YOKOSUKA Cruise Summary

—YK08-06—

"Detection of Multi-scale Slow Earthquakes by using Ocean-bottom Seismic and Geodetic Observation",

Landward slope of Japan Trench, Off Miyagi, Northeastern Japan

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It is important to understand a process of stress accumulation to an asperity. Recently, several different types of slow earthquakes—non-volcanic tremors, very-low-frequency (VLF) earthquakes, or short-term slow slip—have been reported in the Nankai, Cascadia, and Costa-Rica subduction zone. VLF earthquakes are only detected in Nankai subduction zone. The periods of the seismic waves corresponding to VLF earthquakes along the Nankai subduction zone are predominantly in the range of 10–20 s [Obara and Ito, 2005]. The earthquake hypocenters are distributed at a depth of ~10 km above the upper surface of the subducting Philippine Sea Plate. The focal mechanism indicates reverse faulting.

Hydrotectonic events coincident with some seismic signals observed by ocean-bottom-seismometers were first reported by Brown et al. (2005); they used the CAT-meters in the shallow subduction system in certain regions in the Costa Rica subduction zone. Their results suggested that anomalously rapid flow events coincide simultaneously with bursts of seismic noise.

The Pacific plate subducts beneath Tohoku, northeastern (NE) Japan, along the Japan Trench The seismicity along the plate boundary is the highest in the world. The regional seismicity varies from north to south along the Japan Trench. From off Sanriku to off Miyagi, the northern part of the subduction zone, there exist asperities of large earthquakes, that is, earthquakes whose magnitude exceed 7, and some clusters of small or intermediate earthquakes around the asperities. An aseismic slip has been observed as a post-seismic slip after large events. Tsunami earthquakes, a type of slow earthquakes, have also occurred near the Japan Trench.

Non-volcanic tremors, VLF earthquakes, and short-term slow slips have not been observed in NE Japan; this may be attributed to low detectability for long-period events near the trench. During this cruise, we performed temporal ocean-bottom seismic, geodetic, and hydraulics observations in order to detect multiscale slow earthquakes in NE Japan.

In order to detect some evidence of slow earthquakes, we carried out an investigation of cold seeps by using SHINKAI 6500; we deployed of two simplified ocean-bottom benchmarks (SOBBs), replaced two ocean-bottom pressure gauges (OBPs) with an inverted echo sounder, sampled the pore water at the cold seeps, and deployed six long-term ocean-bottom seismometers (OBSs) (Fig. 1).

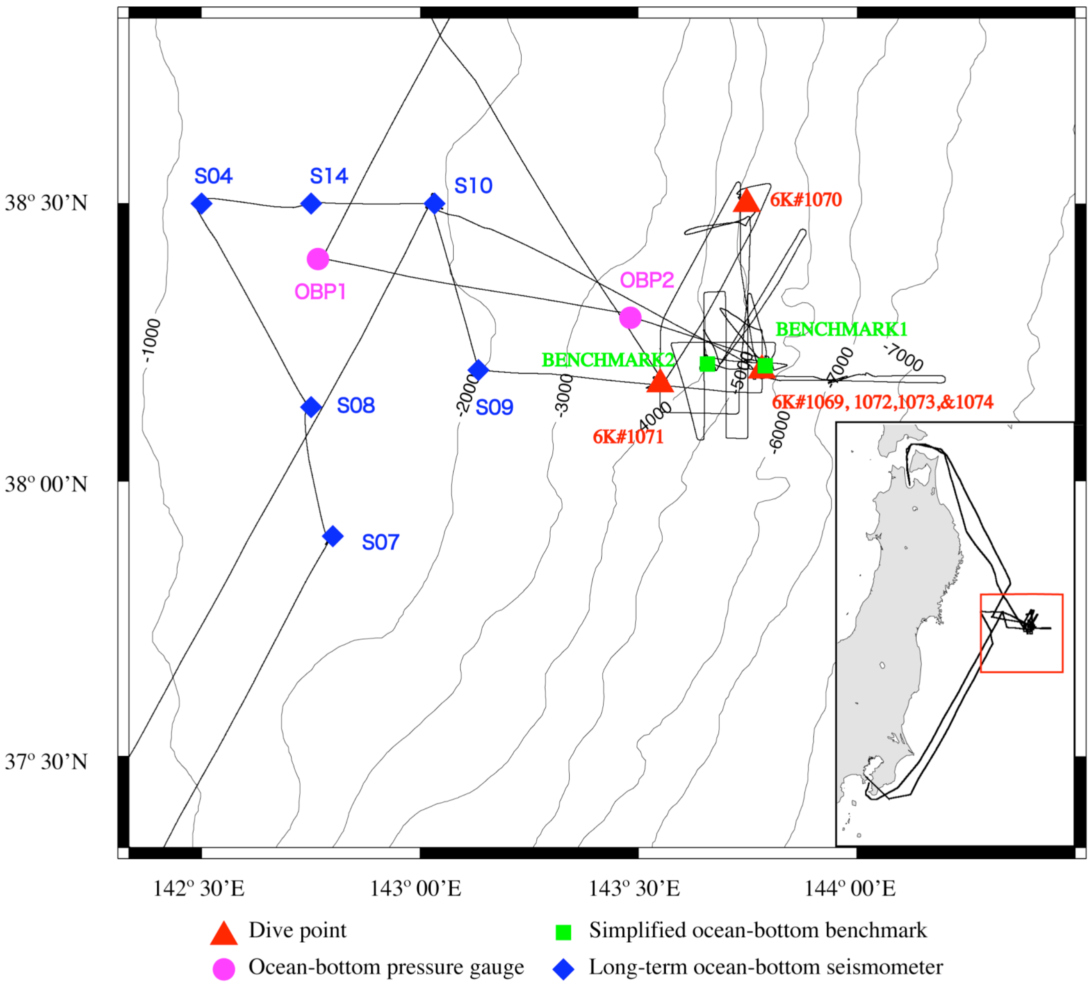

Fig. 1. Cruise track, dive points, and deployed instruments in the research area

In order to observe the transience of fluid flow due to some slow earthquakes, we used osmotically-driven fluid flow meters (CAT-meters). Since data showing the existence of cold seeps in the research area were unavailable, we first investigated about the distribution of chemosynthetic benthic colonies by diving surveys involving the

SHINKAI 6500. Then, we installed CAT-meters on cold seeps by using the SHINKAI 6500.

We carried out six dives with the SHINKAI 6500 in order to search for chemosynthetic benthic colonies, which indicate the existence of a cold seep, and to deploy two CAT meters. We found more than 10 calyptogena colonies in six regions at a depths ranging from 5702 m to 5861m on the dive #1069,#1072,#1073, and #1074 (Fig. 2). Two CAT-meters were deployed on the cold seep.

Fig. 2. Calyptogena colony found on the dive #1069.

We deployed two SOBBs with three types of sensors: short-period seismometers, broadband seismometers, and a pressure gauge. These SOBBs were thrown down from the surface of the sea. One of the SOBBs was deployed on the footwall near the possible faults estimated by traces of calyptogena colonies, which were discovered on dives #1069, #1072, #1073, and #1074. The other was deployed on the hanging wall of a possible fault along the calyptogena colonies, and is also located seaward of the possible fault found out on dive #1071.

We deployed an ocean-bottom pressure gauge (OBP) and an inverted echo sounder (IES) to monitor the vertical movement in the same region. An OBP measures the variation of pressure, while an IES measures the variation of pressure and the two-way travel time of an acoustic pulse between the IES and sea-surface with four type of transmitted signals. We then recovered and deployed two OBPs. The recovered OBPs had recorded the pressure variation for a duration of six months (the data comprises approximately 250000 samples) with a sampling interval of 1 minute. The deployed IESs are sampled every 10 min; the sampling frequency is 10 times the frequency of the transmitted signal.

"Cold seepage" on the seafloor in connection with deep-sea biological communities has been found in tectonically active subduction zones. In order to understand the relationship between the active faults, colonies and cold seepage, we present the geochemical features of the fluids for sediments on the Japan Trench.

During the cruise, the following samples were collected at the Japan Trench: 13 successful near-surface sediment push cores (5–20 cm long) from within and outside the seafloor clam colonies and the two bottom seawater samples just above the clam colonies collected using Niskin bottles.

The pore water samples used in this study were extracted from the sampled sediment cores in an on-board laboratory. Intervals of around 5 cm were extruded from each core. Following extraction, the fluid was filtered through 0.45-μm Millipore filters and then placed in a polypropylene bottle for the measurement of major cations (Na, K, Mg, Ca, Sr, and Ba) and anions (Cl and SO_4) analysis. All samples were stored in a refrigerator till they could be analyzed on land.

The concentrations and stable carbon isotope compositions of light hydrocarbons in pore water will be measured using a previously described method [Tsunogai *et al.*, 2000, 2002] with an isotope ratio monitoring gas chromatography/mass spectrometry system. The components of the major components of pore water will be measured by using an ion chromatograph.

In order to investigate the ordinary seismicity in the downdip portion of the research area, we deployed six OBSs from the deck into the bottom of the sea. These OBSs will be recovered by means of a pop-up system after six months or one year.