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CRUISE REPORT

JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

R/V YOKOSUKA YK15-11 CRUISE

TOWARD THE COMPREHENSIVE UNDERSTANDING OF THE SHINKAI SEEP FIELD, THE SOUTHERN MARIANA FOREARC

JUNE 29, 2015 TO JULY 17, 2015

(YOKOSUKA, JAPAN TO SAIPAN, USA)

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Notice on using

This cruise report is a preliminary documentation as of the end of the cruise. This report may not be corrected even if changes on contents may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

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1. General cruise information

Cruise ID and ship name: YK15-11, R/V Yokosuka

Title of the cruise: Toward the comprehensive understanding of the Shinkai Seep Field, the Southern Mariana Forearc

Chief-Scientist: Yasuhiko Ohara (Hydrographic and Oceanographic Department of Japan, and JAMSTEC)

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Investigation area (Figs. 1 to 4): Mariana Trench

Cruise period and port calls: June 29 to July 17, 2015 (Yokosuka to Saipan, USA)

Shinkai 6500 dive list:
6K-1429: Teruaki Ishii (Site C)
6K-1430: Yasuhiko Ohara (Site C)
6K-1431: Akinori Yabuki (Site A)
6K-1432: Shinsuke Kawagucci (Site A)
6K-1433: Tomoyo Okumura (Shinkai Seep Field, Site A)

YKDT dive list:
YKDT-169 (Site A)
YKDT-170 (Site C)
YKDT-171 (Site C)
YKDT-172 (Site A)

2. Introduction and objectives of the cruise

The 3000 km long Izu-Bonin-Mariana (IBM) arc system is an outstanding example of an intraoceanic convergent plate margin. The IBM forearc is a typical nonaccretionary convergent plate margin; the inner trench slope exposes lithologies found in many ophiolites. To more clearly delineate the geology of the forearc, we have been investigating a ~500 km long region of the Mariana forearc south of ~13°N using the DSV Shinkai 6500 and deep-tow camera since 2006. Discoveries includes the presence of MORB-like basalts that formed during subduction initiation (~51 Ma) [Reagan et al., 2010], a region of forearc rifting unusually close to the trench axis, the Southeast Mariana Forearc Rift [Ribeiro et al., 2013a, b], and a serpentinite-hosted ecosystem near the Challenger Deep, the Shinkai Seep Field [SSF; Ohara et al., 2012].

The SSF was discovered by Shinkai 6500 dive 1234 during YK10-12 cruise of R/V Yokosuka in September 2010. Abundant chemosynthetic biological communities, principally consisting of vesicomyid clams, associated with serpentinized peridotite were discovered [Ohara et al., 2012]. Following this discovery, we conducted YK13-08 cruise of R/V Yokosuka in July 2013 in order to obtain the first in situ chemical and microbiological samples from the SSF. Five Shinkai 6500 dives were successfully completed during the cruise, obtaining the first in situ chemical and microbiological samples from the SSF. Furthermore, these dives discovered carbonate chimneys for the first time in the southern Mariana forearc, as well as fresh volcanic glasses of Mariana Trough affinity. The latter discovery indicates that a backarc basin-like magmatic activity occurs in the forearc, suggesting that the southern Mariana forearc is a tectonically unique place [Stern et al., 2014]. This unique tectonic setting in turn might be responsible for forming the SSF. In 2014 summer, we also had a Shinkai 6500 dive cruise (YK14-13) around the SSF to conduct a comprehensive biogeoscientific investigation there. The cruise discovered other chimney sites (than those discovered in YK13-08 cruise), obtaining a good spatial relationship about the SSF chimney sites and biological colonies.

The past two cruises were successful in discovering carbonate chimneys in the SSF. Although we were successful in obtaining chimney samples, we had not yet been successful in collecting the emanating fluids and we did not know the fluid composition. On the other hand, we also did not know the exact place where the backarc basin-like magmatic activity occurs in the forearc. The two major objectives of YK15-11 cruise were therefore (1) to sample active chimneys with emanating fluids to know the fluid composition, thereby helping understanding of the SSF (in Site A), and (2) to map and sample the shallower part of the inner trench slope, the most promising place to find other occurrences of Mariana Trough-like lavas (in Site A).

In contrast to the region around the SSF, we so far only had a single Shinkai 6500 dive cruise (YK14-13) on the southern Mariana area west of the Challenger Deep, hindering our understanding of the IBM system. Hence, a subordinate objective of YK15-11 was to advance our biogeoscientific understanding of the southern Mariana seafloor west of the Challenger Deep (Site B and C; note that Site B was not investigated by this cruise).

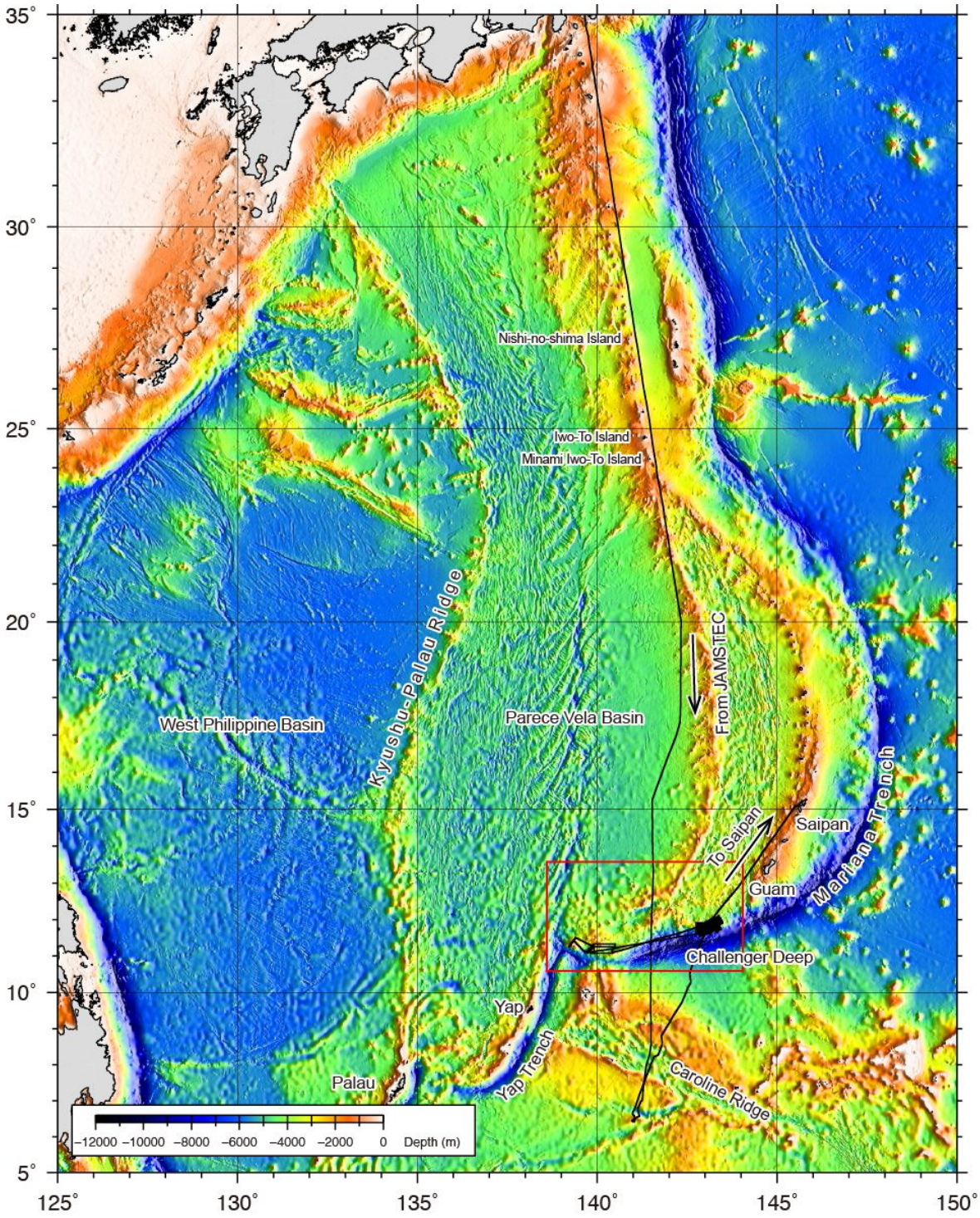

Fig. 1. Index map showing the location of studied area during YK15-11 cruise. The rectangle shown in red indicates the location of Fig. 2. Cruise track lines are also shown.

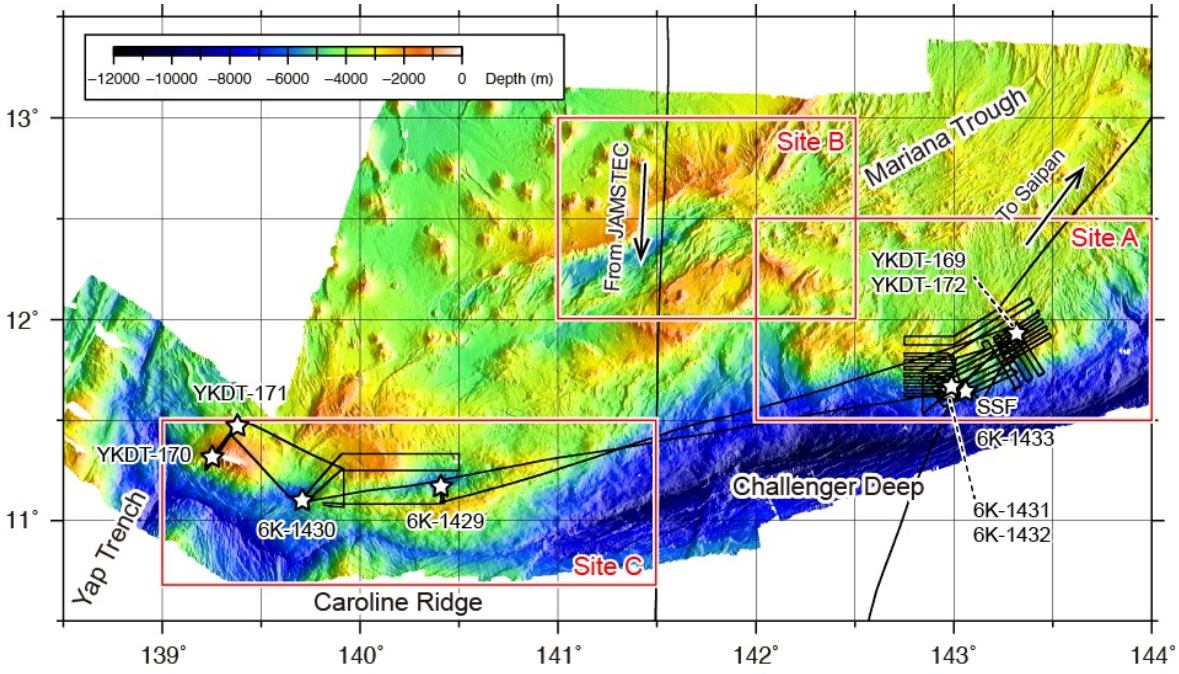

Fig. 2. Location of the dives during YK15-11 cruise. The rectangles shown in red indicate the location of Site A, Site B and Site C. Cruise track lines are also shown. Note that Site B was not investigated by this cruise.

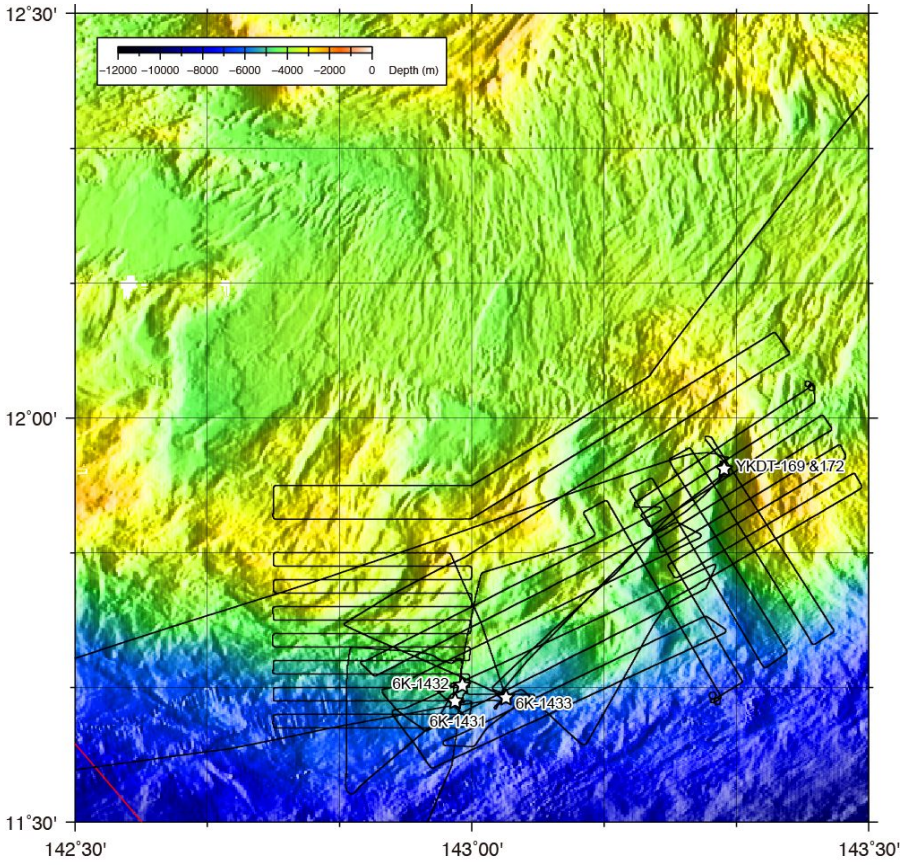

Fig. 3. Location of the dives in Site A. Note that 6K-1433 investigated the Shinkai Seep Field, whereas YKDT-169 and 172 investigated the identical target. Cruise track lines are also shown.

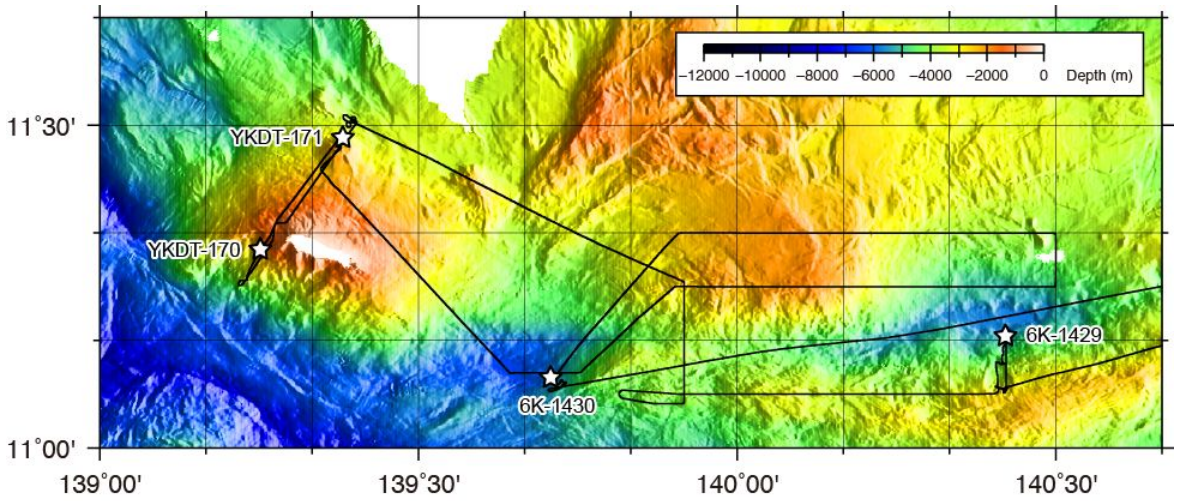

Fig. 4. Location of the dives in Site C. Cruise track lines are also shown.

3. Survey items

During YK15-11 cruise, we have conducted five Shinkai as well as four YKDT dives in Site A and Site C (**Figs. 2 to 4**). Geophysical mappings were also done, especially on the areas around the SSF.

4. Running cruise narrative

Local time (Approximate)	Notes
29-Jun-15	**The Yokosuka YK15-11 cruise began. The Yokosuka was underway to the survey area at the Southern Marianas.**
9:00	All scientists aboard
13:00	YK15-11 cruise began.
30-Jun-15	**Underway to the survey area. At around 13:00, the captain decided to go at full-speed, since Typhoon #9 has emerged in the area southeast of Guam.**
1-Jul-15	**Underway at full-speed. In the morning to early afternoon, the Yokosuka passed by Kita Iwo-To Island, Iwo-To Island, and Minami Iwo-To Island.**
2-Jul-15	**Underway at full-speed.**
3-Jul-15	**Underway at full-speed. The Yokosuka passed by Site A to south. Science meeting was canceled due to rough sea condition.**
4-Jul-15	**The Yokosuka was headed to south to escape from the Typhoon #9.**
22:30	The Yokosuka was as far south as at 6-26.2N, 141-02.5E.
5-Jul-15	**Since the sea condition seemed improved in Site A, the Yokosuka was headed to north.**
6-Jul-15	**Geophysical mapping of Site A, since the sea condition did not allow both Shinkai and YKDT operations.**

8:10	The Yokosuka arrived at Site A.
7-Jul-15	**The first Shinkai dive (6K-1429) was canceled, since the sea condition did not allow both Shinkai and YKDT operations. Geophysical mapping of Site A continued.**
8:00	The first Shinkai dive (6K-1429) was canceled. The chief scientist decided to continue geophysical mapping of Site A.
8-Jul-15	**The first Shinkai dive was again canceled. YKDT-169 was conducted at Site A instead. Since the sea condition of Site C seemed better for Shinkai operation, the Yokosuka moved to Site C during the night.**
11:17	YKDT-169 started (the deep-tow camera was put in the water).
12:53	The YKDT on bottom (4133 m).
14:31	The YKDT off bottom (3998 m).
15:56	The YKDT on deck.
9-Jul-15	**The first Shinkai dive (6K-1429) was conducted at Site C. Teruaki Ishii as the observer. The Yokosuka conducted geophysical mapping during the night.**
9:28	The Shinkai opened vent, start of 6K-1429 dive. Teruaki Ishii as the observer.
11:55	The Shinkai on bottom (5645 m).
16:02	The Shinkai off bottom (4108 m).
18:07	The Shinkai on deck.
10-Jul-15	**YKDT-170 and 171 were conducted at Site C. The Yokosuka conducted geophysical mapping during the night.**
9:11	YKDT-170 started (the deep-tow camera was put in the water).
10:01	The YKDT on bottom (1989 m).
11:02	The YKDT off bottom (1700 m).
11:45	The YKDT on deck.
13:16	YKDT-171 started (the deep-tow camera was put in the water).
14:17	The YKDT on bottom (2604 m).
15:20	The YKDT off bottom (2141 m).
16:13	The YKDT on deck.
11-Jul-15	**6K-1430 was conducted at Site C. Yasuhiko Ohara as the observer. Since the sea condition of Site A seemed improved for Shinkai operation, the Yokosuka moved to Site A during the night.**
9:05	The Shinkai opened vent, start of 6K-1430 dive. Yasuhiko Ohara as the observer.
11:26	The Shinkai on bottom (5693 m).
15:06	The Shinkai off bottom (5049 m).
17:30	The Shinkai on deck.
12-Jul-15	**6K-1431 was canceled. YKDT-172 was conducted at Site A instead. The Yokosuka conducted geophysical mapping during the night.**

8:30	The captain and the Shinkai team operation manager decided canceling of 6K-1431 dive, since the sea condition was still too rough to conduct Shinkai operation. Then, they decided to conduct YKDT.
12:53	YKDT-172 started (the deep-tow camera was put in the water). The target was identical to that of YKDT-169.
13:05	The YKDT on bottom (4130 m).
14:00	The YKDT off bottom (4017 m).
15:27	The YKDT on deck.
13-Jul-15	**6K-1431 was conducted at Site A. Akinori Yabuki as the observer. The Yokosuka conducted geophysical mapping during the night.**
9:01	The Shinkai opened vent, start of 6K-1431 dive. Akinori Yabuki as the observer.
11:21	The Shinkai on bottom (5143 m).
15:21	The Shinkai off bottom (4616 m).
17:35	The Shinkai on deck.
14-Jul-15	**6K-1432 was conducted at Site A. Shinsuke Kawagucci as the observer. The Yokosuka conducted geophysical mapping during the night.**
9:07	The Shinkai opened vent, start of 6K-1432 dive. Shinsuke Kawagucci as the observer.
11:09	The Shinkai on bottom (4746 m).
15:28	The Shinkai off bottom (4215 m).
17:42	The Shinkai on deck.
15-Jul-15	**6K-1433 was conducted at the Shinkai Seep Field, Site A. Tomoyo Okumura as the observer. The Yokosuka conducted geophysical mapping during the night.**
8:59	The Shinkai opened vent, start of 6K-1433 dive. Tomoyo Okumura as the observer.
11:22	The Shinkai on bottom (5831 m).
15:09	The Shinkai off bottom (5648 m).
17:34	The Shinkai on deck.
16-Jul-15	**Underway to port of call. Scientists worked in the labs.**
7:00	The Yokosuka finished geophysical mapping.
7:09	The Yokosuka recovered proton magnetometer.
17-Jul-15	**The Yokosuka arrived at Saipan in the morning. End of the cruise.**
9:00	The Yokosuka arrived at Saipan in the morning. End of the cruise.
12:30	YK15-11 scientists disembarked.

5. Summary of the cruise results

5-1. Site A

Two Shinkai dives at Site A (6K-1431and 6K-1432) investigated the slope ~3.3 NM (=

~6100 m) away from the SSF to the west. 6K-1431 mostly recovered serpentinized peridotites with subordinate gabbro and microgabbros, suggesting that the dive crossed a Moho transition zone of the southern Mariana forearc as shallow as at ~4600 m. The following 6K-1432 investigated the upslope of 6K-1431, recovering serpentinized peridotites as shallow as at ~4500 m and basalts further upslope. The results of these two dives indicate that the Moho locates at ~4500 m in this area.

We were only able to investigate the SSF with a single Shinkai dive (6K-1433) during YK15-11 cruise. 6K-1433 revisited the chimney sites discovered during the past two cruises and noticed that chimneys have grown ~30 cm during the past year, confirming that SSF chimneys are active. However, it should be noted that the dive was not successful to observe emanating fluids from the chimneys.

Apart from the Shinkai dives, two YKDT dives (YKDT-169 and YKDT-172) in Site A investigated a deep valley located at the shallower inner trench slope to the northeast of the SSF. These two YKDT dives observed volcanic terrain floored with pillow basalts and pillow breccias, suggesting that the valley is in fact a rift floored with Marina Trough-like lavas.

5-2. Site C

In Site C, two Shinkai dives (6K-1429 and 6K-1430) investigated an elongated ridge-like structure in the southwestern Mariana forearc to the immediate north of the colliding Caroline Ridge. 6K-1429 mostly recovered serpentinized peridotites, whereas 6K-1430 recovered mostly mud cakes with a single piece of altered basalt.

On the other hand, two YKDT dives (YKDT-170 and YKDT-171) in Site C investigated the western shallow part of the "Peridotite Ridge [Hawkins and Batiza, 1977]" which was investigated by 6K-1397 and 6K-1398 in YK14-13 cruise. Although 6K-1397 and 6K-1398 revealed that the eastern ridge is consisted of peridotites and troctolites as shallow as ~at 3400 m, YKDT-170 and YKDT-171 revealed that the western ridge is consisted of altered basalts. These altered basalts appear to be similar to those collected at the North Yap Escarpment, ~30 NM (~60 km) north of the YKDT dive sites. The basalt at the North Yap Escarpment is dated at ~25 Ma [Ohara et al., 2002].

6. References

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