NT10-16 Cruise Summary

1. Cruise Information

- **Cruise number:** NT10-16
- **Ship name:** R/V Natsushima, ROV Hyperdolphin
- **Title of the cruise:** FY2010 Deep Sea Survey by ROV Hyper Dolphin in Nansei Islands
- **Chief Scientist:** Tatsuhiro Fukuba (University of Tokyo)
  - ○ **Representative of scientific party:** Tatsuhiro Fukuba (University of Tokyo)
  - ○ **Title of proposal:** A study on a novel hydrothermal ore mine survey by *in situ* multi parameter measurements
- **Cruise period:** 8 days from September 4 to September 11, 2010
- **Port call:** dep. Naha, ret. Naha
- **Research area:** Izena Hole and Northeast Izena (NE-Izena) (Fig.1)

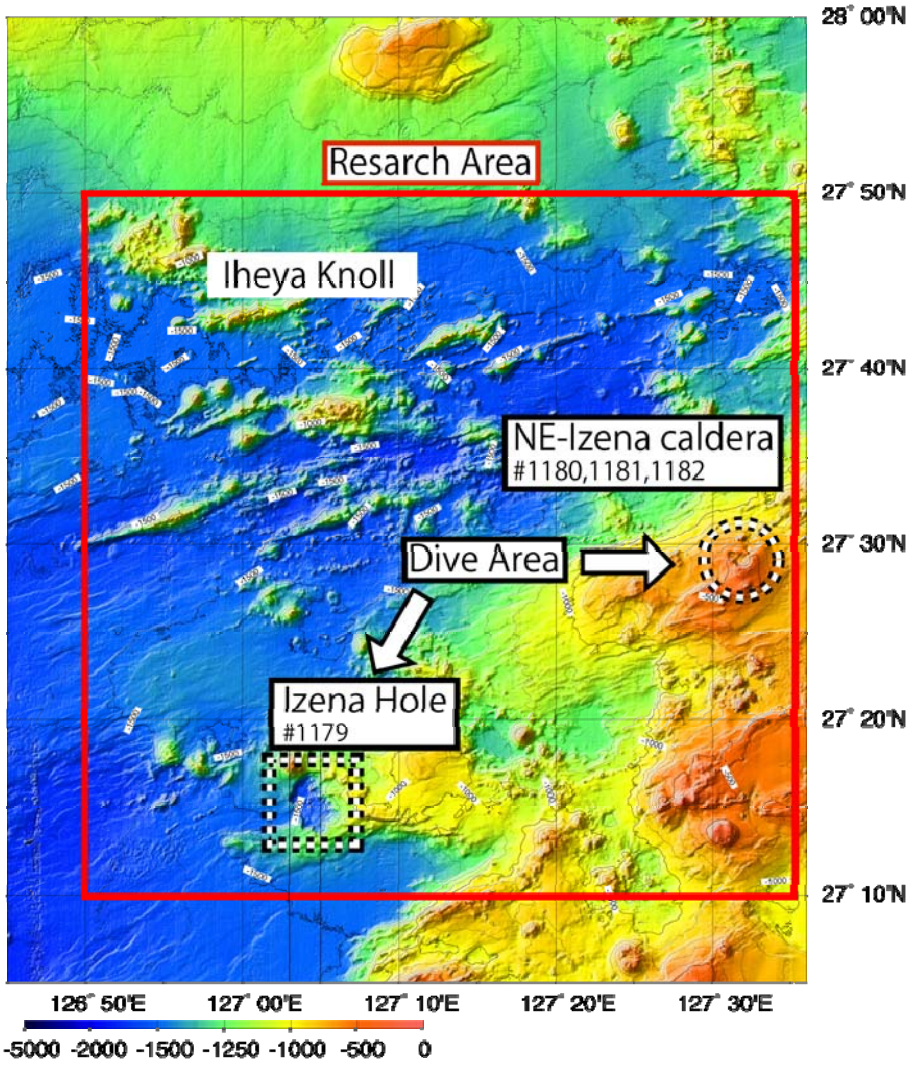

Fig.1 Research Area (Okinawa Trough)

2．Overview of Observation

（Background and Purpose）

NT10-16 cruise was operated based on the proposal #S10-68 titled “A study on a novel hydrothermal ore mine survey by *in situ* multi parameter measurements (representative: Tatsuhiro Fukuba/ University of Tokyo).

As for #S10-68, the purpose of the cruise is to examine the feasibility of a novel method to discover new hydrothermal ore deposits with hot water eruption by utilizing small-sized multi-parameter *in situ* chemical sensors and analyzers.

（Research Works and Operations）

In this cruise, the research works described in the following had been conducted mostly focusing on the hydrothermal activity in Izena Hole and caldera-like landforms in Northeast Izena (NE-Izena). Measurement lines for each survey area are shown in Fig. 2 (Jade site, Izena-Hole), and Fig. 3 to 5 (NE-Izena). During the dive # 1179, the ROV Hyper Dolphin (HPD) dived to Jade hydrothermal site for 1) operational test of chemical sensors, 2) water and rock sample collection, 3) Data acquisition through a straight measurement line. At the dive # 1180 to 1182, we tried to find novel hydrothermal activities using chemical sensors. Water and rock samples were collected simultaneously during all survey operation.

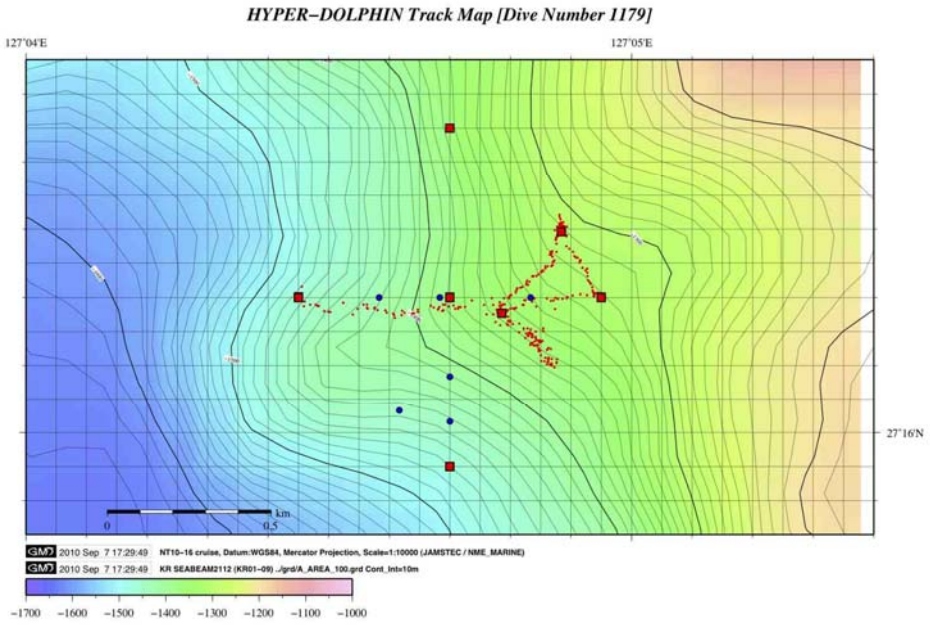

Fig. 2 SSBL track of the HPD during dive # 1179 at Izena-Hole (Jade site)

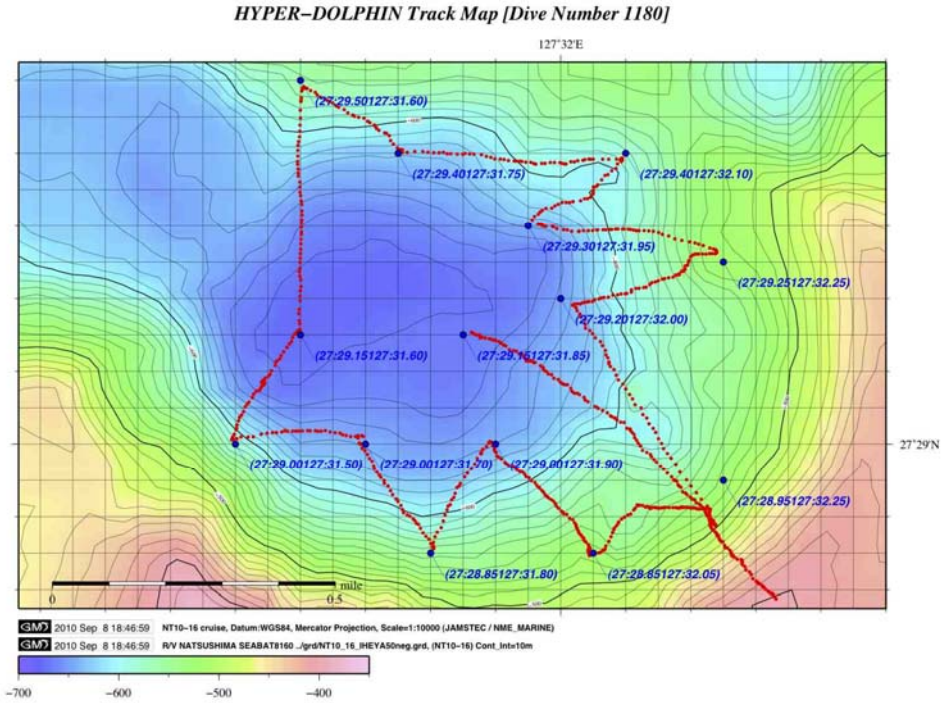

Fig. 3 SSBL track of the HPD during dive # 1180 at NE-Izena

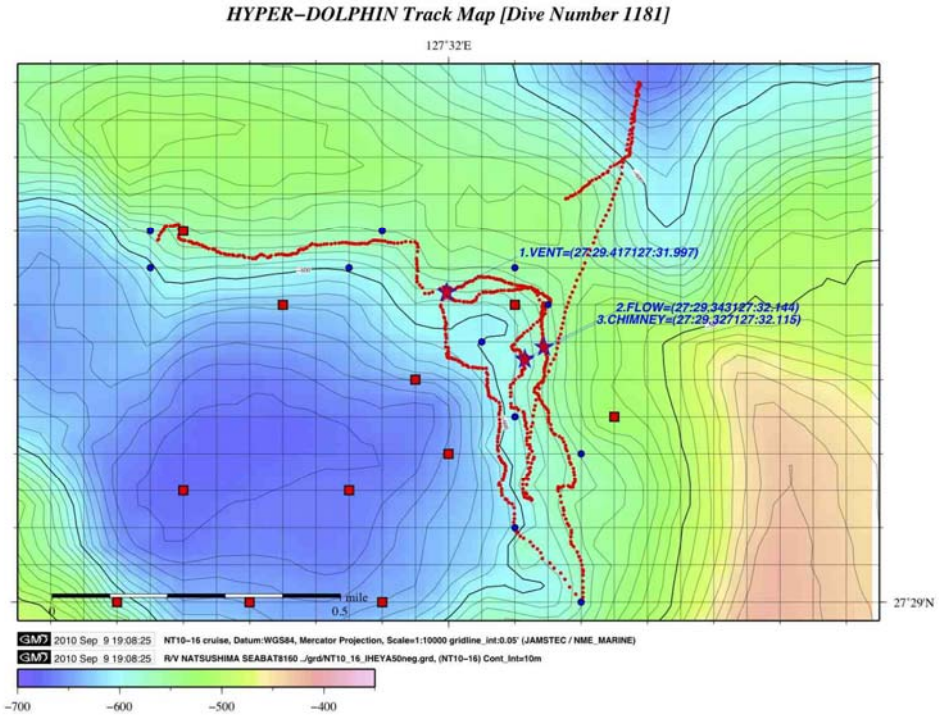

Fig. 4 SSBL track of the HPD during dive # 1181 at NE-Izena

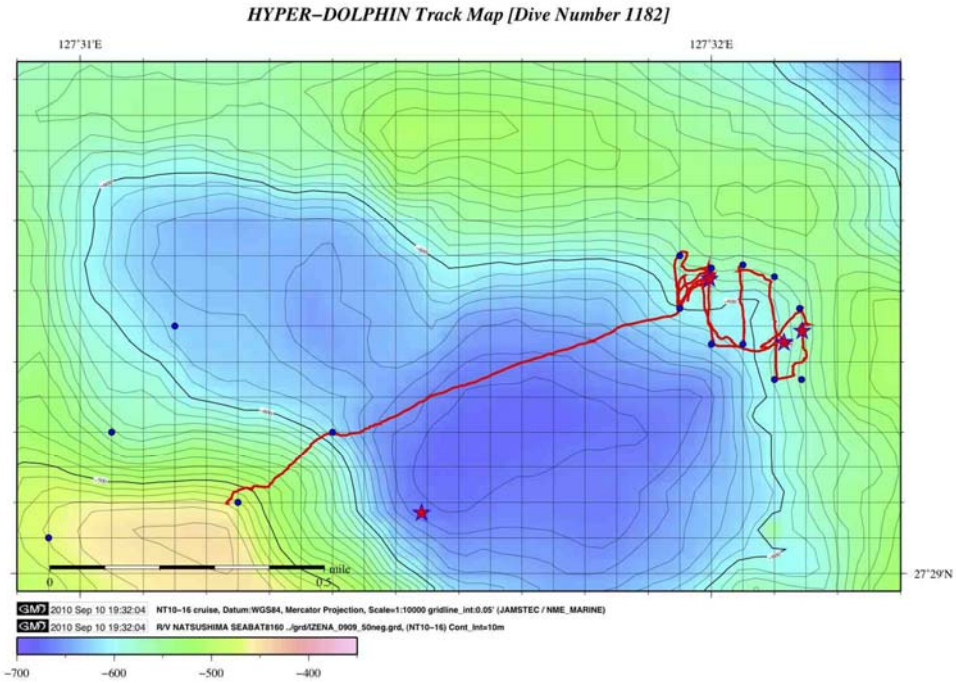

Fig. 5 SSBL track of the HPD during dive # 1182 at NE-Izena

A) Operation of ROV with multiple sensors and analyzers for hydrothermal activity survey

A1) pH measurement using ISFET pH sensors

ISFET (Ion Sensitive Field Effect Transistor) based pH sensors were used to detect low-pH anomalies in hydrothermal active areas. Standalone pH sensors (CRIEPI, JAMSTEC, and Tokyo Univ.) were mounted on the ROV Hyper Dolphin (HPD) for all dives. The ISFET pH sensors worked successfully for all dives and apparent low-pH anomalies were detected at Jade site and caldera.

A2) pH measurement using a signal accumulation type pH sensor (IISA-AMISpH)

In this cruise, a prototype of pH sensor (IISA-AMISpH, Tokyo Univ.) utilizing a Signal Accumulation Type Ion sensor (AMIS) was put on the HPD for at-sea testing of the systems and for practical 2D pH mapping. The IISA-AMISpH was mounted on the HPD for all dives. However, IISA-AMISpH could not obtain successful data because of cable troubles on IISA-AMISpH.

A3) Mn ion quantitative determination using an IISA-Mn

Concentration of Mn ion was continuously monitored using a prototype of IISA (Integrated In Situ Analyzer) –Mn (Tokyo Univ.) to detect hydrothermal plumes. The IISA-Mn was mounted on the HPD for all dives. For all dives, IISA-Mn could obtain positive chemiluminescence peaks when the HPD approached to hydrothermal active areas.

A4) Radioactivity mapping using an Rn sensor

In-situ Rn (gamma rays) sensor using plastic scintillator was installed to HPD on the dives at the NE-Izena Caldera. The sensor was able to detect Rn anomalies, which corresponded with pH and ORP anomalies, at the dive 1180.

A5) Multi parameter chemical sensing

Real-time monitoring of Conductivity, Temperature, Depth and Turbidity using CTD-T sensor was carried out in all dives. Standalone pH/pCO_2/ORP sensor also was mounted on the HPD for all dives. These sensors detected the hydrothermal anomalies that each parameter was accorded.

A6) H_2S quantitative determination using an electrochemical sensor "TANSAKUN"

In situ H_2S quantitative determination was conducted using an electrochemical sensor "TANSAKUN" mounted on HPD. As a result, H_2S concentration anomalies were successfully detected when the HPD approached to hydrothermal active areas.

B) Sampling of seawater for biological and chemical analysis

All water samples were collected by using Niskin water samplers and syringe water samplers (Tokyo Univ.). Rock samples were collected by using manipulators of HPD.

B1) Microbial activity assay using ATP

Using the collected water samples, total microbial ATP contents were measured onboard with luciferin-luciferase based method to assess microbial activities in hydrothermal plumes. As a result, sample from a few points showed apparently higher activities than the other samples.

B2) Culture assay by MPN method

Viable cell number will be analyzed using MPN (Most Probable Number) based culture method. Here, bacteria with the ability to use thiosulphate as their energy source are targeted. Culture was started onboard, and further cultivations will be carried out continuously in laboratory.

C) Sampling of rocks and analysis

Series of rock samples including 1) Dead chimneys, 2) Active chimneys and 3) cap rocks were collected during all dive operations. All rock samples will be analyzed on its elemental composition in laboratory.

(Summary of the Results)

The NT10-16 cruise was successfully carried out as it was planned with 4 HPD dives except for 1 dive cancelation because of typhoon. During the first dive (#1179), all chemical sensors were successfully tested and practical data for hydrothermal plume mapping was obtained at Jade site, Izena Hole. At the first dive at NE-Izena (#1180), HPD surveyed wide area in a north caldera to detect anomalies of water chemistry using various chemical sensors. As a result, apparent anomalies on Mn, H_2S, pH, pCO_2 and ORP were detected around northeast slope of the north caldera whereas any hydrothermal activity was not visually observed. At the dive #1181, we explored the northwest slope intensively. As a result, novel hydrothermal activities with multiple chimneys were discovered at NE-Izena. At the last dive of the cruise (#1182), we visited the novel hydrothermal area to survey in detail. A temperature sensor was equipped on the HPD to measure temperature of hydrothermal fluid. As a result of detailed survey, some novel hydrothermal active sites were discovered. The highest temperature measured during this dive was 247˚C at "Achijah

(Hot-tea in Okinawan Japanese)" site. During all the dives, series of water samples, rock samples including active and dead chimneys were successfully collected for further microbiological analysis.