

## NT10-10 Leg 2 Cruise Summary

### 1. Cruise Information

#### 1.1 Cruise ID

NT10-10 Leg 2

#### 1.2 Ship Name

R/V *Natsushima*

#### 1.3 Title of the Cruise

ROV *Hyper-Dolphin* submersible survey

#### 1.4 Chief Scientist

Hideaki Machiyama (JAMSTEC)

#### 1.5 Title of the Proposal & Representative of the Science Party

#1) Hydrological regime and properties of seafloor accumulation and auto-collapse of methane hydrate under high methane flux environment (Proponent: Hideaki Machiyama, JAMSTEC)

#2) Search for a linkage between the BSR and bottom water methane anomalies along the Toyama Deep Sea Channel in Toyama Trough (Proponent: Toshitaka Gamo, AORI, Univ. Tokyo)

#### 1.6 Cruise Period

June 12 – 21, 2010

#### 1.7 Ports of Call

June 12 Departure     Miyako Port, Iwate

June 21 Arrival        JAMSTEC Pier, Yokosuka, Kanagawa

#### 1.8 Research Area

Japan Sea – western Joetsu Basin and the Toyama Trough –

This cruise was carried out in the western Joetsu Basin for the research proposal #1 and the northern Toyama Trough for the research proposal #2 (Fig. 1).

### 2. Overview of the Observation

#### 2.1 Research proposal #1

##### **1) Background and Objectives**

Joetsu Gas Hydrate Field of the western Joetsu Basin in the eastern margin of the Japan Sea is one of the best fields for gas hydrate studies. There are many methane plumes and active methane seeps associated with gas hydrate blocks in the several mounds on the Umitaka Spur and Joetsu Knoll. Heat flow measurement through nine research cruises in 2004–2008 showed not only extremely high heat flow anomalies but also non-linear temperature profile such as concave/convex profiles and negative geothermal gradients on the mounds. The distribution of high heat flow anomalies and non-linear temperature profiles is important to understand a hydrological regime in the high methane flux area of the Joetsu Gas Hydrate Field.

The main purpose of this research proposal is to clarify the detailed fluid flow around the high methane flux area using multipoint heat flow measurement. The other research purposes are 1) to clarify the relationship between bottom water temperature fluctuation and the negative geothermal gradient in the Japan Sea Proper Water, 2) to evaluate the amount of free gas in sediments using TDR method, 3) to clarify fluid geochemistry, 4) to verify the relationship between benthic organisms and

methane seeps using stable isotope geochemistry, 5) to evaluate the methane plume activity using MBES.

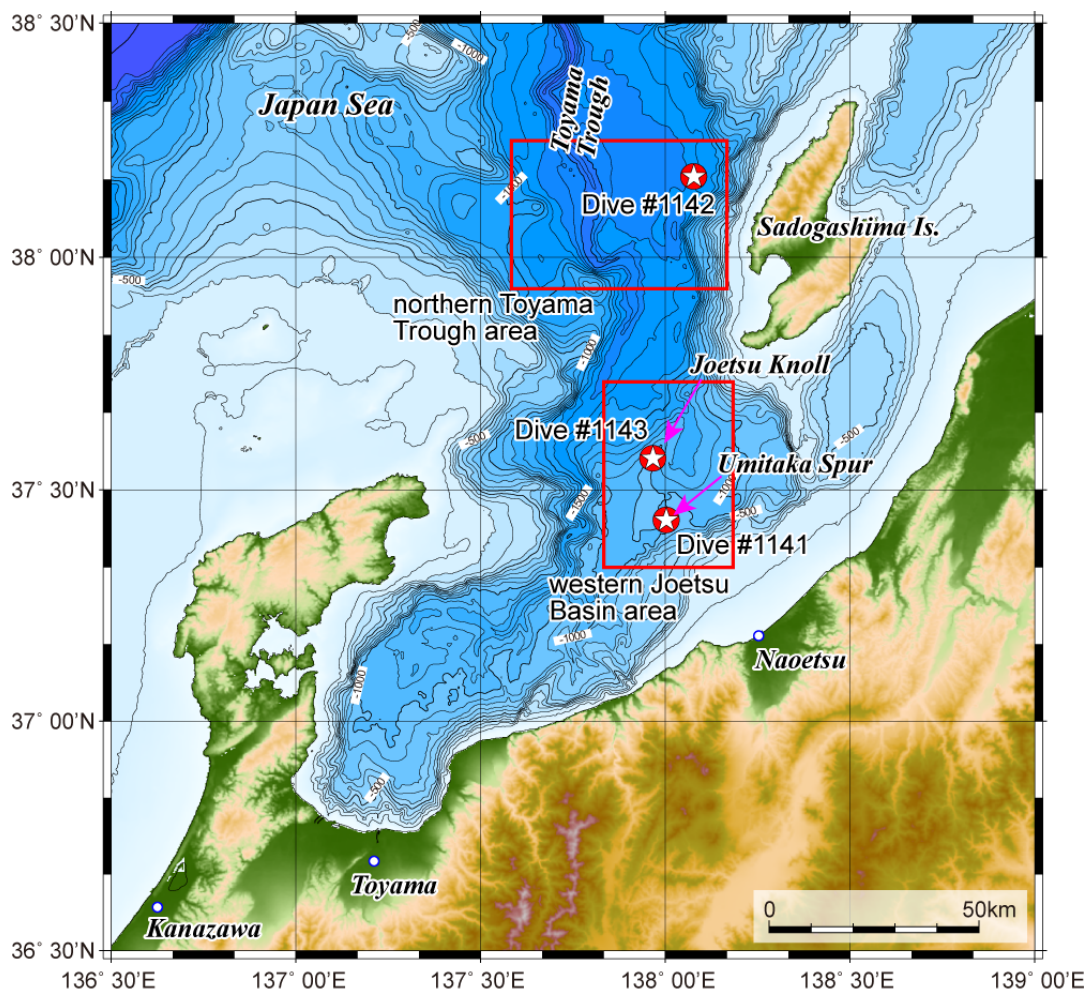
## 2) Methods and Instruments

We conducted 1) heat flow measurement using SAHF, 2) TDR measurement, 3) deployment of a water temperature data logger for long-term monitoring, 4) sampling of sediments and carbonates, 5) sampling of organisms using slurp gun, and 6) methane plume survey using MBES.

## 3) Onboard Results

ROV submersible survey, HPD Dive #1141, was carried out on the western to southwestern slope of the southwestern mound in the middle part of the Umitaka Spur. Seafloor on the western slope of the southwestern mound is covered by muddy sediments. Carbonate crusts crop out around the upper slope, where ascidian *Megalodicopia hians* occurs. A number of carbonate crusts and bacterial mats are found around the western margin of the mound. We found the bacterial mats which were investigated in the NT07-20 Cruise on the southwestern slope of the mound. We conducted multipoint heat flow measurement, TDR measurement, and sampling of sediments and organisms. At some stations, heat flow measurement shows kinked and upward concave temperature profiles.

HPD Dive #1143 was carried out around a mound on the middle part of the Joetsu Knoll. Carbonate crusts are scattered on seafloor on the western slope of the mound. We found a few flocks



**Fig. 1** Index map of the research area and the dive points in the NT10-10 Leg 2 Cruise.

of red snow crabs gathering around of large carbonate crusts. This may be one of red snow crab behaviors. We deployed a water temperature data logger on the western margin of the mound. The crater-like depression discovered in the NT07-20 Cruise is now covered by about 30 cm- to 50 cm-thick muddy sediments. This means that sedimentation rate is extremely high in this area. We conducted multi-point heat flow measurement, TDR measurement, and sampling of push cores and some benthic organisms. Methane bubbles emerging from the seafloor were observed when SAHF was penetrated into the seafloor by 20-30 cm and was pulled out.

Acoustic methane plume survey using MBES was carried out on the summit of the Umitaka Spur and the Joetsu Knoll. Comparing investigation will be carried out after cruise.

## 2.2 Research proposal #2

### 1) Background and Objectives

The purpose of the study is to search for a linkage between the bottom simulating reflector (BSR) in seismics and bottom water methane anomalies geochemically detected along the Toyama deep-sea channel in Toyama Trough.

This research project aims firstly to specify the sub-bottom source of supply of methane plume detected with the previous observations of marine chemistry during the ‘Tansei-maru’ cruise. Our target areas were selected carefully based on characteristics of detailed geomorphology and seismic prospecting data as well as the experience that we found the outcrops of pure methane hydrate in the previous research, NT06-19 Leg 1. The second aim is to find places of cold water seepage which discharge biogenic methane in origin different from the thermogenic as was found in the coastal area in the southern Toyama Trough, including the JOGMEC basic prospecting area ‘Sado Nansei-oki’.

### 2) Methods and Instruments

We conducted bathymetric survey in three subareas. In ROV submersible survey, we also conducted 1) observation of geology and geomorphology, 2) sampling of sediment cores and rocks, 3) sampling of organisms using slurp gun, 4) sampling of seawater using Niskin water sampler, and 5) heat flow measurement using SAHF.

### 3) Onboard Results

Area A1 for submersible survey point was selected by the result of bathymetric survey. We recognized many strong back-scattering spots, which suggest some source materials such as chemosynthetic organisms, carbonate crusts, pock marks bared sandy and/or gravel-rich seabed, and buried gas-hydrate dome.

HPD dive #1142 was carried out on the eastern margin of sediment flat of the central Toyama Trough. No outcrop of bedrock was observed through the surveyed route but sometimes dense fields of sea anemones were happened to be found on muddy bottom. They stood on buried stones within the surface mud less than several centimeters in thickness. An interesting rubble mound is discovered at 1776m.w.d. bottom. Most rubble is of rectangular shaped rhyolite but planar carbonate crusts were also observed on the entire mound surface. One tip of carbonate crust was recovered interstitial spaces (matrix) of this rubble mound were filled by pale skin-colored, kaolin clay. Consequently, this mound concluded to be an old vent of a small ‘mud volcano’, although it includes many lags of rhyolite and rhyodacite. To conclude the dive HPD #1142, it observed the facies boundary between sedimentary flat and piedmont apron of debris flows, although entire region is covered by fragile mud.

The A1 area is composed of an intercalation (alternation) of debris flow deposits and hemipelagic and fluvial (back swamp) formations.