



Cruise Report of NT10-06 Leg 3

“Biogeochemical investigation of CO₂ seep environment at the Yonaguni Knoll IV hydrothermal vent field, the southern Okinawa Trough”

RV Natsushima & ROV HyperDolphin

April 13 (Ishigaki) – 18, 2010 (Naha)

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Cruise Summary

During the expedition of NT10-06 Leg 3 using *RV Natsushima* and *ROV HyperDolphin*, we studied microbiological and biogeochemical characteristics of CO₂ seep environment at the Yonaguni Knoll IV hydrothermal field, the southern Okinawa Trough, Japan. At the CO₂ seep area, the emission of liquid CO₂ has been often observed during the previous JAMSTEC research cruises and RV SONNE. Using ROV, it has been demonstrated that the CO₂ seepage significantly lowers the pH of ambient seawater, and subsequently impacts on the biological ecosystem that sensitively responds to the environmental change. This is extremely unique natural laboratory, which enables us to study potential biological impact of industrial CO₂ capture and sequestration (CCS) into the deep-sea sediment and subsequent ecosystem services such as the possibility of biological CO₂ turnover to organic matter. In collaboration with colleagues in Germany, Max-Planck-Institute for Marine Microbiology and IFM-GEOMAR, we planned to re-visit the CO₂ seep area at the Yonaguni Knoll IV and expand our biogeochemical and microbiological knowledge by deploying some *in-situ* sensor-measurement kits and *in-situ* high-pressure sampling devices.

During NT10-06 Leg 3, we allowed three working days plus a reserve day for the ROV operation. However, unfortunately we encountered very strong low-pressure zone of weather, preventing the green light to dive only for one day. Nevertheless, we performed two ROV dives (#1100 and #1111) within a day as follows: First, we brought MPI-profiler sensor kit to the bottom and start multiple measurements at close locations to the CO₂ seepage. Then, ROV was once recovered and went back to dive again with *in-situ* sampling systems. Although the location was very close to the CO₂ seep site, because of the time severely limited, we could not observe any scientifically important biogeochemical data using *in-situ* sensors. After the ROV operations on MPI-profiler sensor kit and sampling, we recovered the kit and other payloads by hooking the rope. This site is well-known high sea-current area and not-easy to access with ROV and the weather is often unstable. Thus, if the proposal is allowed in the future, we strongly recommend to be given at least one week (i.e, 7 working days) or more to produce a complete scientific data set. Otherwise, our vast efforts on preparation and scientific discussion at the high level will often be in vain –all this depends on the proposal evaluation committees, not on the scientists. This is one of what we learned from the short expedition.

Dive Report: Hyper Dolphin Dive #1110

Date: 17 April 2010

Site Name: Yonaguni Knoll IV hydrothermal field, southern Okinawa Trough

Landing: 24°50.544'N, 122°42.878'E, 1371m

Leaving: 24°50.526'N, 122°42.878'E, 1373.8m

Observer: Yuki Morono (KCC, JAMSTEC)

Objectives:

To deploy MPI-in situ profiler at the reference site.

Dive Summary:

We landed at the reference site 50m south from the originally planned location, where we observed some sea cucumbers and star fishes. A sea cucumber is highly sensitive to the CO₂ seepage, indicating the location is suitable for the reference site. The seabed is normal soft grayish clay. We collected a sea cucumber into canister #1. We found some star fishes, but these are too big for the suction sampler. After we collect one more sea cucumber into the canister #2, we then started to deploy the MPI-profiler. The profiler was first moved from the vehicle, which disturbed the sediments that covered the bottom plate of the profiler. To deploy the profiler onto the fresh, non-disturbed seabed, we stepped back slightly downward of the sea current (<10m), approached again, and grabbed the top-holder with ROV hovering. The profiler was successfully set on the fresh sediment, and then we activated the profiler by pushing the button twice with green light, and left the bottom.

Payloads:

- (1) MPI-in situ profiler
- (2) Suction sampler with 6 collection chambers.
- (3) Niskin bottles (x2)

Location of Events:

Time	Position	Depth	Event
08:22		0m	Start dive

09:41 24°50.544'N, 122°42.878'E, 1371m ROV landed.

09:45 24°50.530'N, 122°42.884'E, 1375.4m Collect a white sea cucumber into No.1 canister

09:50 24°50.528'N, 122°42.880'E, 1375.0m Try to collect a white sea star, but was found to be too big.

09:52 24°50.524'N, 122°42.875'E, 1375.4m Collect another sea cucumber to No.2 canister

09:55 24°50.523'N, 122°42.874'E, 1374.1m Take MPI-profiler from the basket. Tentatively put on the bottom.

10:12 24°50.523'N, 122°42.868'E, 1374.1m Change the vehicle direction

10:15 24°50.526'N, 122°42.880'E, 1374.1m Approach to the profiler and hold the top frame.

10:20 24°50.526'N, 122°42.878'E, 1373.8m Gently set the profiler on the fresh bottom.

10:22 24°50.526'N, 122°42.878'E, 1373.8m Activate the profiler by push the button twice with green light.

10:23 24°50.526'N, 122°42.878'E, 1373.8m Collect water sample by Niskin bottles (x2).

10:24 24°50.526'N, 122°42.878'E, 1373.8m Leave the bottom.

Dive Report: Dive #1111

Date: 17 April 2010

Site Name: Yonaguni Knoll IV hydrothermal field, southern Okinawa Trough

Landing: 24°50.544'N, 122°42.878'E, 1371m

Leaving: 24°50.526'N, 122°42.878'E, 1373.8m

Observer: Yuki Morono (KCC, JAMSTEC)

Objectives:

The major objective of the dive #1111 is (1) to collect the pressured core sample, (2) to deploy the MPI-profiler on the CO₂ lake site, and (3) to collect push core samples at CO₂ lake site.

Dive Summary:

We landed at almost the same site of dive #1110 and found the MPI-profiler soon. We then first tried to take push core with 30 cm #4 corer (blue), but because the retrieval of the core was short and the partial core was lost, we disposed the core and once again tried and around 15cm of the core sample retrieved. Then we picked up 30 cm #3 (yellow) corer and took the core as well (twice trial as well and approx. 15cm of the core sample was retrieved). Overall the sediment at the reference site was very soft and was difficult to take core sample without any disturbance. After we holded the MPI-profiler, we headed to the Abyss vent (site #2). During the transit to the Abyss vent, we observed star fishes, tubeworms, but almost no sea cucumber, indicating the CO₂ vent is close. In previous expedition with Sonne, the transect that we passed was the sulfur pavement, however, this time we observed very soft, fresh sediment covering the seafloor. It is an indicator of the high rate of surface production or volcanic activity around this area after the cruise of Sonne. As we approaching to the Abyss vent, star fish was disappeared and we got to find white patchy CO₂ hydrates. However, we had difficulty to find Abyss vent. By considering the time left, we decided to deploy profiler without finding Abyss vent. We also collected the 4 push core sample while another 3 were left at the site for the easy operation of pressure coring. We moved about 100m west of the MPI-profiler site and find Sonne marker #13, which was placed 2 years ago, followed by the finding of Shinkai 6K marker. Then we finally found Abyss vent. We

retrieve one Niskin water sampling at the site (to the red bottle), and the pressure water sampling was done in very close proximity of the vent. We then started pressure core sampling and successfully retrieved the core and closed two ports. After sampling of 2-3 pavement samples, we headed to the MPI-profiler. On the way to get to the MPI-profiler, we observed some bubbles, which are supposed to be CO₂. At the MPI-profiler site, we took water sample to the Niskin bottle (blue). We retrieve the 3 left core sample and sampled tubeworms (maybe rubber band?). We then hook the MPI profiler and left the bottom. However, 10-15minutes later, we could not see profiler. ROV went down again and found the hook was somehow detached from the MPI-profiler. According to the homer signal, we found the MPI-profiler, hooked again, and left the bottom.

Payloads:

- (1) Pressured core sampler
- (2) Suction sampler with 6 collection chambers
- (3) MBARI-type corer (50cm x 7, 30cm x 2)
- (4) Pressured hydrate sampler

Location of Events:

Time	Position	Depth	Event
13:30		0m	Start dive
14:31	24°50.515'N, 122°41.874'E,	1371m	ROV landed
14:33	24°50.511'N, 122°41.883'E,	1372m	Find MPI profiler and landed
14:40	24°50.511'N, 122°41.883'E,	1372m	core with #4 (blue, 30cm)
14:44	24°50.511'N, 122°41.883'E,	1372m	core with #3 (yellow, 30cm)
14:53	24°50.548'N, 122°41.872'E,	1372.6	Hold MPI-profiler
14:56	24°50.548'N, 122°41.872'E,	1372.6	Head to site #2
15:38	24°50.762'N, 122°42.052'E,	1386m	Look for Abyss vent
15:51	24°50.804'N, 122°42.047'E,	1369m	Find tubeworms and crams
16:05	24°50.776'N, 122°42.096'E,	1387m	Deploy MPI-profiler
16:09	24°50.776'N, 122°42.099'E,	1387m	Activated the MPI-profiler
16:10	24°50.781'N, 122°42.100'E,	1389m	Land again
16:16	24°50.781'N, 122°42.100'E,	1389m	Core #1 (black, 50cm) left at the site

16:19	24°50.781'N, 122°42.100'E,	1389m	Core #2 (blueblack, 50cm) left at the site
16:21	24°50.781'N, 122°42.100'E,	1389m	Core #7 (greenblack, 50cm) left at the site
16:27	24°50.781'N, 122°42.100'E,	1389m	Core #6 (blueyellow, 50cm) top 5-10 cm and bottom 10-15cm was disturbed and placed to the position #2
16:34	24°50.781'N, 122°42.100'E,	1389m	Core #9 (redyellow, 50cm) placed to position #9
16:36	24°50.781'N, 122°42.100'E,	1389m	Core #8 (yellowblack, 50cm) placed to position #7
16:40	24°50.781'N, 122°42.100'E,	1389m	Core #5 (blackred, 50cm) placed to position #6
16:55	24°50.804'N, 122°42.150'E,	1389m	Find crab
16:59	24°50.781'N, 122°42.036'E,	1383m	Find sonne marker #13
17:01	24°50.782'N, 122°42.033'E,	1385m	Find 6K marker, and find Abyss vent, vent was covered with fresh sediment
17:05	24°50.782'N, 122°42.033'E,	1385m	Niskin sampling (red)
17:13	24°50.790'N, 122°42.028'E,	1385m	Pressure water sampling (#3, blue)
17:17	24°50.790'N, 122°42.028'E,	1385m	Pressure core sampling
17:20	24°50.790'N, 122°42.028'E,	1385m	Closed the first port
17:23	24°50.790'N, 122°42.028'E,	1385m	Closed the second port and finished pressure core sampling
17:25	24°50.783'N, 122°42.022'E,	1385m	Collected the pavement sample (x2)
17:29	24°50.783'N, 122°42.022'E,	1385m	Head to MPI-profiler
17:33	24°50.773'N, 122°42.049'E,	1382m	Observe some "CO ₂ " bubbles....
17:42	24°50.809'N, 122°42.102'E,	1388m	Niskin sampling (blue)
17:43	24°50.809'N, 122°42.102'E,	1389m	Retrieve #7 corer into the position #5
17:46	24°50.809'N, 122°42.102'E,	1389m	Retrieve #2 corer into the position #8 (but was broken?)
17:48	24°50.809'N, 122°42.102'E,	1389m	Retrieve #1 corer to the position #1
17:53	24°50.809'N, 122°42.102'E,	1389m	Suction sampling of the tubeworms in canister #1 (next to #2)
18:01	24°50.787'N, 122°42.104'E,	1388m	Hook the MPI-profiler and leave the

bottom

18:58

leave the bottom

Hook again the MPI-profiler and