Submission date 2013/07/09

Cruise Summary

1. Cruise Information

Cruise ID: YK13-05

Name of vessel: YOKOSUKA

Title of the cruise: Quelle 2013 Quest 4: Geochemical, Geomicrobiological and Biogeographical Investigation of Deep-Sea Hydrothermal Activities in the Mid Cayman Ridge, the Caribbean

Chief scientist [Affiliation]: Ken Takai [JAMSTEC]

Representative of the science parties [Affiliation]

Proposal 1) Ken Takai [JAMSTEC]

Proposal 2) Kei Shiomi [JAXA] (Not attended)

Title of proposal:

Proposal 1) Clarification of the diversity of geo- and bio-systems and of the potential principles linking the systems in Central Indian Ridge hydrothermal activities

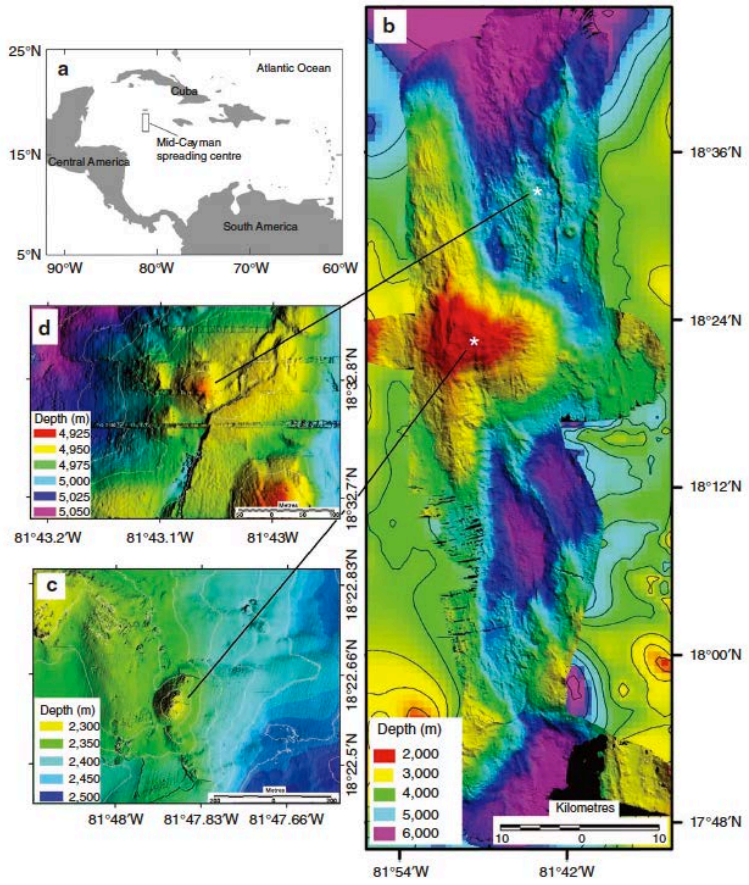
Proposal 2) Ship Observation of Global CO2 Concentration for Atmosphere-Ocean Carbon Exchange Estimation from GOSAT Data (Researchers not attended)

Cruise period: June 17th, 2013 ~ July 3rd, 2013

Ports of call: San Juan, Puerto Rico ~ Cistbal, Panama

Research area: Off Cayman Island, Caribbean

Research map



２. Overview of the Observation

Overview of the observation:

In YK13-05 cruise, we have totally conducted 9 dives of Shinkai6500 in two hydrothermal fields (5 dives in Beebe Field and 4 dives in Von Damm Field) in the Mid Cayman Ridge (MCR). One of the significant events during the cruise, we have successfully attained a live streaming of full-time scientific dive survey of a day (from the preparation of Shinkai6500's dive early morning to the completion of Shinkai6500 onboard). This was the world's first example of a live streaming of a manned submersible's scientific dive survey and was the second example of a successful live streaming of a manned submersible survey after James Cameron's Titanic exploration. More than 300,000 peoples in the world (of course, mainly in Japan) watched the Shinkai6500's day including fantastic images of 5000 m deep seafloor, hydrothermal vents and dense animals there. This challenge highly energized and fostered the deep curiosity and interest of public peoples, particularly younger generations who had never seen or known about the deep-sea world and the unique ecosystem, the yet-unexplored world in this planet. The widespread curiosity in public society will be the most powerful encouragement of the future scientific exploration and investigation of manned submersible that has been quickly replaced by unmanned vehicles such as ROV and AUV.

We have obtained lots of and diverse samples from two of the MCR deep-sea hydrothermal environments. We have confirmed that the world's deepest hydrothermal system (Beebe Field) has about 400 ˚C of endmember hydrothermal fluid and that the hydrothermal fluids probably immediately after effluent from the newly opened conduits represent the supercritical state by direct observation of human eyes and by recorded video images. The hydrothermal fluids from both Beebe and Von Damm fields were characterized by extraordinary high concentrations of H2, which would be the world's highest concentrations or among the highest levels. The H2-enrichment in the fluids are attributed to the association of subseafloor serpentinization somewhere in the overall hydrothermal circulation. However, different concentrations of CH4 in each of the two systems clearly indicated that the hydrothermal recharge and reaction processes of the two systems are quite different. In Von Damm field, CH4 is highly abundant while Beebe hydrothermal fluid contains a concentration level comparable to magmatic input. The different CH4 concentrations in these hydrothermal systems point to the different host rock compositions and hydrothermal reaction processes: serpentinization of mantle peridotite and rapidly proceeding Fisher-Tropsch Type (FTT) reaction in Von Damm field and serpentinization of dunite and/or gabbroic rocks and slaggish proceeding Fisher-Tropsch Type (FTT) reaction in Beebe field. However, it is still a big mystery why quite low concentration of CO2 is present in Von Damm hydrothermal fluids. This is a important subject for future onshore investigation.

According to a proposition proposed by Takai & Nakamura (2010;2011), the H2-enriched hydrothermal

fluid vents would host HyperSLiME-like microbial communities in the proximity of the hydrothermal fluid discharges. Prior to this YK13-05 cruise, we predicted that both Beebe and Von Damm hydrothermal systems harbored extraordinary populations of (hyper)thermophilic H2-trophic methanogens and chemolithotrophic primary production by diverse H2-trophs. However, based on the onboard experiments of microbial H2 consumption using the very fresh chimney samples obtained from both fields, the microbial H2 consumption was found to be much lower than that in the Kairei field in the CIR and the (hyper)thermophilic H2-trophic methanogen populations seemed to be less abundant that those in CIR Kairei field and MAR Raibow field. This preliminary results are quite interesting, and we are going to pursue why (hyper)thermophilic H2-trophic methanogens are less abundant although H2 concentration in the fluids represents the highest ever known. We wish that chemolithotrophic H2-trophs other than (hyper)thermophilic H2-trophic methanogens would serve as the primary producers of these hydrothermal vent microbial communities.

Most of the hydrothermal vent-endemic animal species in two hydrothermal fields were sampled. In tight collaboration between JAMSTEC and University of Southampton, species composition of chemosynthetic animal communities will be completely characterized and the biogeographic and dispersal characteristics of animal components will be pursued based on population genetics, and evolutionary and developmental research.

Finally, during YK13-05 cruise, we have nurtured good international relationship and possible future international collaborations between JAMSTEC, University of Southampton and American microbiology groups. Of course, we will develop much bigger international framework of MCR hydrothermal vent research with our friends who have worked the same time in MCR with R/V Falkor.

The new findings and knowledge from the MCR hydrothermal systems and ecosystems will provide great new aspects to understand the deep-sea hydrothermal systems and associating microbial and biological interactions in this planet.