NT10-02 Sea Trial Report【Summary】

Engineering tests using "MR-X1", a working type AUV and its applications for oceanographic, plate dynamics and biological researches.

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1. Introduction

JAMSTEC is currently conducting a research and development project of the next generation autonomous underwater vehicle (AUV) as the part of "Key Technologies of National Importance" since 2006. The goal of the project is to develop an AUV with the ability of long range over 3,000 km and large payload for surveys of natural resources, improvement of earthquake predictions, and environmental researches. In the initial-five year period, we have concentrated in the improvement of power sources, navigation systems, control systems, acoustic communications, and sonars. On the other hand, science communities need these technologies application to develop new scientific tools.

In this trial, we had two main purposes: engineering evaluations of the developed systems in the project, and scientific applications of our technological capabilities. We had tested a lithium-ion battery system, an inertial navigation system, a distributed CPU system, a synthetic-aperture sonar, a geostationary satellite communication system, and underwater laser propagation measuring system were tested using underwater test-beds as engineering test. For palaeoenvironmental researches, a newly developed mud sampling tool was installed on the hybrid vehicle "MR-X1" and samplings were performed. Geomagnetic observations were also performed with a modified cesium magnetometer which was installed on the MR-X1. A small vehicle "PICASSO" had tested and operated for plankton surveys.

2. Cruise information

Ship:	R/V Natsushima
Period：	Jan. 22, 2010 ~ Feb. 9, 2010
Port call：	JAMSTEC ~ Beppu ~ JAMSTEC
Area：	Sagami-bay, Suruga-bay, and Beppu-bay

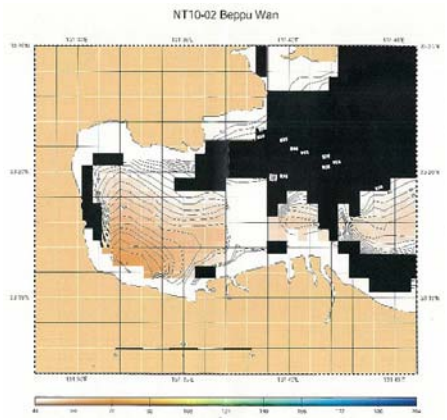

Fig. 1. A diving point at Beppu-bay

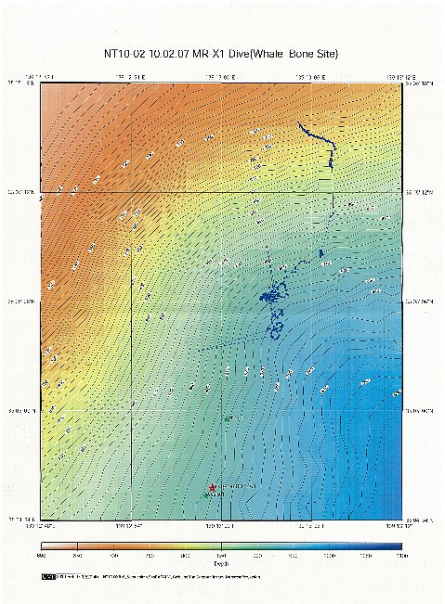

Fig. 2： A MR-X1 track in Sagami-bay

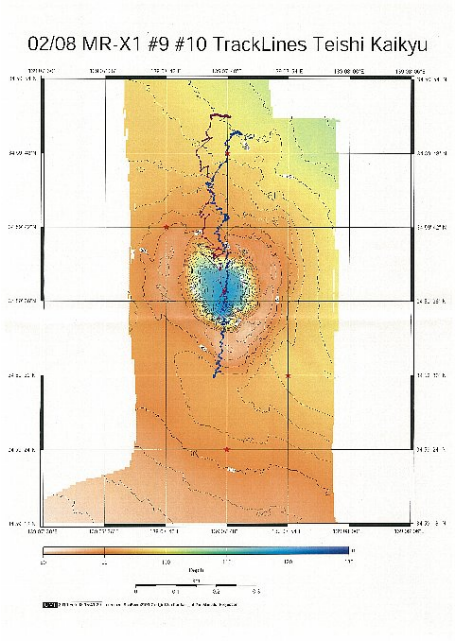

Fig.3： MR-X1 tracks in Teishi-knoll.

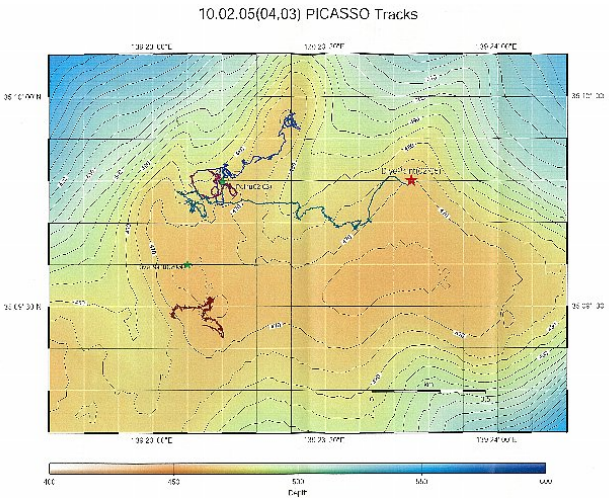

Fig.4: Picasso tracks in Sagami-knoll.

3. Vehicles and tools

3.1 The working type hybrid AUV, “MR-X1”

This vehicle is used as an underwater platform for engineering evaluations.

Fig. 5：MR-X1

Weight：	800～900 kg
Dimension:	2.5 (L) x 0.8(W) x 1.2(H) m
Max. depth rating:	4,000 m
Operation mode:	UROV / AUV
Navigations:	INS, DVL, Depth meter, Altimeter
Observations:	TV camera, Side scan sonar (option)

3.2 Magnetometer and Mud Sampler

Fig. 6： The MR-X1 with the mud sampler (left) and the cesium magnetometer (right).

3.3 A plankton survey robot “PICASSO”

Fig. 7：PICASSO

3.4 The other tools

A small inertial navigation system, a synthetic-aperture sonar, a geostationary satellite communication system, and underwater laser propagation measuring system were testted.

4. Results

4.1 Total number of tests and dives

MR-X1 dives	8 dives	（including mud samplings and magnetometer tests）
PICASSO dives		5 dives

Underwter laser propagation test	4 times
SAS tests	2 times
INS tests	1 times
Geostationary satellite communication tests	5 times
Total	**13 dives and 12 tests**

4.2 Tests

1) Elemental technology evaluations

Modern and classical control theory applications installed on the space distributed CPU system successfully controlled the MR-X1 which was powered by the high-energy lithium-ion battery system (120V, 30 Ah x 2), system.

2) The mud sampler and the magnetometer

The MR-X1 equipped with the mud sampler was tested in Beppu-bay. The vehicle equipped with the magnetometer was tested in Teish-knoll.

3) Satellite communication tests

Using Engineering test satellite VIII, underwater video images were transmitted to the office of JAMSTEC in real time. The connection between a ship-side PC and JAMSTEC's local area network was tested.

4) Laser propagation loss measurements

A laser test frame developed was deployed from Natsushma. We obtained propagation data near the sea-floor at depth of about 350 m in Sagami-bay.

5) The synthetic-aperture sonar tests

A special towed system equipped with the SAS was deployed form Natushima in Sagami-bay and Suruga-bay.

6) The INS test

To evaluate the advantages of the bias-error canceling and gyro-drift canceling system developed, we measured whole errors of the INS system during ship-cruising.