

# CRUISE REPORT

JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

## R/V YOKOSUKA YK10-12 CRUISE

COMPOSITION, STRUCTURE AND TECTONICS OF  
THE SOUTHERN MARIANA FOREARC

SEPTEMBER 17, 2010 TO OCTOBER 1, 2010

(GUAM TO GUAM, USA)



## Table of Contents

<b>List of cruise personnel .....</b>	<b>ii</b>
<b>Note on using.....</b>	<b>iii</b>
<b>Acknowledgements .....</b>	<b>iii</b>
<b>1. General cruise information.....</b>	<b>1</b>
<b>2. Introduction.....</b>	<b>1</b>
<b>3. Objectives of the cruise .....</b>	<b>2</b>
<b>4. Survey items.....</b>	<b>2</b>
<b>5. Running cruise narrative.....</b>	<b>3</b>
<b>6. Summary of the dive results.....</b>	<b>4</b>
<b>7. References .....</b>	<b>5</b>

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**Notice on using**

This cruise report is a preliminary documentation as of the end of the cruise. It may not be corrected even if changes on content are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the Chief Scientist for the latest information before using the report and/or data.

Users of the data and/or results of this cruise are requested to submit their results to Data Integration and Analysis Group, JAMSTEC (diag-dmg@jamstec.go.jp).

**Acknowledgements**

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## 1. General cruise information

Cruise number / ship name: YK10-12 / R/V Yokosuka

Title of the cruise: “Composition, structure and tectonics of the Southern Mariana Forearc”

Chief-Scientist / Affiliation: Yasuhiko Ohara / Hydrographic and Oceanographic Department of Japan (also at IFREE-JAMSTEC)

Proposal number and scientific title: S10-27 “Composition, structure and tectonics of the Southern Mariana Forearc”

### List of participants:

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Katsuyoshi Michibayashi (Shizuoka University)

Teruaki Ishii (Fukada Geological Institute)

Robert Stern (University of Texas at Dallas)

Ignacio Pujana (University of Texas at Dallas)

Fernando Martinez (University of Hawaii)

Guillame Girard (University of Iowa)

Julia Ribeiro (University of Texas at Dallas)

Maryjo Brounce (University of Rhode Island)

Naoaki Komori (Shizuoka University)

Masashi Kino (Shizuoka University)

Shin'ichi Hosoya (Nippon Marine Enterprise, Ltd.)

Investigation area: Southern Mariana Forearc (Fig. 1) (See Fig. 2 for the mapped area and dive sites)

Cruise period and port calls: Sep. 17-Oct. 1, 2010 (Guam to Guam)

### Shinkai 6500 and deep-towed camera dive list (Fig. 2):

6K-#1229: Mark Reagan (Forearc slope to the SW of the Santa Rosa Bank)

6K-#1230: Julia Ribeiro (Southeast Mariana Forearc Rift)

6K-#1231: Ignacio Pujana (Forearc slope to the SSE of the Santa Rosa Bank)

6K-#1232: Katsuyoshi Michibayashi (Forearc slope to the NE of the Challenger Deep)

6K-#1233: Yasuhiko Ohara (Forearc slope to the NE of the Challenger Deep)

6K-#1234: Teruaki Ishii (Forearc slope to the NE of the Challenger Deep)

6K-#1235: Guillaume Girard (Southeast Mariana Forearc Rift)

6K-#1236: Maryjo Brounce (Forearc slope to the NE of the Challenger Deep)

YKDT-#81 (Canceled)

YKDT-#82 (Southeast Mariana Forearc Rift)

YKDT-#83 (Unnamed Ridge northwest of Southeast Mariana Forearc Rift)

YKDT-#84 (Unnamed Ridge northwest of Southeast Mariana Forearc Rift)

YKDT-#85 (Southeast Mariana Forearc Rift)

YKDT-#86 (Southeast Mariana Forearc Rift)

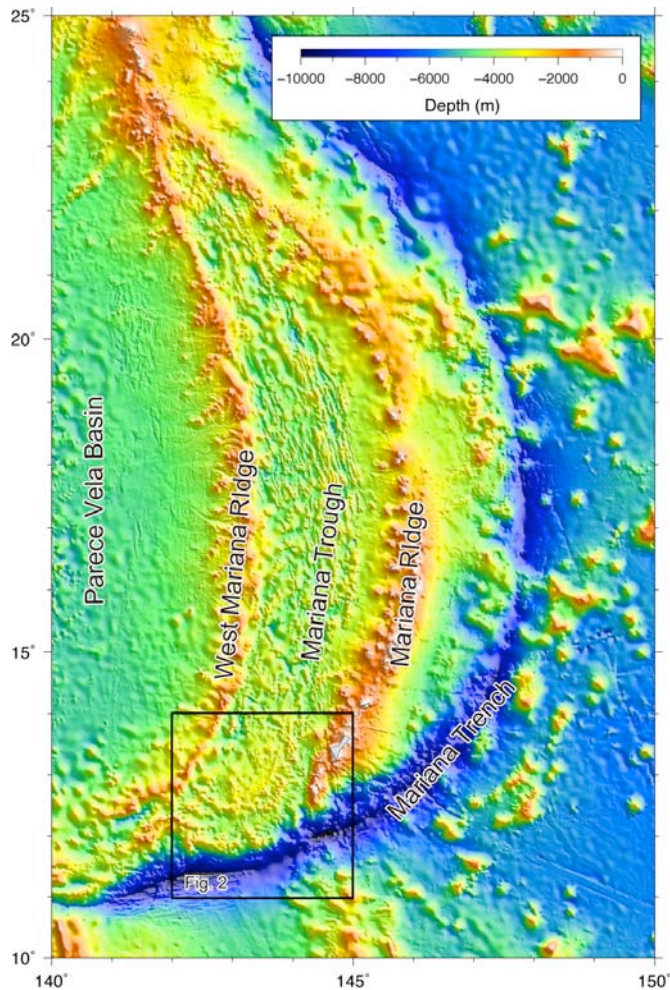
YKDT-#87 (Southeast Mariana Forearc Rift)

YKDT-#88 (Southeast Mariana Forearc Rift)

## 2. Introduction

The 3000-km long Izu–Bonin–Mariana (IBM) arc system is an outstanding example of an intraoceanic convergent plate margin, and has become the particular focus of Japanese and US efforts to understand the operation of the “Subduction Factory” starting in 2004 as YK04-05 cruise in the Bonin Ridge. In 2006 and 2008, twelve DSV Shinkai 6500 dives (973-977 and 1091-1097)

were performed during YK06-12 and YK08-08 Leg 2 cruises along the southern Mariana forearc. This cruise (YK10-12) was the third time that our Japan-US team has returned to study the southern Mariana forearc near Guam.



**Fig. 1.** Index map of the IBM arc system. The GEBCO 08 gridded data were used to make this map. The box indicated the area for Fig. 2.

The fruitful results from the last two cruises in the Mariana forearc include the recovery of the entire suite of rocks associated with what could be termed a “supra-subduction zone ophiolite” that formed during subduction initiation. An important discovery is that MORB-like tholeiitic basalts crop out over large areas. These “fore-arc basalts” (FAB) underlie boninites and overlie diabasic and gabbroic rocks. Potential origins include eruption at a spreading center before subduction began or eruption during near-trench spreading after subduction began at ~ 50 Ma (Reagan et al., 2010). Another important discovery is a region of active forearc rifting at the southern end of the Mariana arc, named Southeast Mariana Forearc Rift (SEMFR). Two dives at SEMFR recovered less-depleted backarc related peridotites (Michibayashi et al., 2009), and fresh basalts and basaltic andesites with petrographic characteristics like backarc basin lavas.

### 3. Objectives of the cruise

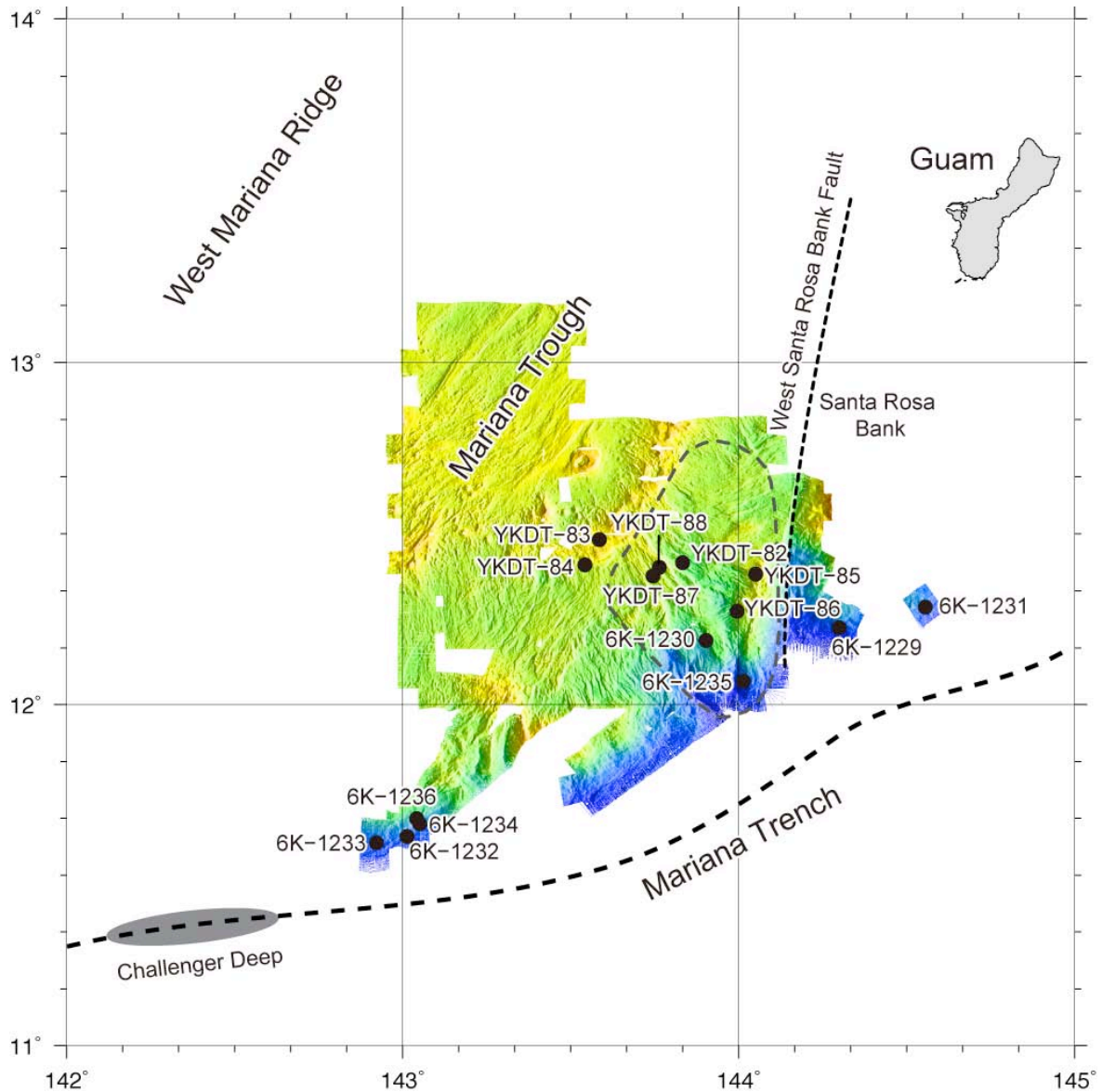
Our previous studies have produced a number of important new observations about the geology of the southern Mariana forearc, however, our understanding of the region is still primitive. The principal objectives of YK10-12 cruise therefore were to tackle three important problems by in-situ dive operations using the Shinkai 6500 and deep-tow camera:

- Increasing the sampling density of FABs along the southern Mariana forearc, thereby providing the clues to subduction initiation processes along the IBM arc.
- Increasing the sampling density of peridotites along the southern Mariana forearc, thereby providing the clues to understand mantle process associated with supra-subduction zone ophiolite.
- Increasing the sampling density in the SEMFR to gain a better understanding of this newly identified active rift and the origin of its near-trench basalts.

### 4. Survey items

During YK10-12 cruise, we have conducted eight Shinai and seven YKDT dives, as well as geophysical mapping of the area shown in Fig. 2.





**Fig. 2.** Bathymetry obtained during YK10-12 cruise. Locations of the Shinkai 6500 and deep-tow camera dives during the cruise are also shown. Southeast Mariana Forearc Rift is indicated by gray dashed line.

### 5. Running cruise narrative

Date (Local time)	Notes
17-Sep-10	The Yokosuka YK10-12 cruise began. Bathymetric survey for the southern tip of the Santa Rosa Bank and Southeast Mariana Forearc Rift and site survey for the Dive #1229 site.
18-Sep-10	Dive #1229 was conducted along the lower western slope of the southern tip of the Santa Rosa Bank. Mark Reagan as the observer. Bathymetric survey for the Dive #1231 area (i.e., east of the Southeast Mariana Forearc Rift).
19-Sep-10	Dive #1230 was conducted along the western slope of a ridge that comprises the Southeast Mariana Forearc Rift. Julia Ribeiro as the observer. Site survey for the Dive #1231 site and geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).

20-Sep-10	Dive #1231 was conducted along the lower western slope of the southern tip of the Santa Rosa Bank, to the east of Dive #1229 site. Ignacio Pujana as the observer. Site survey for the Southeast Mariana Forearc Rift (for Dive #1235).
21-Sep-10	Dive #1232 was conducted along the landward slope of the Mariana Trench, ~40 NM to the east of the Challenger Deep. Katsuyoshi Michibayashi as the observer. Site survey for Dives #1233 and #1234.
22-Sep-10	Dive #1233 was conducted along the landward slope of the Mariana Trench, ~35 NM to the east of the Challenger Deep. The site is to the west of Dive #1232. Yasuhiko Ohara as the observer. Heaving-to during the night.
23-Sep-10	Dive #1234 was conducted along the landward slope of the Mariana Trench, ~35 NM to the east of the Challenger Deep and ~2.5 NM to the northeast of Dive #1231. Teruaki Ishii as the observer. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
24-Sep-10	Dive #1235 was conducted along the western slope of a ridge that comprises the Southeast Mariana Forearc Rift. Guillame Girard as the observer. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
25-Sep-10	Dive #1236 was conducted along the landward slope of the Mariana Trench, approximately upslope section of Dive #1234. Maryjo Brounce as the observer. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
26-Sep-10	YKDT-81 & 82 were conducted, however, YKDT-81 was canceled halfway. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
27-Sep-10	YKDT-83 & 84 were conducted. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
28-Sep-10	YKDT-85 & 86 were conducted. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
29-Sep-10	YKDT-87 & 88 were conducted. Geophysical mapping of the Southeast Mariana Forearc Rift (with proton magnetometer).
30-Sep-10	Geophysical mapping around the Southeast Mariana Forearc Rift (with proton magnetometer)
01-Oct-10	End of the cruise

## 6. Summary of the dive results

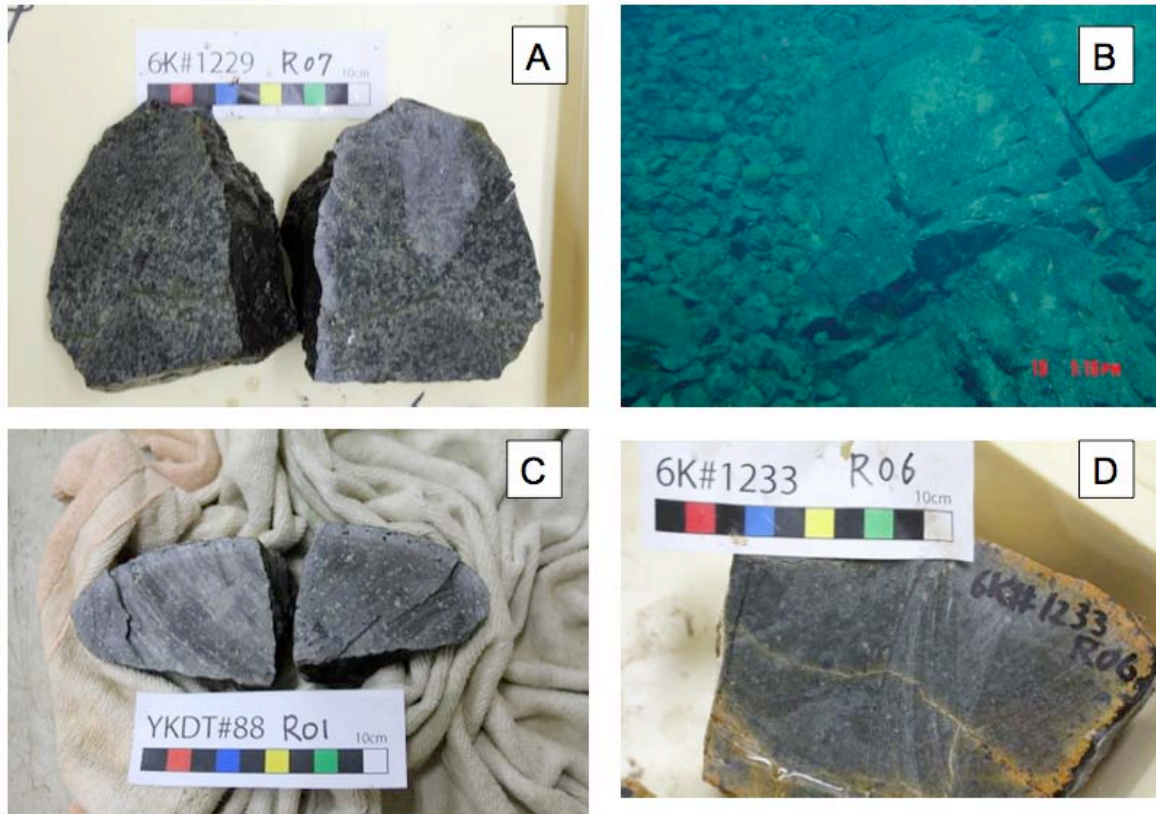
The Shinkai and YKDT dives (total 15 dives), as well as geophysical mapping of the area shown in Fig. 2, completed every principal objectives noted above. The main results obtained by diving studies are:

- Gabbroic rocks associated with FAB were sampled along the forearc slope to the south of the Santa Rosa Bank (6K-#1229, 6K-#1231) (Fig. 3A). This is the first discovery of FAB gabbro in the Mariana forearc.
- We have confirmed the ubiquitous occurrence of fresh young basalt in the SEMFR (6K-#1230, 6K-#1235, YKDT-#82, YKDT-#85, YKDT-#86, YKDT-#87, YKDT-#88) (Fig. 3B).
- Modern boninite was sampled in the SEMFR (YKDT-#88) (Fig. 3C).
- Fresh basalt was sampled in an unnamed ridge northwest of SEMFR (YKDT-#84). Since this ridge was totally unexplored so far, the samples from YKDT-#84 will give us important clues to understand the genesis of the ridge.
- A garnet-amphibolite was sampled in the forearc slope to the NE of the Challenger Deep (6K-#1232).
- Very fresh fertile lherzolites were sampled in the forearc slope to the NE of the Challenger



Deep (6K-#1233) (Fig. 3D).

- Calyptogena colonies were discovered in the forearc slope to the NE of the Challenger Deep (6K-#1234). This is the first cold-seep vent community in the Southern Mariana forearc.
- We have confirmed that the Calyptogena colonies rest on the Moho (6K-#1234, 6K-#1236). During 6K-#1236, boninites, instead of peridotites, were recovered.



**Fig. 3. A.** Gabbro recovered during 6K-#1229. **B.** Typical blocky outcrop of fresh young basalt in the Southeast Mariana Forearc Rift. **C.** Modern boninite recovered from the Southeast Mariana Forearc Rift. **D.** Very fresh fertile lherzolite recovered during 6K-#1233.

## 7. References

- Michibayashi K., Y. Ohara, R.J. Stern, P. Fryer, J.-I. Kimura, M. Tasaka, Y. Harigane, and T. Ishii, Peridotites from a ductile shear zone within back-arc lithospheric mantle, southern Mariana Trench: results of a Shinkai 6500 dive, *Geochemistry, Geophysics, Geosystems*, 10, Q05X06, doi:10.1029/2008GC002197, 2009.
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