

Cruise Summary

1. Cruise Number / Ship Name: YK08-04/ R/V “Yokosuka”
2. Title of the Proposal: Seafloor-Borehole Integrated Hydrologic Observation
in the Nankai Seismogenic Zone
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5. Investigation Area: Nankai Trough off Kumano
6. Period of the cruise: April 4, 2008 to April 10, 2008

Fluids in subduction zones strongly control mechanical strength of rocks. Their distribution, migration and discharge processes are crucial to understand structural evolution such as plate boundary fault deformations. Variation of geochemical component and/or seep rate with time is one of indicators for stress condition within an accretionary prism. We deployed five seep meters and one long-term temperature meter at the base of the fault scarp and the mud volcano to monitor one year's variation of seep activity. YK07-09 was cancelled by a hatch trouble of Shinkai 6500 although the cruise planned for retrieval of these instruments and deployment of new ones. All instruments were successfully retrieved by NT07-E01 that scheduled for an emergency action. However, instrument deployment and exploration of new seep sites were postponed.

We planned this cruise for studies of unexplored faults and deployments of seep meters again. Primary objective of our study is to measure fluctuation of seep activity and to examine the cause of the fluctuation in terms of short-term environmental changes of formation such as seismic activities including VLF (Very Low Frequency) and tidal effect. Therefore, our study would contribute ongoing IODP NanTroSEIZE as a pilot observation of hydrogeology for future long-term borehole observatory. Secondary objective is acquisition of sediment samples from methane seep sites for microbiological studies. Most of the methane seeping upward in the marine sedimentary column is intercepted biologically by the anaerobic oxidation of methane (AOM) and in thus prevented from reaching the atmosphere. There is now a consensus that AOM can be mediated by consortia of methane-oxidizing Archaea and sulfate-reducing bacteria, although microorganisms responsible for AOM have remained isolated and characterized. To better study microbial AOM, we have to be more effort to cultivate and obtain the microbes responsible for the AOM reaction in pure culture. After obtaining deep-sea sediments from the Nankai Trough area, we will culture these microbes using a special cultivation apparatus. To understand the nitrogen cycle in the anoxic methane-seep sediments, moreover, we try to cultivate with stable isotopes to investigate if ANME have ability to fix nitrogen gas.

We conducted three dives of “Shinkai 6500” in the Nankai Trough off Kumano (Fig. 1). Dive

studies at three isolated sites have individual objectives and achievements as follows.

Dive #1061: We conducted seafloor observation across the distinct lineament on the elongated basin north of the Oodai Ridge. It is inferred that this lineament corresponds to a strike slip fault identified by an axis displacement of a deep-sea canyon. This dive confirmed continuous cliffs with pervasive landslides suggesting active crustal movement occurring along this lineament (Fig. 2A). No cold seep was observed during the dive survey.

Dive #1062: We deployed two CAT-meters (seep meter developed by Scripps Institute of Oceanography) at the bacterial mats in the small terrace of the upper slope of the fault scarp at the “Oomine Ridge” (Fig. 2B). This fault corresponds to one of branched faults of the mega-splay fault off Kumano. We will try two year’s seep monitoring using these CAT-meters at cold seep sites. For future heat flow measurements, we also deployed one BTMS (Bottom-Water Temperature Monitoring System) at the outside of bacterial mats. The primary objective of these monitoring is to obtain more information about variations of seep rate and tectonic activities. Surface sediment samples for microbiological and geochemical studies were also successfully obtained. We could not find barite chimney discovered during YK06-03 although we carefully observed the seafloor around the previous yield location.

Dive #1063: Dai-hachi Kumano Knoll is a juvenile mud volcano which is about 40 meter in height and 0.8 kilometer in diameter. Previous Shinkai and AUV dives revealed that the knoll has thick roof sediments which correspond to the surrounding trough sediments, and that a wide discolored zone of very active bacterial mats and Calyptogena colonies occur at some areas along the foot of the knoll. The purposes of the Shinkai dive 1063 are to make sure how cold seep distribute and to take some sediment cores and very near surface water samples for geochemical and microbiological analyses. Seawater thermometer is adopted for long term monitoring of bottom water temperature.

As a result, the Shinkai vehicle found that the area of the previously found discolored area at the southwestern foot of the knoll has disappeared, and that the most of the Calyptogena have died in the last two years. The mud surface completely turned to the normal brown but the mud scraped by the vehicle indicated still sulfate black. When the vehicle moved to the area of blight spots on sidescan sonar image at the southeast foot of the knoll, some living Calyptogena were observed. In this area, we operated very near surface water sampling just above the black mud and recovered MBARI push cores in the spaghetti-like worms. Seawater thermometer and a new marker #65 were set on the mud at this location.

As mentioned above, we successfully deployed long-term monitoring instruments according to the original plan, and took samples for microbiological and geochemical studies although the discolored area at the No. 8 Kumano Knoll was disappeared. Two CAT-meters’ records for two years will provide us with information about changes of cold seep activities. Two BTMS will record basic data of bottom water temperature for heat flow calibration. Moreover, microbiological and geochemical studies using sediment and seawater samples will reveal relationships between microbiological and geochemical processes within surface sedimentary sequence.

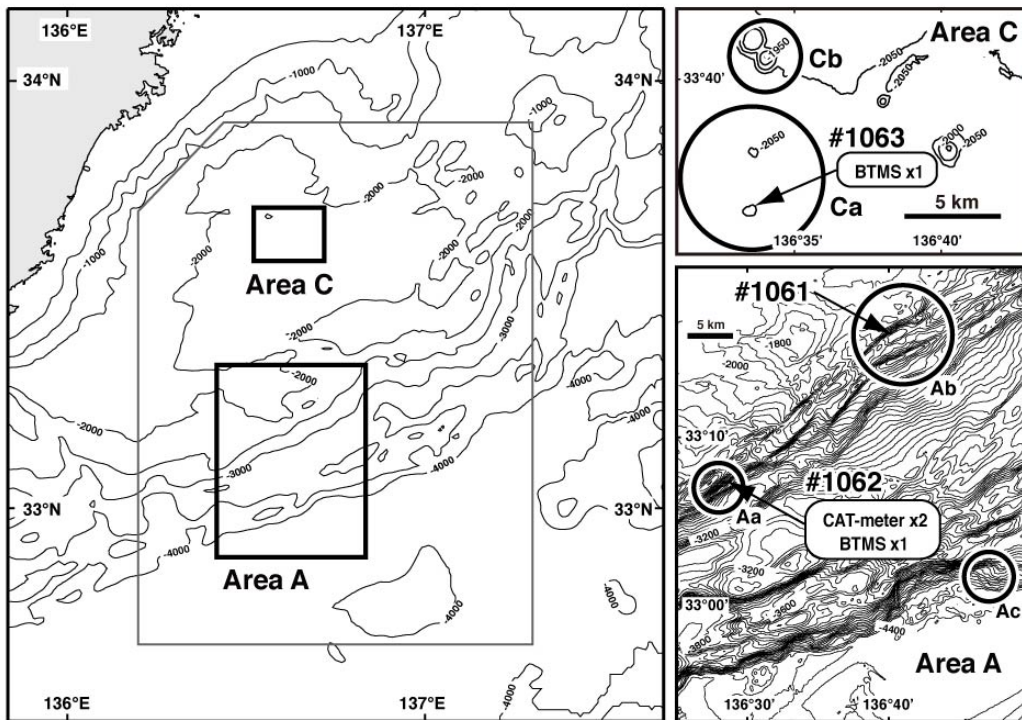


Fig. 1 Dive area map of YK08-04

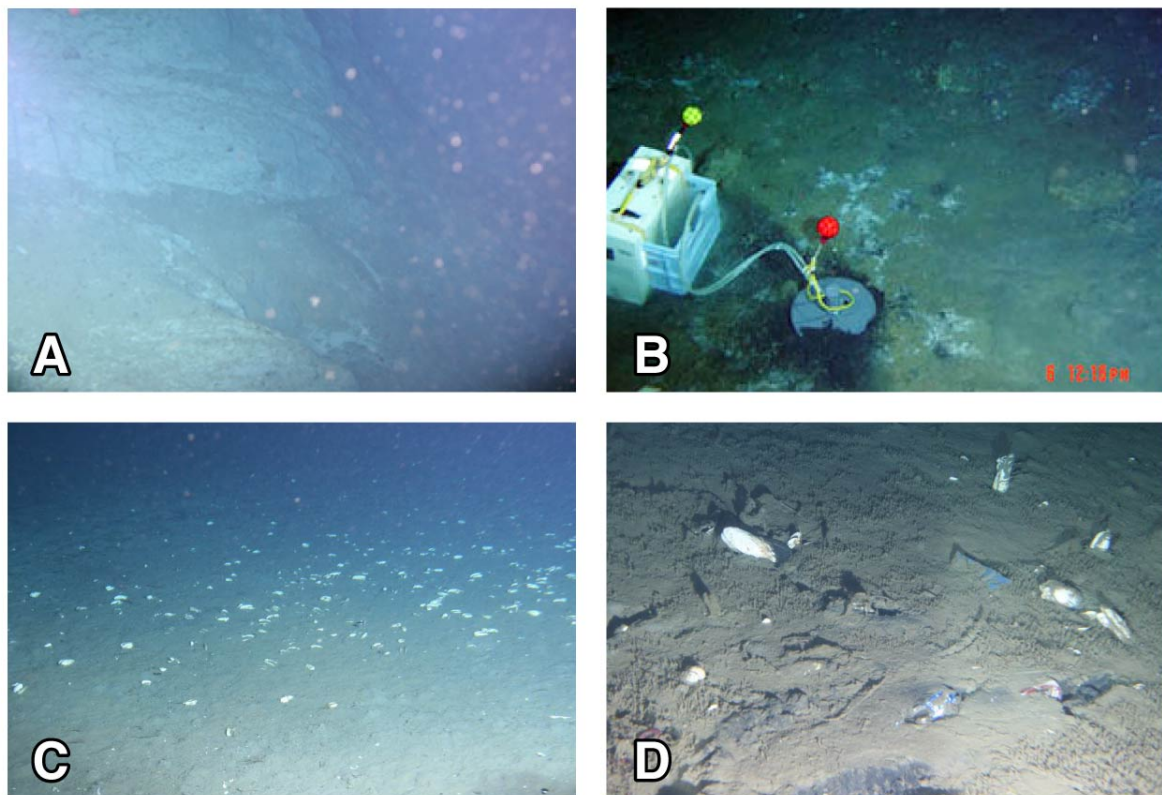


Fig. 2 Select photographs. (A) NE-SW trending steep slope during Dive#1061. (B) CAT-meter deployment at the fault scarp during Dive#1062. (C) Dead clam colony southeast of the No. 8 Kumano Knoll observed on Dive#1063. (D) Seep site located south of the knoll during Dive#1063.