

Japan Agency for Marine Science and Technology

1. Cruise Information

- Cruise ID YK15-10
- Name of Vessel R/V Yokosuka
- Cruise Title Investigation on Mud Volcano-like feature on the Kumano
 Basin Edge Fault Zone -The fight against Kuroshio Current
- Chief Scientist and Representatives of the Science Parties
 Miho ASADA [JAMSTEC]
- Title of proposal Investigation on Mud Volcano-like feature on the Kumano Basin
 Edge Fault Zone
- Cruise Period 16th June 2015 – 23rd June 2015
- Ports of Call Shimizu ~ JAMSTEC, Yokosuka
- Research Area Kumano Basin and Kumano Basin Edge Fault Zone

2. Researchers

2-1. Onboard Scientists and Marine Technician

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Graduate School of Science and Engineering, YAMAGUCHI University

MITSUTERU KUNO, Marine Technician, Nippon Marine Enterprise Ltd.

On Shore Scientists

TAKUROH NOGUCHI and KANAE KOMAKI

Kochi University

2-2 AUV Urashima Operation team

AKIHISA ISHIKAWA	Operation Manager
KEITA MATSUMOTO	1st Submersible Staff
KEIGO SUZUKI	2nd Submersible Staff
FUMITAKA SAITO	2nd Submersible Staff
RYO SAIGO	2nd Submersible Staff
YUDAI TAYAMA	2nd Submersible Staff

2-3. R/V Yokosuka Officers and Crews

YOSHIYUKI NAKAMURA	Captain
YASUHIKO SAMMORI	Chief Officer
TSUBASA SHIOJIMA	2nd Officer
RYO YAMAGUCHI	3rd Officer
KAZUNORI NOGUCHI	Chief Engineer
DAISUKE GIBU	1st Engineer
KENTA IKEGUCHI	2nd Engineer
YOSHIHIRO OTSUGA	3rd Engineer
FUKUO SUDA	Chief Electronic op.
YUKA MORIWAKI	2nd Elect. op.
YOSHIKAZU KURAMOTO	3rd Elect. op.
EMI SAWAYANAGI	Jr.3rd Elect. op.
TADAHIKO TOGUCHI	Boat Swain
YUKITO ISHII	Quarter Master
YUKI YOSHINO	Quarter Master
NAOKI IWASAKI	Quarter Master
TAKUYA MIYASHITA	Quarter Master
JUN SHINODA	Sailor
YUTA MOTOOKA	Sailor
RYUSEI KANEKO	Sailor
KATSUYUKI YOSHIDA	No.1 Oiler

KAZUO SATO	Oiler
SOTA MISAGO	Oiler
HIROMU FUKUDA	Assistant Oiler
SEIYA WATANABE	Assistant Oiler
KEISUKE KANEMITSU	Assistant Oiler
TORU WADA	Chief Steward
KATSUYUKI OMIYA	Steward
MASANAO KUNITA	Steward
YOSHITAKA YAMAMOTO	Steward
KOKI SHINOHARA	Steward

3. Introduction to the Cruise

3.1 Overview of the cruise YK15-10

The Kumano Basin Edge Fault Zone (KBEFZ) is settled bathymetrically at a boundary between a flat Kumano Basin and the Nankai Trough. There are a large number of faults on the KBEFZ, which is developed characteristic geology on this area. Bangs et al. (2010) suggests that the characteristic bathymetric feature, the notch, was made by bursts of seafloor by methane hydrate dissociation, which would be triggered by drastic faulting. Martin et al. (2010) indicates that the KBEFZ is developed strike-slip fault zone and related the notches due to a zonal contraction and consequent strain partitioning by a northwestward pushing of the Philippine Sea Plate subducting obliquely beneath the Eurasia Plate. The IODP result has reported such a regional limited-extensional stress field near the KBEFZ although there are a compressional stress field in general, based on a distribution of stress field measured by stress sensors installed into several wells (Lin et al., 2010).

A mud volcano-like structure being characterized by an acoustically transparent dome thrusting through the BSR and dragging up the sediment layers was found at the KBEFZ using 3D seismic images. We conducts high-resolution acoustic observation using the *AUV-Urashima* on the Mud volcano-like structure. The first priority of our cruise is to find out mud flow and/or crater on and around the Mud Volcano-like structure, and to know history of activity of the Mud volcano-like structure. Based on these results, we aim to discuss why and how the Mud volcano-like structure was appeared at the KBEFZ.

3.2 Cruise objectives

- To find out Mud Volcanoes at Kumano Basin Edge Fault Zone
- To observe Tectonic features around the Mud Volcanoes
- To observe chemosynthetic hydrothermal features and geological features such as landslides via high-resolution acoustic investigation

3.3 Research area

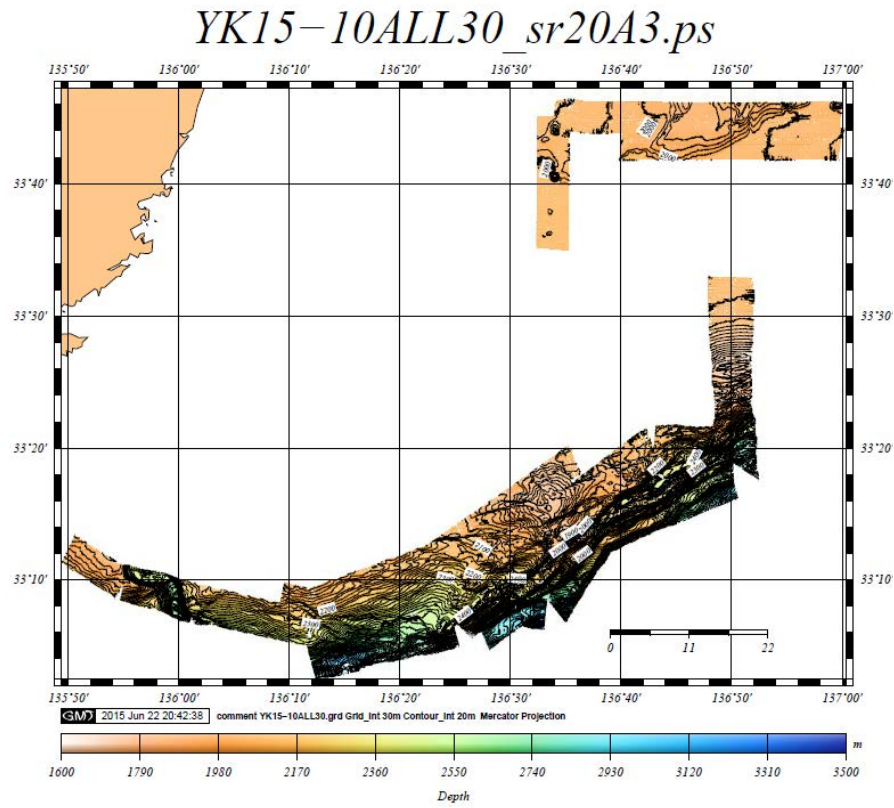


Figure 1. Bathymetry map obtained by our cruise

Table 1. Ship log of the cruise

16 June	Sail out, proceeding to research area from Simizu port	East-4 (Moderate breeze)
17	"Urashima" dive#211	NE-4 (Moderate breeze)
18	Avoid rough sea off Shimotsu(Wakayama) port.	North-2(Light breeze)
19	Avoid rough sea off Shimotsu(Wakayama) port and proceeding to research area.	North-4 (Moderate breeze)
20	Break "Urashima" dive & MBES survey.	SE-3(Gentle breeze)
21	"Urashima" Dive#212	NE-3(Gentle breeze)
22	"Urashima" Dive#213	ENE-2(Light breeze)
23	Disembarked at JAMSTEC	

4. Equipments

4-1. Surface Geophysical Survey

We conducted a multi-narrow bathymetric survey, and collected bathymetry data and backscattering strength distribution. Multi-narrow beam bathymetric data were obtained using a KONGSBERG EM122 (Swath width 50° x 50°; 432 beams with its width of 2°). XBTs were done in the research area (Table 4-1-1). We also conducted sub-Bottom profiler survey using RedgeTech 3300-HM (beam angle 30°) during this cruise. The GPS (Global Positioning System) was used to derive the ship location.

4.1.1 XBT Operation

Sampling interval: 50 msec

Detectable Temperature: -2.22~35.55 deg.C

Accuracy: ±0.2 deg.C

Table 2. XBT sites

Data number	Data	Latitude	Longitude
0145	2015/06/16 11:03:10	33-34.8004N	136-50.8821E
0146	2015/06/16 21:03:33	33-16.4735N	136-33.7377E
0147	2015/06/17 11:14:57	33-09.5912N	136-24.2219E
0148	2015/06/19 21:00:37	33-13.0094N	136-37.6057E
0149	2015/06/20 05:37:30	33-34.5726N	136-33.9072E

4.1.2. Kongsberg multi-beam echo sounder

Kongsberg EM122

Frequency: 12 kHz

Swath: 120° along the first night survey, and 100° for following lines

Beam Width: 2°

Number of receiving beams: 288

Number of points: 432 (2×2°)

Beam pattern: Equi-distance mode

Real-time Processing: inflection at seafloor and flexion of acoustic signals

Method of seafloor detection: Intensity and phase difference

Pulse length: 2, 5, 15 ms (FM chirp)

Range interval: 2kHz (37cm)



4.1.3 Sub-bottom profiler

Sub bottom profiler 3300-HM (EdgeTech)

Transducer array: 4x4 device flat array

Range of frequency: 2~16 kHz, Center Frequency

Type of pulse: FM

Band width: 2~16 kHz

Pulse length: 5~100 ms

Resolution: 8cm, 2~12 kHz

Penetration: 6 m (sand), 80 m (soft clay)

Beam width: 3.5 kHz 4.5 kHz 6 kHz

4×4 33° 24° 20°



4.1.4 ADCP

Ultrasonic multi-layered ADCP

Teledyne RD Instruments, OS-ADCP

Frequency: 38 kHz

Type of trasducer: phased array

Beam number: 4

Beam angle: 30 degree

Number of layer: 128 layers (max)

Transmitting interval: 0.4 Hz (minimal)

thickness of layer: 4~64 m (broadband, configurable)

8~64 m (narrowband, configurable)

Controlled display and software: VmDas, WinADCP, etc.



4.2 Deep-sea observation using AUV "Urashima"

Developed by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) since 1998, "Urashima" is one of the largest AUVs currently working in the world. Its large size enables the Urashima to realize the long duration, leading to the long cruise range of 100 km (with Li-ion battery), or 300 km (with fuel cell). As an underwater navigation device, Urashima employs high-precision inertial navigation system (INS) composed of ring-laser gyro and Doppler velocity log (DVL). During the dive, Urashima collects oceanographic data such as salinity, water temperature, pH, conductivity, and dissolved oxygen. At the same time, Urashima is able to investigate the sea bottom and sub-bottom structure by using acoustic imaging devices such as side scan sonar (SSS) or sub-bottom profiler.

Table 3. Principal dimensions and main specifications of *Urashima*.

L.O.A.	10 m
Breadth	1.3 m
Height	1.5 m
Cruising speed	2.2~2.3 kts
Max. Operating Depth	3500 m
Mass	10000 kg
Observation Equipments	- Side Scan Ssonar and Sub-Bottom Profiler (EdgeTech2200) - Multi-Narrow Beam (Seabat7125) - CTD etc



4.2.1 pH sensor

pH sensor are deployed to detect pH anomaly of the methane bubble release from mud volcanoes. The sensor (pH-12, Kimoto Elec.) is composed with the glass electrode and reference electrode. These electrodes are converted by the vinyl chloride, which is controlled by pressure. Sampling intervals was set to 1 min during the YK15-10, measuring day and night (in air and water) through the cruise.



Arrangements of the pH meter installed in *Urashima*.

4.2.2

Multi-beam echo sounder

Seabat7120

Frequency: 400 kHz

Transmitting power
: 208 db

Beam range: 200 m

Ping interval: 400 msec

Pulse length: 160 msec

4.2.3 Sidescan sonar

and Sub-bottom profiler

EdgeTech2200

SSS

Frequency: 100 kHz

Transmitting power
: 210 db

Ping interval: 500 msec

SBP

Frequency: 1~6 kHz chirp

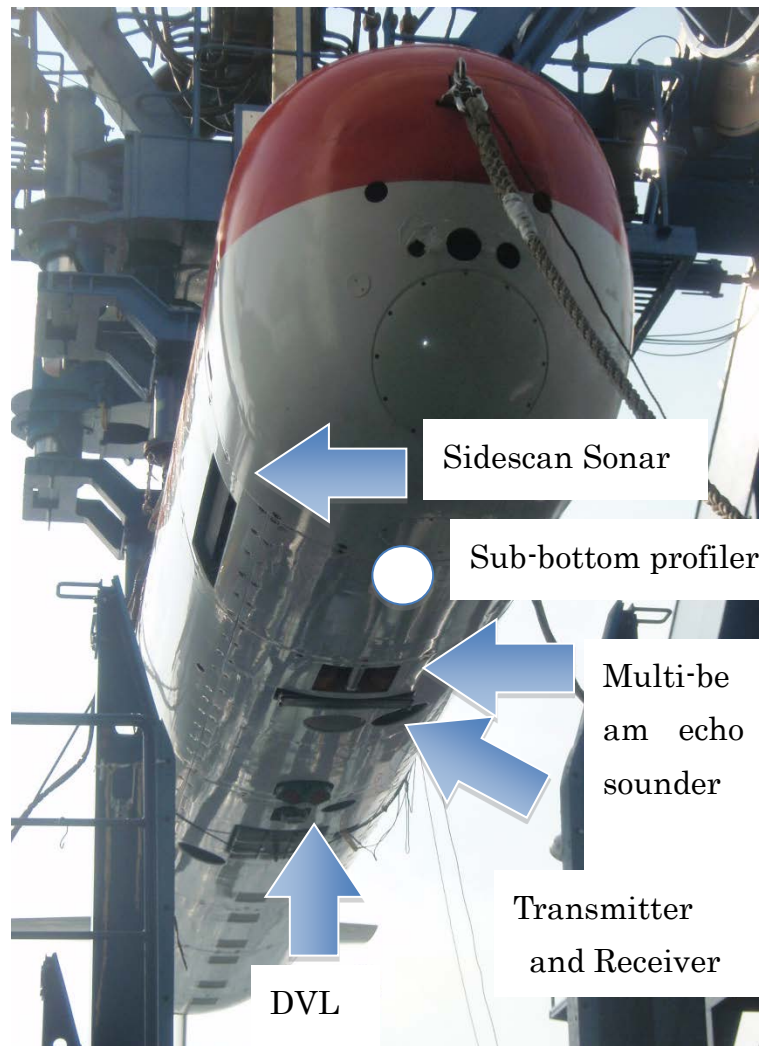
Transmitting power: 202 db

Beam width: 30°

4.2.4 Doppler Velocity Log

Frequency: 300 kHz

Pulse interval: 800 msec



5. AUV Dives

5.1 Urashima dive #211

Date : 17th Jun., 2015

Dive event log

07:07	Hoisted up "Urashima" .
07:15	Launched "Urashima".
08:58	"Urashima" started dive#211.
16:25	"Urashima" released ballast.
16:59	"Urashima" refloated.
17:28	Recovered "Urashima" & finished the operation.

5.2 Urashima dive #212

Date: 21th June, 2015

Dive event log:

07:12	Hoisted up "Urashima" .
07:21	Launched "Urashima".
08:50	"Urashima" started dive#212.
16:30	"Urashima" released ballast.
16:56	"Urashima" refloated.
17:54	Recovered "Urashima" & finished the operation.

5.3 Urashima dive #213

Date: 22th June, 2015

Dive event log

07:26	Hoisted up "Urashima" .
07:34	Launched "Urashima".
08:40	"Urashima" started dive#213.
12:00	"Urashima" released ballast.
12:29	"Urashima" refloated.
13:26	Recovered "Urashima" & finished YK15-10.

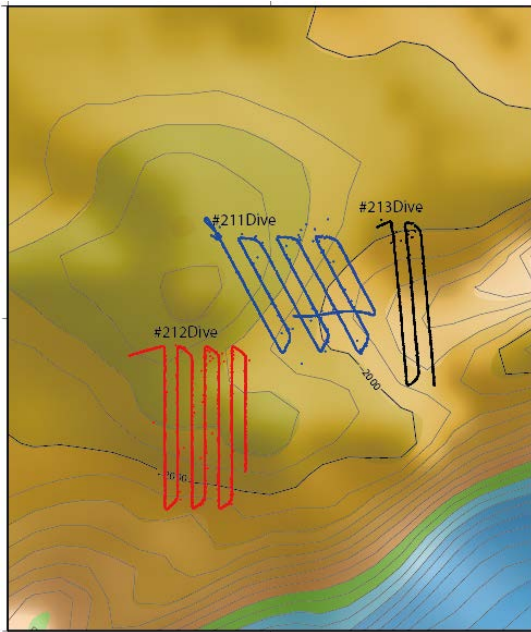


Figure 2. Vehicle trajectory of *Urashima* dive #211 (blue), #212 (red), and #213 (black).

6. Preliminary Result

During the cruise YK15-10, our AUV investigation reveals that the MV-like feature shows a prominent bathymetrical feature on multibeam echo sounder data, mudflow-like facies on sidescan sonar imagery, acoustically transparent body below the ~50 m seafloor on sub-bottom profiler image, and anomalous pH sensor data. All of these data strongly indicate MV activity at the KBEFZ.

The strong Kuroshio Current and seasonal rainy front are the most difficult problem on our cruise. The strong Kuroshio Current keep bad sea state for long time, so that not only AUV dives but also almost all of shipboard investigation was difficult through the cruise. To do enough observation, we should choose cruising season more carefully and we are needed efforts for arranging design of survey lines those are not resist the strong Kuroshio Current.

7. Acknowledgment

The author would like to express thanks to all officers and crew members of R/V-Yokosuka and AUV-Urashima, Captain Nakamura and AUV-operation Chief Ishikawa, heading the list. It is their every effort that enabled us to complete our mission in YK15-10 cruise.

2015/07/23□