Cruise Summary

1. Cruise information

1-1. Cruise number: YK08-07

Ship name: R/V Yokosuka and S/V Shinkai 6500, JAMSTEC

1-2. Title of the cruise: Proposal number S08-24

Scientific title: Three-dimensional configuration of earthquake faults concerning the recent great earthquakes -- Seafloor tectono-morphology of the eastern Amur Plate and its genesis

1-3. List of participants of onboard scientific party:

Chief Scientist:	Akira Takeuchi	*1	(Representative of the science party)
Deputy Chief Scientist:	Masato Joshima	*2	
Scientists:	Testuya Miwa	*3	
	Taku Nemoto	*4	
	Hajime Chiba	*5	
Students:	Kanako Yoshida	*6	
	Kyohei Matsumoto	*6	
	Badalahu Bao	*6	
Marine Tech.:	Satoshi Okada	*7	

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*7 Nippon Marine Enterprise, Ltd.

1-4. Cruise period and port calls: May 29-June 18, 2008 (Kurihama to Yokosuka, JAMSTEC)

1-5: Research Area: Northeastern margin of Japan Sea within the region enclosed by the following coordinates:

Surface survey: 41°10.0’N-43°30.0’N, 138°30.0’E-139°45.0’E; 2000～3600m.w.d.

Submersible dives : 42°30.0’N -43°10.0’N, 139°00.0’E -139°45.0’E; 2500～3350m.w.d.

2. Shinaki 6500 dive list

#1075: Masato Joshima / Lat. N42°42.5’ Lon. E139°30.4', 3323 m.w.d / Closer inspection of bottom ruptures formed at the 1993 Hokkaido Nansei-oki earthquake (1)

#1076: Taku Nemoto / Lan. N42°42.5' Lon. E139°30.4', 3323 m.w.d / Investigation of microbial mat in the tsunami source area of 1993 Hokkaido Nansei-oki earthquake

#1077: Tetsuya Miwa / Lat. N42°45.6' Lan. E139°28.9', 3327 m.w.d / Seabed ecological surve y along the zone of earthquake rupture

#1078: Hajime Chima / Lat. N42°45.4' Lon. E139°28', 3322 m.w.d / Acoustic imaging of the bottom rupture zone of the 1993 Hokkaido Nansei-oki earthquake

#1079: Akira Takeuchi / Lat. N42°57.0' Lon. E139°27.8', 3333 m.w.d / Closer inspection of bottom ruptures formed at the 1993 Hokkaido Nansei-oki earthquake (2)

#1080: Masato Joshima / Lat. N42°53.64' Lon. E139°26.7', 3293 m.w.d / Closer inspection of bottom ruptures formed at the 1993 Hokkaido Nansei-oki earthquake (3)

#1081: Tetsuya Miwa / N42°53.64' E139°24.66', 2570.6 m.w.d / Investigation of bottom disturbance at around drill holes of ODP 796

#1082: Akira Takeuchi / Lat. N42°46.9' Lon. E139° 10.8', 3250 m.w.d / Investigation of bottom disturbance at around the epicenter of 1993 Hokkaido Nansei-oki earthquake

#1083: Hajime Chima / Lat. N42°41.9' Lon. N42°41.9', 3145 m.w.d / Cold seepage and microbial mat at the bottom off Cape Motta (1)

#1084: Taku Nemoto / Lat. N42°41.9' Lon. E139°41.4', 3145 m.w.d / Cold seepage and microbial mat at the bottom off Cape Motta (2)

3. Overview of Observations

3-1. Objectives: The purpose of the cruise R/V YOKOSUKA YK08-07 is to investigate seafloor geomorphology of the eastern margin of Amur Plate and three-dimensional configuration of earthquake faults concerning the recent great earthquakes. During the cruise in the northeast margin of Japan Sea, ten dives (1075-1084) of manned submersible Shinkai 6500 were conducted onto the Okushiri Ridge and the Shiribeshi Trough, off southwest Hokkaido.

3-2. Results

3-2-1. Earthquake Geology:

(1)Sub-bottom profiler made clear that the active fault along the west margin of Shiribeshi trough is a low-angle reverse fault, which inclines to the Okushiri ridge, and that the unit vertical displacement was about 2.0 m. Moreover, underground deformation corresponds with distribution of tectonic features in the bottom geomorphology, such as sand-blow traces, auto-brecciations, and microbial mats due to cold seepages.

(2) Sea bottom of the very epicenter of the 1993 Hokkaido Nansei-oki earthquake on the west side slope of the Okushiri Ridge was composed of semi-consolidated sedimentary layers, which has been damaged remarkably by high-speed destruction in situ, 'auto-brecciation', as occurred in the zone along the surface

earthquake fault where large-scale landslides and slope collapses had also occurred on the east slope of the Ridge.

(3)Temporal changes in the co-seismic disturbance of the sea bottom, 15 years aging since the earthquake were observed. The fundamental data for paleoseismological age-determination were obtained.

3-2-2. Deep-sea ecosystems

The relation between a microbial mat and an active fault became clear. That is, microbe mats would not be distributed everywhere in the Japan Sea bottom but along with the earthquake faults as was observed in the source area of the 1993 Hokkaido nansei-oki earthquake. Remarkable microbial mats were formed and sustained along the boundary fault with the sedimentary flat of the Shiribeshi trough.

Such an east-west asymmetry clearly indicates a west-dipping reverse faulting for the earthquake source fault. Moreover, the linear zonal arrangement of cold seepages and microbial mats along the source fault suggests that (a) this sub-bottom active fault serves as a gush passage of the groundwater to cultivate microbes and also that (b) the deeper fluid might participate in earthquake generation.

(1) At the basin bottom (3300 m.w.d) and surrounding, the organisms mainly composed of amphipods and polynoids show that biological density is not so high. On the flank of the Okushiri ridge, the shallower the dive ascent, the more benthics were seen. As for small scallop *Delectopecten randolphi*, larger individuals are distributed particularly in the shallower slope. Swimming organisms such as fish and jellyfish were not observed there.

(2) As for biota, in contrast to the basin floor, more biological on the ridge slope, although variety in type is not so wide. There was no significant difference in the density of organisms between the east flank and the west slope of Okushiri Ridge.

(3) The cruise collected large amounts of samples such as small bivalve-shells, sea slugs (*nudibranchia*), internal organs of polynoids, and many shells of small scallop. The former two might be described as new species.

(4) Number of dead squid falling from the shallow water was observed feeding benthic organisms.

(5) Biota in the water depth larger than 2500 m.w.d is monotonous while the diversity of biota in shallower waters less than 2300 m.w.d were recognized as the abrupt emergence of fish and crabs. It is determined that this change cannot be attributed to water temperature because of its constancy (0.2 ~ 0.3 °C). The water pressure distribution, as well as the abundance ratio of the food and ocean currents, etc., could explain as the biological factors of the abrupt change in biota in the Japan Sea. Contrarily, low diversity of life in the Japan Sea due to its obstructive tendency may help to follow up certain deep-sea organisms and species, and give rise to a good model to investigate the dependence of pressure.

3-2-3. Earthquake damage of ODP Hole 796

The discovered hole-A of ODP 796, excavated four years before the earthquake, located in the source region of the 1993 earthquake, was unhurt for appearance. The hole-B may have collapsed in case of the same earthquake because of its location on the mass-wasted slope. It is possible that the strong ground motion is controlled to be suppressed due to the volcanic basement of sedimentary layers, which is as

shallow as illustrated by the seismic reflection profiles.

3-2-4. Ocean chemistry

Focusing on the Okushiri ridge and the Shiribeshi trough, geochemical samples were taken from deepest water, bottom water, and sediment pore water under a variety of geologic conditions. We expect the continued elucidation of the factors of perennial change in marine environment of the sites of cold seepage and surroundings as well as habitat conditions of microbial mats.

4. Conclusion on Paleoseismology

4-1. The submersible dives visited the epicenter of the 1993 Hokkaido Nansei-oki earthquake on the west side slope of the Okushiri ridge for the first time. Sea bottom composed of semi-consolidated sedimentary layers has been damaged remarkably by high-speed destruction in situ, that is, ‘auto-brecciation’.

4-2. Large-scale landslides and slope collapses had also occurred on the east slope of the same ridge. Remarkable microbial mats were formed along the boundary fault with the sedimentary flat of the Shiribeshi trough. Such an east-west asymmetricity clearly indicates a west-dipping reverse faulting for the earthquake source fault. Moreover, the zonal arrangement of cold seepages and microbial mats along the source fault suggests that the fluid took part in the earthquake occurrence.

4-3. The discovered hole-A of ODP796, excavated four years before the earthquake, located in the source region of the 1993 earthquake, was unhurt for appearance. The hole-B may have collapsed in case of the same earthquake because of its location on the mass-wasted slope. It is possible that the strong ground motion is controlled to be suppressed due to the volcanic basement of sedimentary layers, which is so shallow as illustrated by the seismic reflection profiles.

4-4. In order to compare the surface geological structure with the deep hypocenter fault, re-analysis of the reflection data with comparison to the various data obtained by the cruise is going to be carried out from now on.

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