

NT10-05 Cruise Summary

1. Cruise Information

● **Cruise number:** NT10-05 Leg2

● **Ship name:** R/V Natsushima

● **Title of the cruise:** FY2010 Deep Sea Survey by ROV Hyper Dolphin in Kagoshima Bay

● **Chief Scientist:** Teruo Fujii (University of Tokyo)

○ **Representative of scientific party:** Teruo Fujii (University of Tokyo)

○ **Title of proposal:** A study on adaptive *in situ* measurement method based on Mapping-by-AUV

○ **Representative of scientific party:** Junichiro Ishibashi (Kyushu University)

○ **Title of proposal:** Geochemical studies on gas-fluid-sediment interactions within modern sediment at the Wakamiko submarine crater, Kagoshima Bay, south Kyushu

● **Cruise period:** 13 days from March 18 to March 30, 2010

● **Port call:** dep. Kagoshima, ret. Kagoshima

● **Research area:** Wakamiko Caldera in Kagoshima Bay (Fig.1)

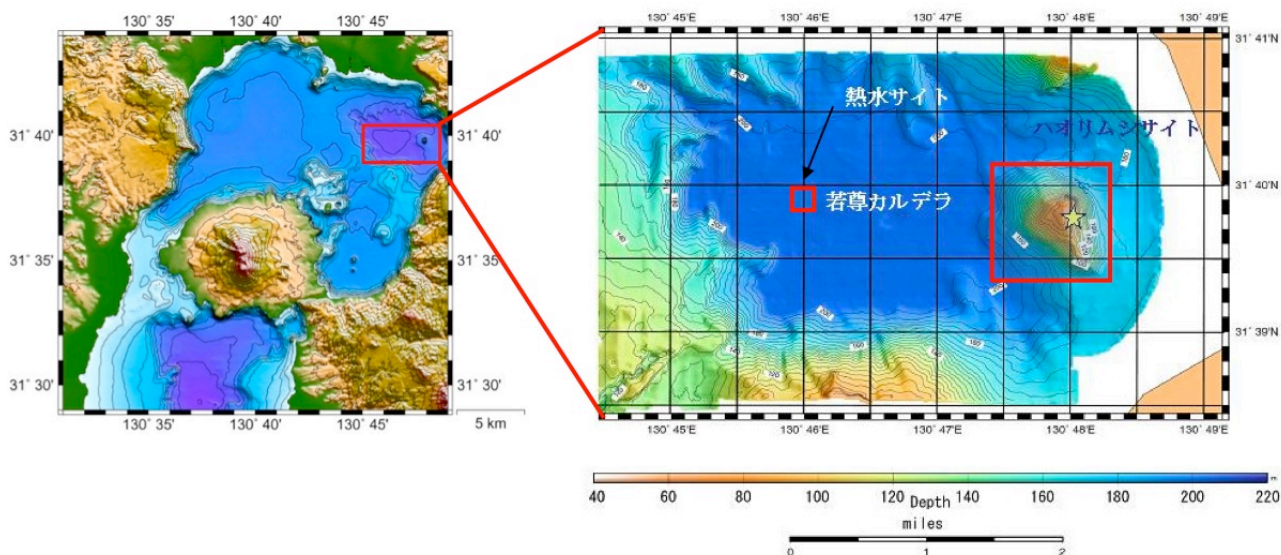


Fig.1 Research Area (Wakamiko Caldera in Kagoshima Bay)

2. Overview of Observation

(Background and Purpose)

NT10-05 cruise was operated based on the proposal #S09-76 titled “A study on adaptive *in situ* measurement method based on Mapping-by-AUV (representative: Teruo Fujii / University of Tokyo) and #S09-75 titled “Geochemical studies on gas-fluid-sediment interactions within modern sediment at the Wakamiko submarine crater, Kagoshima Bay, south Kyushu” (representative: Junichiro Ishibashi / Kyushu University).

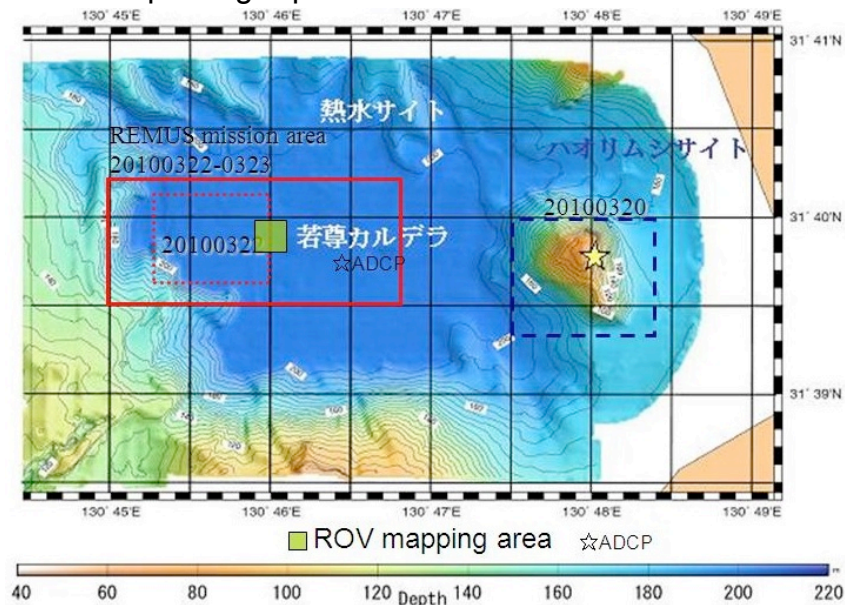
As for #S09-76, the purpose of the cruise is to examine the feasibility of a new method of adaptive measurement by ROV based on the results of mapping by AUV, combining small-sized *in situ* measurement systems and mapping technologies to understand the complex spatio-temporal behavior of hydrothermal plumes.

As for #S09-75, the purpose of the cruise is to study variety of geochemical processes in a marine shallow-water hydrothermal system located in the Wakamiko submarine crater. The

working hypothesis is involvement of submarine fumarole into the hydrothermal fluid modifies fluid chemistry such as pH, and controls hydrothermal interactions and precipitations occurred in the sediment layer.

(Research Works and Operations)

In this cruise, the research works described in the following has been conducted mostly focusing on the hydrothermal activity in Wakamiko caldera (Fig.2). The adaptive measurement using AUV and ROV has been done in the area of “Haorimushi site” at the east end of the caldera considering the maximum operating depth 100m of AUV REMUS.



AUV mapping area [Red line : (3/22-23) , Red dotted line : (3/22), Blue dotted line :(3/20)
 Fig.2 Details of the Operation Site and the Mapping Areas by AUV and ROV

A. A study on adaptive *in situ* measurement method based on Mapping-by-AUV

A1) Development of a new method of adaptive measurement based on mapping-by-AUV

In order to develop a new method of adaptive measurement by ROV based on mapping-by-AUV, the operation of AUV REMUS from R/V Natushima was attempted. The REMUS 100 (Length:1800mm, Diameter:ø190) was equipped several *in situ* chemical sensors (Fig. 3). The deployment and recovery of tow transponder mooring systems for auto navigation of REMUS were carried out from R/V Natsushima, and the transponder installations and the deployment and recovery of the REMUS were conducted using a small boat launched from R/V Natsushima. In this cruise, we held three times of operation and the one of them was a continuous observation in night time for 13 hours.



Fig.3 AUV REMUS

A2) Development of Integrated *in situ* Analyzers (IISA series)

Two prototypes of small-sized *in situ* measurement systems, 1) *in situ* gene analysis system (IISA-gene), and 2) Signal Accumulation Type pH sensor (IISA-AMISpH) were put on the ROV Hyper Dolphin (HPD) for at-sea testing of the systems. To compare pH data, a reliable ISFET-pH sensor was also mounted on an ROV near IISA-AMISpH was mounted.

● ***in situ* gene analysis system (IISA-gene)** : mounted on HPD in 4 dives (#1091, #1096, #1101, #1103). Seawater samples were also collected using Niskin samplers. During dive #1091 and #1101, gene analysis was successfully carried out and clear increases of signal were observed.

● **Signal Accumulation Type pH sensor (IISA-AMISpH)**: mounted on HPD in 9 dives (#1090, #1092, #1093, #1094, #1096, #1098, #1099, #1101, and #1103). Another pH ISFET sensor was also operated simultaneously to compare the data. Both pH sensors worked successfully and at some positions close to hydrothermal activity, low-pH anomalies were detected.

A3) 4D Mapping of Hydrothermal Plumes by *in situ* Combined Measurement

Fundamental data sets for the development of the measurement method to understand the spatio-temporal behavior of hydrothermal plumes were obtained by conducting the mapping survey of the plume in the Wakamiko Caldera, taking into account of the tidal phase in this area. A grid of survey lines with 100m spacing was set in the area shown in Fig.2, and let the ROV Hyper Dolphin cruised at 0.6knot on two horizontal planes at different depths (160m, 185m) following the survey lines in four kinds of tidal phases (low, high, rising, and falling). Eight sets of grid mapping data including CTD, Turbidity, pH, etc. were obtained in total. A CTD-Pyron water sampling system mounted twelve sampling bottles was installed on the vehicle, too, so that we can conduct additional analysis on the collected seawater samples. Using the collected water samples, total microbial ATP contents were measured with luciferin-luciferase based method to assess microbial activities in hydrothermal plumes. Physical parameters, especially the current in and outside the caldera, were measured at the same time by placing an ADCP (Acoustic Doppler Current Profiler) at the bottom at the south-east point as shown in Fig.2. We are now working on the obtained data to get 3D pictures and to build a model to explain the behavior of hydrothermal plumes.

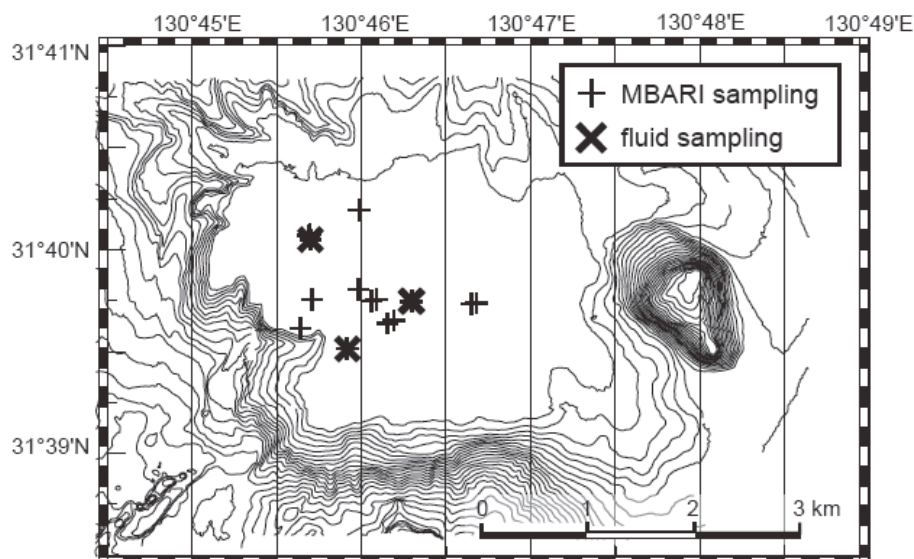


Fig.4 Localities of fluid sampling and MBARI core sampling during NT10-05 cruise

B. Geochemical studies on gas-fluid-sediment interactions within modern sediment at the Wakamiko submarine crater, Kagoshima Bay, south Kyushu

B1) Geochemical and mineralogical studies of samples collected from active hydrothermal fields

In order to study variety of geochemical processes in a marine shallow-water hydrothermal system, 27 fluid samples (mainly by the ROCS sampler), 26 sediment samples (mainly by a MBARI corer), 5 gas samples (Fig.4). Besides these, seawater samples in water column above the hydrothermal fields were collected by Niskin bottles.

Geochemical analysis of the fluid and gas samples will be conducted for major elements composition, organic species composition, gas composition, trace element composition, and isotopic composition. The systematic study will provide key information to discuss origin of the hydrothermal fluid and its evolving processes during fluid circulation. Mineralogical studies of the geological samples will provide important constraints for physical and chemical condition in sediment layer within the active hydrothermal fields. Geochemical studies of pore fluids extracted from the MBARI core samples will provide information on distribution of the hydrothermal component and on behavior of trace elements during hydrothermal interactions.

B2) Test Operation of seafloor instruments

During the dive expedition, we conducted test operation of the following instruments those were developed for working on the seafloor.

- *in situ* incubation machine: an automatic incubation system to monitor microbial activities at the *in situ* condition on the seafloor. The incubated water sample were taken at 0, 12, 24, 36 hours after the deployment, and successfully recovered after the incubation.
- GAMOS (Geochemical Anomaly MONitoring System): a flow injection analysis system working on the seafloor. The GAMOS was tuned for manganese concentration determination using chemiluminescence and deployed together with CTD above a shimmering vent.
- *in situ* Pore water extraction system (iPow): developed to collect pore fluid sample directly from the surface sediment and to measure thermal gradient in the sediment. The iPow was deployed beside a tiny shimmering vent and successfully collected the pore fluid that contains the hydrothermal component.
- Medusa: a fluid current meter to monitor continuously venting hydrothermal fluid flux, by combination of two thermistors and a heater. In this expedition, it was deployed at two different hydrothermal fields.

(Summary of the Results)

In this cruise, AUV REMUS was deployed from R/V Natsushima for the first time to develop a new method using both AUV and ROV and 13 hours mission was successfully conducted. The measured data of REMUS can be displayed only in 15 minutes after the mission, they can be used for the following ROV mission leading to 'adaptive' measurement. Two prototypes of *in situ* measurement systems (IISA-gene and IISA-AMISpH) were deployed and useful information to further improve the systems could be collected. Eight horizontal layers were measured for plume mapping using ROV. Based on the obtained data, a method to get 4D pictures of hydrothermal plumes will be developed. Moreover, a variety of samples in the Wakamiko area were collected, and *in situ* measurement machines were deployed. Geochemical processes in this area will be further discussed based on the analysis of these samples and measured data.