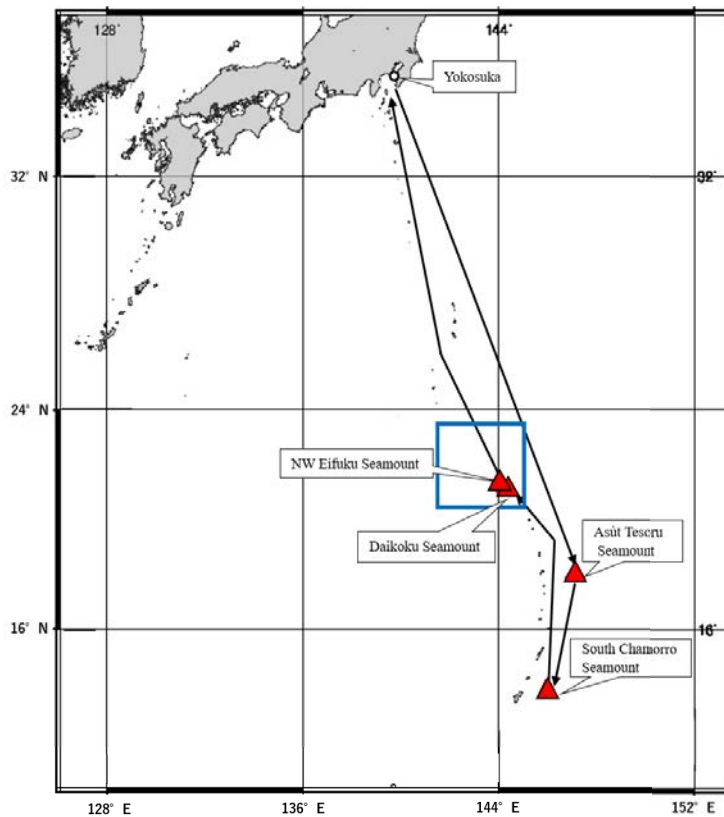


Cruise Summary

1. Cruise Information

- Cruise ID: KM23-05
- Name of vessel: Kaimei
- Title of the cruise: Geochemical, microbiological and biological processes in abnormal fluid pools of the Mariana Forearc Serpentinite Seamounts and Volcanic Arc hydrothermal systems
- Chief scientist: Ken Takai [X-star, JAMSTEC]
- Representative of the Science Party: Ken Takai [X-star, JAMSTEC]
- Title of proposal: Geochemical, microbiological and biological processes in abnormal fluid pools of the Mariana Forearc Serpentinite Seamounts and Volcanic Arc hydrothermal systems
- Cruise period: February 28, 2023 ~ March 29, 2023
- Ports of departure / call / arrival: JAMSTEC Yokosuka ~ JAMSTEC Yokosuka
- Research area: Mariana Forearc and northern Mariana Volcanic Arc
- Research map



2. Overview of the Observation

- Overview of the observation

In KM23-05 cruise, we totally conducted 19 dives of KM-ROV and BMS in the NW Eifuku, Daikoku, South Chamorro, Asut Tesoru Seamounts. One of the cruise foci was whether a true active seafloor microbial ecosystem is present in the extreme alkaline and reductive seafloor environments of the Mariana Forearc serpentinite seamounts or not. The other one was to justify that the hydrothermal liquid/supercritical CO₂ pools host a diversity of feedstock inorganic compounds and building block organic molecules, and abiotic chemical evolution, as a hatchery places for generation of primordial life.

In the NW Eifuku Seamount, we successfully gathered liquid/supercritical CO₂ containing other volatiles, directly derived from the pristine magmatic degassing, at the seafloor, and measured the composition by in situ Raman spectroscopy. The Raman spectrometry obtained from genuine liquid/supercritical CO₂ without contamination of hydrothermal fluids and seawater was the first example ever. In addition, the depth- spectrometry of the phase transition was also determined by in situ Raman spectroscopy and genuine liquid/supercritical CO₂ was sampled by the pressure-conserved sampler. The laboratory measurement of the detail volatile composition will clarify what kinds of chemical species, especially feedstock inorganic compounds and building block organic molecules for prebiotic chemical evolution, are preserved in the genuine liquid/supercritical CO₂ of the NW Eifuku Seamount, and are identified by our in situ Raman spectroscopy. Furthermore, we are now planning another similar expedition in the Okinawa Trough in August-September, 2023. The Okinawa Trough has a diversity of deep-sea hydrothermal systems that host large scales of liquid/supercritical CO₂ pools in the organics-rich sediments. The geological and geochemical environments of hydrothermal systems between the Okinawa Trough and Mariana Volcanic Arc are quite different. Thus, future comparative study of the chemical composition and isotopic properties between the Okinawa Trough and Mariana Volcanic Arc hydrothermal systems will provide much deeper insight into previous unknown properties and roles of seafloor liquid/supercritical CO₂ pools in the primordial ocean and even in the modern ocean.

In the Daikoku Seamount, we also gathered CO₂ droplets and bubbles containing other volatiles, directly derived from the pristine magmatic degassing, at the seafloor, and measured the composition by in situ Raman spectroscopy. However, due to the located shallow depth of the hydrothermal field (<430 m), all the CO₂ droplets and bubbles were present as gas phase. Although the genuine volcanic gas was sampled and measured by in situ Raman spectroscopy for the first time at the seafloor, investigation of liquid/supercritical CO₂ pools was not successful in the Daikoku Seamount hydrothermal field. However, we encountered a big surprise in the Daikoku Seamount. The Daikoku Seamount is famous to host lakes of molten sulfur, specifically 'Sulfur Cauldron' discovered in 2006, and a number of dive surveys have

revealed the significant volcanic activities, including an eruption event in 2014 leading to the formation of a new basin-like crater. During this cruise, we found that the new crater is currently home to a much larger molten sulfur lake than the Sulfur Cauldron, which we named the 'Rengoku' sulfur lake. This discovery was immediately summarized as a manuscript of field observation by the lead authors of Drs. Sawada and Chen, and submitted to an appropriate journal via internet from the ship. Outstanding volume of sulfur supply of the Rengoku sulfur lake and the Daikoku Seamount caldera would support probably entire planktonic, benthic and seafloor microbial and faunal communities in the seamount. The Daikoku Seamount, because of its shallower depth and enormous volcanic volatile emission, may represent the heaven for hidden biodiversity of microorganisms and metazoans in the ocean supported by volcanic volatiles.

In the South Chamorro Seamount, we successfully obtained the relatively clean core samples of serpentinite mud at deeper than 20 mbsf for onshore microbiological exploration of cultivation and metagenomic approaches through struggling BMS operations, and a plenty of pristine serpentinization-driven fluid through the artificial well established (destroyed) through the previous ODP & IODP expeditions and other dive surveys by the well trained ROV operations. As compared to the previous observation, the H₂ concentration in the fluid was increased (>1 mM) and the pore-water H₂ concentration was for the first time determined. One of the most important target samples, fluid and pore-water gas samples, was abundantly collected. Future combined microbiological and geochemical investigation will clarify whether a true active seafloor microbial ecosystem is present in the extreme alkaline and reductive seafloor environments of the South Chamorro Seamount or not, and whether the simple abundant organic compounds in the serpentinite mud and fluid are derived from abiogenic or biogenic processes, or thermogenic sources. In addition, during this cruise, we successfully re-classified the distribution and composition of chemosynthetic faunal communities in the summit area of the South Chamorro Seamount. Indeed, the distribution and composition of chemosynthetic faunal communities have been never documented as the peer-reviewed scientific article. Thus, the re-classification was immediately summarized as a manuscript of field observation of distribution and brief description of faunal composition by the lead author of Dr. Chen, and submitted to an appropriate journal via internet from the ship.

Finally, in the Asut Tesoru Seamount, we again successfully obtained the relatively clean core samples of serpentinite mud at deeper than 20 mbsf for onshore microbiological exploration of cultivation and metagenomic approaches through struggling BMS operations, and a plenty of pristine serpentinization-driven fluid through the artificial well established in IODP expedition 366 by the well trained ROV operations. Extraordinary high concentration H₂, even more abundant concentration, and less abundant hydrocarbons were determined in the Asut Tesoru Seamount as compared to those in the South Chamorro

Seamount. The significantly increased H₂ concentration in the artificial well fluid than in the pore-water was common in both the South Chamorro and Asut Tesoru Seamounts. This may be due to the extra amount of H₂ production in the artificial wells, e.g., H₂ generation during the metal iron of casing pipe and highly alkaline and reductive pore fluid. Anyway, future combined microbiological and geochemical investigation, and comparison between different serpentine seamounts with different geological and geochemical conditions will clarify whether a true active subseafloor microbial ecosystem is present in the extreme alkaline and reductive subseafloor environments of the Mariana Forearc serpentinite seamounts or not, and whether the simple abundant organic compounds found in the Mariana Forearc serpentinite seamounts are derived from abiogenic or biogenic processes, or thermogenic sources. In addition, during this cruise, we successfully found the existence of chemosynthetic faunal species in the summit area of the Asut Tesoru Seamount. Indeed, the discovery of deep-sea chemosynthetic faunal ecosystem associated with seepages of serpentinization-driven fluids was the second example in the Mariana Forearc serpentinite seamounts, the third in the Mariana region, and the fifth in the world. Thus, the discovery was immediately summarized as a manuscript of field observation of distribution and brief description of faunal composition by the lead author of Dr. Chen, and submitted to an appropriate journal via internet from the ship.

What a fruitful expedition this is! This is the simple words for summary of this cruise.