4.4. R/V Natsushima and ROV Hyper-Dolphin

Ocean research vessel Natsushima was built as a support vessel of submersible SHINKAI 2000 in 1980s. R/V Natsushima was reconstructed as a support vessel of Hyper-Dolphin.

4.4.1 General Information about R/V Natsushima

Ayumi Mizota, Keigo Suzuki, Yui Hashimoto, and Satoshi Shimizu

Length:	67.4m	Bow thruster:	1
Width:	13.0m	Maximum speed:	12kt
Depth:	6.3m	Duration:	8400 mile
Max capacity:	55 persons		
Gross Tonnage:	1553t		
Main prop:	2 axis, CPP		

4.4.2 Research Equipment

Ayumi Mizota, Keigo Suzuki, Yui Hashimoto, and Satoshi Shimizu

(1) PDR

This can record a water depth at right below and make contour map together with navigation data.

Max depth: more than 3000m

Record Range: 200～800m (changeable)

Frequency:	12 kHz +/-5%
Output:	more than110dB (0dB ubar at 1m)
Directivity:	conical beam pattern
Beam width:	15deg. +/-5 deg. (-3dB)
Pulse width:	1, 3, 10, 30msec

(2) XBT equipment

XBT profile a vertical water temperature by free-fall probe.

Maximum measurable depth: 1830m

Measure range:-2 deg. - +35 deg.

(3) Navigation equipment

Position of the ship is measured by DGPS within about 3m error. ROV and transponder are measured by acoustic positioning system.

(4) Laboratory

There are laboratories at the back part of second deck. Each room has AC100V power supply and LAN. The video of HPD diving and deck-camera video are distributed to the laboratories and every cabin.

- Second laboratory: There are two desktop PCs (windows and Mac), equipment for video editing, color copy with printer, meeting desk and white board. Hi-vision video of HPD is distributed to this laboratory. You can copy from a digital βcam and S-VHS to S-VHS/VHS, Hi8 and DV.
- Third laboratory: There are two sinks, refrigerator (-80deg. low temperature refrigerator, Incubator, domestic refrigerator, ice maker, ice crasher) and reagent water system (ORGANO, Milli-QSPTOC). And sea water for experiment is supply to the sink.
- Dry laboratory: There are a work desk and a shelf for baggage. This room has 4 beds to be used as a private one in case that there are many researchers.

At the work deck, there is a rock-cutter room

- Rock-cutter room: There are a rock cutter and two grinders. And exclusive video player is set to describe rocks with playing video of ROV diving.

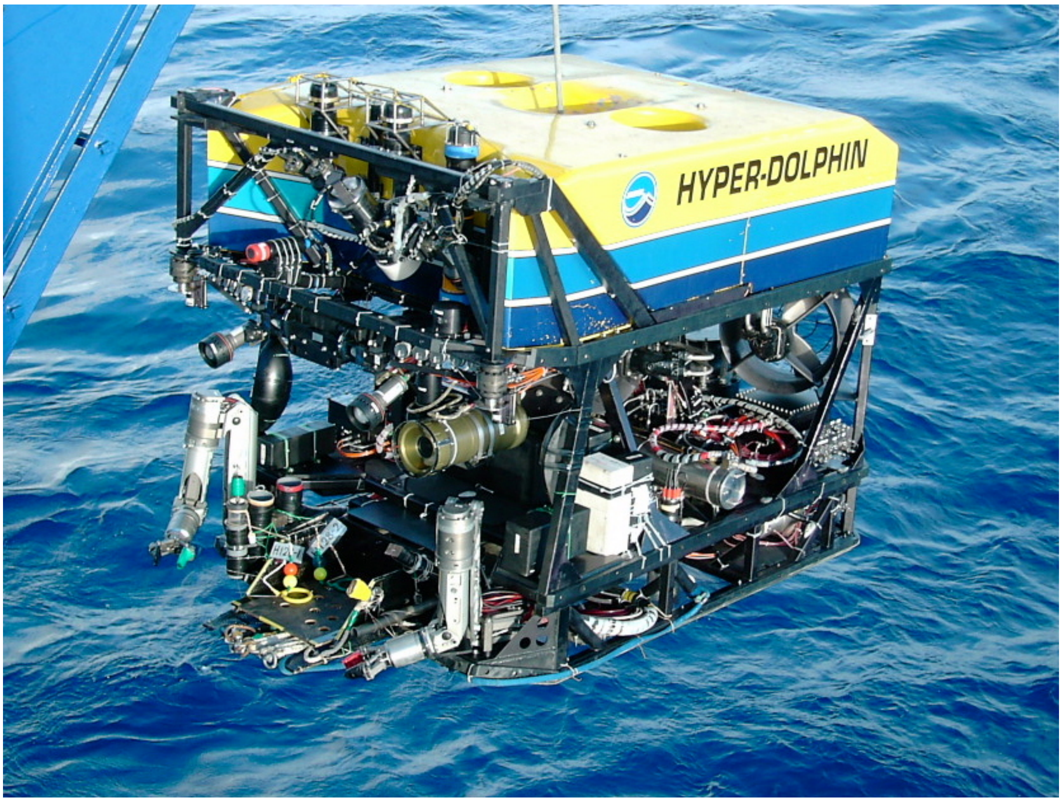
4.4.3 ROV Hyper-Dolphin

Ayumi Mizota, Keigo Suzuki, Yui Hashimoto, and Satoshi Shimizu

Hyper Dolphin is 3000m ROV which was built by SSI (Canada) in 2001. The vehicle has two manipulator, a Hi-definition super harp TV camera, and a color CCD TV camera. In addition, digital photo camera, black and white TV camera for back side monitoring, altitude sensor, depth sensor (with temperature sensor), sonar for obstacle avoidance sonar.

Principal specification

Length: about 3.0m
Breadth: about 2.0m
Height: about 2.3m
Weight in the air: about 3800kg
Depth capability: Maximum 3000m
Payload weight: -100kg (in the air)
Speed in the water: 0-3kt
Manipulators: 2 sets



(1) Manipulator capability

Pivot: 7 pivoted
Working load: in the water 68kg (max outreach)
Length of arm: 1.53m
Grasping power: 450kg
Hoisting power: max 250kg (vertical)
Hand opening width: right 77mm, left 195mm

(2) TV camera

High-definition TV camera: 1

- Sensitivity：F1.8 at 2 lux
- S/N ratio：43db

・Resolution：800 TV lines
・Pressure capsule size：(Length)　63.9cm　　(Diameter)　21.6
・Weight in air：36kg

Color CCD TV camera: 1

・Photography Device：1/2 inch Interline Transfer , POWER HAD CCD（×3）
・Horizontal Resolution：750TVL
・Minimum Photographic Subject Illumination：5Lux @ 1.4
・S/N Ratio：60dB
・Focal Length：5.5mm ～ 77mm
・Zoom Ratio：12 Twice
・Iris Diaphragm：Automatic Adjustment F1.9 ～ F16

Pan Tilt Equipment：

・Pan：90°Above
・Tilt：90°（They are those with restrictions by the position）

Black-and-white TV camera: 1

(3) Digital phot camera
Type : Seamax DPC7000 (DSSI)

(4) Obstacle avoidance sonars
Type : SIMRAD MS1000
Range : 10, 20, 25, 50, 100, 200m change
Detective distance: max 200m
Transmission frequency: 330kHz±1kHz

(5) Altitude sonar
Type: SIMRAD MS1007
Frequency: 200 kHz
Measure range: -200m
Accuracy: -2m

(6) Depth sensor (with temperature sensor)
Type: made by Paroscientific, Inc
Range of measuring depth: -4000m
Range of measuring temperature: -2-40deg.

4.4.4 SAHF (heat flow measurement)

Eiichiro Araki and Keigo Suzuki

4.4.4.1. Instrument

Stand-Alone Heat Flow meter (SAHF) is designed to measure heat flow by manned submersibles or ROVs. Five thermistors situated within the probe at 11 cm intervals. Originally, SAHF took measurements as “OFF LINE” system, heat flow was measured while observer is conducting something else at that position or elsewhere. SAHF can also be used for long-term monitoring of sub-bottom temperature. In NT05-02 cruise, we connected a cable to the ROV Hyper Dolphin to monitor the measurement data simultaneously as each measurement was made. We prepared two SAHFs, designated as SAHF-6 and SAHF-7. These SAHFs are equipped with LED, which flashes during operation.

Fig 4.4.4.1 shows the graphical description of SAHF. The following is description of SAHF.

Description:

Material	Alloy of titanium
Weight	4.0 kg in air, 2.6 kg in seawater
Length of pressure case	294 mm
Diameter of pressure case	85 mm (this is for SAHF-1 unit)
Length of probe	600 mm
Diameter of probe	13.8 mm (filled by silicon oil inside)
Number of thermistors	5
Intervals of thermistors	110 mm
Accuracy	0.01 °C
Resolution	0.001 °C
External Interface	RS232C (9600bps, 8 bit, Non-parity, 2 stop-bit)

4.4.3 SAHF (Araki and Suzuki)

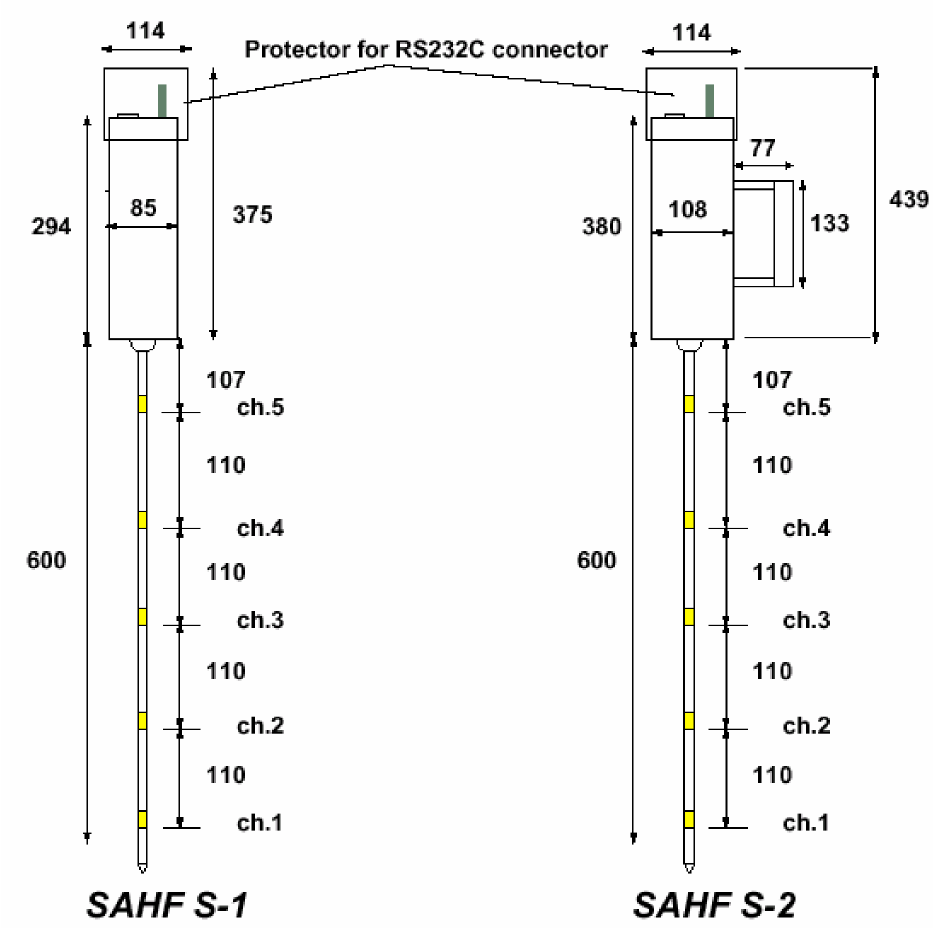


Fig. 4.4.4.1: Description of SAHF.

4.4.5 Gamma ray sensor

Hideaki Machiyama

In situ seafloor gamma ray measurement is one of the effective tools for seafloor dynamics, such as fault activity, submarine landslides, and cold seep and hydrothermal venting activity (e.g., Hattori and Okano, 2000, 2001, 2002). JAMSTEC has started the *in situ* seafloor gamma ray measurement since November, 1997 (Hattori and Okano, 1998).

Gamma ray spectrometer utilize 3 inch (76.3mm) spherical NaI(Tl) scintillator and the signal processor including DA converter in a pressuer bottole. The data (digitalizing 256 channel data) are transmitted to the onboard (ROV operation container) through RS-232C line. We can monitor *in situ* gamma ray intensity and energy spectrum in a PC. After processing data, we get total count per sec. (cps) value of gamma ray and contents of K, U-, and Th-series redionucleids.

In the NT05-02 Cruise, the sensor was equipped to the right side of the basket of the ROV Hyper-Dolphin (Fig. 4-4-5-1). The sensor always touches the seafloor when ROV completely landed (Fig. 4-4-5-2).

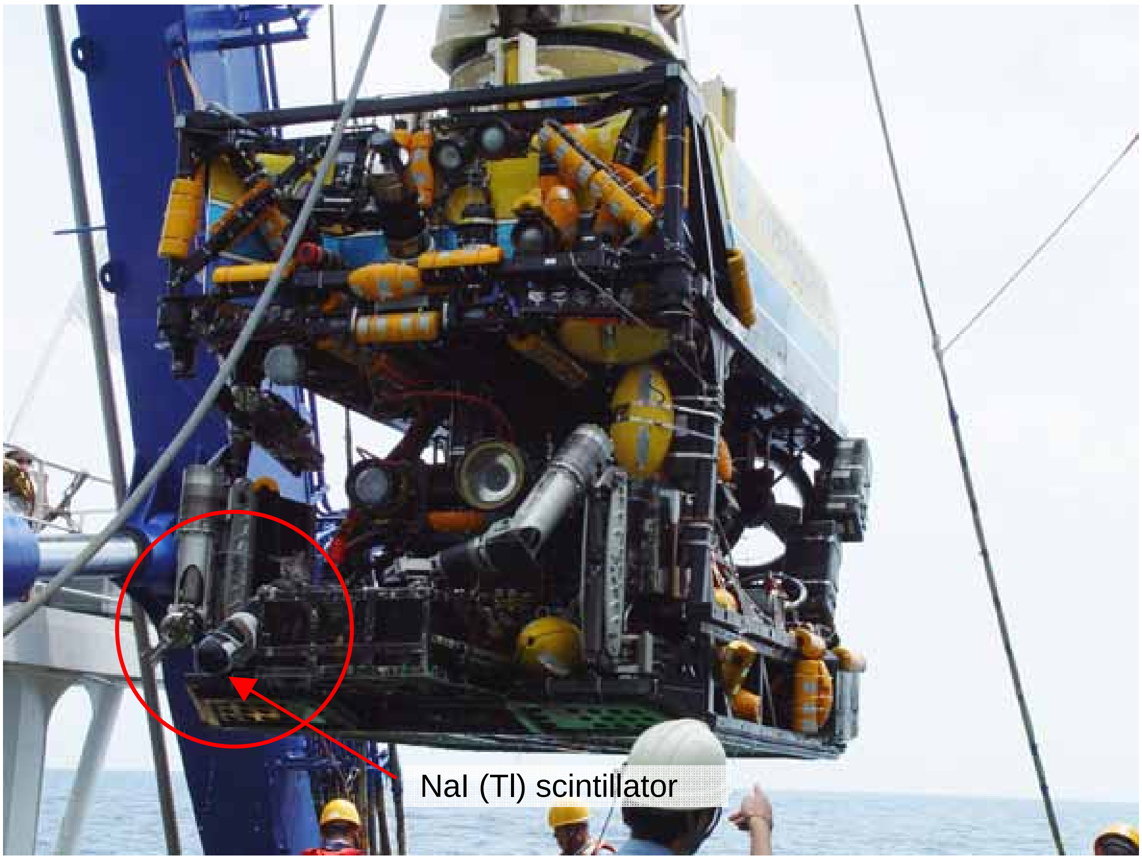


Fig. 4-4-5-1. Gamma ray sensor equipped in ROV Hyper-Dolphin.

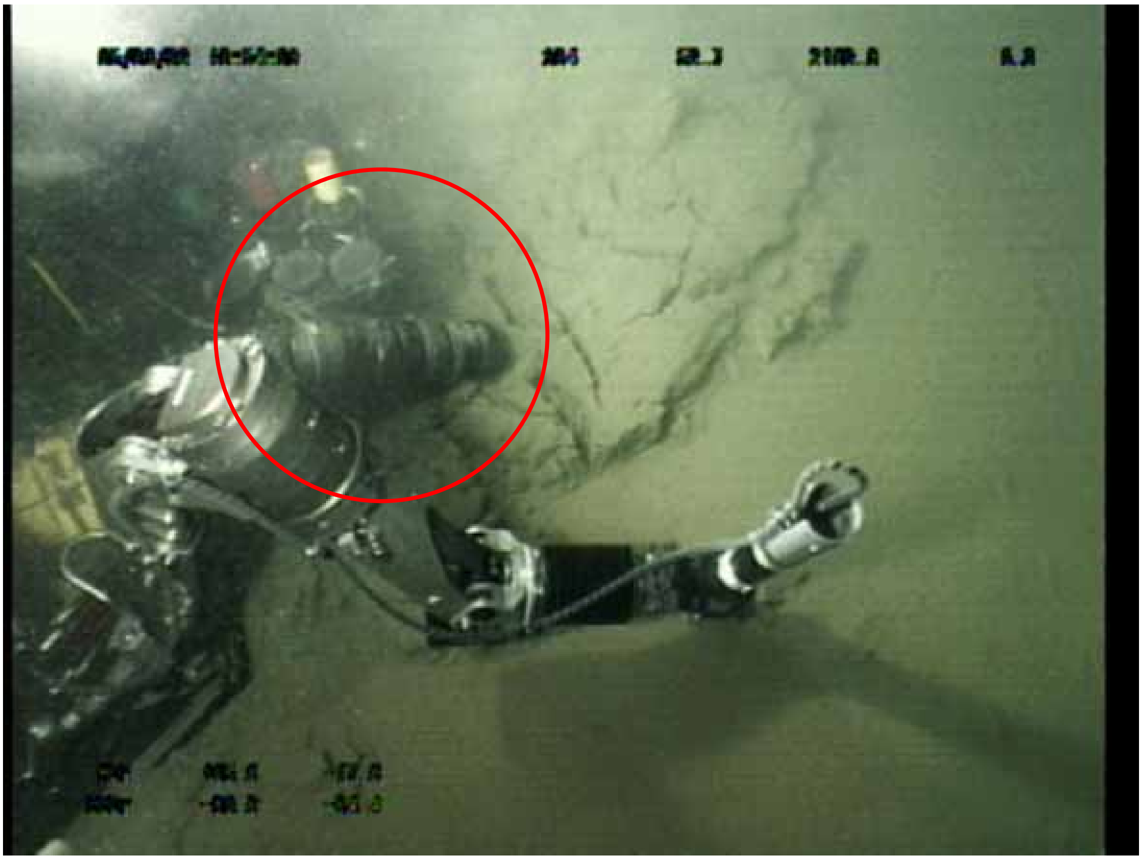


Fig. 4-4-5-2. Seafloor gamma ray measurement in Dive #384.

References

Hattori, M. and Okano, M., 1998, In situ sea bottom gamma ray surveys by manned submersibles and ROV, JAMSTEC Jour. Deep Sea Res., 14, 639-660. (in Japanese with English abstract)

Hattori, M. and Okano, M., 2000, Results of sea bottom gamma ray survey in 1998 and 1999, JAMSTEC Jour. Deep Sea Res., 16, 57-67. (in Japanese with English abstract)

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4.4.6 CTD-DO measurement

Keigo Suzuki and Eiichiro Araki

During each ROV dive, we conducted CTD+DO measurement. We used Seabird CTD Sea-Bird SBE19 (Model SBE19-04 serial number 1919726-2755) and Oxygen sensor S/N throughout the cruise. The system has conductivity, temperature, depth, and oxygen sensor in it. During the measurement, water is fed to the oxygen sensor and then to other sensors by a diaphragm pump. We cannot run the pump in air. Therefore, we connect syringe filled with pure water to the inlet so that we do not introduce air bubbles in the sensor system. Data is recorded in memory in the sensor housing. The CTD-DO sensor was attached in the front of the ROV Hyper Dolphin (Figure 4.4.6.1).

Before deployment, we replace batteries (nine UM-1 type alkaline cells), set clock, and check status thorough serial link using Seaterm software running on Windows. The battery lasts for two-day continuous operation at 2 samples per second. We set the sensor to sample data every second. We replaced batteries every two dives. Before each ROV dive, the magnet switch of the SBE19 sensor was switched on to start measurement. After ROV recovery, we switched off the sensor and uploaded data (using Seaterm). Usually, before starting each measurement, we cleared the memory in the sensor.

Read measurement data are processed using the software "SBEDataProcessing-Win32". Using the software, we converted uploaded data (.hex) and after bin-averaging, output in ASCII format. The format for the output ASCII data are described in header file created during the data processing as shown by Table 4.4.6.1.

4.4.5 CTD-DO (Suzuki and Araki)

Figure 4.4.6.1 CTD-DO sensor attached in the front of ROV Hyper dolphin

Table 4.4.6.1 Example Header file for the CTD-DO data process.

```
* Sea-Bird SBE19 Data File:
* FileName = C:¥Documents and Settings¥Natsu¥デスクトップ¥Dive385.hex
* Software Version 1.49
* Temperature SN = 2755
* Conductivity SN = 2755
* System UpLoad Time = Mar 03 2005 20:52:55
* ds
* SEACAT PROFILER V3.1b SN 2755   03/02/05  23:54:45.103
* strain gauge pressure sensor: S/N = 171082,  range = 15000 psia,  tc
= 121
* clk = 32767.648   iop = 154   vmain = 9.9   vlith = 2.2
* mode = PROFILE  ncasts = 2
* sample rate = 1 scan every 0.5 seconds
* samples = 127367   free = 46761   lwait = 0 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 0
* logdata = NO
* S>
* dh
* cast 1  03/02  14:51:39   samples 66388 to 127366 sample rate = 1 scan
every 0.5 seconds  stop = switch off
* S>
# nquan = 13
# nvalues = 60979
# units = specified
# name 0 = scan: Scan Count
# name 1 = timeJ: Julian Days
# name 2 = prSM: Pressure, Strain Gauge [db]
# name 3 = t090C: Temperature [ITS-90, deg C]
# name 4 = c0S/m: Conductivity [S/m]
# name 5 = depSM: Depth [salt water, m]
# name 6 = potemp090C: Potential Temperature [ITS-90, deg C]
# name 7 = sal00: Salinity [PSU]
# name 8 = sigma-・0: Density [sigma-theta, Kg/m^3]
# name 9 = svCM: Sound Velocity [Chen-Millero, m/s]
# name 10 = oxsatML/L: Oxygen Saturation [ml/l]
```

```
# name 11 = oxML/L: Oxygen, Beckman/YSI [ml/l]
# name 12 = flag:  0.000e+00
# span 0 =         1,      60979
# span 1 =  61.619201,  61.972083
# span 2 =   -18.611,   1287.642
# span 3 =    5.4359,    30.8947
# span 4 =  0.020953,   5.736610
# span 5 =   -18.477,   1274.401
# span 6 =    5.3242,    30.8981
# span 7 =    0.0924,    34.6129
# span 8 =   -4.5353,    26.9169
# span 9 =   1490.67,    1544.48
# span 10 =   4.37737,    7.06668
# span 11 =  -0.13556,   -0.09048
# span 12 = 0.0000e+00, 0.0000e+00
# interval = seconds: 0.5
# start_time = Mar 02 2005 14:51:39
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2755, 13 Feb 99
# sensor 1 = Frequency 1  conductivity, 2755, 13 Fbp 99, cpcor = -9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230454, 09 Nov 98
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230454, 09 Nov 98
# sensor 4 = Extrnl Volt  2  pH, 180295, 19-Feb-99
# sensor 5 = Pressure Voltage, 171082, 16 Feb 99
# datcnv_date = Mar 05 2005 09:55:34, 5.32a
# datcnv_in = C:¥Program Files¥Sea-Bird¥data¥NT0502¥Dive385¥Dive385.hex
C:¥Program Files¥Sea-Bird¥data¥NT0502¥Dive382¥19-2755.CON
# datcnv_skipover = 0
# file_type = ascii
*END*
```