrated investigation for marine earth sciences in the Weddell Sea and the South Pacific: Fulfillment of R/V Hakuho-maru 30th anniversary expedition

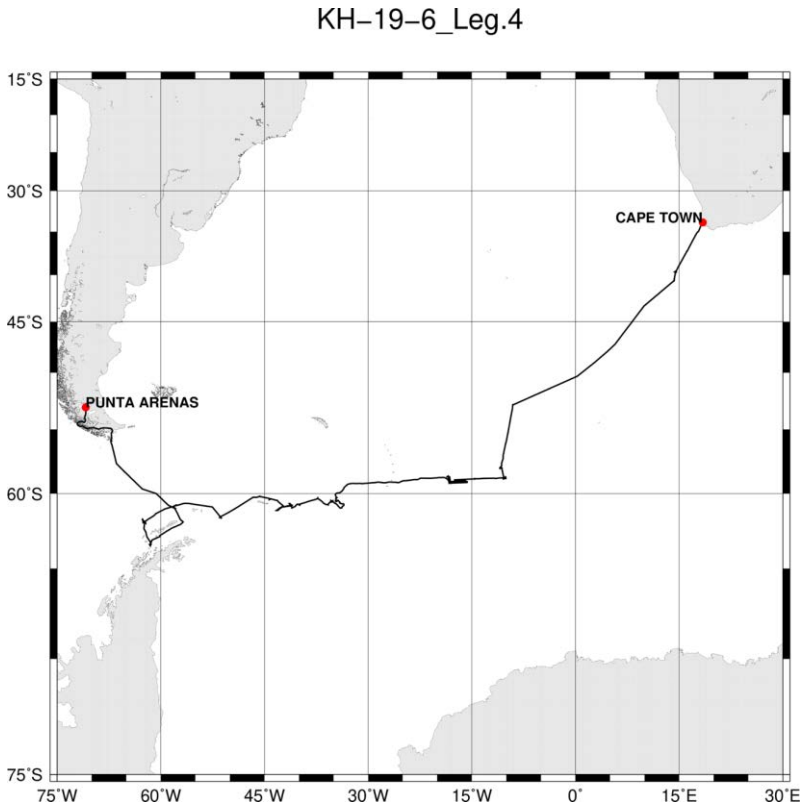
● Chief Scientist [Affiliation]: Minoru Ikehara [Kochi University]

● Cruise period: Dec. 19, 2019 - Jan. 16, 2020

● Ports of departure / call / arrival: Punta Arenas to Cape Town

● Research area: Atlantic sector of the Southern Ocean

○ Research map



● Representative of Science Party [Affiliation]

Paleoceanographic investigation of the Weddell Gyre history

Minoru Ikehara [Kochi University]

Linkage between climate and tectonics in the Scotia Sea and South Sandwich trench

Asuka Yamaguchi [The University of Tokyo]

Distribution of microplastics in the Southern Ocean

Hidetaka Nomaki [JAMSTEC]

Do submarine volcanism in mid-ocean ridges impact global climate change?

Hiroaki Koge [AIST]

Diversity and ecology of zooplankton in the Weddell Sea

Takuya Ohnishi [The University of Tokyo]

Deep-sea benthic organisms and their activities in the Antarctic Ocean

Hidetaka Nomaki [JAMSTEC]

2. Overview of Research Activities

2-1. Underway Geophysics (Koge et al.)

Following instruments equipped with the R/V *Hakuho-maru* were utilized for shipboard geophysical observation in the KH-19-6 cruise; a multi-narrow beam echo sounder (MBES); proton precession magnetometer (PPM), shipboard three-component magnetometers (STCM), shipboard gravimeter, and sub-bottom profiler (SBP). During this cruise, we successfully obtained the observation data on Seabeam2030 (bathymetry), Bathy2010 (SBP), STCM- KOBE, and gravimeter. The measurements and data recording were continuously conducted along ship tracks with average speed of generally 12–15 kt except within the exclusive economic zones of other countries. Seawater sound velocity profile (SVP) were obtained by XCTD/XBT, and applied to acoustic depth ranging of the MBES system. We analyzed MBES data using the software "CARIS" during the cruise. The operation of proton procession magnetometer showed the successful signal level (average ~55-65) during the observation, for the aim of revealing temporal change of the mid-ocean ridge and fracture zone activity.

2-2. Piston core sampling (Yamaguchi et al.)

A piston corer was used to obtain sediment samples during this cruise. It consists of a 900 kg-weight, a total 14 m-long (4 m x 2 + 6 m) or 12 m long (6 m x 2) stainless steel barrel and polyvinyl chloride (PVC) inner pipe, a core bit, a core catcher, a wired piston cylinder inside and a trigger arm (all belonging to AORI). The inner diameter of inner pipe is 74 mm. Either a 1-m long gravity corer "75-gravity corer" (belonging to AORI), a 100-kg weighed multiple-type corer "Asyura" (belonging to Kochi University), or a 100-kg cone-shape weight "Apollo" were used as pilot weight.

Sediment cores were collected using a piston corer (PC) at sites on the Bransfield Strait (PC01), South Shetland Trench (PC02, 03, 04 and 05), Powell Basin (PC06), north of Vulcan Fracture Zone (PC07), south of Bullard Fracture Zone (PC08) and north of Agulhas Ridge (PC10) (Fig.1). These sites were chosen carefully with the help of bathymetry and sub-bottom profiles.

2-3. Multiple core sampling (Nomaki et al.)

Surface sediment samples were collected with a Barnet-type multiple corer to minimize a sediment disturbance during the corer penetration into sediments. The multiple corer equipped eight 60-cm long core tubes with an inner diameter of 82 mm. Specific core tubes were used for certain scientific objectives. In some multiple corer deployments, we attached a deep-sea camera and a temperature and dissolved oxygen sensor to a stainless frame of the multiple corer. The camera was pre-programmed to record up to 2 hours of video during the multiple corer sampling on the seafloor. The sensor recorded during entire multiple corer deployments; i.e. before the multiple corer deployment to the recovery on deck. After recovery of the multiple corer onboard, we retrieved sediments with overlying seawater and kept chilled either outside the deck or in a cold room. Each sediment core was processed subsequently with an appropriate protocol for each scientific purpose.

2-4. Dredge (Tani et al.)

We conducted 18 dredge surveys during the KH-19-6-Leg 4 cruise based on two major scientific objectives:

1. Understanding the crustal structures and ages of the South Orkney microcontinent including those of the surrounding Bruce and Discovery Banks
2. Tracing the temporal variation of oceanic crust formation along the Vulcan Fracture Zone, American-Antarctic Ridge

Along with rock sampling, we have simultaneously studied benthos that were brought on deck with the rocks and sediments. As part of the dredging, we also attached a video camera to the chain above the dredge to capture images of undersea outcrops during dredging.

2-5. Plankton net sampling (Ohnishi et al.)

In order to reveal population structure and gene flow of key zooplankton in pelagic oceans, Norpac net with 100 μm mesh size was vertically towed to collect zooplankton at the depth of 0–200 m. Bulk samples were preserved in 99% ethanol. Key zooplankton species will be picked up from bulk zooplankton, and mtCOI sequences and genome-wide SNP data will be obtained foe each species. The results in the Weddell Sea and the South Pacific will be compared with those in the North Pacific and the Indian Ocean, which were collected during previous research cruises aboard on the R.V. Hakuho-maru. Other bulk samples collected by Norpac net with 335 μm or 100 μm mesh sizes were frozen at –20°C or store in RNAlater. These samples can be used to investigate diets and evolution of functional genes in a local population of key zooplankton species.

2-6. Sea water sampling (Kato et al.)

During the cruise, we collected surface seawater containing living plankton (special hand

net and membrane filter), seawater (glass bottle) and organic matters (GF/F filter) using seawater pumps, which are located at left side of the R/V Hakuho-Maru (~5 m water depth). This seawater sampling aims to obtain biogeographic/ecological data of the marine plankton as well as geochemical data of seawater in the Southern Ocean.

2-7. Microscale bacterial diversity (Yokochi)

Bacteria are now recognized as key players in marine biogeochemical processes. However, the findings are only based on the context of macro- and mesoscale oceanographic features. As the diversity and functions of bacteria (about one micrometer cell size) are defined by processes and interactions occurring in much smaller scale, it is needed to focus on bacterial dynamics at microscale, not at larger scale. In this cruise, we collected on-board pumping seawater samples at a certain interval of latitude and longitude to explore bacterial diversity at microscale in order to understand a role of bacteria in marine biogeochemical processes. To collect the microscale water samples, we used a microscale water sampling (MWS) device. Using this MWS device, we can collect 96 samples (one microliter each) at once. Additionally, we performed a microcosm experiment to investigate the microscale dynamics of bacteria during a phytoplankton bloom at several stations.

2-8. Sea ice sampling (Ikehara)

Sea ice samples were collected at a site (60°33.9’S, 35°24.7’W) near dredge site D13 in the Scotia Sea on 2 January 2020. Two blocks of sea ice were collected with a special net, which is produced by a square flame (1.7 m length) and net. Sea ice blocks were broken into pieces. Samples were stored in clean plastic box in a storage (-20°C) during the cruise. Sea ice samples will be analyzed for diatoms, planktonic foraminifers, and organic geochemistry.