NT12-07 Cruise Summary

Cruise ID:	NT12-07
Research vessel:	R/V Natsushima
Title of cruise:	FY2011 Deep sea survey by the ROV Hyper-Dolphin at Kagoshima Bay and off Cape Noma-Misaki
Title of proposals:	"Experimental testing of instrumentation to perform in situ multi-element chemical analysis at a hydrothermal site". - Blair Thornton, The University of Tokyo "Towards the development of deep-sea organismal clocks". - Yoichi Yusa, Nara Women's University "Study on reproductive and dispersal strategy of *Osedax japonicus*". - Tomoko Yamamoto, Kagoshima University
Cruise period:	March 24, 2012 (Naha, Okinawa) March 29, 2012 (Kagoshima) (6 days)
Survey site:	Kagoshima Bay and Off Cape Noma-Misaki

Objectives

The main objectives of the cruise were as follows:

Subject 1: to investigate the application laser-induced plasmas as a mechanism to perform in situ multi-element analysis of both liquids and solids at sea,

Subject 2: to collect biological samples to obtain information concerning barnacle growth to develop deep-sea clocks, and

Subject 3: to establish a sampling method for *Osedax japonicus*, and evaluate their dispersal ability and reproductive period.

The main objective of Subject 1 is to test the principle of using a laser-induced plasma as a mechanism to perform in situ analysis of the chemical composition of liquids and solids on the seafloor. A 3000m depth rated prototype device, I-SEA (In-situ Seafloor Element Analyzer) has been developed under the 'Program for the development of fundamental tools for the utilization of marine resources' of the Japanese Ministry of Education. The devices employs a technique known as laser-induced breakdown spectroscopy (LIBS), which is a form of atomic emission spectroscopy. This cruise was the first time I-SEA has been tested at sea, and the first application of LIBS at sea. In addition to testing of I-SEA, a long range 3D seafloor mapping device was tested for the first time and both gamma radiation and continuous seawater pH measurements were made during this cruise.

The main objective of Subject 2 was to collect barnacle samples to investigate their potential application as deep-sea clocks. Their growth speed varies depending on the species, and their shells often have distinct growth lines. These characteristics may facilitate them to be used as “organismal clocks”: by knowing the growth speed or the time needed to add a growth line, the minimum time their substrata exist in the sea can be estimated.

The main objective of Subject 3 was to study the reproductive and dispersal strategy of *Osedax japonicus*. Once large marine mammals die and their carcasses sink into deep sea, they supply a large amount of unusual organic matter to deep-sea ecosystems. After consumption of soft tissue by scavengers, bacterial decomposition of oil-rich skeleton produces an anaerobic environment. This is followed by a sulphophilic stage with sulfide efflux and carbon fixation by chemosynthetic bacteria. Thus, deep-sea whale falls are expected to support a widespread and characteristic fauna including chemosymbiotic species. *Osedax* polecats have only been discovered on whale bones naturally. *Osedax japonicus* has been discovered and described at the whale fall off Cape Noma-Misaki and is thought to be an ideal model animal for studying the reproductive and dispersal strategy of endemic species in this unique habitat. The objective during this cruise was to establish a sampling method for this species, and to evaluate their dispersal ability and reproductive period.

Overview of observations and results

The NT12-07 cruise was conducted based on three separate proposals; #S11-56 “Experimental testing of instrumentation to perform in situ multi-element chemical analysis at a hydrothermal site”, proposed by Blair Thornton of The University of Tokyo, #S11-10 “Towards the development of deep-sea organismal clocks”, proposed by Yoichi Yusa of Nara Women's University, and #S11-76 “Study on reproductive and dispersal strategy of *Osedax japonicus*”, proposed by Tomoko Yamamoto of Kagoshima University.

A total of four dives were conducted in Kagoshima Bay and off Cape Noma-Misaki, using the ROV Hyper-Dolphin and the R/V Natsushima between March 24, 2012 and March 29, 2012. Dives HPD#1359 and HPD#1362 were conducted in Wakamiko caldera at a depth of approximately 200m in Kagoshima Bay. During the dives, the ROV was instrumented with sensors to perform in situ multi-element chemical analysis, long range seafloor mapping, seafloor radiation measurements and continuous pH measurements. Sampling of seawater and sediments was performed together with temperature measurements of vent fluids. During the first part of HPD#1359, plasma

based multi-element analysis of seawater composition was performed using the I-SEA, where the laser used to induce the plasmas was focused directly into the seawater to map the composition of a 100m by 100m area at a depth of approximately 200m. Figure 1 shows details of the spectra for calcium, lithium and potassium. During measurements of seawater, signals thought to originate from particulate matter were observed as well, as show in figure 2, which shows part of a C_2 swan band. Visual mapping and seawater sampling were performed at an altitude of 6m. Gamma radiation and pH measurements were also continuously performed. During the second part of the dive, a long term temperature measurement device was deployed near an active vent, and sediment sampling was performed. Radiation measurements and high resolution spectroscopy were performed near several active hydrothermal vents. During HPD#1362, experiments were performed in the same area, where this time chemical analysis was performed via a fibre optic cable to enable the plasma to be generated on specific targets. Visual mapping, radiation measurements and pH measurements were performed as in the HPD#1359. During the first half of the dive, Hyper-Dolphin followed lawnmower pattern covering an area of 70m by 70m and measurements of seawater composition were performed. During the second half of the dive, LIBS measurements were performed on solids. During these dives, successful in situ multi-element analysis was achieved for the first time, and it was demonstrated that plasmas can be used as a mechanism for in situ chemical analysis of both liquids and solids at sea.

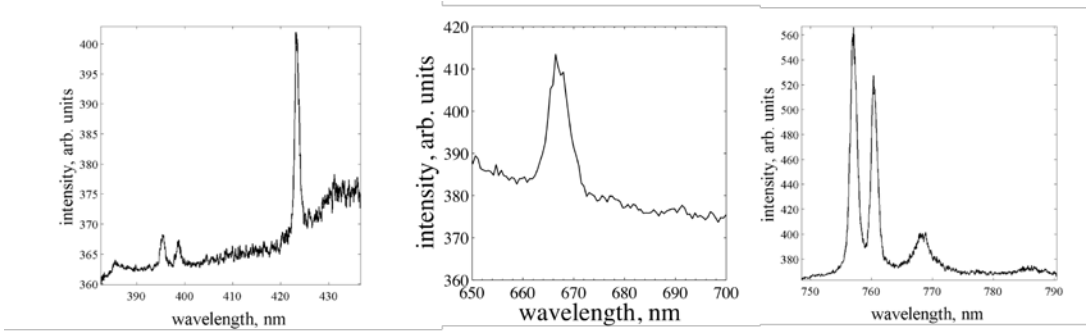

Fig. 1 Detailed views of spectra observed from seawater measurements at 200m depth showing calcium (left), lithium (center) and potassium (right)

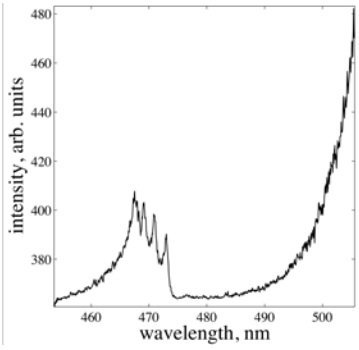

Fig. 2 Detailed views of a C_2 swan band measured at 200m depth. The signal is thought to originate from particulate matter suspended in the seawater.

Dives HPD#1360 and HPD#1361 were conducted on the same day off Cape Noma-misaki. During the former of these dives, the *Osedax* colonization device Namekujira_11 deployed on 13 April 2011 was successfully located at a depth of 229m and four frames were recovered. An individual of *S. stearnsii* that was attached when the frame was deployed could be recovered. Furthermore, small individuals of *Osedax* sp. were found on pig bones, and one individual each of *Octolasmis* sp. and *Scalpellidae* sp. as well as several hundred individuals of *Heteralepas* sp. that had settled on the artificial substrate of the Namekujira_11 device could be recovered.

During HPD#1362, the #6 whale fall was observed. At whale fall #6 four small pieces of whale bone, two crinoids, some sea anemones, and water and sediment samples were collected. As the ROV moved towards the #7 whale fall, we observed the animal community on the sand bottom. A fish, a ctenophoran (*Lyrocteis imperatoris*), a barnacle (*Scalpellum streansii*), and three individuals of octocorals were collected. The growth of the *S. stearnsii* individual will be measured by counting the growth lines after staining. Most of the *Heteralepas* sp. have been preserved and later their sizes will be measured so that their growth in maximum one year can be inferred. Together with data obtained on the NT10-07 cruise, where individuals of the same species that had been attached for a maximum of 4 months have been collected, a growth curve can be calculated. The remaining individuals of *Heteralepas* sp. will be reared so that their growth can further be monitored. The *Osedax* will be cultured on a whale bone and pig bones at JAMSTEC and Nara Women's University to observe their reproductive trait.

Acknowledgements

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