

Cruise Summary YK09-08

1. Cruise Information

Cruise number	YK09-08
Ship name	R/V YOKOSUKA and AUV URASHIMA
Cruise name	URASHIMA survey dives
Chief scientist	Kyoko OKINO (Ocean Res. Inst., Univ. Tokyo)
Principal Investigator 1	Kyoko OKINO (Ocean Res. Inst., Univ. Tokyo)
Proposal 1	High-resolution, 3-dimensional and multi-sensor mapping of three hydrothermal sites in the southern Mariana Trough
Principal Investigator 2	Taishi TSUBOUCHI (JAMSTEC)
Proposal 2	Exploration of deep subsurface environment by metagenomic analysis
Date	29 June 2009 - 17 July 2009
Ports of call	Yokosuka(JAMSTEC) - Wakayama
Research Area	Mariana Trough (see Fig.1)

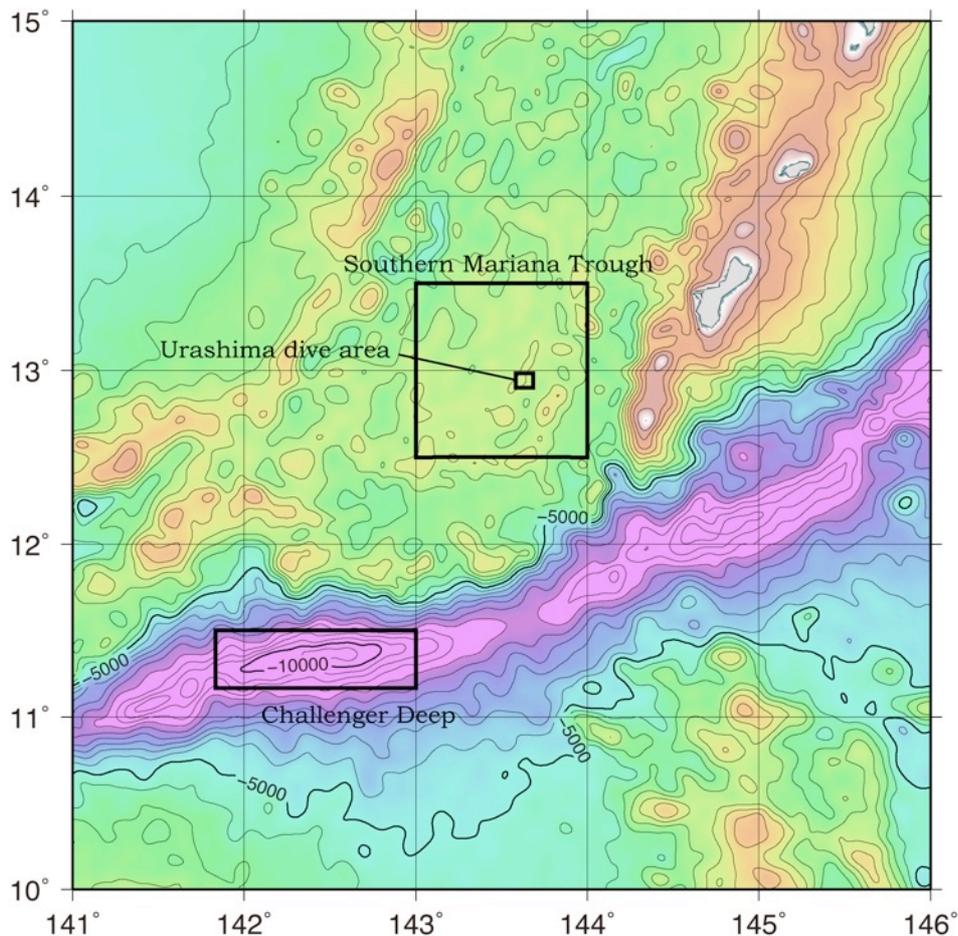


Fig.1 Survey areas. Five URASHIMA dives and the related underway geophysical survey were conducted in the southern Mariana Trough area (Proposal 1) and two 10K free fall camera dives were done in the world's deepest Challenger Deep area (Proposal 2).

2. Overview

2.1 High-resolution, 3-dimensional and multi-sensor mapping of three hydrothermal sites in the southern Mariana Trough

Background and Objectives

Three hydrothermal sites (Snai, Archean, Pika, Fig.2) have been known in the southern Mariana Trough. These sites are located just on the active backarc spreading axis, the eastern foot of the axial high and the top of an off-axis seamount about 5 km from the axis, respectively. Geochemical characteristics of the hydrothermal fluids and underneath volcanic rocks are different among these closely located three sites, where signature of arc magmatism is strong in the backarc spreading axis and is weak in off-axis seamount closer to the active arc. The purpose of this study is to reveal the detailed geological structure around these hydrothermal vent sites and the temporal and spatial distribution of hydrothermal plume originated from these sites in higher resolution than ever. Three-dimensional, high resolution, physical, chemical and microbiological mapping both in water column and seafloor can lead us to understand the tectonic setting that controls the type of hydrothermal activity, and to evaluate the effect of hydrothermal circulation on ocean via hydrothermal plume.

AUV URASHIMA survey

We conducted the three-dimensional, multi-sensor mapping of three hydrothermal sites using AUV *URASHIMA*. The survey items were as follows:

- detailed geological and structural mapping of hydrothermal sites by multi-beam echo sounder and side scan sonar
- hi-resolution magnetic anomaly mapping by newly equipped fluxgate magnetometers and Overhauser magnetometer
- three-dimensional plume mapping by CTD, H₂S, pH and ORP sensors
- Geochemical and microbiological analysis of sea water sampled by newly equipped Niskin water sampler

Additional underway geophysical survey by R/V Yokosuka was also done.

Preliminary results

Total five dives of AUV *URASHIMA* were successfully done in the hydrothermal area of the southern Mariana Trough. Dive#90 was planned for detecting the upper limit of the hydrothermal plume at water depth of 2600m. Three dives, Dive#91-93, were done at the constant altitude of 80 m, designed for detailed geological and magnetic mapping for each site. Last dive, Dive #94, was for detecting plume anomalies at the center depth of the plume, roughly at 150 m above seafloor. The dive tracks are shown in Fig.2, where the navigation is based on SSBL.

Dive#90 : Two survey lines across the backarc spreading axis at the depth of 2600 m were done and all equipments and sensors were tested. Unfortunately, any plume signal was not observed.

Dive#91 : The Snail site located on the backarc spreading axis was explored at the constant altitude of 80m. The plume signal was detected by the physical and chemical sensors, and large negative magnetic anomaly was observed at SSW of the Snail site, the area known as the Yamanaka site, though the detailed investigation of tectonic setting has not been done. Swath bathymetry by SEABAT and side scan image by EdgeTech sonar were successfully collected.

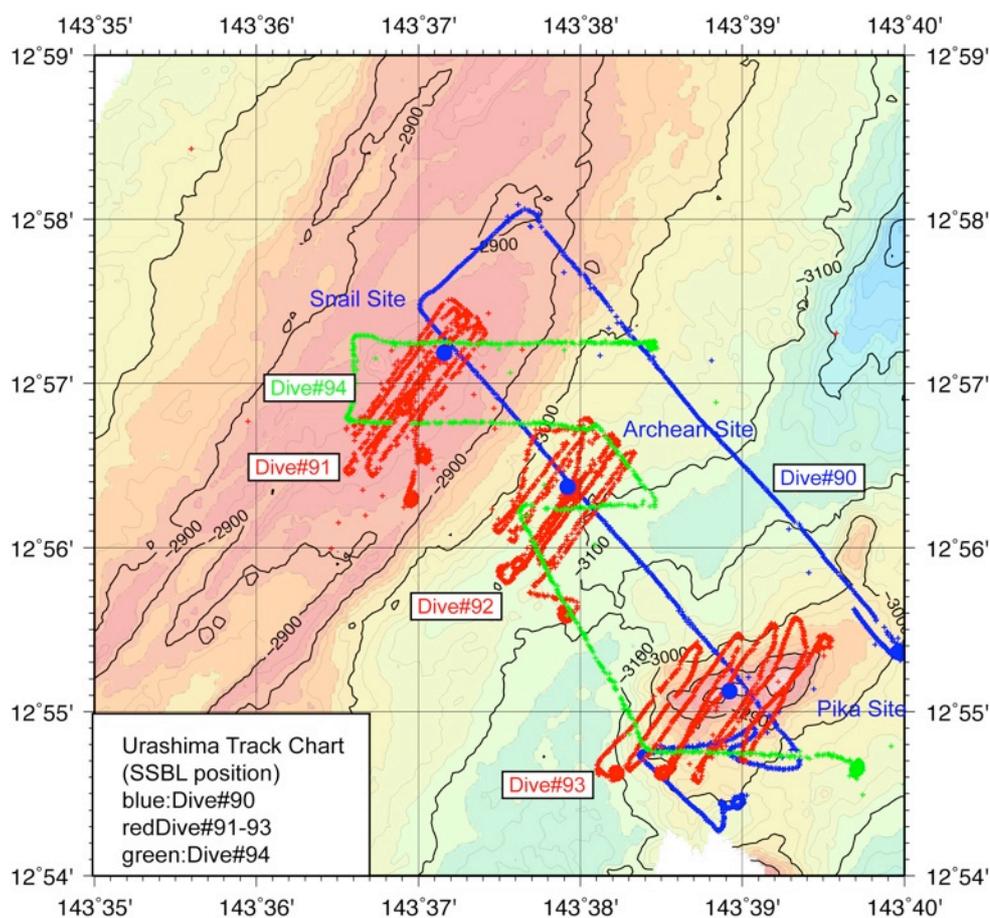
Dive#92: The Archean site located at the foot of spreading axis was explored at the constant altitude of 80m. The plume signal was occasionally detected in wide area. Swath bathymetry by SEABAT and side scan image by EdgeTech sonar were successfully collected.

Dive#93: The Pika site located on a seamount at 5km off axis was explored at the constant altitude of 80m. The strong plume signal and distinctive magnetic anomaly were observed at the southwestern slope of the seamount. Swath bathymetry by SEABAT and side scan image by EdgeTech sonar were successfully collected.

Dive#94: Dive#94 visited three hydrothermal sites roughly at 150m above seafloor. The plume signal was slightly detected. The total magnetic force was successfully recorded by the Overhauser magnetometer along a part of the track.

This cruise is first proposal-based *URASHIMA* dive survey and is generally considered a success. It is particularly worth noting that we succeeded at world's first water sampling by AUV and at collecting high quality near bottom magnetic data.

The program was supported by *KAKENHI* Grant-in-Aid for Scientific Research on Innovative Areas, Project TAIGA: Trans-crustal Advection and In-situ biogeochemical processes of Global sub-seafloor Aquifer.



2.2 Exploration of deep subsurface environment by metagenomic analysis

Background and Objectives

The destination of this study is understanding of the earth which has a large biosphere called “abyssal floor and crust” in a comprehensive manner. The abyssal environments are classified roughly into two groups that is dynamic circumstance like hydrothermal vent or static environment has no special event. Almost all of the deep sea seems to be the static environment, so that we focus the static hadal sea floor and try to analysis the relationship between microbes and its surroundings. During YK09-08 cruise, we try to collect the sea sediments for studying the below three items. 1) meta-genomic data that are gained by analyzing nucleic acids, like DNA/RNA are essential for life activities. 2) geobiochemical data which are from high-molecule chemical substances affects these surroundings. 3) physical data which from conductivity and particle density in the hadal sea sediments.

10K free fall camera

We collected the saline mud samples from the world’s deepest Challenger Deep at ~10,920 m, in order to analyze the community of deep sea microbes. The 10K free fall camera system was used for recording video images of hadal environment. The CTD meter and bait traps were also equipped on the free fall system to study the physical environment and to capture some benthos samples.

Preliminary Results

Two 10K free fall camera dives were successfully conducted at the Challenger Deep (Fig. 3). The sediment cores and some hadal sea floor lives were collected by bottom sampler ‘Ashura’ and bait traps equipped on 10K free fall camera system.

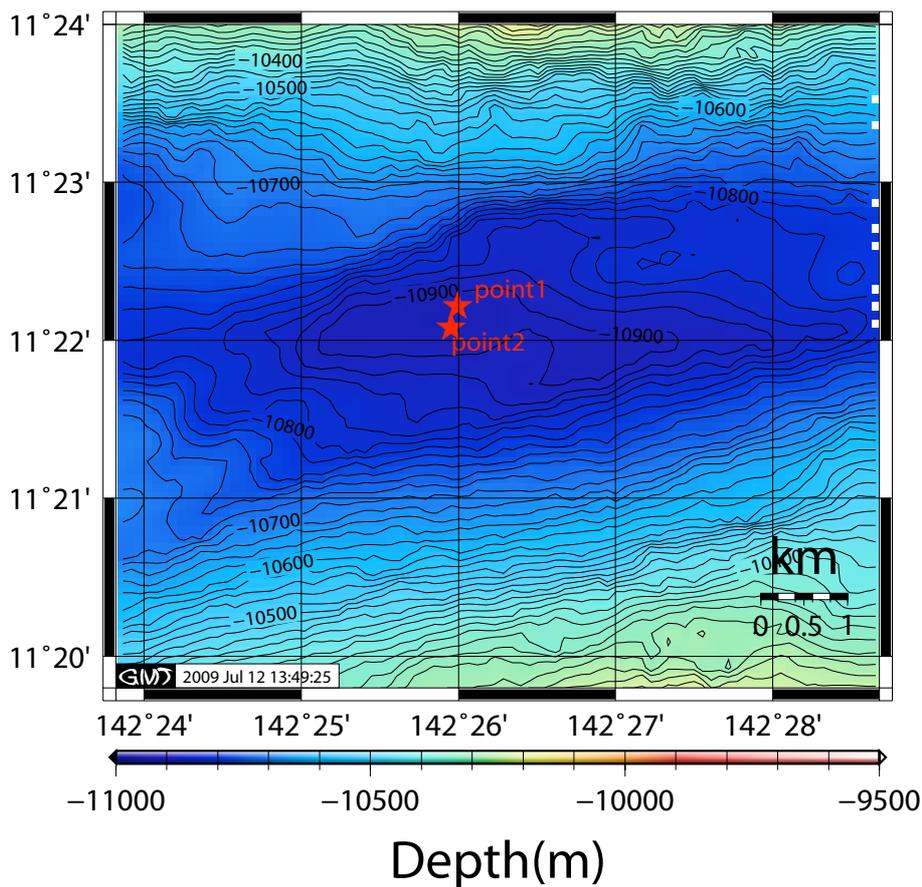


Fig.3 Locations of 10K free fall camera system dives.

Dive #1 : The system was landed on the Challenger Deep at the depth of 10,886m and successfully recovered after 50 minutes stay at the bottom. We collected the more than 4 liter of saline mud and two amphipoda.

Dive#2 The system was landed on the deepest part of the Challenger deep at 10,897 m. After 2.5 hours of stay on the bottom, it was successfully recovered. As well as mud samples, more than 200 amphipoda were collected by the bait trap. We also took the video image of the hadal seafloor when the system had just landed.