doi : 10.17596/0003514

# R/V Mirai Cruise Report
# MR07-07
# (Leg 2 and Leg 3)

***January 26 – March 2, 2008***
***Tropical Ocean Climate Study***

Edited by
Hideaki Hase

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

**Contents**

## 1. Cruise name and code

Tropical Ocean Climate Study
MR07-07 (Leg 2 and Leg 3)
Ship: R/V MIRAI
Captain: Masaharu Akamine (Leg 2)
Captain: Yasushi Ishioka (Leg 3)

## 2. Introduction and observation summary

### 2.1. Introduction

The warm water pool located at the western equatorial Pacific and eastern Indian Oceans has the highest sea surface temperature in the ocean all over the world. The interaction between the ocean and atmosphere in that region becomes important for climate change, such as ENSO (El Niño/Southern Oscillation) in the Pacific Ocean and Dipole mode in the Indian Ocean. To understand the interaction processes, we conducted recovery/re-deployment of the sea surface meteorological and subsurface hydrographical monitoring buoys called TRITON (TRI-angle Trans Ocean buoy Network)/m-TRITON. These buoys have advantage of analysis for long- term variability in the warm water pool. We also carried out other observations, such as ADCP moorings, CTD measurements and shipboard meteorological observation, for understanding the Ocean and atmospheric conditions.

### 2.2. Overview

#### 2.2.1. Ship

R/V MIRAI
Captain Masaharu Akamine (Leg 2)
Captain Yasushi Ishioka (Leg 3)

#### 2.2.2. Cruise code

MR07-07 Leg 2 and Leg 3

#### 2.2.3. Project name

Tropical Ocean Climate Study

#### 2.2.4. Undertaking institution

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15, Natsushima-cho, Yokosuka 237-0061, Japan

#### 2.2.5. Chief Scientist

Hideaki Hase (JAMSTEC)

#### 2.2.6. Period

January 26$^{th}$, 2008 (Nakagusuku, Okinawa) – March 2$^{nd}$, 2008 (Sekinehama)

#### 2.2.7. Research Participants

Total 29 scientists and technical staffs participated from 8 different institutions and companies.

### 2.3. Observation summary

| | |
|---|---|
| TRITON buoy recovery: | 2 sites |
| m-TRITON buoy deployment: | 2 sites |
| K-TRITON buoy deployment: | 1 site |
| ADCP buoy deployment: | 1 site |
| ADCP buoy recovery: | 1 site |
| Piston core observation: | 3 sites |
| Argo float: | 3 launches |
| CTD including water sampling: | 6 casts |
| XCTD: | 4 launches |
| Surface meteorology: | continuous |
| Shipboard ADCP measurement: | continuous |
| Surface temperature and salinity measurements by intake method | continuous |

*** Other specially designed observations have been carried out.

## 2.4 Observed oceanic and atmospheric conditions

**Leg 2**

A weak Dipole Mode phenomenon in the tropical Indian Ocean has developed since the end of July 2007, was in the mature phase in October, and finished in November 2007. In mid February 2008, northwesterly wind associated with monsoon prevailed around the observation area of the eastern Indian Ocean. The shipboard ADCP data during Leg 2 indicated that the westward currents dominated in the surface layer of the equator, but reversed eastward currents intensified subsurface layer.

**Leg 3**

Associated with the low pressure developed at the east of Hokkaido, strong northwesterly wind up to 25 m/sec prevailed, and sea condition was very rough with the wave height of 6 m. As the results, the schedule was delayed, and the recovery of J-KEO buoy was not conducted.

## 3. Period, port of call, cruise log and cruise track

### 3.1. Period

January 26th - March 2nd, 2008

### 3.2. Ports of call

| | |
|---|---|
| Nakagusuku, Okinawa | (Departure; January 26th, 2008) |
| Yokohama | (February 25th – 26th, 2008) |
| Sekinehama | (Arrival; March 2nd, 2008) |

### 3.3. Cruise log

| SMT (Ship Mean Time) | UTC | Event |
|---|---|---|
| Jan. 26 (Sat.) | | |
| 15:40 | 06:40 | Departure from Nakagusuku (SMT = UTC + 9.0)<br>Start Leg-2 of MR07-07 cruise<br>Cruise to Piston core observation position |
| Jan. 27 (Sun.) | | |
| 10:00 | 01:00 | Safety guidance for participants |
| 13:15 | 04:15 | Boat drill |
| 16:45 | 07:45 | Konpira-san ceremony |
| Jan. 28 (Mon.) | | |
| 10:00 | 01:00 | Meeting for observation |
| 22:00 | 13:00 | Adjust SMT to UTC + 8.0 |
| Jan. 29 (Tue.) | | |
| 13:00 | 05:00 | Pirates station drill |
| Jan. 30 (Wed.) | | |
| | | Cruise to Piston core observation position |
| Jan. 31 (Thu.) | | |
| | | Cruise to Piston core observation position |
| Feb. 01 (Fri.) | | |
| | | Cruise to Piston core observation position |
| Feb. 02 (Sat.) | | |
| 06:07 | 22:07 | Starting of continuous monitoring of surface sea water, and shipboard observations (Data available periods are from 06:30 to 16:00 on Feb 2nd in SMT in the Malaysian EEZ.) |
| 22:00 | 14:00 | Adjust SMT to UTC + 7.0 |
| Feb. 03 (Sun.) | | |
| 13:00-15:36 | 06:00-08:36 | Piston core observation PC-01 (05-03.92 N, 094-29.09 E, 2708 m) |
| Feb. 04 (Mon.) | | |
| 08:05-10:30 | 01:05-03:30 | PC-02 (05-01.53 N, 094-25.60 E, 2707 m) |

| | | |
|---|---|---|
| 13:01-15:30 | 06:01-08:30 | PC-03 (04-59.96 N, 094-23.43 E, 2710 m) |
| 22:00 | 15:00 | Adjust SMT to UTC + 6.0 |
| Feb. 05 (Tue.) | | |
| 12:30 | 06:30 | Restart of continuous monitoring of surface sea water, and shipboard observations (because of entering in the Open Seas) |
| Feb. 06 (Wed.) | | |
| 08:05-10:12 | 02:05-04:12 | Recovery of ADCP mooring at 90E on the equator |
| 13:00-15:09 | 07:00-09:09 | Deployment of ADCP mooring at 90E on the equator (4409 m, 00-00.42 N, 090-03.79 E) |
| 15:15 | 09:15 | XCTD X001 (4539 m, 01-40.96 S, 090-01.69 E) |
| 15:41-16:49 | 09:41-10:49 | CTD C01 (4433 m, 00-00.58 N, 090-04.43 E) |
| Feb. 07 (Thu.) | | |
| 04:05 | 22:05 | Search of TRITON buoy T18 releaser position |
| 05:34-05:59 | 23:34-23:59 | CTD C02 (4707 m, 01-40.96 S, 090-08.31 E) |
| 07:59-11:20 | 01:59-05:20 | Recovery of m-TRITON buoy at 1.5S, 90E |
| 13:00-15:12 | 07:00-09:12 | Recovery of TRITON buoy T18 at 1.5S, 90E |
| Feb. 08 (Fri.) | | |
| 08:10-12:23 | 02:10-06:23 | Deployment of m-TRITON buoy at 1.5S, 90E (4689 m, 01-39.63 S, 089-59.72 E) |
| 13:50-15:06 | 07:50-09:06 | CTD C03 (4554 m, 01-40.88 S, 090-01.49 E) |
| Feb. 09 (Sat.) | | |
| 10:02-11:12 | 04:02-05:12 | CTD C04 (4834 m, 03-36.08 S, 093-00.36 E) |
| 11:18 | 05:18 | Argo float launch (4838 m, 03-36.72 S, 093-00.08 E) |
| 15:58-17:08 | 09:58-11:08 | CTD C05 (4906 m, 04-17.98 S, 094-00.31 E) |
| 17:17 | 11:17 | Argo float launch (4911 m, 04-18.25 S, 094-03.79 E) |
| Feb. 10 (Sun.) | | |
| 08:06-12:06 | 02:06-06:06 | Deployment of m-TRITON buoy at 5S, 95E (5007 m, 04-57.11 S, 094-58.90 E) |
| 13:07-14:22 | 06:07-08:22 | CTD C06 (4999 m, 04-58.15 S, 095-01.29 E) |
| Feb. 11 (Mon.) | | |
| 08:06-11:38 | 02:06-05:38 | Recovery of TRITON buoy T17 at 5S, 95E |
| 11:41 | 05:41 | Argo float launch (5005 m, 05-00.34 S, 095-03.79 E) |
| 11:45 | 05:45 | XCTD X002 (4997 m, 04-59.87 S, 095-03.84 E) |
| 22:00 | 16:00 | Adjust SMT to UTC + 7.0 |
| 23:00 | 16:00 | Stop of continuous monitoring |
| Feb. 12 (Tue.) | | |
| 22:00 | 15:00 | Adjust SMT to UTC + 8.0 |
| Feb. 13 (Wed.) | | |
| | | Cruise to Yokohama |

| | | |
|---|---|---|
| Feb. 14 (Thu.) | | |
| 00:00 | 16:00 | Restart of continuous monitoring |
| Feb. 15 (Fri.) | | |
| 15:31 | 07:31 | Stop of continuous monitoring |
| Feb. 16 (Sat.) | | |
| | | Cruise to Yokohama |
| Feb. 17 (Sun.) | | |
| | | Cruise to Yokohama |
| Feb. 18 (Mon.) | | |
| | | Cruise to Yokohama |
| Feb. 19 (Tue.) | | |
| | | Cruise to Yokohama |
| Feb. 20 (Wed.) | | |
| | | Cruise to Yokohama |
| Feb. 21 (Thu.) | | |
| 22:00 | 14:00 | Adjust SMT to UTC + 9.0 |
| | | Cruise to Yokohama |
| Feb. 22 (Fri.) | | |
| | | Cruise to Yokohama |
| Feb. 23 (Sat.) | | |
| | | Cruise to Yokohama |
| Feb. 24 (Sun.) | | |
| | | Cruise to Yokohama |
| Feb. 25 (Mon.) | | |
| 15:00 | 06:00 | Arrival at Yokohama |
| | | Finish Leg-2 of MR07-07 cruise |
| Feb. 26 (Tue.) | | |
| 15:50 | 06:50 | Departure from Yokohama (SMT = UTC + 9.0) |
| | | Start Leg-3 of MR07-07 cruise |
| | | Cruise to JKEO/K-TRITON buoy position |
| 18:00 | 09:00 | Start of continuous monitoring of surface sea water, and shipboard observations |
| Feb. 27 (Wed.) | | |
| 09:00 | 00:00 | Safety guidance for participants |
| 10:30 | 01:30 | Meeting for observation |
| 13:15 | 04:15 | Boat drill |
| 16:45 | 07:45 | Konpira-san ceremony |
| Feb. 28 (Thu.) | | |

| | | |
|---|---|---|
| | | Postponement of JKEO/K-TRITON buoy operation owing to rough sea condition |
| 22:00 | 13:00 | Adjust SMT to UTC + 10.0 |
| | | |
| Feb. 29 (Fri.) | | |
| 08:12 | 22:12 | XCTD X003 (5377 m, 37-54.43 N, 146-38.86 E) |
| 12:45-17:36 | 02:45-07:36 | Deployment of K-TRITON buoy (5407 m, 38-04.82 N, 146-25.20 E) |
| 18:08 | 08:08 | SCoTD drifter launch (38-05.97 N, 146-28.11 E) |
| 18:22 | 08:22 | Sampling sea surface water using bucket |
| 18:34 | 08:34 | XCTD X004 (5406 m, 38-04.85 N, 146-28.14 E) |
| 22:00 | 12:00 | Adjust SMT to UTC + 9.0 |
| | | |
| Mar. 1 (Sat.) | | |
| | | Cruise to Sekinehama |
| | | |
| Mar. 2 (Sun.) | | |
| 08:00 | 23:00 | Stop of continuous monitoring |
| 13:10 | 04:10 | Arrival at Sekinehama |

### 3.4 Cruise Track

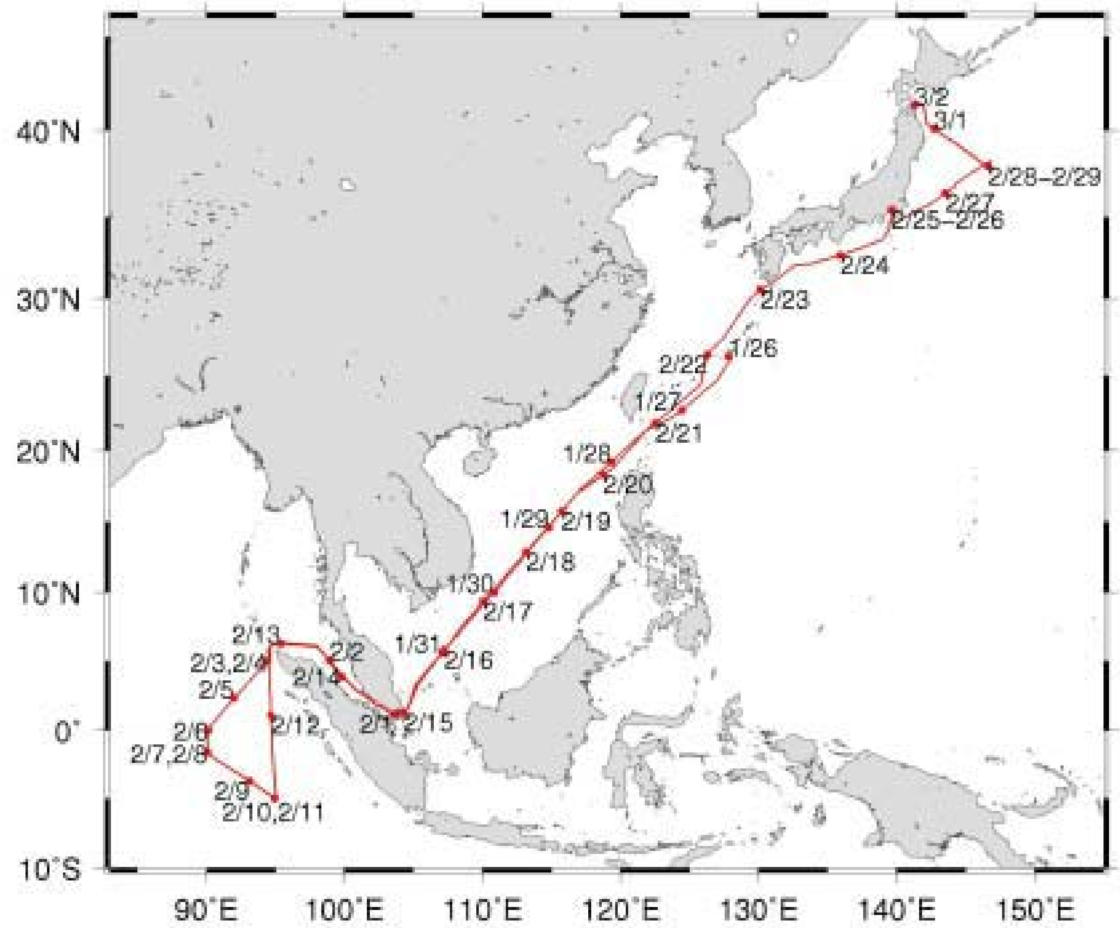



Fig. 3.4-1 Cruise Track of MR07-07 leg2 and leg3

## 4. Chief scientist

Hideaki Hase
Research scientist II
IORGC, JAMSTEC
2-15, Natsushima-cho, Yokosuka, Kanagawa 237-0061, JAPAN

5.1 On board scientists, engineers, technical staffs and observers

Leg 2

| No | Name | Institute | Position |
|---|---|---|---|
| 1 | Hideaki Hase | JAMSTEC | Chief Scientist |
| 2 | Masayuki Yamaguchi | JAMSTEC | Engineer |
| 3 | Kohsaku Arai | AIST | Scientist |
| 4 | Udrekh | BPPT | Scientist |
| 5 | Jaka Prastya | Territory Directorate of Defense Department, Indonesia | Security Officer |
| 6 | Nor Aini Binti Abu Kasim | Malaysian Meteorological Department | Observer |
| 7 | Keisuke Matsumoto | MWJ | Technical Staff |
| 8 | Tomohide Noguchi | MWJ | Technical Staff |
| 9 | Hiroki Ushiromura | MWJ | Technical Staff |
| 10 | Shinsuke Toyoda | MWJ | Technical Staff |
| 11 | Tatsuya Tanaka | MWJ | Technical Staff |
| 12 | Ayumi Takeuchi | MWJ | Technical Staff |
| 13 | Yusuke Sato | MWJ | Technical Staff |
| 14 | Yuko Sagawa | MWJ | Technical Staff |
| 15 | Yasushi Hashimoto | MWJ | Technical Staff |
| 16 | Masaki Taguchi | MWJ | Technical Staff |
| 17 | Masatomo Hisazumi | MWJ | Technical Staff |
| 18 | Shinya Okumura | GODI | Technical Staff |
| 19 | Kazuho Yoshida | GODI | Technical Staff |

Leg 3

| No | Name | Institute | Position |
|---|---|---|---|
| 1 | Hideaki Hase | JAMSTEC | Chief Scientist |
| 2 | Masanori Konda | JAMSTEC | Scientist |
| 3 | Hiroyuki Tomita | JAMSTEC | Scientist |
| 4 | Katsuhiro Nomura | JAMSTEC | Scientist |
| 5 | Yoshiyuki Nakano | JAMSTEC | Scientist |
| 6 | J. Michael Strick | PMEL/NOAA | Engineer |
| 7 | Brent Justin Pounds | PMEL/NOAA | Engineer |
| 8 | Tomohide Noguchi | MWJ | Technical Staff |
| 9 | Keisuke Matsumoto | MWJ | Technical Staff |
| 10 | Hiroki Ushiromura | MWJ | Technical Staff |
| 11 | Shinsuke Toyoda | MWJ | Technical Staff |
| 12 | Tatsuya Tanaka | MWJ | Technical Staff |
| 13 | Ayumi Takeuchi | MWJ | Technical Staff |
| 14 | Hirokatsu Uno | MWJ | Technical Staff |
| 15 | Katsunori Sagishima | MWJ | Technical Staff |
| 16 | Masanori Enoki | MWJ | Technical Staff |
| 17 | Kazuho Yoshida | GODI | Technical Staff |
| 18 | Wataru Tokunaga | GODI | Technical Staff |

## 5.2 R/V MIRAI crew member

**<Leg2>**

| | | |
|---|---|---|
| Masaharu | Akamine | Master |
| Yasushi | Ishioka | Chief Officer |
| Takeshi | Isohi | 1st Officer |
| Yoshimichi | Nagai | 2nd Officer |
| Noriyuki | Hatachi | 3rd Officer |
| Hideaki | Nomura | Chief Engineer |
| Koji | Masuno | 1st Engineer |
| Hiroyuki | Tohken | 2nd Engineer |
| Toshio | Kiuchi | 3rd Engineer |
| Shuji | Nakabayashi | C/Radio Officer |
| Hisao | Oguni | Boatswain |
| Keiji | Yamauchi | Able Seaman |
| Masami | Sugami | Able Seaman |
| Yukiharu | Suzuki | Able Seaman |
| Takashi | Soejima | Able Seaman |
| Kazuyoshi | Kudo | Able Seaman |
| Tsuyoshi | Sato | Able Seaman |
| Tsuyoshi | Monzawa | Able Seaman |
| Masashige | Okada | Able Seaman |
| Norimichi | Aosaki | Sailor |
| Yusuke | Asano | Sailor |
| Hideaki | Tamotsu | Sailor |
| Sadanori | Honda | No.1 Oiler |
| Yukitoshi | Horiuchi | Oiler |
| Toshimi | Yoshikawa | Oiler |
| Shigeaki | Kinoshita | Oiler |
| Nobuo | Boshita | Oiler |
| Daisuke | Taniguchi | Oiler |
| Hitoshi | Ota | Chief Steward |
| Hatsuji | Hiraishi | Cook |
| Tatsuya | Hamabe | Cook |
| Kozo | Uemura | Cook |
| Yoshiteru | Hiramatsu | Cook |

**<Leg3>**

| | | |
|---|---|---|
| **Yasushi** | **Ishioka** | **Master** |
| **Haruhiko** | **Inoue** | **Chief Officer** |
| **Takeshi** | **Isohi** | **1st Officer** |
| **Yoshimichi** | **Nagai** | **2nd Officer** |
| **Noriyuki** | **Hatachi** | **3rd Officer** |
| **Koichi** | **Higashi** | **Chief Engineer** |
| **Koji** | **Masuno** | **1st Engineer** |
| **Hiroyuki** | **Tohken** | **2nd Engineer** |
| **Toshio** | **Kiuchi** | **3rd Engineer** |
| **Shuji** | **Nakabayashi** | **C/Radio Officer** |
| **Kunihiko** | **Omote** | **Boatswain** |
| **Masami** | **Sugami** | **Able Seaman** |
| **Yukiharu** | **Suzuki** | **Able Seaman** |
| **Takashi** | **Soejima** | **Able Seaman** |
| **Yohsuke** | **Kuwabara** | **Able Seaman** |
| **Kazuyoshi** | **Kudo** | **Able Seaman** |
| **Tsuyoshi** | **Sato** | **Able Seaman** |
| **Takeharu** | **Aisaka** | **Able Seaman** |
| **Tsuyoshi** | **Monzawa** | **Able Seaman** |
| **Norimichi** | **Aosaki** | **Sailor** |
| **Hideaki** | **Tamotsu** | **Sailor** |
| **Yukitoshi** | **Horiuchi** | **No.1 Oiler** |
| **Toshimi** | **Yoshikawa** | **Oiler** |
| **Shigeaki** | **Kinoshita** | **Oiler** |
| **Yoshihiro** | **Sugimoto** | **Oiler** |
| **Nobuo** | **Boshita** | **Oiler** |
| **Kazumi** | **Yamashita** | **Oiler** |
| **Hitoshi** | **Ota** | **Chief Steward** |
| **Hatsuji** | **Hiraishi** | **Cook** |
| **Tatsuya** | **Hamabe** | **Cook** |
| **Kozo** | **Uemura** | **Cook** |
| **Yoshiteru** | **Hiramatsu** | **Cook** |

# 6 General Observations
## 6.1 Meteorological measurement
### 6.1.1 Surface Meteorological Observation

(1) Personnel

| | | |
|---|---|---|
| Kunio Yoneyama | (JAMSTEC): Principal Investigator (Not on-board) | |
| Shinya Okumura | (Global Ocean Development Inc., GODI) | -Leg2- |
| Wataru Tokunaga | (GODI) | -Leg3- |
| Kazuho Yoshida | (GODI) | -Leg2, 3- |

(2) Objectives

Surface meteorological parameters are observed as a basic dataset of the meteorology. These parameters bring us the information about the temporal variation of the meteorological condition surrounding the ship.

(3) Methods

Surface meteorological parameters were acquired during the observation of MR07-07 Leg2 and Leg3 cruises. In these cruises, we used two systems for the observation.

i. MIRAI Surface Meteorological observation (SMET) system
ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

i. MIRAI Surface Meteorological observation (SMET) system

Instruments of SMET system are listed in Table.6.1.1-1 and measured parameters are listed in Table.6.1.1-2. Data were collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set consists of 6-second averaged data.

ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system designed by BNL (Brookhaven National Laboratory, USA) consists of major three parts.

a) Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
b) Zeno Meteorological (Zeno/Met) system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.
c) Scientific Computer System (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

SCS recorded PRP data every 6 seconds, Zeno/Met data every 10 seconds. Instruments and their locations are listed in Table.6.1.1-3 and measured parameters are listed in Table.6.1.1-4.

We have checked the following sensors, before Leg2 cruise and after Leg3 cruise for the quality control as post processing.

i. Young Rain gauge (SMET and SOAR)

Inspect of the linearity of output value from the rain gauge sensor to change Input value by adding fixed quantity of test water.

ii. Barometer (SMET and SOAR)

Comparison with the portable barometer value, PTB220CASE, VAISALA.

iii.Thermometer (air temperature and relative humidity) (SMET and SOAR)

Comparison with the portable thermometer value, HMP41/45, VAISALA.

(4) Preliminary results

Figures 6.1.1 show the time series of the following parameters;

Wind (SOAR)
Air temperature (SOAR)
Relative humidity (SOAR)
Precipitation (SOAR, Optical rain gauge)
Short/long wave radiation (SOAR)
Pressure (SOAR)
Sea surface temperature (SMET)
Significant wave height (SMET)

(5) Data archives

These meteorological data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC just after the cruise. Corrected data sets will be available from K. Yoneyama of JAMSTEC.

(6) Remarks

i. We observed in EEZ of Japan, open sea of Indian Ocean and EEZ of Malaysia (except territorial waters) in Leg2 cruise, and all area in Leg3 cruise.

| | |
|---|---|
| EEZ of Japan: | 06:40UTC, 26 Jan. – 06:30UTC, 27 Jan. |
| | 08:00UTC, 21 Feb. - 06:00UTC, 25 Feb. |
| Open sea of Indian Ocean: | 06:30UTC, 05 Feb. – 16:00UTC, 11 Feb. |
| EEZ of Malaysia: | 22:30UTC, 01 Feb. – 08:00UTC, 02 Feb. |
| | 16:00UTC, 13 Feb. – 08:00UTC, 14 Feb. |
| Leg 3 cruise: | 06:50UTC, 26 Feb. – 04:10UTC, 02 Mar. |

ii. Following periods, SST (Sea Surface Temperature) datasets are available.

00:00UTC, 27 Jan. – 06:30UTC, 27 Jan.
22:30UTC, 01 Feb. – 08:00UTC, 02 Feb.
06:30UTC, 05 Feb. – 16:00UTC, 11 Feb.
16:00UTC, 13 Feb. – 08:00UTC, 14 Feb.
09:00UTC, 26 Feb. – 23:00UTC, 01 Mar.

Table.6.1.1-1 Instruments and installations of MIRAI Surface Meteorological observation system

| Sensors | Type | Manufacturer | Location (altitude from surface) |
|---|---|---|---|
| Anemometer | KE-500 | Koshin Denki, Japan | foremast (24 m) |
| Tair/RH | HMP45A | Vaisala, Finland | |
| (with 43408 Gill aspirated radiation shield | | R.M. Young, USA) | compass deck (21 m) |
| | | | starboard side and port side |
| Thermometer: SST | RFN1-0 | Koshin Denki, Japan | 4th deck (-1m, inlet -5m) |
| Barometer | AP370 | Koshin Denki, Japan | captain deck (13 m) |
| | | | weather observation room |
| Rain gauge | 50202 | R. M. Young, USA | compass deck (19 m) |
| Optical rain gauge | ORG-115DR | Osi, USA | compass deck (19 m) |
| Radiometer (short wave) | MS-801 | Eiko Seiki, Japan | radar mast (28 m) |
| Radiometer (long wave) | MS-202 | Eiko Seiki, Japan | radar mast (28 m) |
| Wave height meter | MW-2 | Tsurumi-seiki, Japan | bow (10 m) |

Table.6.1.1-2 Parameters of MIRAI Surface Meteorological observation system

| Parameter | | Units | Remarks |
|---|---|---|---|
| 1 | Latitude | degree | |
| 2 | Longitude | degree | |
| 3 | Ship's speed | knot | Mirai log, DS-30 Furuno |
| 4 | Ship's heading | degree | Mirai gyro, TG-6000, Tokimec |
| 5 | Relative wind speed | m/s | 6sec./10min. averaged |
| 6 | Relative wind direction | degree | 6sec./10min. averaged |
| 7 | True wind speed | m/s | 6sec./10min. averaged |
| 8 | True wind direction | degree | 6sec./10min. averaged |
| 9 | Barometric pressure | hPa | adjusted to sea surface level |
| | | | 6sec. averaged |
| 10 | Air temperature (starboard side) | degC | 6sec. averaged |
| 11 | Air temperature (port side) | degC | 6sec. averaged |
| 12 | Dewpoint temperature (starboard side) | degC | 6sec. averaged |
| 13 | Dewpoint temperature (port side) | degC | 6sec. averaged |
| 14 | Relative humidity (starboard side) | % | 6sec. averaged |
| 15 | Relative humidity (port side) | % | 6sec. averaged |
| 16 | Sea surface temperature | degC | 6sec. averaged |
| 17 | Rain rate (optical rain gauge) | mm/hr | hourly accumulation |
| 18 | Rain rate (capacitive rain gauge) | mm/hr | hourly accumulation |
| 19 | Down welling shortwave radiation | W/m2 | 6sec. averaged |
| 20 | Down welling infra-red radiation | W/m2 | 6sec. averaged |
| 21 | Significant wave height (bow) | m | hourly |
| 22 | Significant wave height (aft) | m | hourly |
| 23 | Significant wave period (bow) | second | hourly |
| 24 | Significant wave period (aft) | second | hourly |

Table.6.1.1-3 Instruments and installation locations of SOAR system

| Sensors (Zeno/Met) | Type | Manufacturer | Location (altitude from surface) |
|---|---|---|---|
| Anemometer | 05106 | R.M. Young, USA | foremast (25 m) |
| Tair/RH | HMP45A | Vaisala, Finland | |
| (with 43408 Gill aspirated radiation shield | | R.M. Young, USA) | foremast (23 m) |
| Barometer | 61201 | R.M. Young, USA | |
| (with 61002 Gill pressure port | | R.M. Young, USA) | foremast (22 m) |
| Rain gauge | 50202 | R.M. Young, USA | foremast (24 m) |
| Optical rain gauge | ORG-815DA | Osi, USA | foremast (24 m) |

| Sensors (PRP) | Type | Manufacturer | Location (altitude from surface) |
|---|---|---|---|
| Radiometer (short wave) | PSP | Epply Labs, USA | foremast (24 m) |
| Radiometer (long wave) | PIR | Epply Labs, USA | foremast (24m) |
| Fast rotating shadowband radiometer | | Yankee, USA | foremast (24 m) |

Table.6.1.1-4 Parameters of SOAR system

| Parameter | Units | Remarks |
|---|---|---|
| 1 Latitude | degree | |
| 2 Longitude | degree | |
| 3 SOG | knot | |
| 4 COG | degree | |
| 5 Relative wind speed | m/s | |
| 6 Relative wind direction | degree | |
| 7 Barometric pressure | hPa | |
| 8 Air temperature | degC | |
| 9 Relative humidity | % | |
| 10 Rain rate (optical rain gauge) | mm/hr | |
| 11 Precipitation (capacitive rain gauge) | mm | reset at 50 mm |
| 12 Down welling shortwave radiation | W/m2 | |
| 13 Down welling infra-red radiation | W/m2 | |
| 14 Defuse irradiance | W/m2 | |

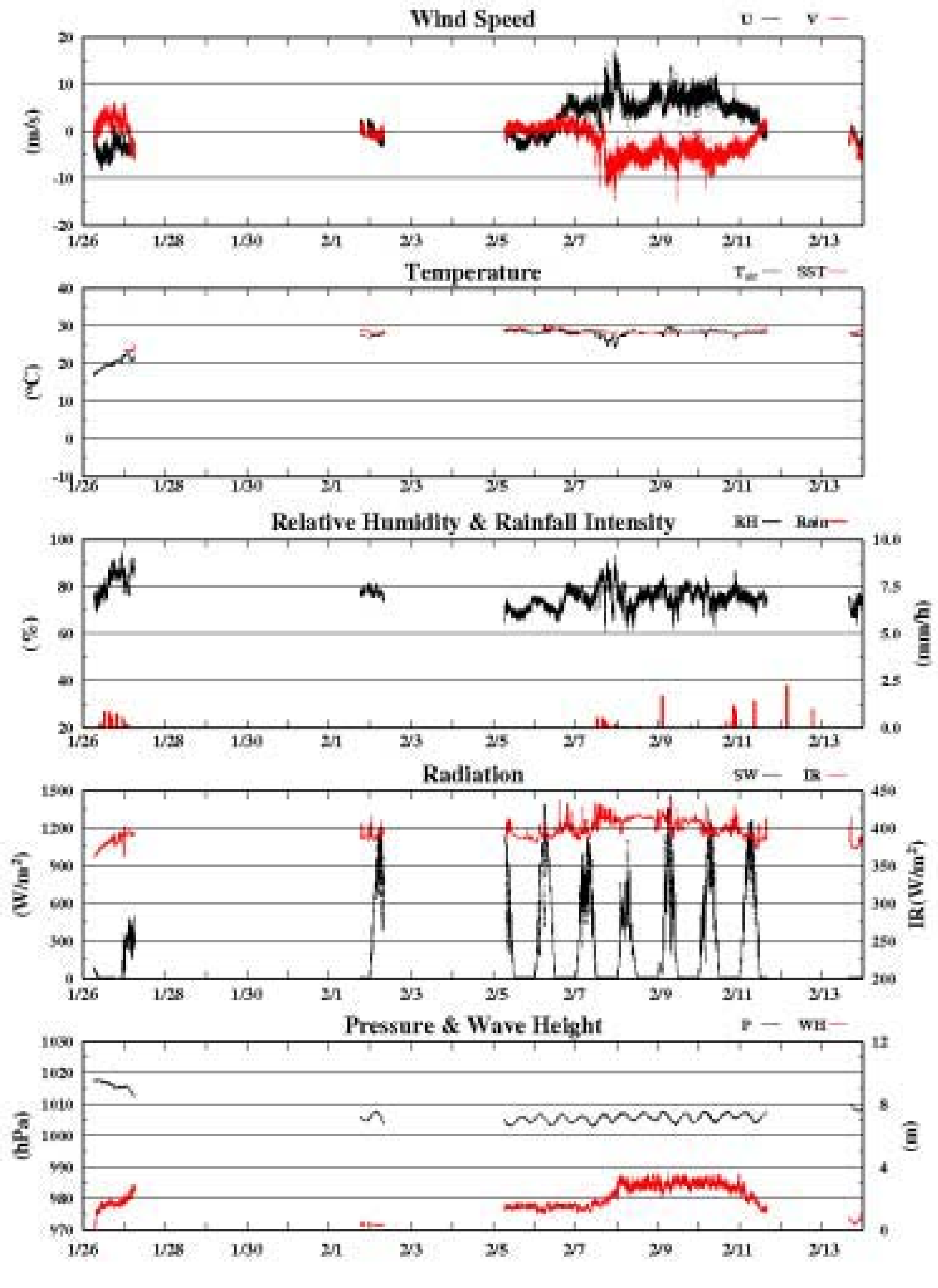



Fig.6.1.1 Time series of surface meteorological parameters during the MR07-07 Leg2 and Leg3 .

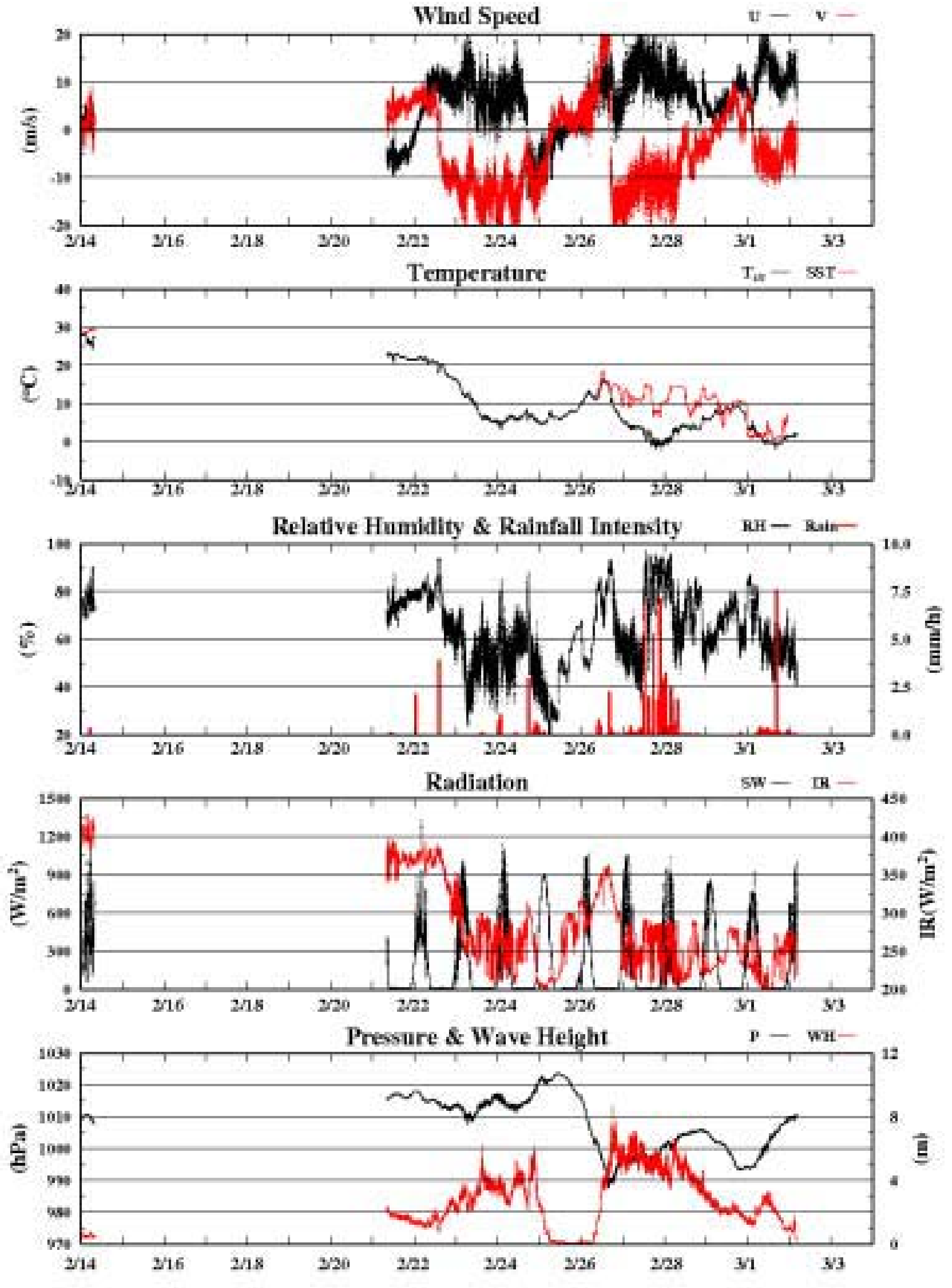



Fig.6.1.1 (Continued)

### 6.1.2 Ceilometer

(1) Personnel

| | | |
|---|---|---|
| Kunio Yoneyama | (JAMSTEC): Principal Investigator (Not on-board) | |
| Shinya Okumura | (Global Ocean Development Inc., GODI) | -Leg2- |
| Wataru Tokunaga | (GODI) | -Leg3- |
| Kazuho Yoshida | (GODI) | -Leg2, 3- |

(2) Objective

The information of the cloud base height is important to understand the processes on the exchange of water and energy between the atmospheric boundary layer and the layer above, and horizontal / vertical distribution of the cloud. As one of the methods to measure them, the ceilometer observation was carried out.

(3) Methods

We measured cloud base height and backscatter profile using CT-25K (VAISALA, Finland) ceilometer during the observation of MR07-07 Leg2 and Leg3 cruises.

Major parameters for the measurement configuration are as follows;

| | |
|---|---|
| Laser source: | Indium Gallium Arsenide (InGaAs) Diode |
| Transmitting wave length: | 905±5 nm at 25 deg-C |
| Transmitting average power: | 8.9 mW |
| Repetition rate: | 5.57kHz |
| Detector: | Silicon avalanche photodiode (APD) |
| Responsibility at 905 nm: | 65 A/W |
| Measurement range: | 0～7.5 km |
| Resolution: | 50 ft in full range |
| Sampling rate: | 60 sec |

On the archived dataset, three cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft.). If the apparent cloud base height could not be determined, vertical visibility and the height of detected highest signal are calculated instead of the cloud base height.

(4) Preliminary results

Fig. 6.1.2-1 shows the first, second and third lowest cloud base height which the ceilometer detected during the observation of these cruises.

(5) Data archives

Ceilometer data obtained during these cruises will be submitted to and archived by the Marine-Earth Data and Information Department （MEDID） of JAMSTEC.

(6) Remarks

We observed at open sea of Indian Ocean and EEZ of Malaysia (except territorial waters) in Leg2 cruise, and all area in Leg3 cruise.

| | |
|---|---|
| EEZ of Malaysia: | 22:30UTC, 01 Feb. – 08:00UTC, 02 Feb. |
| | 16:00UTC, 13 Feb. – 08:00UTC, 14 Feb. |
| Open sea of Indian Ocean: | 06:30UTC, 05 Feb. – 16:00UTC, 11 Feb. |
| Leg 3 cruise: | 06:50UTC, 26 Feb. – 04:10UTC, 02 Mar. |

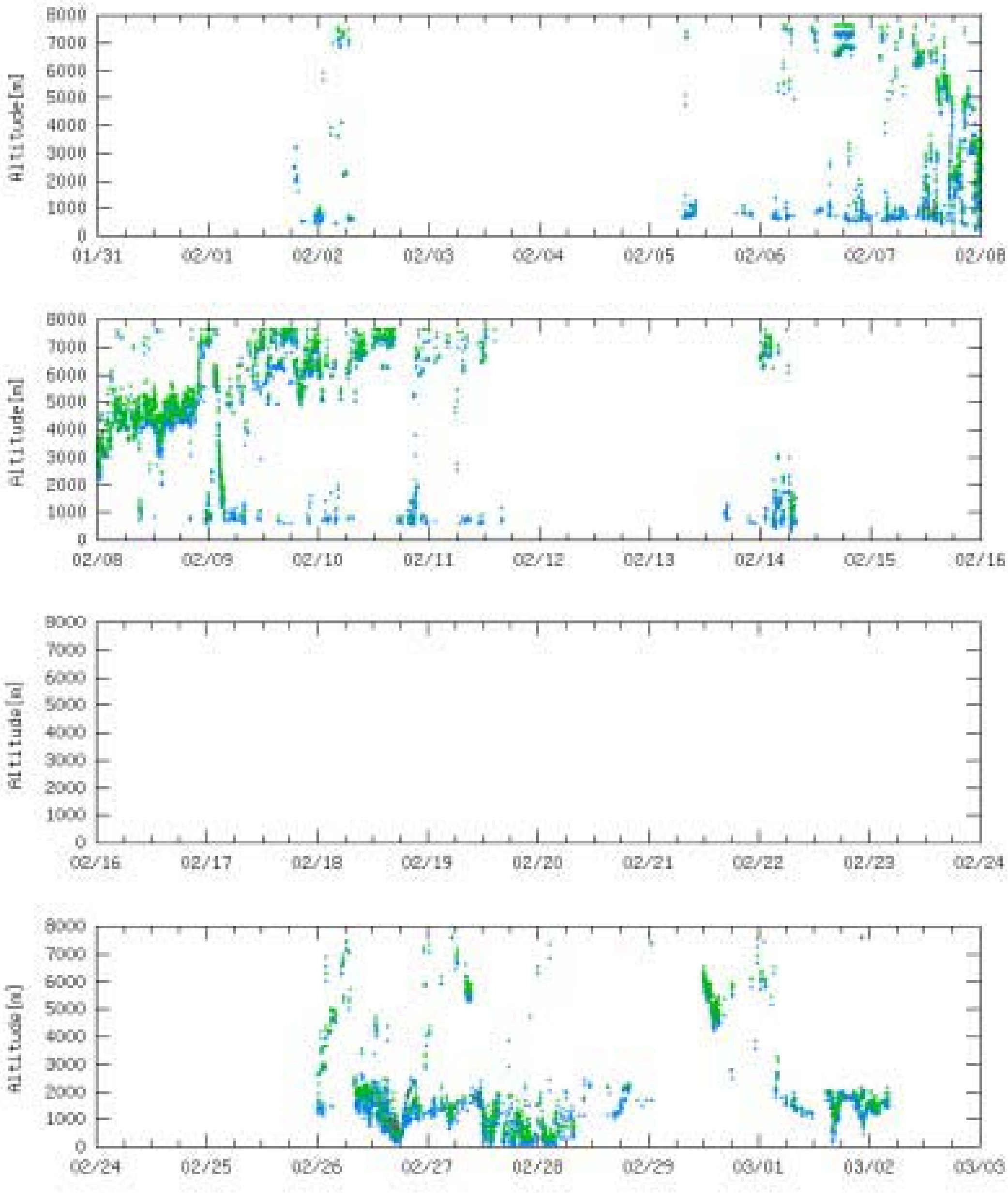



Figure 6.1.2-1 1st (blue), 2nd (green) and 3rd (red) lowest cloud base height during MR07-07 Leg2 and Leg3 cruises.

## 6.2 CTD/XCTD observations
### 6.2.1. CTD

| | | |
|---|---|---|
| Personnel | Hideaki Hase | (JAMSTEC): Principal investigator |
| | Shinsuke Toyoda | (MWJ): Operation leader |
| | Tatsuya Tanaka | (MWJ) |

(1) Objective

Investigation of oceanic structure and water sampling.

(2) Overview of the equipment and observation

CTD/Carousel water sampling system (CTD system), which is 36-position Carousel Water Sampler (SBE 32) with SBE 9plus (Sea-Bird Electronics Inc) attached with sensors, was used during this cruise. 12-litter Niskin bottles were used for sampling seawater. The CTD system was deployed from starboard on working deck. During this cruise, 7 casts of CTD observation were carried out (see Table 6.2.1-1). At Stn.C01, from C03 to C06, primary sensors had a problem. So we used data of secondary temperature, conductivity sensors at all Stn. At Stn.C04, we changed primary temperature sensor.

(3) List of sensors and equipments

| | |
|---|---|
| Under water unit: | SBE, Inc., SBE 9plus, S/N 0677 |
| Temperature sensor: | SBE, Inc., SBE 03plus, S/N 03P2730 (Primary: Stn.C01-C03) |
| | SBE, Inc., SBE 03plus, S/N 03P4418 (Primary: Stn.C04-C06) |
| Temperature sensor: | SBE, Inc., SBE 03-04/F, S/N 031524 (Secondary) |
| Conductivity sensor: | SBE, Inc., SBE 04-04/O, S/N 041203 (Primary) |
| Conductivity sensor: | SBE, Inc., SBE 04-02/O, S/N 041088 (secondary) |
| Oxygen sensor: | SBE, Inc., SBE 43, S/N 430330 |
| Pump: | SBE, Inc., SBE 5T, S/N 054598 (Primary) |
| Pump: | SBE, Inc., SBE 5T, S/N 053118 (Secondary) |
| Deck unit: | SBE, Inc., SBE 11plus, S/N 11P7030-0272 |
| Carousel Water Sampler: | SBE, Inc., SBE 32, S/N 3227443-0391 |
| Water sample bottle: | General Oceanics, Inc., 12-litre Niskin-X |

(4) Data processing

The SEASOFT-Win32 (Ver. 5.27b) was used for processing the CTD data. Descriptions and settings of the parameters for the SEASOFT were written as follows.

DATCNV converted the raw data to scan number, pressure, depth, secondary temperature, secondary conductivity, descent rate, modulo error count and pump status. DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3.0 seconds, and the offset was set to 0.0 seconds.

ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, secondary temperature, secondary conductivity, and descent rate were over 3.0 seconds. And secondary salinity, secondary sigma-theta and secondary potential temperature were computed.

WILDEDIT marked extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, depth, secondary temperature, secondary conductivity and decent rate.

CELLTM used a recursive filter to remove conductivity cell thermal mass effects from the measured secondary conductivity. Typical values used were thermal anomaly amplitude alpha = 0.03 and the time constant 1/beta = 7.0.

FILTER performed a low pass filter on pressure with a time constant of 0.15 seconds. In order to produce zero phase lag (no time shift) the filter runs forward first then backwards.

SECTION selected a time span of data based on scan number in order to reduce a file size. The minimum number was set to be the starting time when the CTD package was beneath the sea-surface after activation of the pump. The maximum number was set to be the end time when the package came up from the surface.

LOOPEDIT marked scans where the CTD was moving less than the minimum velocity of 0.0 m/s (traveling backwards due to ship roll).

BINAVG averaged the data into 1 dbar pressure bins. The center value of the first bin was set equal to the bin size. The bin minimum and maximum values are the center value plus and minus half the bin size. Scans with pressure greater than the minimum and less than or equal to the maximum were averaged. Scans were interpolated so that a data record exists in every dbar.

DERIVE was used to compute secondary salinity, secondary sigma-theta and secondary potential temperature

SPLIT was used to split data into the down cast and the up cast.

(5) Preliminary Results

Date, time and locations of the CTD casts are listed in Table 6.2.1-1. Vertical profile (down cast) of secondary temperature and secondary salinity with pressure are shown in Figure 6.2.1-1, 6.2.1-2.

(6) Data archive

All raw and processed data files will be submitted to the Data Management Office (DMO) and will be opened to public via “R/V MIRAI Data Web Page” in the JAMSTEC web site.

Table 6.2.1-1 CTD Cast table

| Stnnbr | Castno | Date(UTC) (mmddyy) | Time(UTC) Start | Time(UTC) End | BottomPosition Latitude | BottomPosition Longitude | Depth | Wire Out | Max Depth | Max Pressure | CTD Filename | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 1 | 020608 | 09:41 | 10:49 | 00-00.66N | 090-04.85E | 4444.0 | 2058.2 | 2000.4 | 2021.1 | C01M01 | ADCP subsurface mooring recovery and deployment<br>Primary T, C and DO sensors had a problem. |
| C02 | 1 | 020608 | 23:34 | 23:59 | 01-40.95S | 090-08.37E | 4707.0 | 503.6 | 502.8 | 506.3 | C02M01 | JEPP and TRITON (No. 18) recovery |
| C03 | 1 | 020808 | 07:50 | 09:06 | 01-40.95S | 090-01.55E | 4525.0 | 2010.9 | 2001.5 | 2022.2 | C03M01 | JEPP deployment<br>Primary T, C and DO sensors had a problem. |
| C04 | 1 | 020908 | 02:58 | 03:27 | 03-36.08S | 093-00.48E | 4837.0 | 797.1 | 802.6 | 796.8 | C04M01 | Primary T sensor was changed (S/N03P2730→03P4188).<br>Primary T, C and DO sensors had a problem.<br>The observation was discontinued. |
| C04 | 2 | 020908 | 04:02 | 05:12 | 03-36.26S | 093-00.48E | 4839.0 | 2012.4 | 2001.1 | 2022.3 | C04M02 | ARGO<br>re-observation<br>Primary T, C and DO sensors had a problem. |
| C05 | 1 | 020908 | 09:58 | 11:08 | 04-18.04S | 094-00.39E | 4909.0 | 2013.7 | 2002.2 | 2023.9 | C05M01 | ARGO<br>Primary T, C and DO sensors had a problem. |
| C06 | 1 | 021008 | 07:07 | 08:22 | 04-58.40S | 095-01.48E | 5001.0 | 2022.3 | 2000.1 | 2020.2 | C06M01 | JEPP deployment<br>Primary C and DO sensors had a problem. |

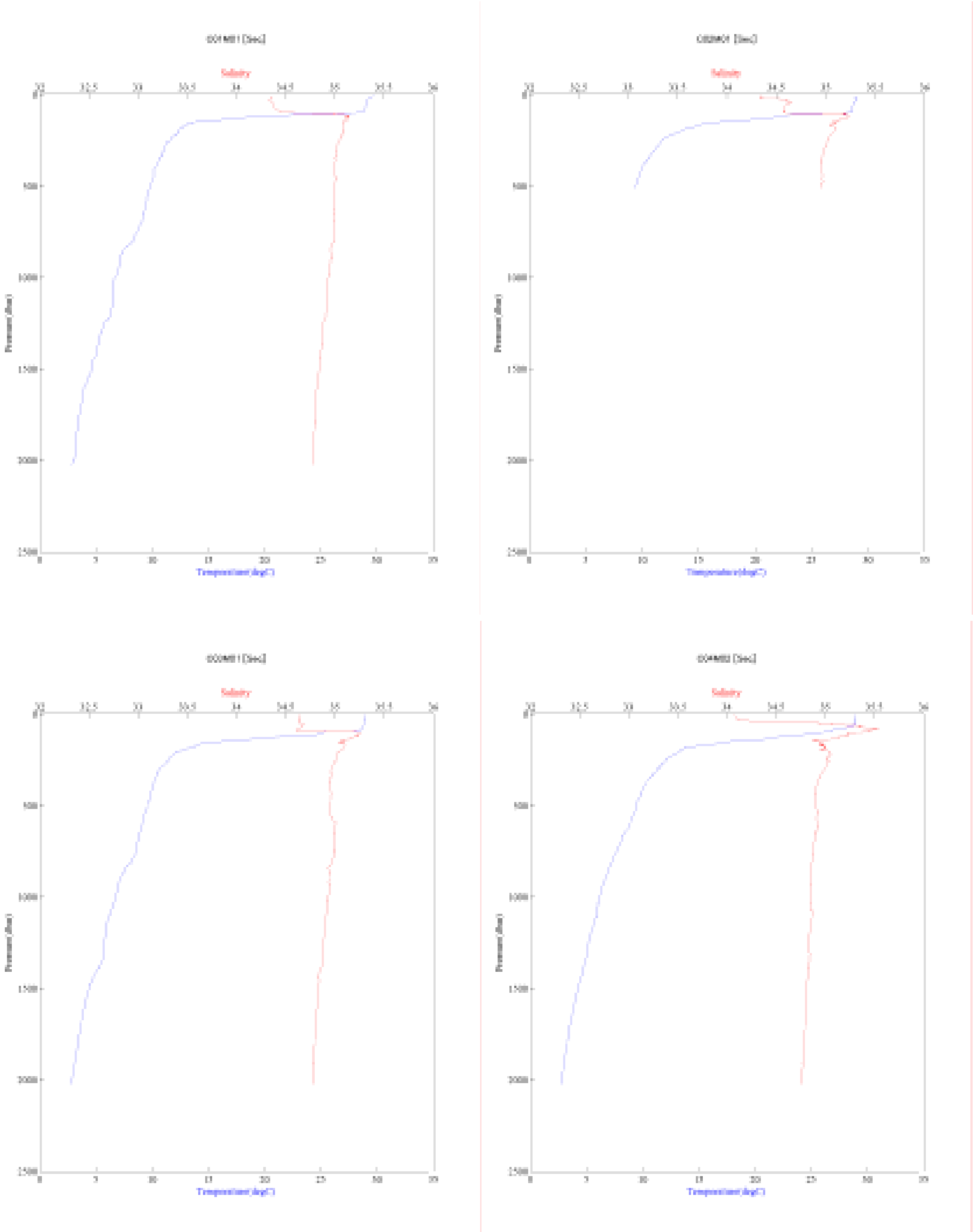


Figure 6.2.1-1 CTD profile (C01-C04)

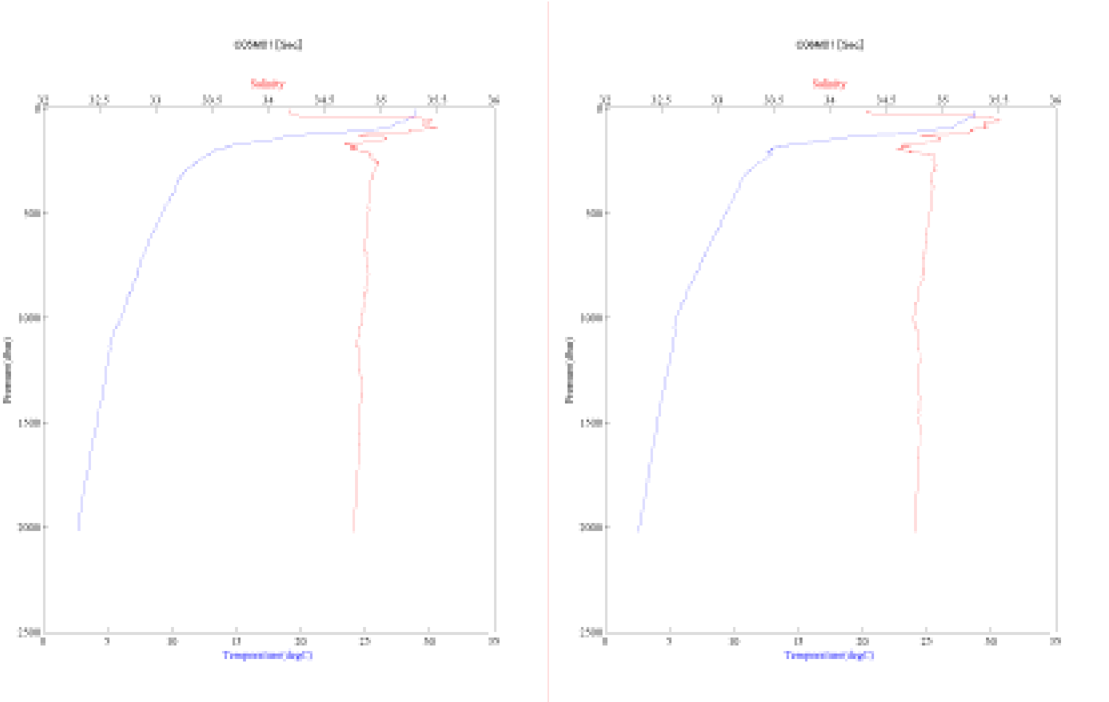


Figure 6.2.1-2 CTD profile (C05, C06)

### 6.2.2 XCTD

| | | |
|---|---|---|
| Hideaki Hase | (JAMSTEC): Principal Investigator | |
| Shinya Okumura | (Global Ocean Development Inc., GODI) | -leg2- |
| Wataru Tokunaga | (GODI) | -leg3- |
| Kazuho Yoshida | (GODI) | -leg2, 3- |

(1) Objectives

Comparing to the data of the buoys, the XCTD (eXpendable Conductivity, Temperature & Depth profiler) observation were carried out near the buoys after their deployment.

(2) Parameters

According to the manufacturer's information, the range and accuracy of parameters measured by the XCTD are as follows;

| Parameter | Range | Accuracy |
|---|---|---|
| Conductivity | 0~60 [mS] | +/- 0.03 [mS/cm] |
| Temperature | -2~35 [deg-C] | +/- 0.02 [deg-C] |
| Depth | 0~1,000 [m] | 5 [m] or 2% at depth, whichever is greater |

(3) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by the XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (version 1.07) made by Tsurumi-Seiki Co..

We dropped 4 probes (X001-X004) by using automatic launcher. The summary of XCTD observation and launching log are shown in Table 6.2.2-1.

(4) Preliminary results

Vertical profiles of temperature and salinity are shown in Fig. 6.2.2-1 and Fig. 6.2.2-2.

(5) Data archives

XCTD data obtained in this cruise will be submitted to the JAMSTEC Marine-Earth Data and Information Department (MEDID) and will be available via "R/V MIRAI Data Web Page" in JAMSTEC home page.

Table 6.2.2-1 XCTD observation and launching log

| Station No. | Launc Time (UTC) | | Finish time | Launch Position | | Measured Depth(m) | Water Depth (m) | Surface Temp. (degC) | Surface Salinity (PSU) | Probe S/N |
|---|---|---|---|---|---|---|---|---|---|---|
| | date | time | | Latitude | Longitude | | | | | |
| <Leg2> | | | | | | | | | | |
| 001 | 2/6 | 9:15:13 | 9:21 | 1-40.96S | 90-01.69E | 1,035 | 4,539 | 28.918 | 34.664 | 07064651 |
| 002 | 2/11 | 5:45:03 | 5:50 | 4-59.87S | 95-03.84E | 1,033 | 4,997 | 28.815 | 34.348 | 07064652 |
| <leg3> | | | | | | | | | | |
| 003 | 2/28 | 22:12:18 | 22:17 | 37-54.44N | 146-38.86E | 1,035 | 5,377 | 14.627 | 34.645 | 06079367 |
| 004 | 2/29 | 8:34:27 | 8:39 | 38-04.85N | 146-28.15E | 1,035 | 5,406 | 10.306 | 34.24 | 06079368 |

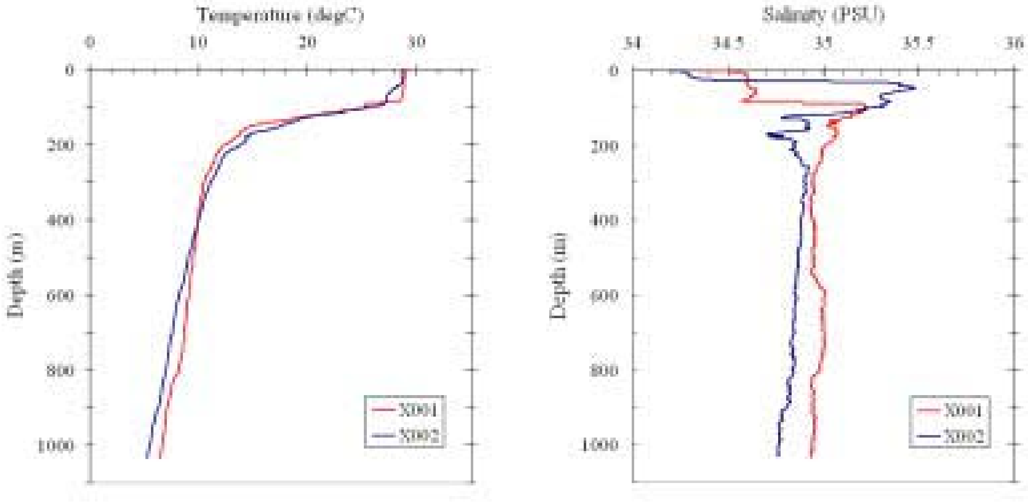



Fig 6.2.2-1 Vertical profiles of temperature and salinity (Leg2)

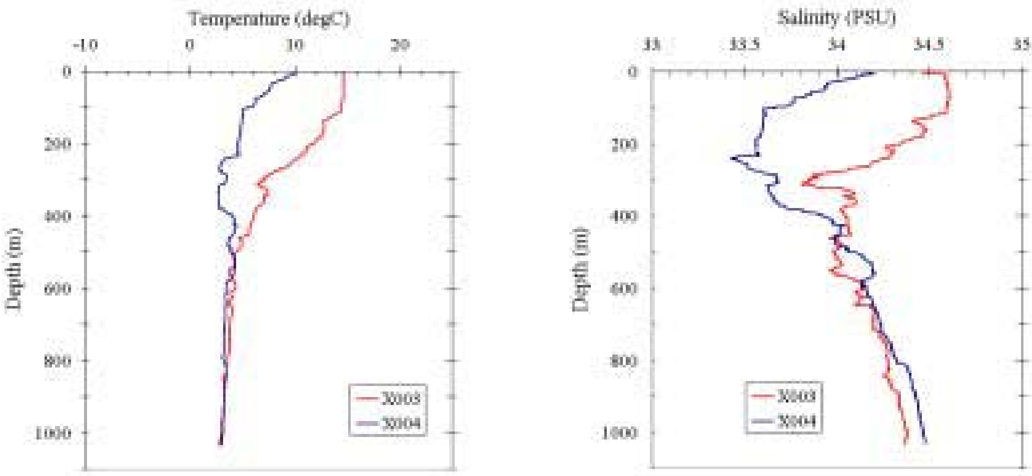



Fig 6.2.2-2 Vertical profiles of temperature and salinity (Leg3)

## 6.3 Validation of CTD cast data

### 6.3.1 Salinity measurement of sampled seawater

**(1) Personnel**

**Tatsuya Tanaka (MWJ)** : Operation reader

**(2) Objectives**

To provide a calibration for the measurement of salinity of bottle water collected on the CTD casts and EPCS.

**(3) Instrument and Method**

**a. Salinity Sample Collection**

Seawater samples were collected with 12 liter Niskin-X bottles and EPCS. The salinity sample bottle of the 250ml brown glass bottle with screw cap was used for collecting the sample water. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. The sample bottle was sealed with a plastic insert thimble and a screw cap ; the thimble being thoroughly rinsed before use. The bottle was stored for more than 24 hours in the laboratory before the salinity measurement.

The kind and number of samples taken are shown as follows ;

Table 6.3.1-1 Kind and number of samples

| Kind of Samples | Number of Samples |
|---|---|
| Samples for CTD | 46 |
| Samples for EPCS | 9 |
| Total | 55 |

**b. Instruments and Method**

The salinity analysis was carried out on R/V MIRAI during the cruise of MR07-07Leg2 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62827) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. The thermometer monitored the ambient temperature and the other monitored a bath temperature.

The specifications of the AUTOSAL salinometer and thermometer are shown as follows ;

Salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.)

| | | |
|---|---|---|
| Measurement Range | : | 0.005 to 42 (PSU) |
| Accuracy | : | Better than ±0.002 (PSU) over 24 hours without re-standardization |
| Maximum Resolution | : | Better than ±0.0002 (PSU) at 35 (PSU) |

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

| | | |
|---|---|---|
| Measurement Range | : | -40 to +180 deg C |
| Resolution | : | 0.001 |
| Limits of error ±deg C | : | 0.01 (24 hours @ 23 deg C ±1 deg C) |
| Repeatability | : | ±2 least significant digits |

The measurement system was almost the same as Aoyama *et al.* (2002). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. The ambient temperature varied from approximately 21 deg C to 24 deg C, while the bath temperature was very stable and varied within +/- 0.002 deg C on rare occasion. The measurement for each sample was done with a double conductivity ratio and defined as the median of 31 readings of the salinometer. Data collection was started 5 seconds after filling the cell with the sample and it took about 15 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity with the algorithm for the practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, an eighth filling of the cell was done. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity. The measurement was conducted in about 7 hours per day and the cell was cleaned with soap after the measurement of the day.

**(4) Preliminary Result**

**a. Standard Seawater**

Standardization control of the salinometer was set to 456 and all measurements were done at this setting. The value of STANDBY was 5394 +/- 0001 and that of ZERO was 0.0+0000 or 0.0+0001. The conductivity ratio of IAPSO Standard Seawater batch P148 was 0.99982 (double conductivity ratio was 1.99964) and was used as the standard for salinity. 4 bottles of P148 were measured.

Fig.6.3.1-1 shows the history of the double conductivity ratio of the Standard Seawater batch P148. The average of the double conductivity ratio was 1.99963 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

The specifications of SSW used in this cruise are shown as follows ;

| | | |
|---|---|---|
| batch | : | P148 |
| conductivity ratio | : | 0.99982 |
| salinity | : | 34.993 |
| preparation date | : | 10-October-2006 |

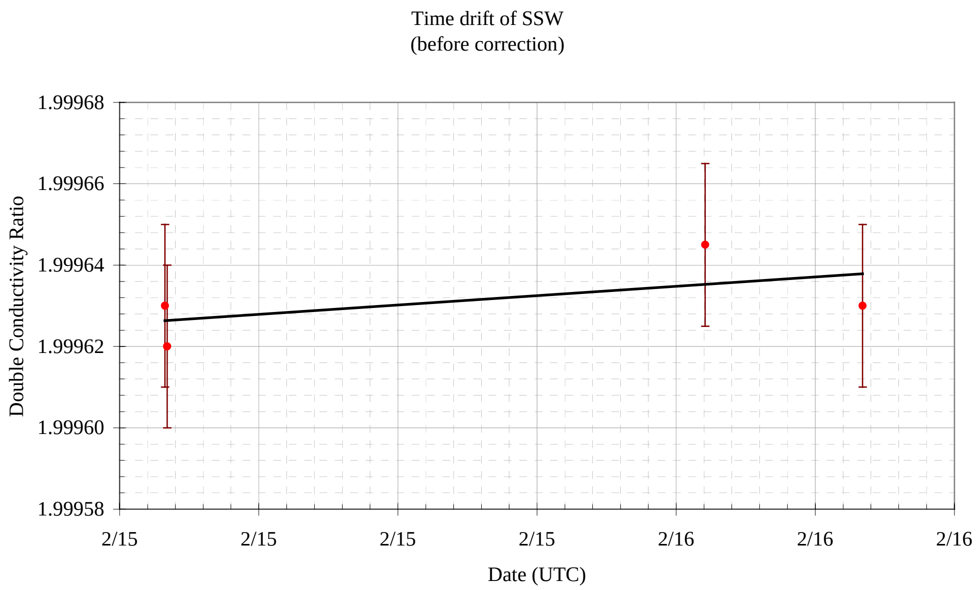



**Fig. 6.3.1-1 History of double conductivity ratio for the Standard Seawater batch P148 (before correction)**

### b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by a pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 6 samples in order to check for the possible sudden drifts of the salinometer.

### c. Replicate Samples

We estimated the precision of this method using 23 pairs of replicate samples taken from the same Niskin bottle. There was one bad pair of replicate samples. Fig.6.3.1-2 shows the histogram of absolute difference between replicate samples. The average and the standard deviation of absolute difference among 22 pairs (excluding one bad pair) of replicate samples were 0.0002 and 0.0001 in salinity, respectively.

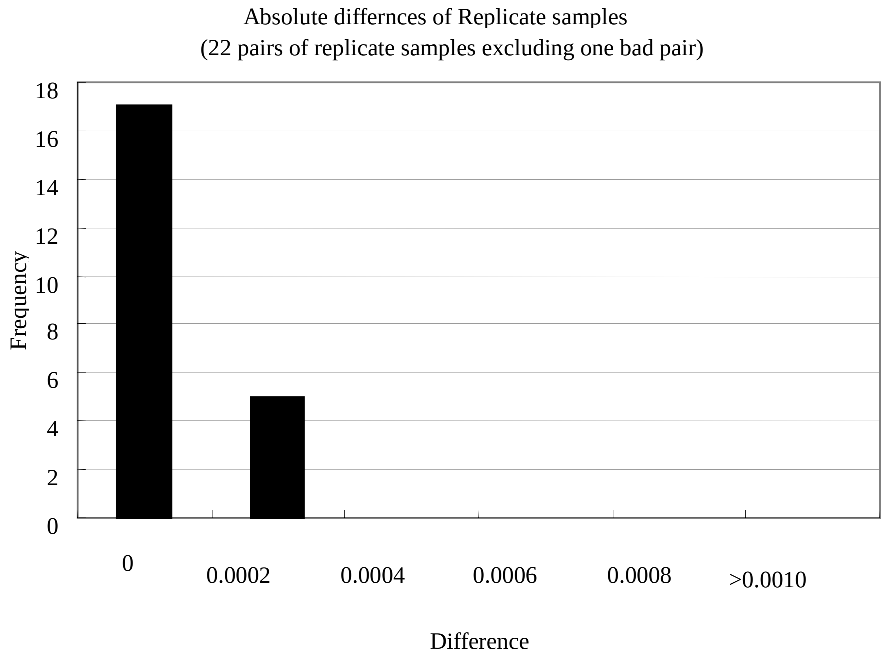



**Fig. 6.3.1-2 The histogram of the absolute difference between replicate samples (22 pair of replicate samples excluding one bad pair)**

### (5) Data archive

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

### (6) Reference

・Aoyama, M., T. Joyce, T. Kawano and Y. Takatsuki : Standard seawater comparison up to P129. Deep-Sea Research, I, Vol. 49, 1103～1114, 2002

・UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 1981

## 6.4 Continuous monitoring of surface seawater

(1) Personnel

Hideaki HASE (JAMSTEC): Principal Investigator
Ayumi TAKEUCHI (MWJ): Operator

(2) Objective

(Leg.2) Measurement of temperature, salinity and dissolved oxygen of the sea surface water in the eastern Indian Ocean.

(Leg.3) Measurement of temperature and salinity of the sea surface water in the northwestern Pacific Ocean.

(3) Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) has five kind of sensors and can automatically measure salinity, temperature (two systems), dissolved oxygen and fluorescence in near-sea surface water continuously, every 1-minute. We measured salinity, temperature (two systems) and dissolved oxygen during Leg.2 cruise. In Leg.3 cruise, We measured salinity and temperature (two systems). Salinity is calculated by conductivity on the basis of PSS78. This system is located in the "*sea surface monitoring laboratory*" on R/V MIRAI. This system is connected to shipboard LAN-system. Measured data is stored in a hard disk of PC every 1-minute together with time and position of ship, and displayed in the data management PC machine.

Near-surface water was continuously pumped up to the laboratory and flowed into the *Continuous Sea Surface Water Monitoring System* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves and was 12L/min. The flow rate is measured with flow meter.

Specification of the each sensor in this system of listed below.

a) Temperature and Conductivity sensor
SEACAT THERMOSALINOGRAPH
Model: SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number: 2118859-2641
Measurement range: Temperature -5 to +35℃, Conductivity 0 to 6.5 S m-1
Accuracy: Temperature 0.01℃ 6month-1,Conductivity 0.001 S m-1 month-1
Resolution: Temperatures 0.001℃, Conductivity 0.0001 S m-1

b) Bottom of ship thermometer
Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number: 032607
Measurement range: -5 to +35℃
Resolution: ±0.001℃
Stability: 0.002℃ year-1

c) Dissolved oxygen sensor
Model: 2127A, HACH ULTRA ANALYTICS JAPAN, INC.
Serial number: 44733
Measurement range: 0 to 14 ppm
Accuracy: ±1% at 5℃ of correction range
Stability: 1% month-1

d) Flow meter

Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 l min-1
Accuracy: ±1%
Stability: ±1% day-1

The monitoring periods (UTC) during this cruise are listed below.

| | | |
|---|---|---|
| (Leg.2) | Start : 2008/02/01 22:30 | Stop : 2008/02/02 08:00 |
| | Start : 2008/02/05 06:30 | Stop : 2008/02/11 16:00 |
| | Start : 2008/02/13 16:00 | Stop : 2008/02/14 08:00 |
| (Leg.3) | Start : 2008/02/26 09:58 | Stop : 2008/03/01 22:59 |

(4) Preliminary Result

Preliminary data of temperature, salinity, dissolved oxygen, at sea surface are shown in Fig.6.4-1(Leg.2) and Fig.6.4-2(Leg.3) . We took the surface water samples to compare sensor data with bottle data of salinity for 1 time per day, and measured. This is shown in Fig.6.4-3. All the salinity samples were analyzed by the Guildline 8400B.

(5) Date archive

The data were stored on a CD-R, which will be submitted to the Data Management Office (DMO) JAMSTEC, and will be opened to public via"R/V MIRAI Data Web Page"in JAMSTEC homepage.

(6) Remarks

We deleted the data in the territorial waters, Kingdom of Thailand EEZ, and Republic of Indonesia EEZ because of no permission. These periods(UTC) are listed below.

From : 2008/02/02 08:01 To : 2008/02/05 05:29
From : 2008/02/11 16:01 To : 2008/02/13 15:59

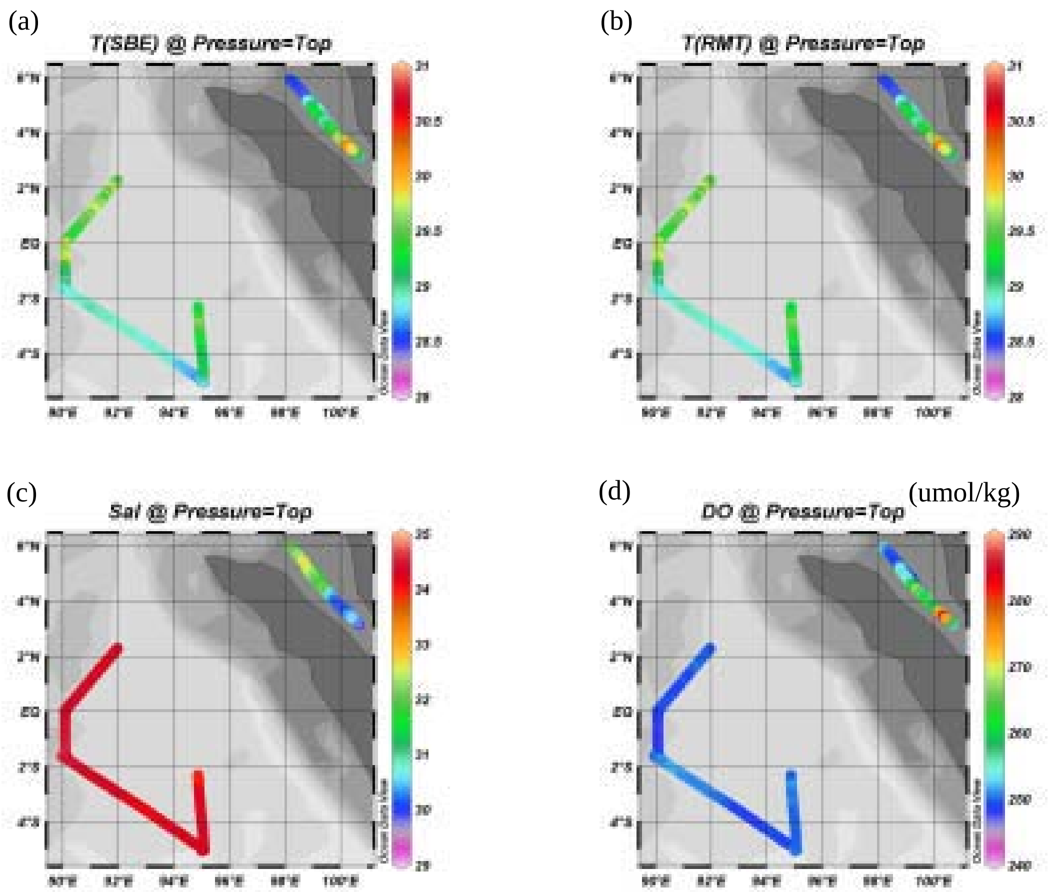



Fig.6.4-1 Spatial and temporal distribution of temperature (SBE) (a), temperature (RMT) (b), salinity (c) and dissolved oxygen (d) during Leg.2 cruise .

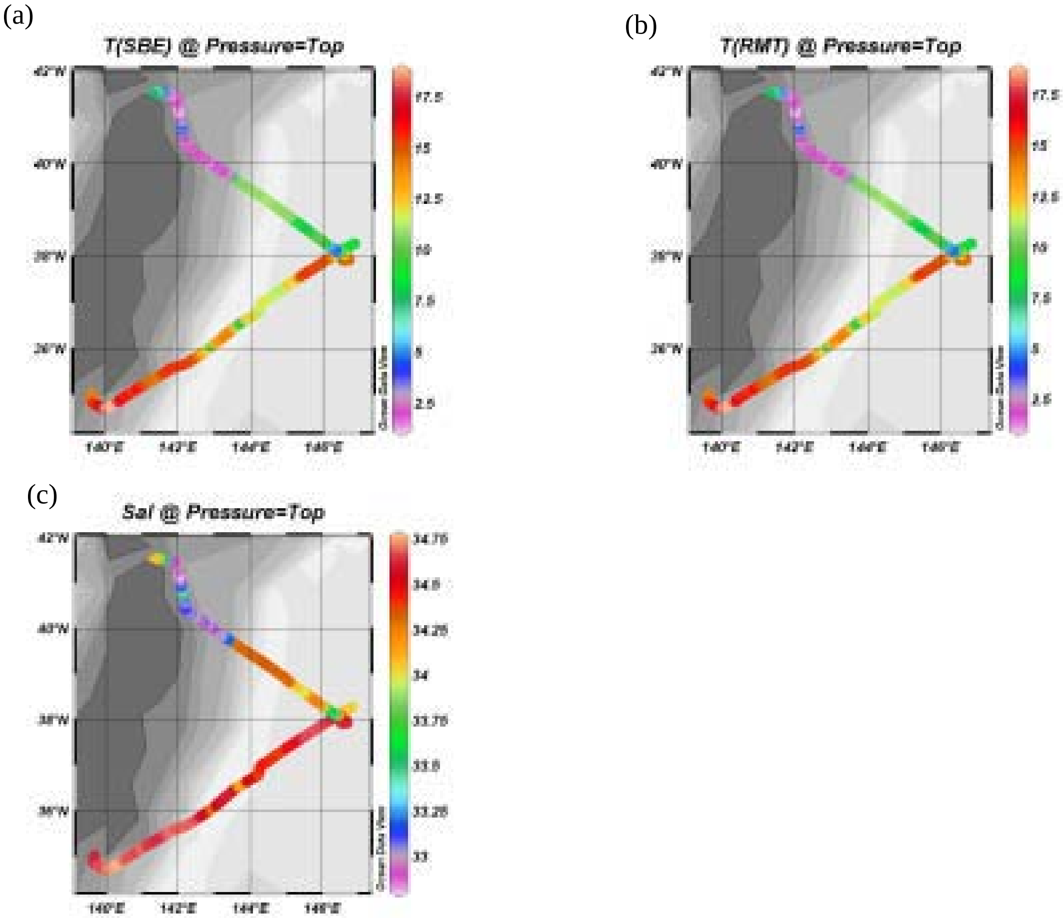



Fig.6.4-2 Spatial and temporal distribution of temperature (SBE) (a), temperature (RMT) (b) and salinity (c) during Leg.3 cruise .

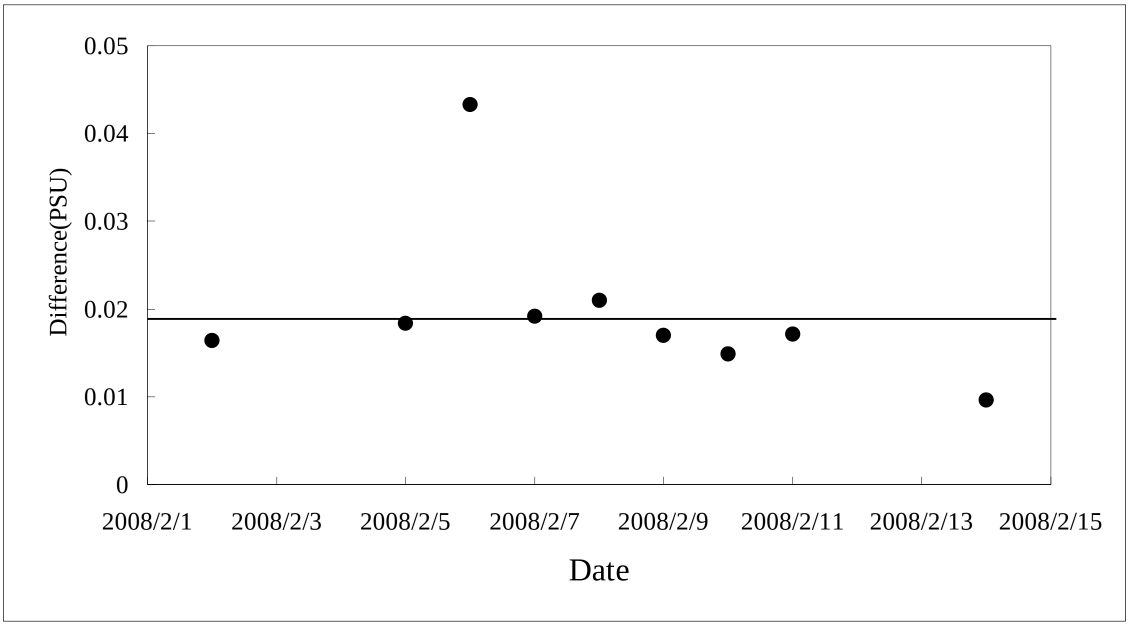



Fig.6.4-3 Variability of difference between sensor data and bottle data in salinity. The mean of the difference was 0.0197±0.0094 psu.

## 6.5 Shipboard ADCP

(1) Personnel

| | | |
|---|---|---|
| Hideaki Hase | (JAMSTEC): Principal Investigator | |
| Shinya Okumura | (Global Ocean Development Inc., GODI) | -leg2- |
| Wataru Tokunaga | (GODI) | -leg3- |
| Kazuho Yoshida | (GODI) | -leg2, 3- |

(2) Objective

To obtain continuous measurement of the current profile along the ship's track.

(3) Methods

Upper ocean current measurements were made during the observation of the MR07-07 leg2 and leg3 cruises, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V MIRAI. We had operated the instrument was configured for water-tracking mode recording.

The system consists of following components;

i ) 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;

ii ) the Ship's main gyro compass (Tokimec, Japan), continuously providing ship's heading measurements to the ADCP;

iii ) a GPS navigation receiver (Trimble 4000DS ) providing position fixes;

iv ) a personal computer running data acquisition software (VmDas version 1.4.0, RD Instruments, USA). The clock of the logging PC are adjusted to GPS time every 5 minutes.

v ) high-precision attitude information, heading, pitch and roll, are also stored in N2R data file with a time stamp.

The ADCP was configured for 16 m processing bin and 8 m blanking distance. The sound speed at the transducer is calculated from temperature, salinity (constant value; 35.0 psu) and depth (6.5 m; transducer depth) by equation in Medwin (1975). Data was made at 16-m intervals starting 31-m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are shown bellow;

***Bottom-Track Commands***

| | |
|---|---|
| BP = 001 | Pings per Ensemble |

***Environmental Sensor Commands***

| | |
|---|---|
| EA = +00000 | Heading Alignment (1/100 deg) |
| EB = +00000 | Heading Bias (1/100 deg) |
| ED = 00065 | Transducer Depth (0 - 65535 dm) |
| EF = +0001 | Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99] |
| EH = 00000 | Heading (1/100 deg) |
| ES = 35 | Salinity (0-40 pp thousand) |
| EX = 00000 | Coord Transform (Xform:Type; Tilts; 3Bm; Map) |
| EZ = 1020001 | Sensor Source (C;D;H;P;R;S;T) |
| | C(1): Sound velocity calculate using ED, ES, ET(temp.) |
| | D(0): Manual ED |
| | H(2): External synchro |
| | P(0), R(0): Manual EP, ER (0 degree) |

| | |
|---|---|
| | S(0): Manual ES |
| | T(1): Internal transducer sensor |
| ***Timing Commands*** | |
| TE = 00:00:02.00 | Time per Ensemble (hrs:min:sec.sec/100) |
| TP = 00:02.00 | Time per Ping (min:sec.sec/100) |
| ***Water-Track Commands*** | |
| WA = 255 | False Target Threshold (Max) (0-255 counts) |
| WB = 1 | Mode 1 Bandwidth Control (0=Wid,1=Med,2=Nar) |
| WC = 064 | Low Correlation Threshold (0-255) |
| WD = 111 111 111 | Data Out (V;C;A PG;St;Vsum Vsum^2;#G;P0) |
| WE = 5000 | Error Velocity Threshold (0-5000 mm/s) |
| WF = 0800 | Blank After Transmit (cm) |
| WG = 001 | Percent Good Minimum (0-100%) |
| WI = 0 | Clip Data Past Bottom (0=OFF,1=ON) |
| WJ = 1 | Rcvr Gain Select (0=Low,1=High) |
| WM = 1 | Profiling Mode (1-8) |
| WN = 040 | Number of depth cells (1-128) |
| WP = 00001 | Pings per Ensemble (0-16384) |
| WS = 1600 | Depth Cell Size (cm) |
| WT = 000 | Transmit Length (cm) [0 = Bin Length] |
| WV = 999 | Mode 1 Ambiguity Velocity (cm/s radial) |

(4) Preliminary results

Fig. 6.5-1 to Fig. 6.5-3 show current vector along the ship track in the observed period. The data was processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

(5) Data archive

The data obtained in this cruise will be submitted to the Marine-Earth Data and Information Department（MEDID）of JAMSTEC, and will be opened to the public via “R/V Mirai Data Web Page” in JAMSTEC home page.

(6) Remarks

We have observed at open sea of Indian Ocean and EEZ of Malaysia (except territorial waters) in leg2 cruise, and all area in leg3 cruise.

| | |
|---|---|
| EEZ of Malaysia: | 01 Feb. 22:30 UTC - 02 Feb. 16:00 UTC |
| | 13 Feb. 16:00 UTC - 14 Feb. 08:00 UTC |
| Open sea of Indian Ocean: | 05 Feb. 06:30 UTC - 11 Feb. 16:00 UTC |
| Leg 3 cruise: | 26 Feb. 06:50 UTC – 02 Mar. 04:10 UTC |

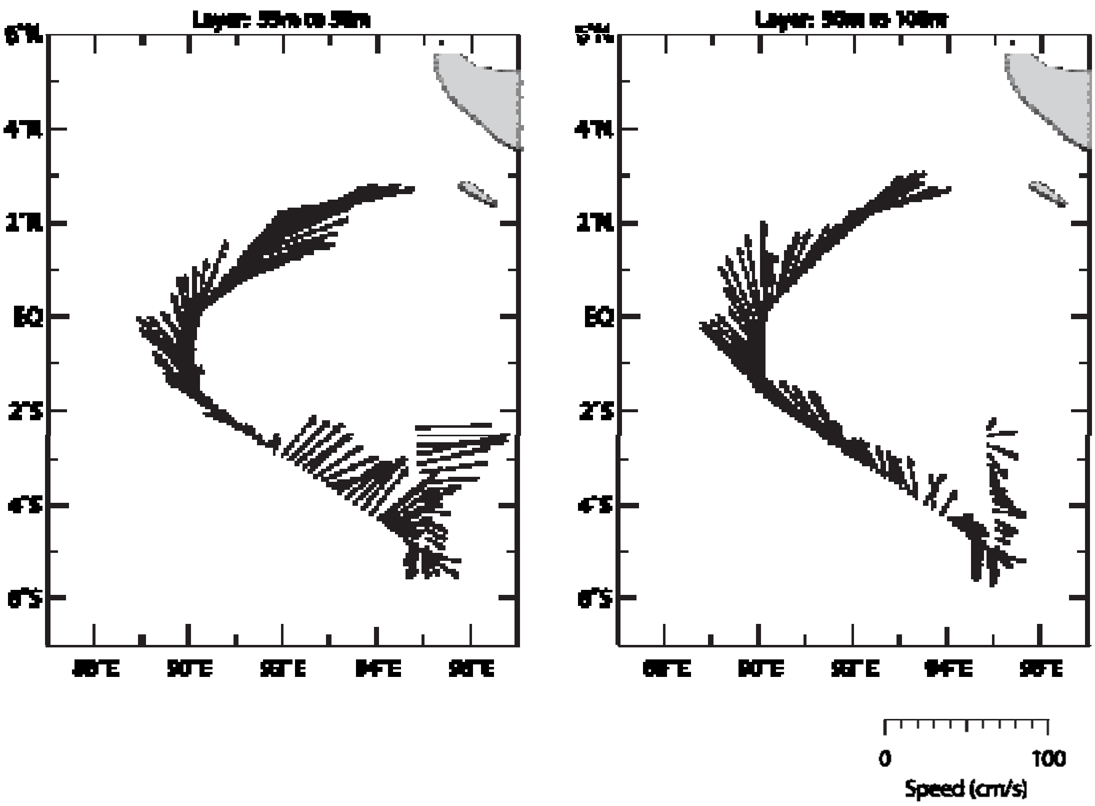



Fig. 6.5-1 Current vector. (Depth layer: 35 m to 50 m and 50 m to 100 m)

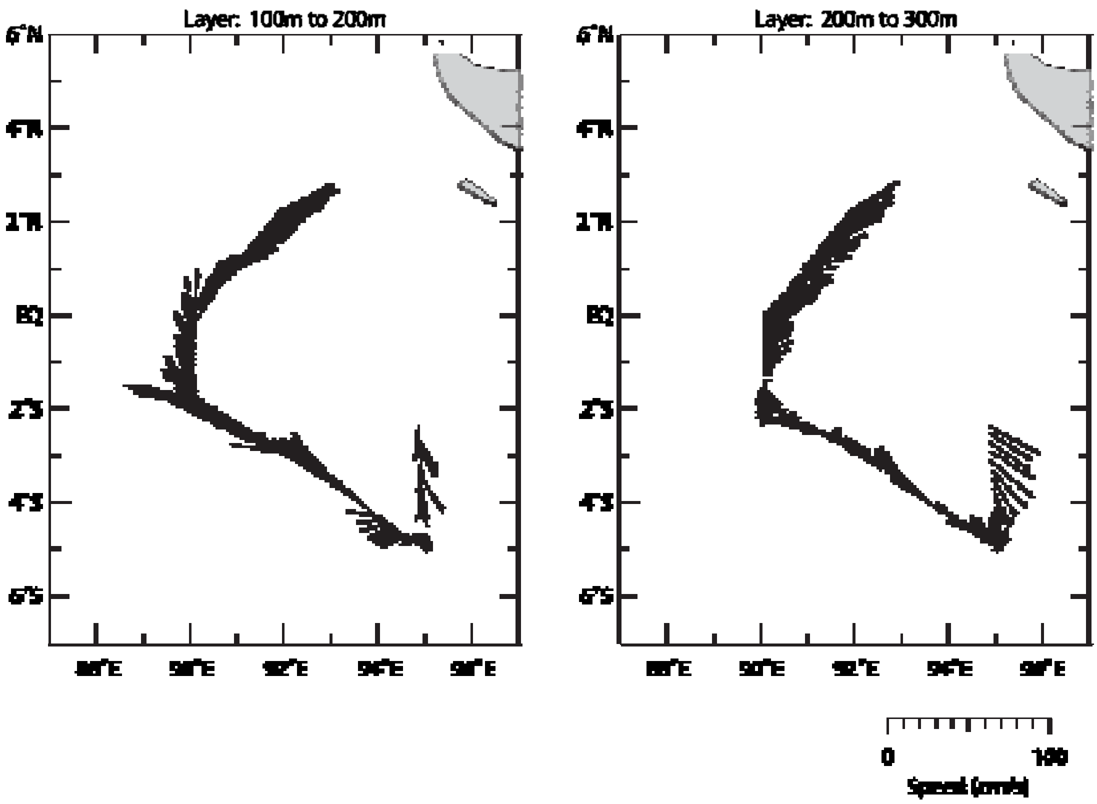



Fig. 6.5-2  Current vector. (Depth layer: 100 m to 200 m and 200 m to 300 m)

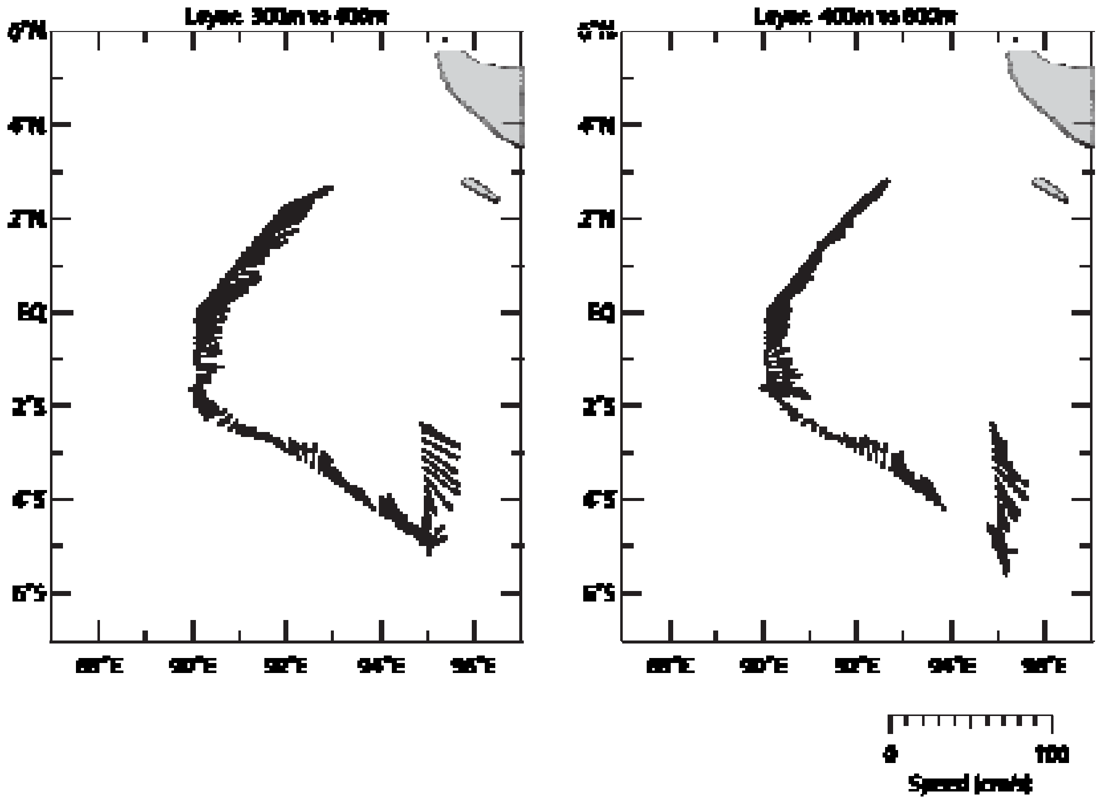



Fig. 6.5-3  Current vector. (Depth layer: 300 m to 400 m and 400 m to 600 m)

## 6.6 Underway geophysics

### 6.6.1 Sea Surface Gravity

| | |
|---|---|
| Takeshi Matsumoto (University of the Ryukyus): | Principal investigator (Not on-board) |
| Shinya Okumura (Global Ocean Development Inc.) | - Leg2 - |
| Kazuho Yoshida (GODI) | - Leg2, 3 - |
| Wataru Tokunaga (GODI) | - Leg3 - |

(1) Introduction

The distribution of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the observation of the MR07-07 Leg2 and Leg3 cruise.

(2) Parameters

Relative Gravity [CU: Counter Unit]
[mGal] = (coef1: 0.9946) * [CU]

(3) Data Acquisition

We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) during this cruise. To convert the relative gravity to absolute one, we measured gravity using portable gravity meter (Scintrex gravity meter CG-3M), at Nakagusuku, Yokohama and Sekinehama port as reference points.

(4) Preliminary Results

Absolute gravity shown in Table 6.6.1-1

Table 6.6.1-1

| No. | Date | U.T.C. | Port | Absolute Gravity [mGal] | Sea Level [cm] | Draft [cm] | Gravity at Sensor *1 [mGal] | L&R *2 Gravity [mGal] |
|---|---|---|---|---|---|---|---|---|
| #01 | Jan/25 | 03:53 | Nakagusuku | 979114.70 | 285 | 628 | 979115.62 | 11386.76 |
| #02 | Feb/26 | 01:33 | Yokohama | 979741.00 | 250 | 620 | 979741.81 | 12013.20 |
| #03 | Mar/02 | 07:51 | Sekinehama | 980371.92 | 312 | 607 | 980372.92 | 12642.00 |

*1: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431
*2: LaCoste and Romberg air-sea gravity meter S-116

(5) Data Archives

Gravity data obtained during this cruise will be submitted to the JAMSTEC Marine-Earth Data and Information Department (MEDID), and will be archived there.

(6) Remarks

We have observed at open sea of Indian Ocean and EEZ of Malaysia (except territorial waters) in this cruise.

| | |
|---|---|
| EEZ of Malaysia: | 01 Feb. 22:30 UTC – 02 Feb. 16:00 UTC |
| | 13 Feb. 16:00 UTC – 14 Feb. 08:00 UTC |
| Open sea of Indian Ocean: | 05 Feb. 06:30 UTC – 11 Feb. 16:00 UTC |

### 6.6.2 Sea Surface Three-Component Magnetic Field

| | |
|---|---|
| Takeshi Matsumoto (University of the Ryukyus): | Principal investigator (Not on-board) |
| Shinya Okumura (Global Ocean Development Inc.) | - Leg2 - |
| Kazuho Yoshida (GODI) | - Leg2, 3 - |
| Wataru Tokunaga (GODI) | - Leg3 - |

(1) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the observation of the MR07-07 leg2 and Leg3 cruise.

(2) Parameters

Three-component magnetic force [ nT ]
Ship's attitude [ 1/100 deg ]

(3) Method of Data Acquisition

A sensor of three-component fluxgate magnetometer is set on the top of foremast. Sampling is controlled by 1pps (pulse per second) standard clock of GPS signals. Navigation information, 8 Hz three-component of magnetic force, and VRU (Vertical Reference Unit) data are recorded every one second.

For calibration of the ship's magnetic effect, we made a running like a "figure-eight" turn (a pair of clockwise and anti-clockwise rotation). This calibration carried out as below.

07 Feb. 2008, 09:24 to 09:47 about at 01-33S, 90-06E
10 Feb. 2008, 09:02 to 09:31 about at 05-04S, 95-01E
01 Mar. 2008, 12:50 to 13:18 about at 40-59N, 142-04E

(4) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

Magnetic force data obtained during this cruise will be submitted to the JAMSTEC Marine-Earth Data and Information Department (MEDID), and will be archived there.

(6) Remarks

We have observed at open sea of Indian Ocean and EEZ of Malaysia (except territorial waters) in this cruise.

| | |
|---|---|
| EEZ of Malaysia: | 01 Feb. 22:30 UTC – 02 Feb. 16:00 UTC |
| | 13 Feb. 16:00 UTC – 14 Feb. 08:00 UTC |
| Open sea of Indian Ocean: | 05 Feb. 06:30 UTC – 11 Feb. 16:00 UTC |

### 6.6.3 Swath Bathymetry


| | |
|---|---|
| Takeshi Matsumoto (University of the Ryukyus): | Principal investigator (Not on-board) |
| Shinya Okumura (Global Ocean Development Inc.) | - Leg2 - |
| Kazuho Yoshida (GODI) | - Leg2, 3 - |
| Wataru Tokunaga (GODI) | - Leg3 - |


(1) Introduction

The objective is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets. And we need to confirm the depth at the location of deployment of TRITON, K-TRITON and ADCP mooring buoys in order to design these mooring systems.

In addition, we have collected vertical sediments information for coring the periphery of 05-00N/94-25E in this cruise.

(2) Data Acquisition

R/V MIRAI is equipped with a Multi Beam Echo Sounding system (MBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.). The system was used for bathymetry mapping during the observation of the MR07-07 Leg2 and Leg3 cruise. Sub Bottom profiler (SBP) is an add-on option to the "SEABEAM 2100".

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the surface (6.2m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD or XCTD data by the equation in Mackenzie (1981) during the cruise.

Table 6.6.3-1 shows system configuration and performance of SEABEAM 2112.004 system and SBP subsystem.

Table 6.6.3-1 System configuration and performance

SEABEAM 2112.004 (12 kHz system)

| | |
|---|---|
| Frequency: | 12 kHz |
| Transmit beam width: | 2 degree |
| Transmit power: | 20 kW |
| Transmit pulse length: | 3 to 20 msec. |
| Depth range: | 100 to 11,000 m |
| Beam spacing: | 1 degree athwart ship |
| Swath width: | 150 degree (max)<br>120 degree to 4,500 m<br>100 degree to 6,000 m<br>90 degree to 11,000 m |
| Depth accuracy: | Within < 0.5% of depth or +/-1m,<br>whichever is greater, over the entire swath.<br>(Nadir beam has greater accuracy; typically within < 0.2% of depth or +/-1m, whichever is greater) |

Sub-Bottom Profiler (4 kHz system)

| | |
|---|---|
| Frequency: | 4 kHz |
| Transmit beam width: | 5 degree |
| Sweep: | 5 to 100 msec |
| Depth Penetration: | As much as 75 m (varies with bottom composition) |
| Resolution of sediments: | Under most condition within < tens-of-centimeters range<br>(dependent upon depth and sediment type) |

(3) Preliminary Results

The other results will be published after primary processing.

(4) Data Archives

Bathymetric data obtained during this cruise will be submitted to the JAMSTEC Marine-Earth Data and Information Department, and will be archived there.

(5) Remarks

We have observed at open sea of Indian Ocean and the periphery of coring point.

| | |
|---|---|
| The periphery of coring point: | 03 Feb. 02:28 UTC – 03 Feb. 23:36 UTC |
| Open sea of Indian Ocean: | 05 Feb. 06:30 UTC – 11 Feb. 16:00 UTC |

## 6.7 Satellite image acquisition

### 6.7.1 NOAA/HRPT

| | | |
|---|---|---|
| Hideaki Hase | (JAMSTEC): Principal Investigator | |
| Shinya Okumura | (Global Ocean Development Inc., GODI) | -leg2- |
| Wataru Tokunaga | (GODI) | -leg3- |
| Kazuho Yoshida | (GODI) | -leg2, 3- |

(1) Objectives

It is our objectives to collect data of cloud image and sea surface temperature in a high spatial resolution mode from the Advance Very High Resolution Radiometer (AVHRR) on the NOAA polar orbiting satellites. Infrared (ch. 4) image provides cloud system information for atmospheric observation.

(2) Method

We received the down link High Resolution Picture Transmission (HRPT) signal from NOAA satellites. We processed the HRPT signal with the in-flight calibration and computed the sea surface temperature by the Multi-Channel Sea Surface Temperature (MCSST) method. A daily composite map of MCSST data was processed for each day on the R/V MIRAI for the area, where the R/V MIRAI located.

We received and processed NOAA data throughout MR07-07 Leg2 and Leg3 cruises.

(3) Preliminary results

Fig. 6.7.1-1 shows sea surface temperature on the eastern Indian Ocean. It is a composite map of MCSST data from 1st February to 15th February 2008

(4) Data archives

These raw data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC just after the cruise.

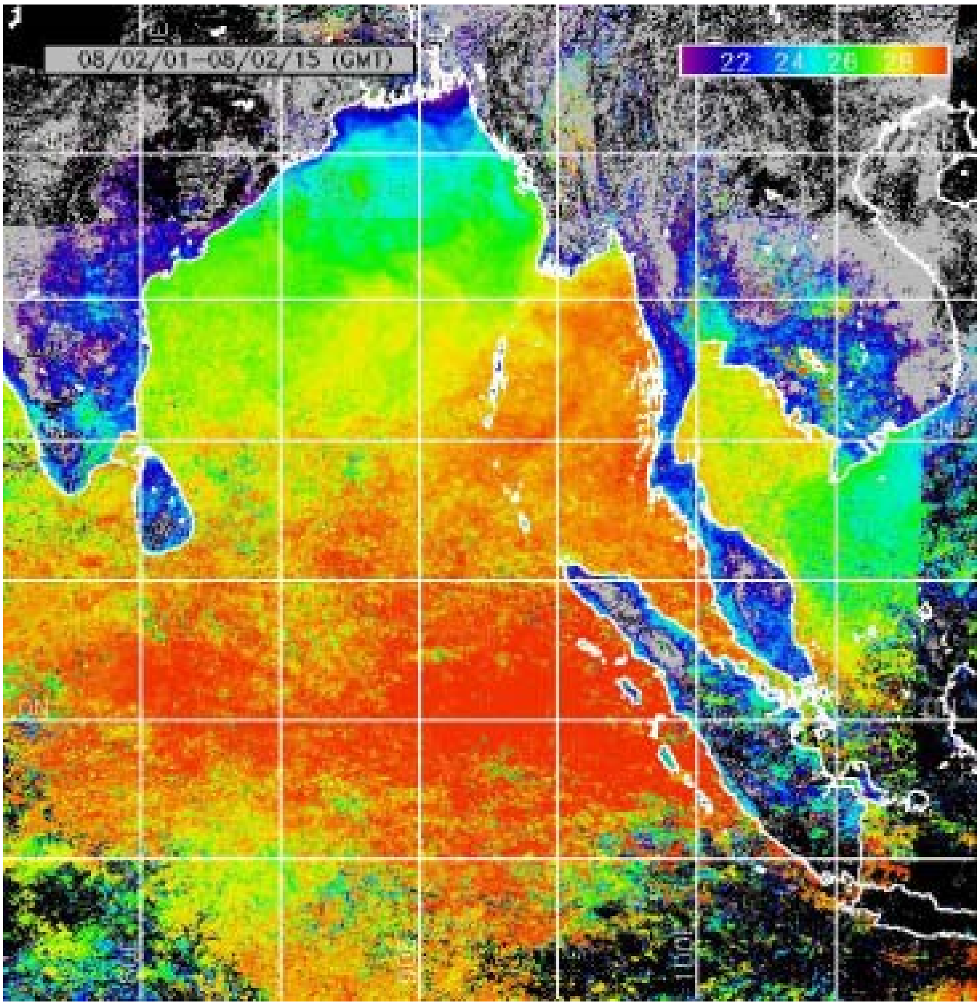



Fig. 6.7.1-1 MCSST composite image, from 1st February to 15th February 2008.

# 7 Special Observations

## 7.1 TRITON moorings

### 7.1.1 TRITON Mooring Operation

(1) Personnel

| | |
|---|---|
| Hideaki Hase | (JAMSTEC): Principal Investigator |
| Masayuki Yamaguchi | (JAMSTEC): Engineer |
| Keisuke Matsumoto | (MWJ): Operation Leader |
| Tomohide Noguchi | (MWJ): Technical Staff |
| Masaki Taguchi | (MWJ): Technical Leader |
| Hiroki Ushiromura | (MWJ): Technical Staff |
| Shinsuke Toyoda | (MWJ): Technical Staff |
| Tatsuya Tanaka | (MWJ): Technical Staff |
| Masatomo Hisazumi | (MWJ): Technical Staff |
| Ayumi Takeuchi | (MWJ): Technical Staff |

(2) Objectives

Two TRITON buoys have been successfully recovered during this R/V MIRAI cruise (MR07-07 Leg2). One of the TRITON buoy (No.18006) was recovered from wire to acoustic releaser, because this buoy was suffered from vandalism damages. Top buoy with the wire (500m) was already recovered.

(3) Measured parameters

Meteorological parameters: wind speed, direction, atmospheric pressure, air temperature, relative humidity, radiation, precipitation.

Oceanic parameters: water temperature and conductivity at 1.5m, 25m, 50m, 75m, 100m, 125m, 150m, 200m, 300m, 500m 750m, depth at 300m and 750m, currents at 10m.

(4) Instrument

1) CTD and CT

SBE-37 IM MicroCAT

A/D cycles to average : 4
Sampling interval : 600sec
Measurement range, Temperature : -5～+35 deg-C
Measurement range, Conductivity : 0～+7 S/m
Measurement range, Pressure : 0～full scale range

2) CRN(Current meter)

SonTek Argonaut ADCM

Sensor frequency : 1500kHz
Sampling interval : 1200sec
Average interval : 120sec

3) Meteorological sensors

Precipitation

R.M.YOUNG COMPANY MODEL50202/50203

Atmospheric pressure

PAROPSCIENTIFIC.Inc. DIGIQUARTZ FLOATING BAROMETER 6000SERIES

Relative humidity/air temperature,Shortwave radiation, Wind speed/direction

Woods Hole Institution ASIMET

| | |
|---|---|
| Sampling interval : | 60sec |
| Data analysis : | 600sec averaged |

(5) TRITON recovered

| | |
|---|---|
| Nominal location | 5S, 95E |
| ID number at JAMSTEC | 17005 |
| Number on surface float | T08 |
| ARGOS PTT number | 20275 |
| ARGOS backup PTT number | 13066 |
| Deployed date | 07 Dec. 2006 |
| Recovered date | 11 Feb. 2008 |
| Exact location | 05－01.57S, 94－59.75E |
| Depth | 5,012m |

| | |
|---|---|
| Nominal location | 1.5S, 90E |
| ID number at JAMSTEC | 18006 |
| Number on surface float | T14 |
| ARGOS PTT number | 23510 |
| ARGOS backup PTT number | 13067 |
| Deployed date | 05 Dec. 2006 |
| Recovered date | 07 Feb. 2008 |
| Exact location | 01－35.63S, 90－05.42E |
| Depth | 4,712m |

*: Dates are UTC and release time for recoveries.

(6) Data archive

Hourly averaged data are transmitted through ARGOS satellite data transmission system in almost real time. The real time data are provided to meteorological organizations via Global Telecommunication System and utilized for daily weather forecast. The data will be also distributed world wide through Internet from JAMSTEC and PMEL home pages. All data will be archived at The JAMSTEC Mutsu Institute.

TRITON Homepage: http://www.jamstec.go.jp/jamstec/triton

### 7.1.2 Inter-comparison between shipboard CTD and TRITON data

(1) Personnel

| | |
|---|---|
| Hideaki Hase | (JAMSTEC): Principal Investigator |
| Keisuke Matsumoto | (MWJ): Operation Leader |
| Hiroki Ushiromura | (MWJ): Technical staff |
| Shinsuke Toyoda | (MWJ): Technical staff |

(2) Objectives

TRITON CTD data validation

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

TRITON buoy underwater sensors are equipped along a wire cable of the buoy below sea surface. We used the same CTD (SBE 9/11Plus) system with general CTD observation (See section 5) on R/V MIRAI for this intercomparison. We conducted 1 CTD cast at each TRITON buoy site before recovery. R/V MIRAI was kept the distance from the TRITON buoy within about 2 nm.

TRITON buoy data was sampled every 1 hour except for transmission to the ship. We compared CTD observation by R/V MIRAI data with TRITON buoy data using the 1 hour averaged value.

As our temperature sensors are expected to be more stable than conductivity sensors, conductivity data and salinity data are selected at the same value of temperature data. Then, we calculate difference of salinity from conductivity between the shipboard CTD data on R/V MIRAI and the TRITON buoy data for each recovery of buoys.

Compared site

| Observation No. | Latitude | Longitude | Condition |
|---|---|---|---|
| 17005 | 5S | 95E | Before Recover |

(5) Results

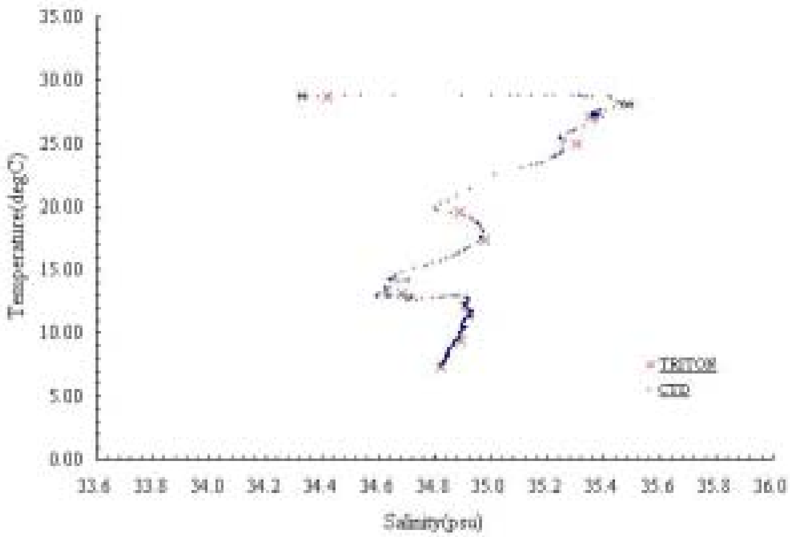
Most of temperature, conductivity and salinity data from TRITON buoy showed good agreement with CTD cast data in T-S diagrams. See the Figures 7.1.2-1(a).

The estimations were calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.929 to 0.073 for all depths. Below 300db, salinity differences are from –0.014 to 0.007 (See the Figures 7.1.2-2(a) and Table 7.1.2-2 (a)). The absolute average of salinity differences was 0.107 with absolute standard deviation of 0.261.

The estimations of time-drift were calculated as recovered buoy data minus deployed buoy data. The difference of salinity over 1 year had the variation ranging from –0.759 to 0.075, for all depths. Below 300db, the difference of salinity over 1 year had the variation ranging from –0.005 to 0.026(See the figures 7.1.2-2(b)). The absolute average of salinity differences was 0.095 with absolute standard deviation of 0.211.

(6) Data archive

All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 5)




Observation No. 17005 Before Recovery

Fig 7.1.2-1(a) T-S diagram of TRITON buoys data and shipboard CTD data

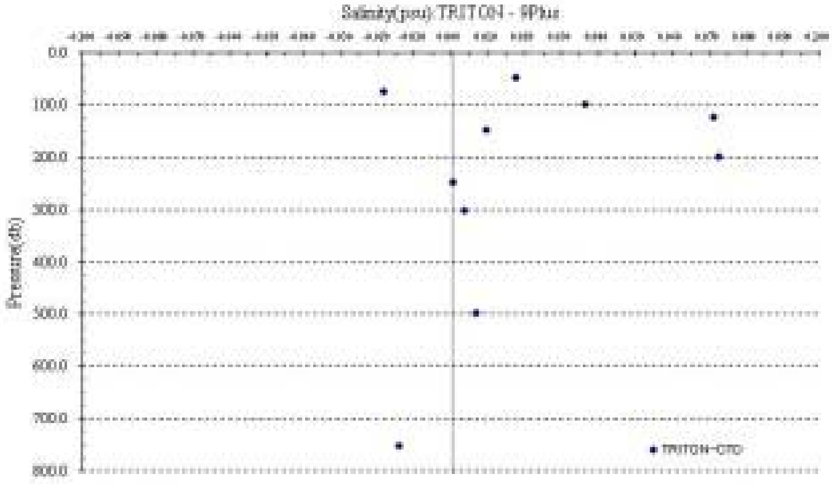



Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

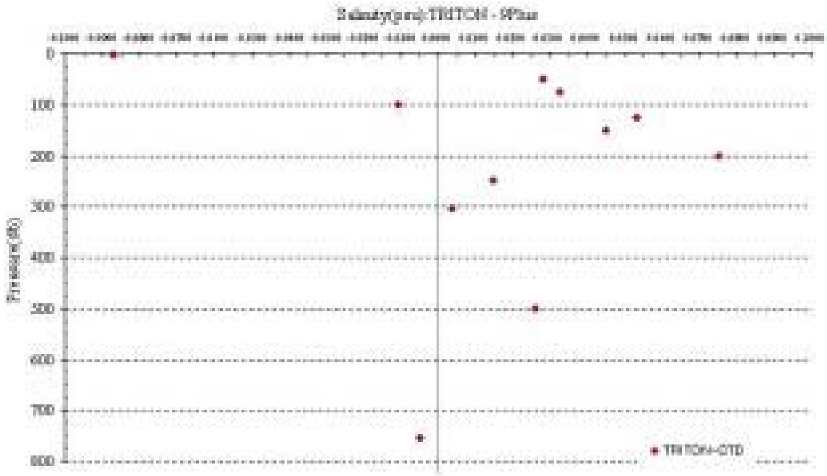



Fig.7.1.2.-2 (b) Salinity differences between deployment data and recovery data for 1year Observation No.17

Table 7.1.2.-2(a) Data differences between TRITON buoys data and ship board CTD data before recovery

| Observation No. | Pressure (db) | Temperature (degC) | Conductivity (S/m) | Salinity (psu) |
|---|---|---|---|---|
| 17005 | 1.5 | 0.00 | -0.016 | -0.103 |
| 17005 | 25.0 | -0.01 | -0.136 | -0.929 |
| 17005 | 50.0 | -0.01 | 0.002 | 0.018 |
| 17005 | 75.0 | -0.02 | -0.005 | -0.018 |
| 17005 | 100.0 | -0.15 | -0.011 | 0.037 |
| 17005 | 125.0 | -0.11 | -0.002 | 0.072 |
| 17005 | 150.0 | 0.04 | 0.005 | 0.010 |
| 17005 | 200.0 | -0.01 | 0.007 | 0.073 |
| 17005 | 250.0 | -0.02 | -0.002 | 0.001 |
| 17005 | 303.5 | 0.06 | 0.007 | 0.004 |
| 17005 | 500.0 | -0.01 | 0.000 | 0.007 |
| 17005 | 754.5 | 0.00 | -0.002 | -0.014 |

## 7.2 m-TRITON moorings

(1) Personnel

| | |
|---|---|
| Keisuke Mizuno | (JAMSTEC): Principal Investigator (Not on board) |
| Hideaki Hase | (JAMSTEC): Oceanographer (On-board Principal Investigator) |
| Masayuki Yamaguchi | (JAMSTEC): Engineer |
| Yasuhisa Ishihara | (JAMSTEC): Engineer (Not on board) |
| Takeo Matsumoto | (JAMSTEC): Engineer (Not on board) |
| Masaki Taguchi | (MWJ): Technical Leader |
| Keisuke Matsumoto | (MWJ): Operation Leader |
| Tomohide Noguchi | (MWJ): Technical Staff |
| Ayumi Takeuchi | (MWJ): Technical Staff |
| Shinsuke Toyoda | (MWJ): Technical Staff |
| Hiroki Ushiromura | (MWJ): Technical Staff |
| Tatsuya Tanaka | (MWJ): Technical Staff |
| Masatomo Hisazumi | (MWJ): Technical Staff |

(2) Objective

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called warm pool that affects the global atmosphere and causes El Nino phenomena. The formation mechanism of the warm pool and the air-sea interaction over the warm pool have not been well understood. Therefore long term data sets of temperature, salinity, currents and meteorological elements have been required at fixed locations. The TRITON program aims to obtain the basic data to improve the predictions of El Nino and variations of Asia-Australian Monsoon system.

TRITON buoy (included m-TRITON buoy) array is integrated with the existing TAO (Tropical Atmosphere Ocean) array, which is presently operated by the Pacific Marine Environmental Laboratory/National Oceanic and Atmospheric Administration of the United States. TRITON is a component of international research program of CLIVAR (Climate Variability and Predictability), which is a major component of World Climate Research Program sponsored by the World Meteorological Organization, the International Council of Scientific Unions, and the Intergovernmental Oceanographic Commission of UNESCO. TRITON will also contribute to the development of GOOS (Global Ocean Observing System) and GCOS (Global Climate Observing System).

One m-TRITON buoys have been successfully recovered and two m-TRITON buoys deployed during this R/V MIRAI cruise (MR07-07 Leg2). From this cruise, two TRITON buoys deployed in Indian Ocean were altered m-TRITON buoys.

(3) Method

The m-TRITON buoy observes oceanic parameters and meteorological parameters as follows:

| | |
|---|---|
| Meteorological parameters: | wind speed, direction, air temperature, relative humidity, shortwave radiation, precipitation. |
| Oceanic parameters: | water temperature and conductivity, current |

Details of the instruments used on the m-TRITON buoy is summarized as follows:

Oceanic sensors

1) CTD (Conductivity-Temperature-Depth meter, Sea Bird Electronics Inc.)

SBE-37 IM Micro CAT

| | |
|---|---|
| A/D cycles to average : | 4 |
| Sampling interval : | 600sec |
| Measurement range, Temperature : | -5～+35 deg-C |
| Measurement range, Conductivity : | 0～+7　S/m |
| Measurement range, Pressure : | 0～full scale range |

2) TD (Temperature and Depth meter, Sea Bird Electronics Inc.)

SBE-39 IM

| | |
|---|---|
| Sampling interval : | 600sec |
| Measurement range, Temperature : | -5～+35 deg-C |
| Measurement range, Pressure : | 0～full scale range |

3) CRN (Current meter)

DVS　Doppler Volume Sampler (Teledayne RD Inc.)

| | |
|---|---|
| Sensor frequency : | 2400kHz |
| Sampling interval : | 600sec |
| Average interval: | 120sec |

* DVS fasten only the buoy of the 0-79E.

Meteorological sensors

1) Precipitation (R.M.Young Co.)

MODEL50202/50203

Sampling interval : 600sec

2) Relative humidity/air temperature ( Rotronic Co.)

MODEL MP101A

Sampling interval : 600sec

3) Shortwave radiation (Eppley Co.)

MODEL PSP

Sampling interval : 600sec

4) Wind speed/direction (R.M.Young Co.)

MODEL 05106

Sampling interval : 600sec

*Meteorological sensors were assembled that used A/D (Analougue/Digital) conversion PCB (Print Cycle Board) made from MARITEC(Marine Technology Center)/JAMSTEC

Data logger and ARGOS transmitter

1) Data logger

I/O: RS485 has controlled of meteorological sensors.

RS232C has controlled of compass , GPS and Inductive modem.

2) ARGOS transmitter

Hourly averaged data are being transmitted through ARGOS transmitter.

(4) Results

Locations of deployment and recovery are as follow:

Locations of deployment

| | |
|---|---|
| Nominal location | 1.5S, 90E |
| ID number at JAMSTEC | 18501 |
| ARGOS PTT number | 29020 |
| Deployed date (UTC) | 08 Feb. 2008 |
| Exact location | 01 39.64S, 89 59.73E |
| Depth | 4,689 m |

| | |
|---|---|
| Nominal location | 5S, 95E |
| ID number at JAMSTEC | 17501 |
| ARGOS PTT number | 29040 |
| Deployed date (UTC) | 10 Feb. 2008 |
| Exact location | 04 57.11S, 94 58.91E |
| Depth | 5,007 m |

Locations of recovery

| | |
|---|---|
| Nominal location | 1.5S, 90E |
| ID number at JAMSTEC | 18501 |
| ARGOS PTT number | 24770 |
| Deployed date (UTC) | 04 Dec. 2006 |
| Recovered date (UTC) | 07 Feb.2008 |
| Exact location | 01 42.98S, 90 08.78E |
| Depth | 4,714 m |

(5) Data archive

Hourly averaged data were transmitted via ARGOS satellite data-transmission system in real time. These data will be archived at the JAMSTEC Yokosuka Headquarters. And the data will be distributed world wide through internet from the JAMSTEC web site (http://www.jamstec.go.jp/).

(6) Photos

Details of surface buoy of the m-TRITON buoy is summarized as follows

| | |
|---|---|
| Total Height | : 5.6m |
| Diameter | : 1.8m |
| Weight [in Air] | : 800kg |
| Total Buoyancy | : 3,000kg |

m-TRITON buoy [18502] and R/V MIRAI

## 7.3 ADCP subsurface mooring

(1) Personnel

| | |
|---|---|
| Hideaki Hase | (JAMSTEC): On board Investigator |
| Iwao Ueki | (JAMSTEC): not on board |
| Tomohide Noguchi | (MWJ): Operation leader |
| Keisuke Matsumoto | (MWJ): Technical staff |
| Hiroki Usiromura | (MWJ): Technical staff |
| Sinsuke Toyoda | (MWJ): Technical staff |
| Tastuya Tanaka | (MWJ): Technical staff |
| Masaki Taguchi | (MWJ): Technical staff |
| Masatomo Hisazumi | (MWJ): Technical staff |
| Ayumi Takeuchi | (MWJ): Technical staff |

(2) Objectives

The purpose is to get the knowledge of physical process in the eastern equatorial Indian Ocean. Sub-surface currents were observed by using ADCP moorings along the equator. In this cruise (MR07-07 Leg2), we deployed one sub-surface ADCP mooring at EQ-90E and recovered one ADCP moorings at EQ-90E.

(3) Parameters

・Current profiles
・Echo intensity
・Pressure, Temperature and Conductivity

(4) Methods

Two instruments are mounted at the top float of the mooring. One is ADCP (Acoustic Doppler Current Profiler) to observe upper ocean layer currents from subsurface down to around 400m depths. The other is CTD to observe pressure, temperature and salinity for correction of sound speed and depth variability. Details of the instruments and their parameters are as follows:

1) ADCP

◆Work Horse Long Ranger ADCP 75 kHz (Teledyne RD Instruments, Inc.)
Distance to first bin : 8 m
Pings per ensemble : 27
Time per ping : 6.66 seconds
Bin length : 8.00 m
Sampling Interval : 3600 seconds
Deployed ADCP
・ Serial Number : 1645 (Mooring No.080206-0090E)

Recovered ADCP
・ Serial Number : 1248 (Mooring No.061203-0090E)

2) CTD

◆SBE-37 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

Deployed CTD

・ Serial Number : 1775 (Mooring No.080206-0090E)

Recovered CTD

・ Serial Number : 1388 (Mooring No.061203-0090E)

3) Other instrument

◆Acoustic Releaser (BENTHOS,Inc.)

Deployed Acoustic Releaser

・ Serial Number : 630 (Mooring No.080206-0090E)
・ Serial Number : 692 (Mooring No.080206-0090E)

Recovered Acoustic Releaser

・ Serial Number : 955 (Mooring No.061203-0090E)
・ Serial Number : 663 (Mooring No.061203-0090E)

(5) Deployment

The ADCP mooring deployed at EQ-90E was planned to play the ADCP at about 400m depths. After we dropped the anchor, we monitored the depth of the acoustic releaser.

・The position of the mooring No.080206-0090E

Date: 06 Feb. 2008 Lat: 00-00.4230N Long: 90-03.7982E Depth: 4409m

(6) Recovery

We recovered one ADCP mooring which was deployed on 3 Dec.2006 (MR06-05 Leg2 cruise). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code.

Results were shown in the figures in the following pages.

Fig.7.3-1 shows CTD pressure, temperature and salinity data (EQ-90E).

Fig.7.3-2 shows the ADCP velocity data (zonal and meridional component / EQ-90E).

(7) Data archive

The velocity data will be reconstructed using CTD depth data. The all data will be archived by the member of TOCS project at JAMSTEC.

All data will be submitted to DMO at JAMSTEC within 3 years after each recovery.

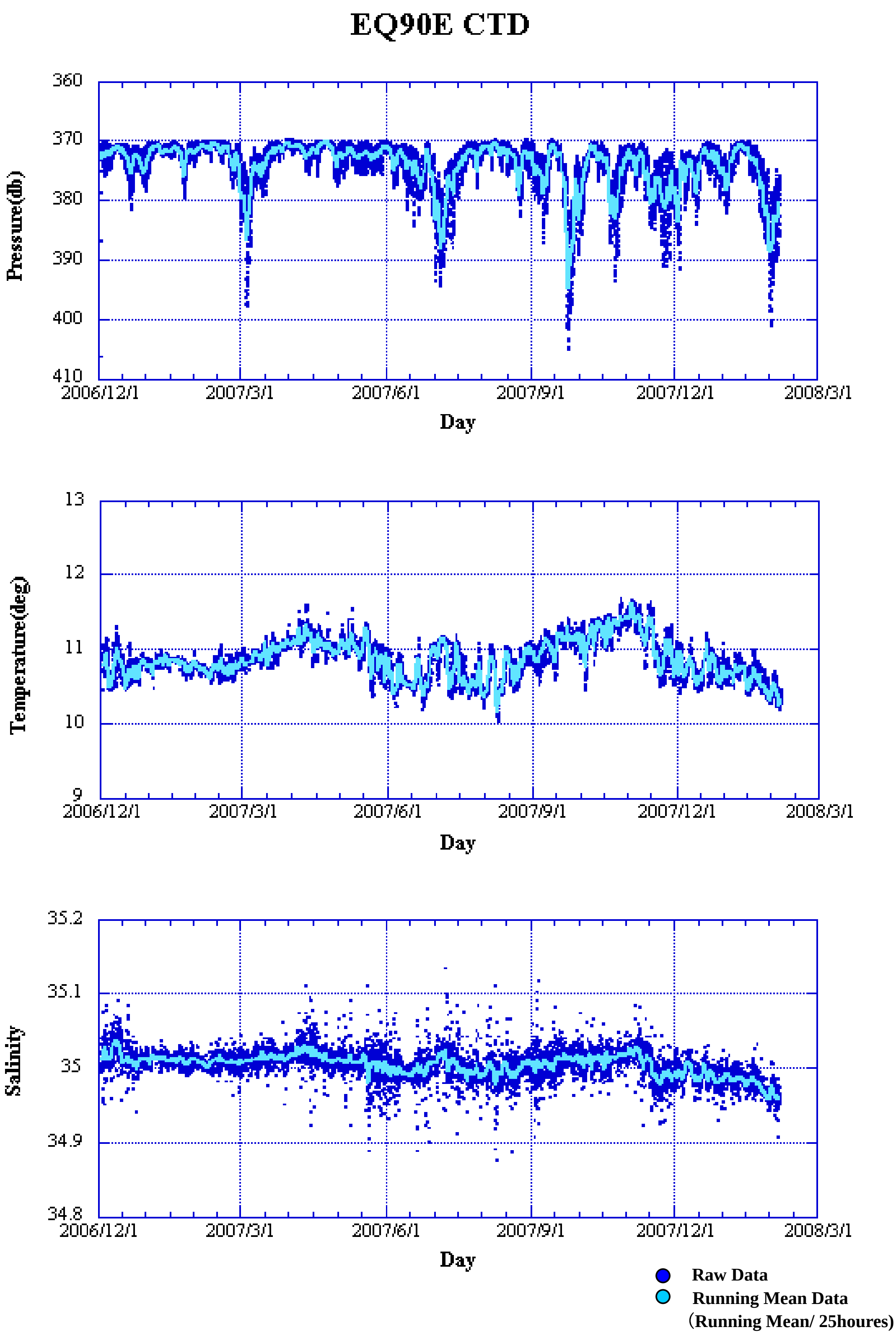



Fig.7.3-1 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-90E mooring (2006/12/3-2008/2/6)

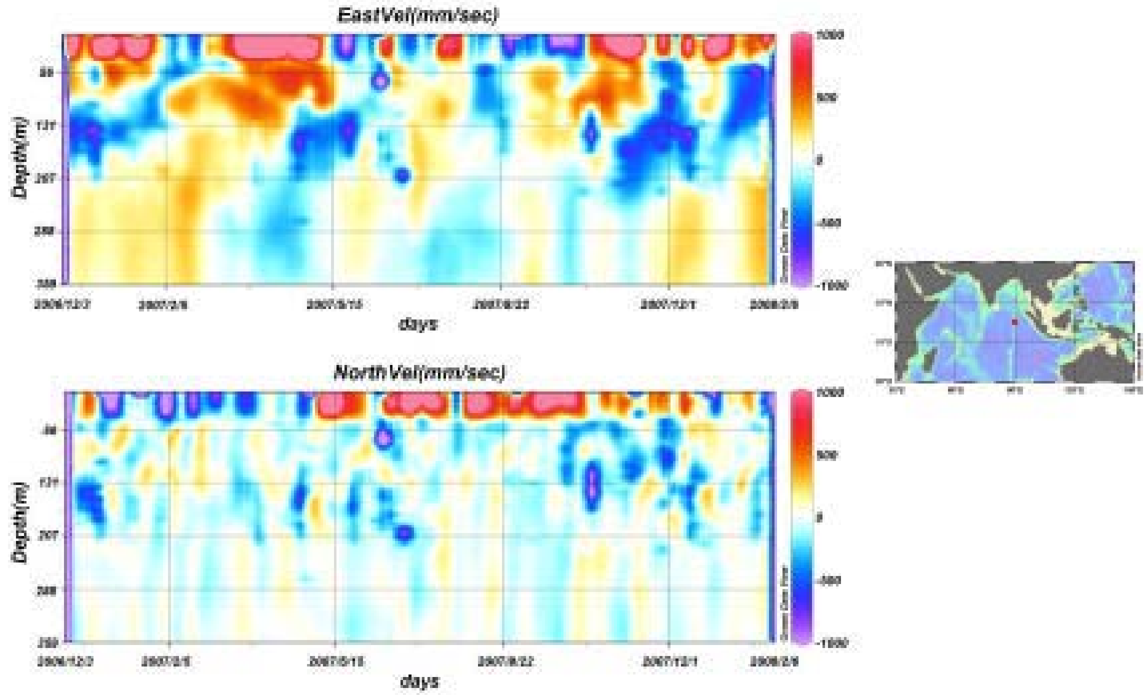



Fig.7.3-2 Time Series of zonal and meridional velocities of EQ-90E mooring (2006/12/3-2008/2/6)

## 7.4 Piston core observations

Khosaku Arai (GSJ-AIST)
Udrekh (BPPT, Indonesia)
Yusuke Sato (MWJ)
Yuko Sagawa (MWJ)
Yasushi Hashimoto (MWJ)
*Section 7.4.3 has been reported by Marine Work Japan Ltd.

### 7.4.1 Introduction

The Sumatra-Andaman Earthquake (Mw 9.3) of 26th December 2004 and subsequent Indian Ocean Tsunami attack not only Sumatra but also the counties which faced to the Indian Ocean including Malaysia, Thai, India and Sri Lanka. The epicenter was estimated site off Simuelue Island, off Aceh, northern Sumatra, Indonesia. The rupture was propagated to the north along the Nicobar and Andaman Islands over 1,000 km long. However, generation mechanism of huge tsunami is remained unresolved, the West Andaman fault is possibly initiation key for the Sumatra-Andaman Earthquake (Fig. 7-4-1). We will examine the collapse of steep cliff along the West Andaman fault that is possible affected by large earthquake (Fig. 7-4-2).

Cooperation study between GSJ-AIST and BPPT desires to concerning examination of the recurrence pattern of large earthquake in Aceh basin which along the West Andaman fault using turbidite paleo-seismologic techniques. Understanding the recurrence pattern of large earthquake such as the Sumatra-Andaman Earthquake should be useful for fortunately decreasing the human damage under the geo-hazard.

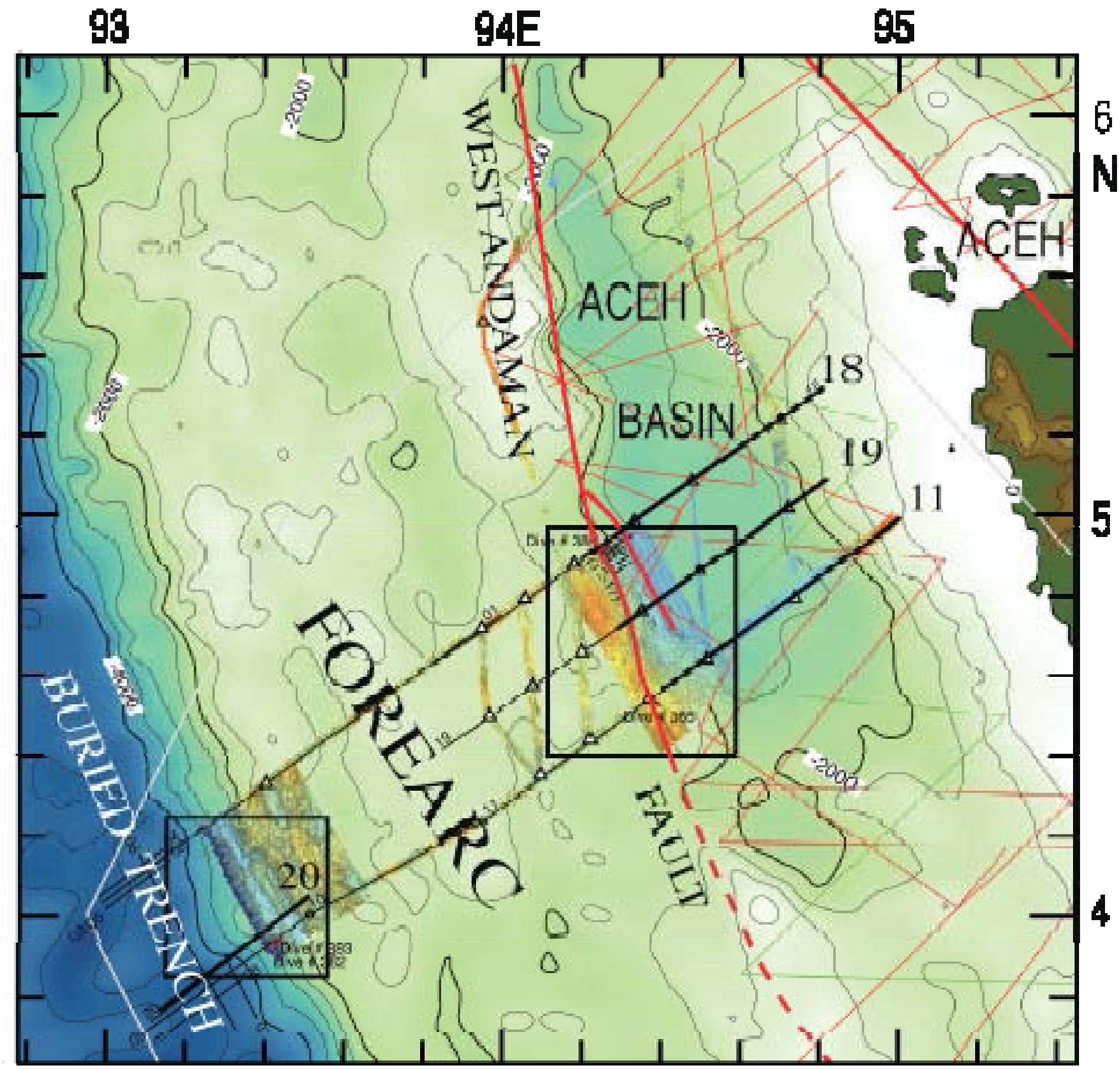



Fig. 7-4-1 Location of study area and tectonic and geomorphic setting of February – March 2005 emergency cruise by R/V Natsushima (JAMSTEC: Soh et al., 2005, Seeber et al., 2007). Piston cores corrected on the line number 18.

### 7.4.2 Methods

The piston core position will decide based on the site survey using SeaBeam and sub-bottom profiler images. Fig. 7-4-2 shows the image of proposed piston core site. To reveal the occurrence the turbidity sediments, detailed describe is necessary.

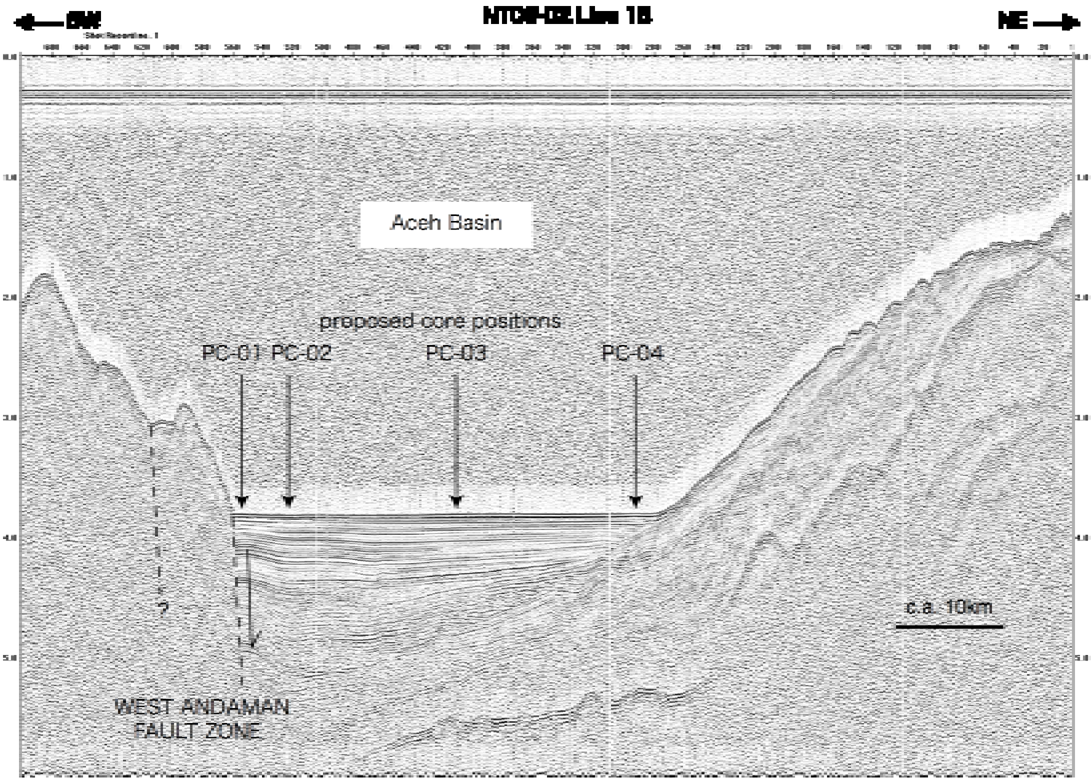



Fig. 7-4-2 Proposed piston core site on MR07-07 leg 2. Survey line (Line 18 of NT05-02 cruise) is shown in Fig. 7-4-1.

As a preparatory research of the core samplings, 4 kHz SBP (Sub-Bottom Profiling survey) and multi narrow beam (SEA BEAM 2100: detailed system configuration in 6.6.3 in this volume) bathymetric mapping were carried out to same line of NT05-02 cruise (Fig. 7-4-1). We decide the piston core site in a depocenter of Aceh Basin (Station 3 in Fig. 7-4-3) and two SW sites (Stations 2 and 1 in Fig. 7-4-3) along outer arc height. Continuous parallel reflectors were observed on the SBP profiles (Fig. 7-4-4). Reflectors were slightly undulated and thicknesses of uppermost sediments tend to increase into depocenter. In contrast, thickness of white reflector, which occur 3,610-3,620 msec was clearly decrease into depocenter.

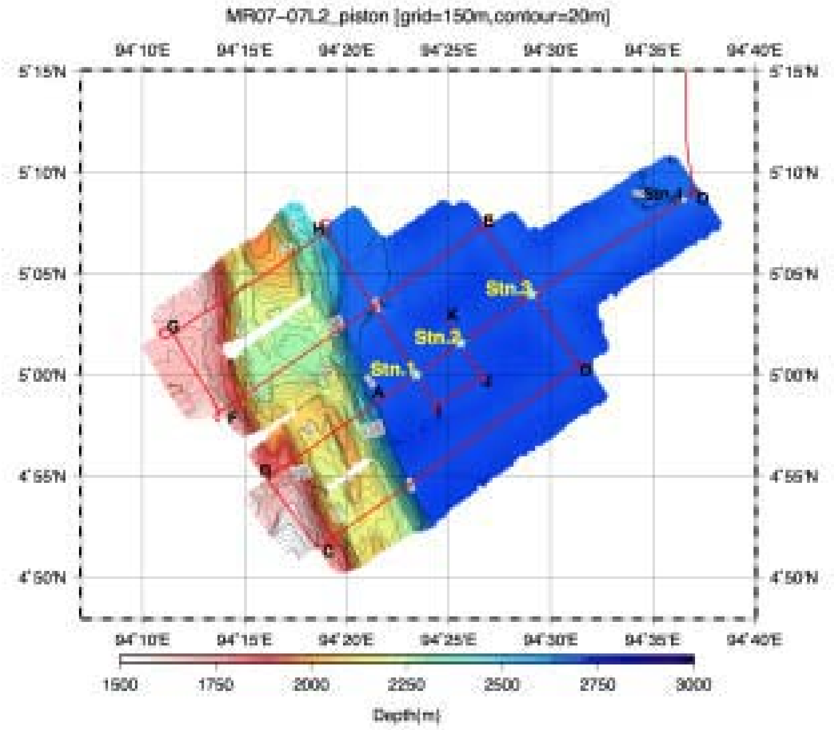



Fig. 7-4-3 Bathymetric map of Aceh Basin and track chart of site survey for piston cores. Station numbers show planed position of piston core (PC-01 to PC-03).

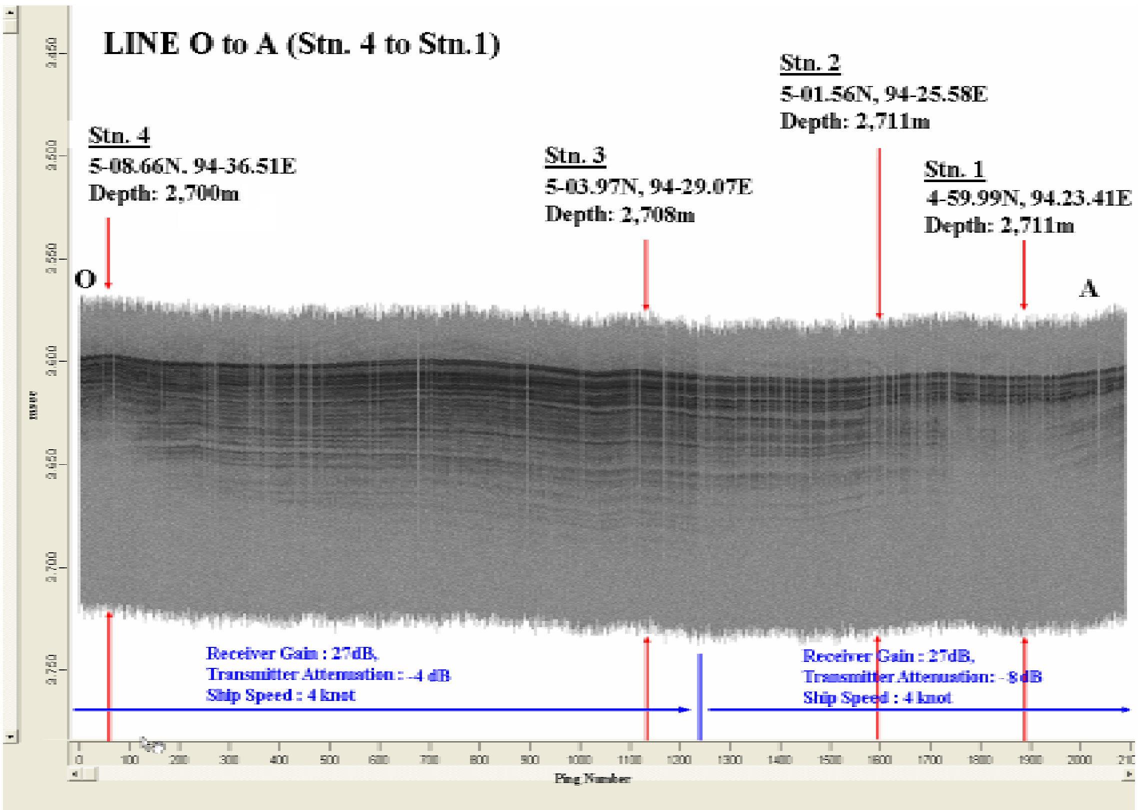


Fig. 7-4-4 Continuous parallel refractors were observed on the SBP profiles. Position of the line is shown in Fig. 7-4-3. Profile ranges from NE to SW.

Piston core sampler of MR07-07 was shown in Fig.7-4-5. Multiple pilot core sampler named “Ashura”, which is equipped with three acrylic sub core were operated as a trigger weight of piston core sampler. After getting piston cores, onboard analyses were starting on the following flow in Fig. 7-4-6.

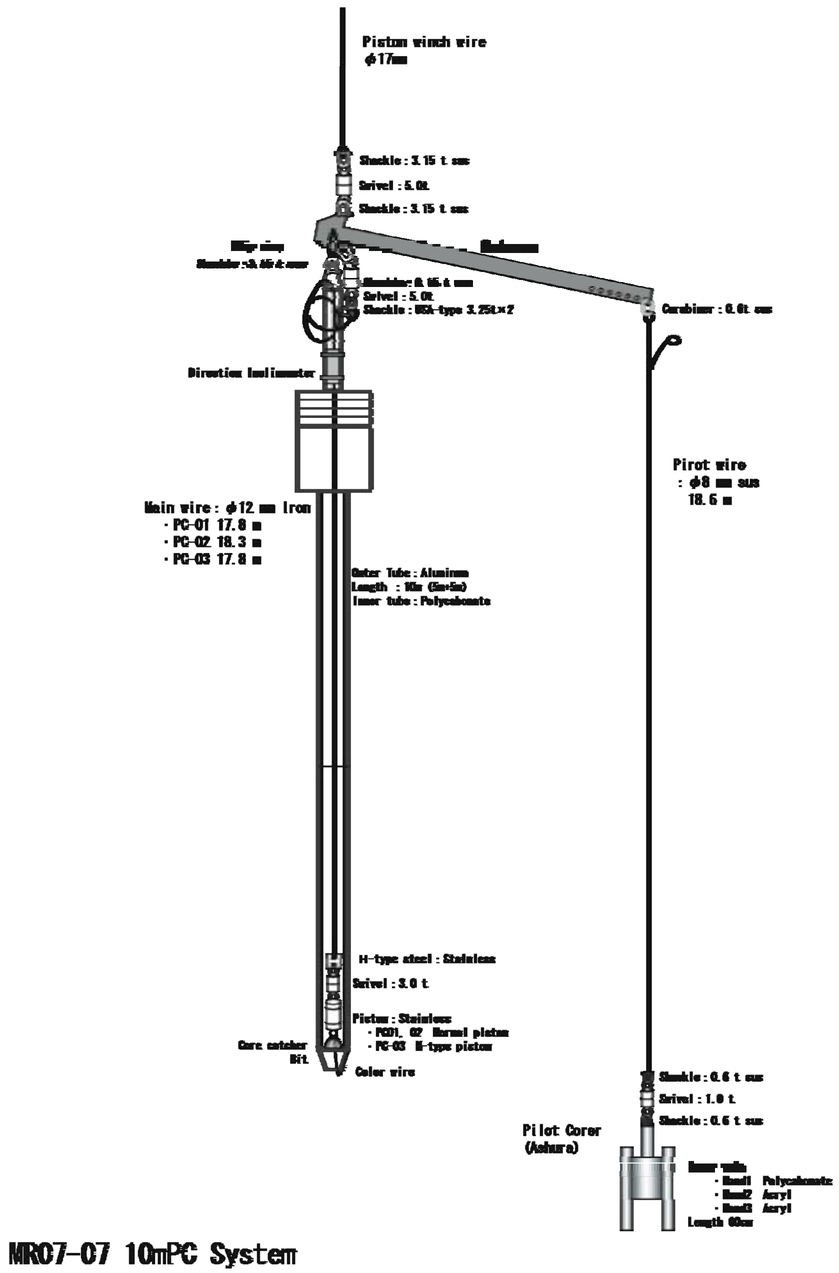



Fig. 7-4-5 MR07-07 Leg 2 10 m piston core system.

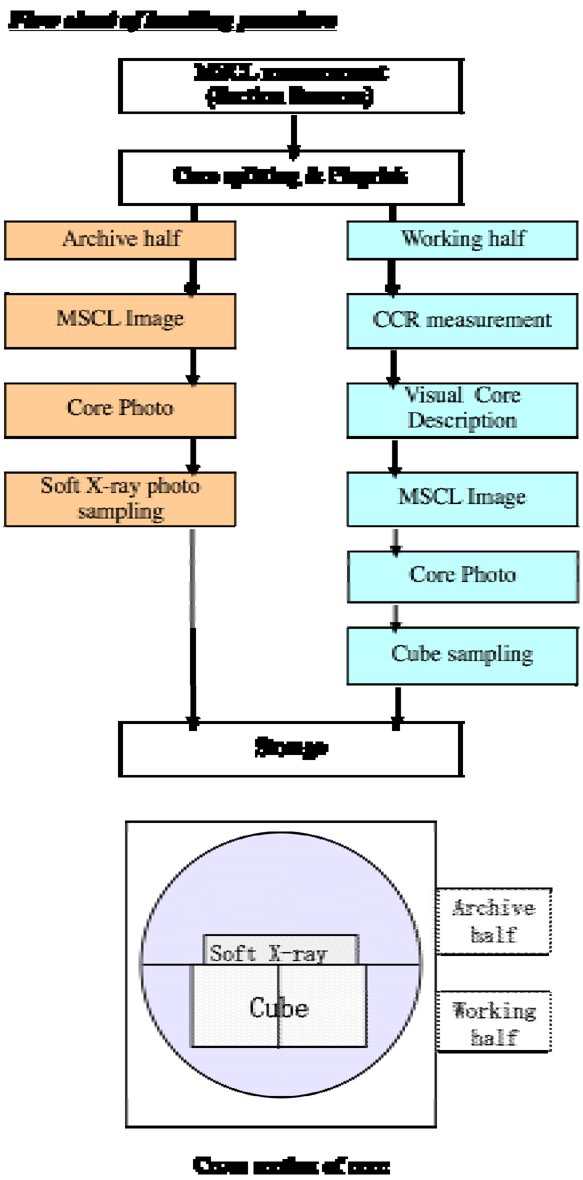



Fig. 7-4-6 Working flow of MR07-07 Leg 2.

### 7.4.3 Preliminary results of onboard Analyses (Marine Work Japan Ltd.)

**Sampling Location**

In total, three piston cores were obtained during MR07-07 Leg2 cruise (Table 7-4-1).

Table 7-4-1 Summary of sediment cores during the Cruise MR07-07 Leg2.

| Core ID | Date | Latitude(°) | Longitude(°) | Depth(m) | Core length(cm) |
|---|---|---|---|---|---|
| PC-01 | 2008/2/3 | 5-03.9254N | 94-29.0912E | 2,708 | 778.0 |
| PC-02 | 2008/2/4 | 5-01.5380N | 94-25.6083E | 2,707 | 645.5 |
| PC-03 | 2008/2/4 | 4-59.9662N | 94-23.4315E | 2,710 | 707.4 |

**Compass and inclination**

We confirmed performance of the piston corer by a compass with inclinometer (APC-USB: Alec-electronics co., Ltd.). In many case, these data also indicate compass and inclination for sediments (Fig.7-4-7). But in case of PC-01, split line was tilted toward the direction of the X-. Compass and inclination data during corer on bottom are shown Table 7-4-2.

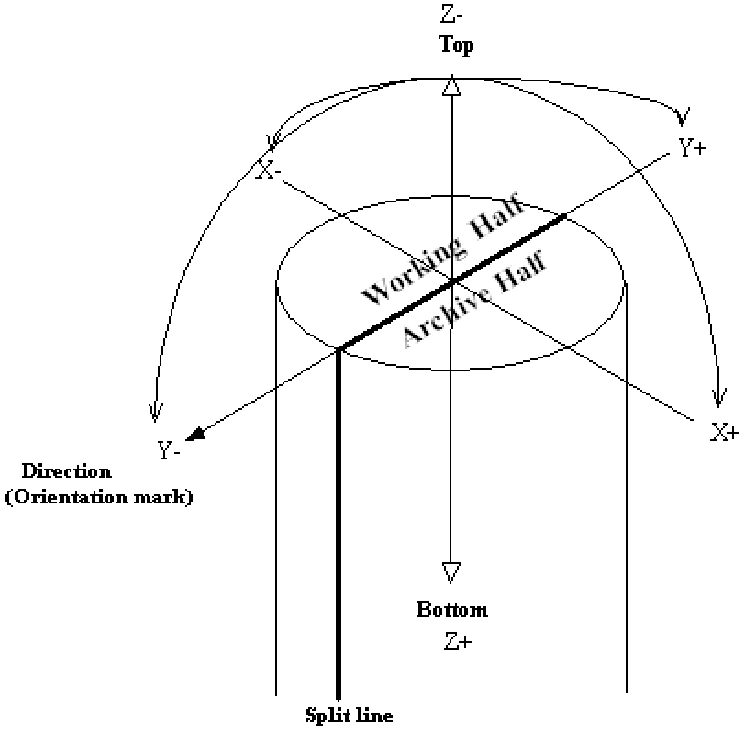



Fig.7-4-7 Relationship of inclinometer and cores.

Table 7-4-2 Compass and inclination during corer on bottom

| Core ID | Compass(°) | | | X Inclination (°) | | | Y Inclination (°) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ave. | Max. | Min. | Ave. | Max. | Min. | Ave. | Max. | Min |
| PC-01 | 308.2 | 326.23 | 293.98 | -0.1 | 2.80 | -3.19 | 0.9 | 15.44 | -23.55 |
| PC-02 | 291.1 | 303.17 | 278.43 | 0.5 | 3.92 | -9.81 | 2.3 | 12.63 | -18.98 |
| PC-03 | 339.1 | 352.52 | 287.94 | 1.2 | 9.30 | -5.67 | 2.5 | 13.88 | -8.81 |

**MSCL measurements**

A GEOTEK multi-sensor core logger (MSCL) has three sensors, which is gamma-ray attenuation (GRA), P-wave velocity (PWV), and magnetic susceptibility (MS). There were measured on whole-core section before splitting using the onboard MSCL. These data measurement was carried on every 1 or 2 cm.

GRA was measured a gamma ray source and detector. These mounted across the core on a sensor stand that aligns them with the center of the core. A narrow beam of gamma ray is emitted by Caesium-137 ($^{137}$Cs) with energies principally at 0.662MeV. Also, the photon of gamma ray is collimated through 5mm diameter in rotating shutter at the front of the housing of $^{137}$Ce. The photon passes through the core and is detected on the other side. The detector comprises a scintillator (a 2” diameter and 2” thick NaI crystal).

GRA calibration assumes a two-phase system model for sediments, where the two phases are the minerals and the interstitial water. Aluminum has an attenuation cofficient similar to common minerals and is used as the mineral phase standard. Pure water is used as the interstitial-water phase standard. The actual standard consists of a telescoping aluminum rob (five elements of varying thickness) mounted in a piece of core liner and filled with distilled water. GRA was measured with 10 seconds counting.

MS was measured using Bartington loop sensor that has an internal diameter of 100mm installed in MSCL. An oscillator circuit in the sensor produces a low intensity (approx. 80 A/m RMS) non-saturating, alternating magnetic field (0.565kHz). MS was measured with 1 second.

PWV was measured two oil filled Acoustic Rolling Contact (ARC) transducers, which are mounted on the center sensor stand with gamma system. These transducers measure the velocity of P-Wave through the core and the P-Wave pulse frequency.

All results are processed to eliminate data gaps between sections and then plotted in Figs. 7-4-8 to 10.

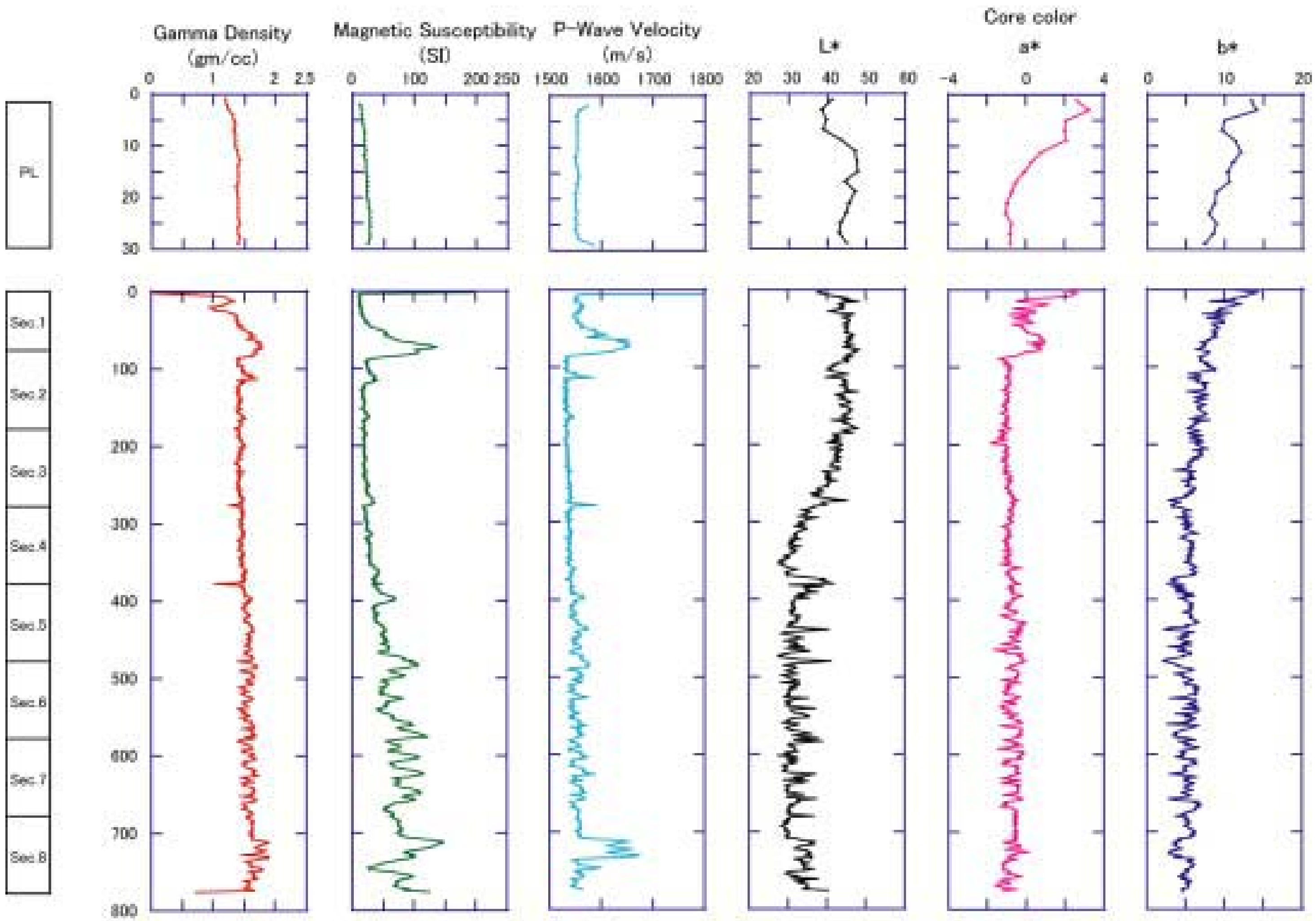



Fig. 7-4-8 MSCL and Color reflectance results of MR07-07 Leg.2 PC-01 & PL01 (HAND1)

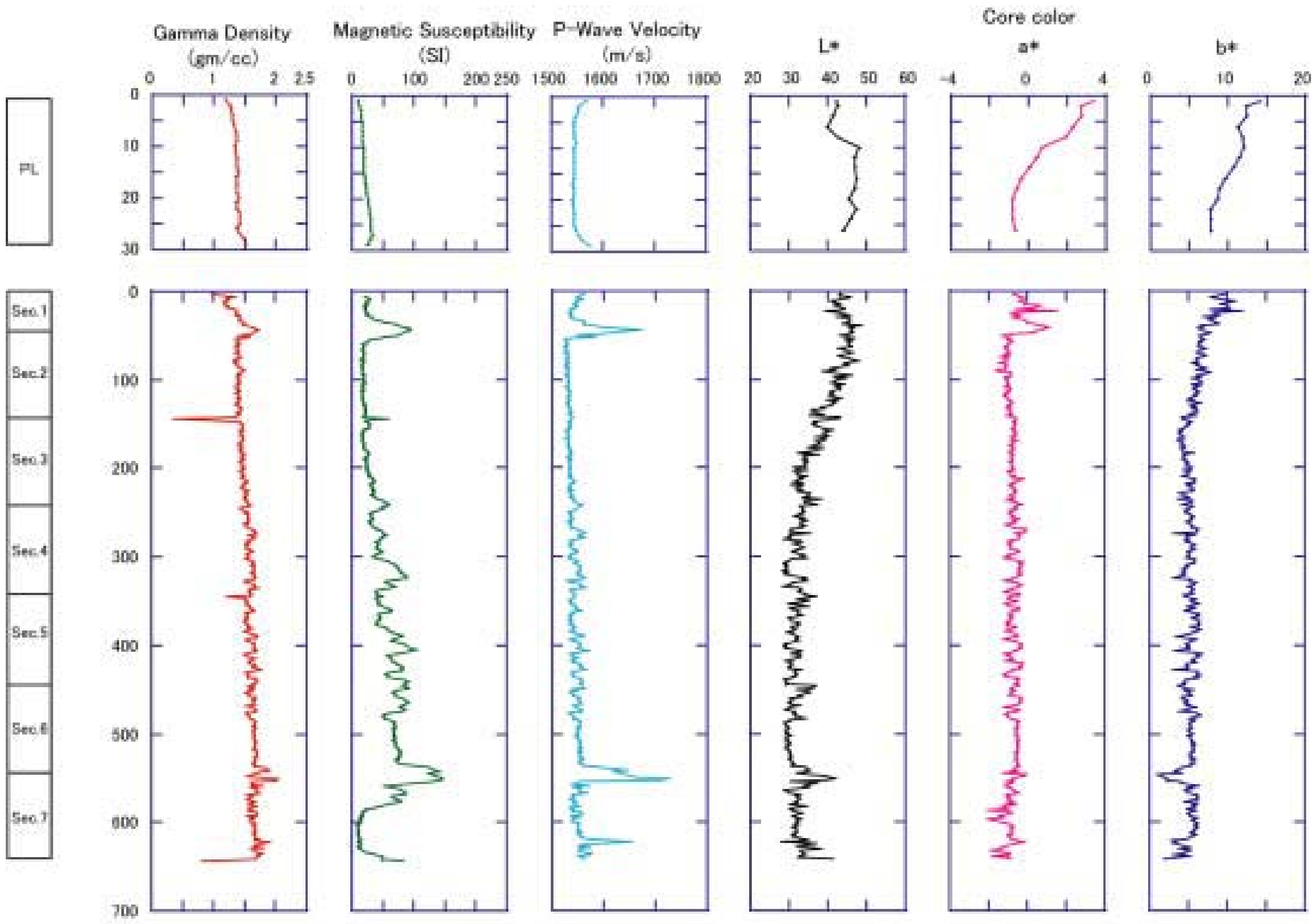



Fig. 7-4-9 MSCL and Color reflectance results of MR07-07 Leg.2 PC-02 & PL02 (HAND1)

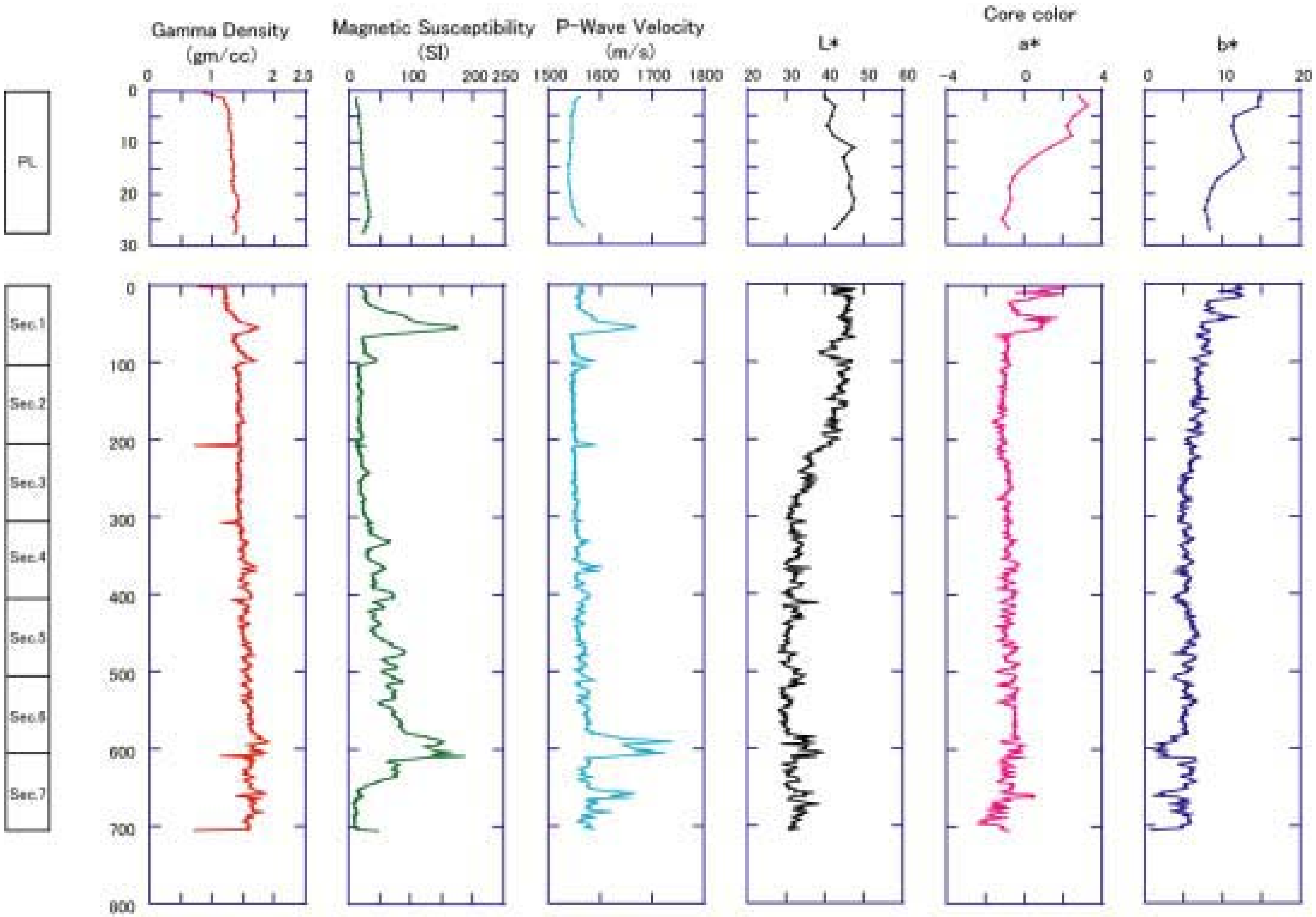



Fig. 7-4-10 MSCL and Color reflectance results of MR07-07 Leg.2 PC-03 & PL03 (HAND1)

**CCR measurements**

Core Color Reflectance was measured by using the Minolta CM-2002 reflectance photospectrometer using 400 to 700nm in wavelengths. This is a compact and hand-held instrument, and can measure spectral reflectance of sediment surface with a scope of 8mm diameter. To ensure accuracy, the CM-2002 was used with a double-beam feedback system, monitoring the illumination on the specimen at the time of measurement and automatically compensating for any changes in the intensity or spectral distribution of the light. Calibration was carried out using the zero and white calibration piece (Minolta CM-2002 standard accessories) without crystal clear polyethylene wrap before the measurement of core samples. The color of working half core was measured on every 2-cm through crystal clear polyethylene wrap.

The Core Color Reflectance data was indicated as second CIE (Commission International d'Eclairage) 1976 color space in terms of L*, a* and b* values. The color reflectance data are indicated by color parameters of L*, a*, b* (L*: black and white, a*: red and green, b*: yellow and blue). L* value indicates lightness and corresponds to black (L*=0) and white (L*=100). a* and b* are chromaticity. The plus values correspond to reddish, the minus one to greenish. For b* value, the plus values correspond to yellowish, the minus one to bluish. Spectral data can be used to estimate the abundance of certain components of sediments. All results are plotted to Figs. 7-4-8 to 10 with MSCL results.

**Soft X-ray Photograph**

Soft X-ray photograph analysis system (Soft-X), PRO-TEST 150 (SOFTEX), was used to observe sedimentary structures of samples. The total 108 sediment slabs were collected from cores using original plastic cases (200*30*7mm). X-ray photographs of samples through the plastic cases were taken under a standard condition that is practically known (50kVp, 2mA, 200seconds). During this cruise, the samples were photographed in 24 negatives that were developed on board. The results will be stored at AIST.

**Core Photographs**

After splitting each section of piston and pilot cores into working and archive halves, sectional photographs of working and archive were taken using a NIKON (D1x) digital camera. When using the digital camera, shutter speed was 1/80 and 1/90, F value was 4.2 and 4.8, Exposure value was 0 and –0.3. Sensitivity ISO 400 was used on positives. Details for settings were included on property of each file.

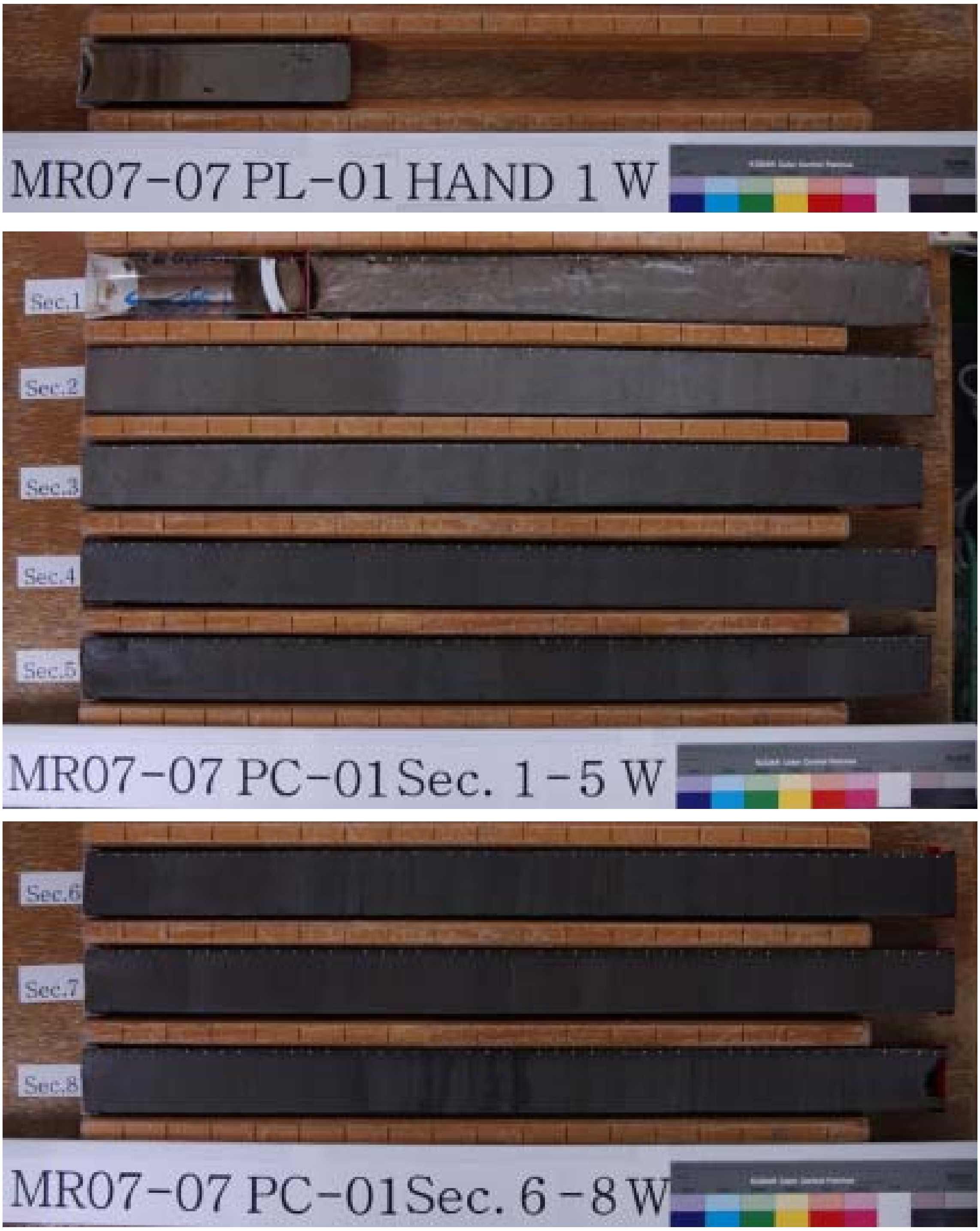


Fig. 4-7-11 Photographs of W-half core PL-01 Hand1 and PC-01

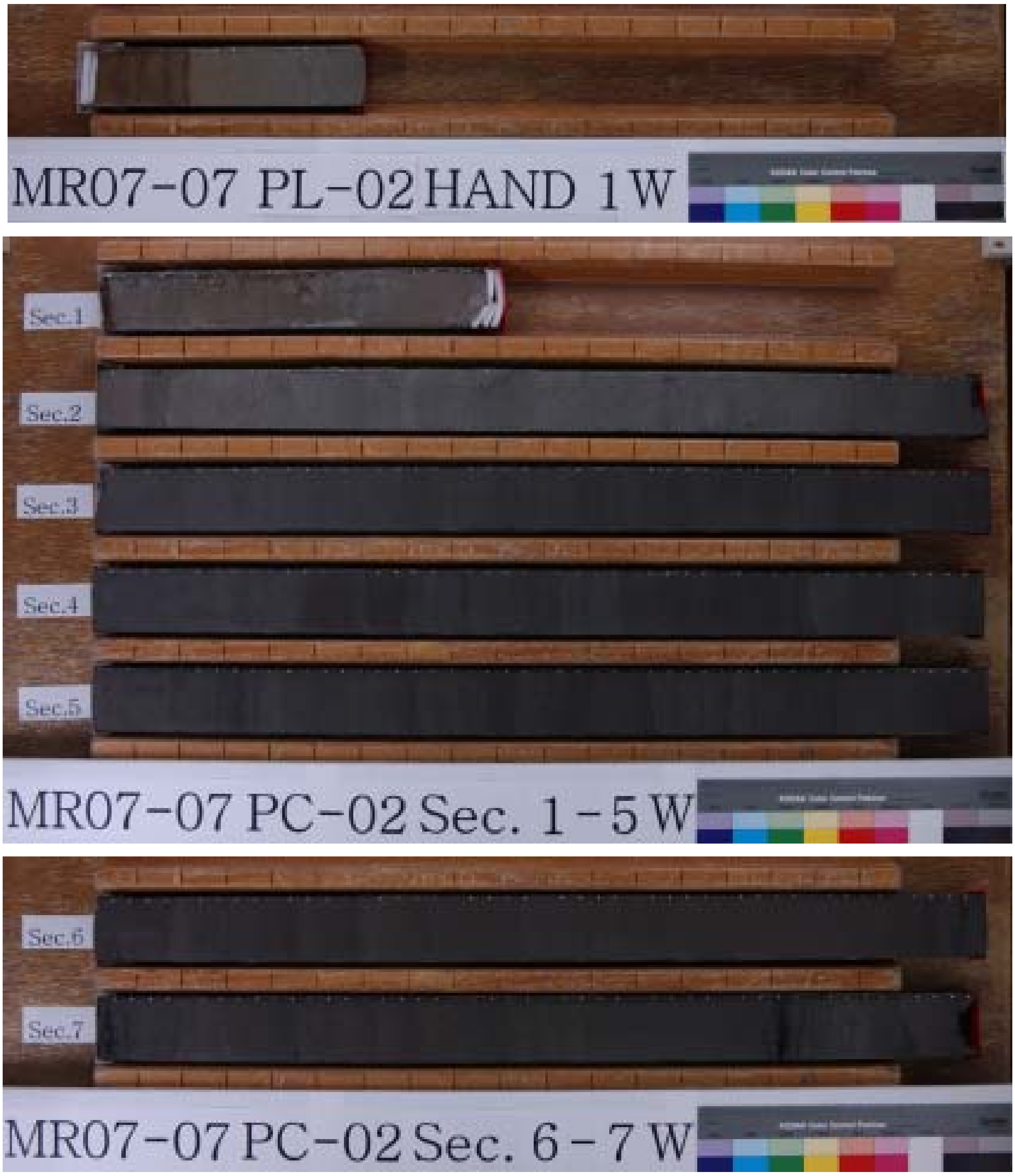


Fig. 4-7-12 Photographs of W-half core PL-02 Hand1 and PC-02

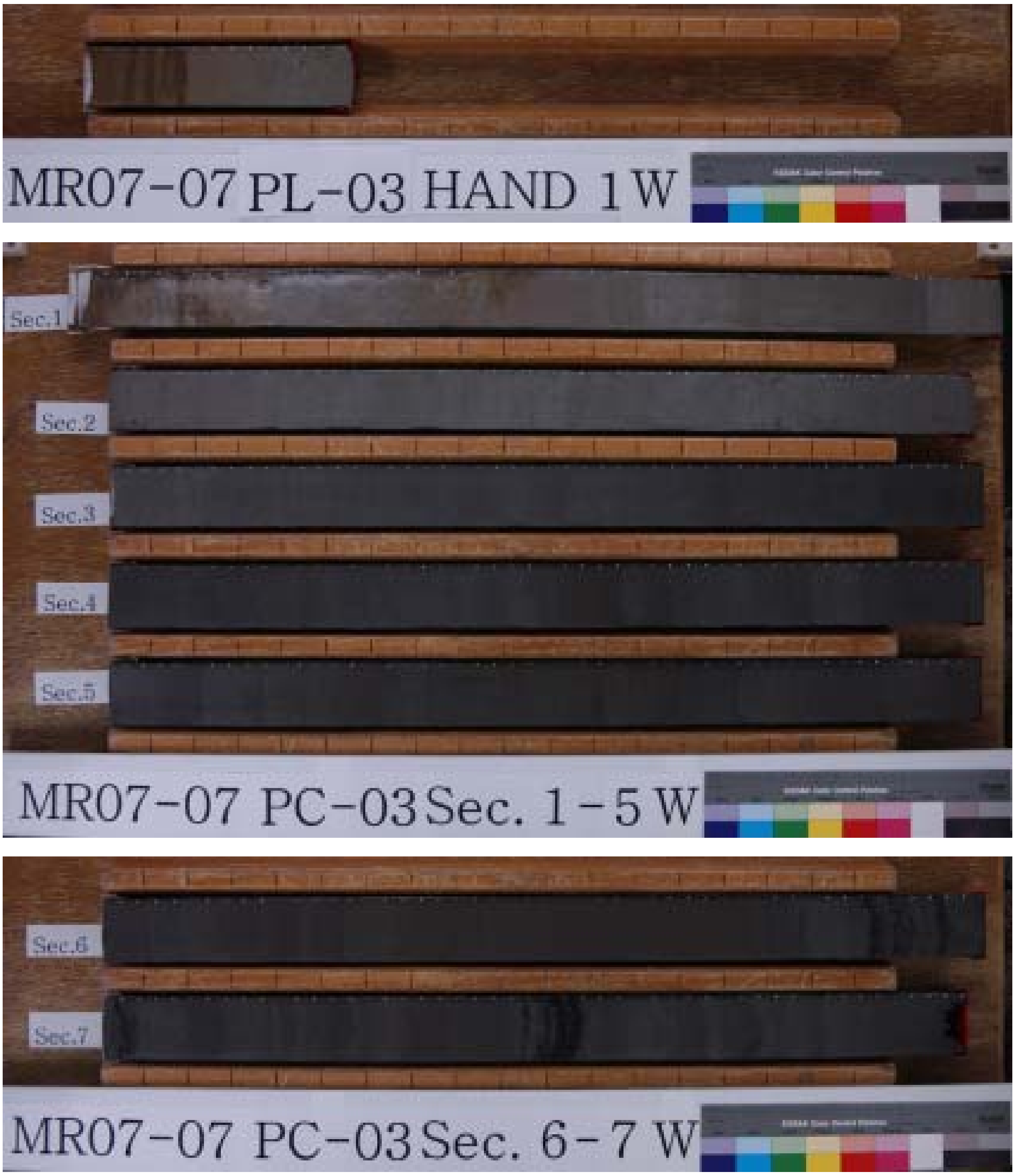



Fig. 7-4-13 Photographs of W-half core PL-03 Hand1 and PC-03

## 7.4.4 Preliminary results (Core description)

### PC-01

Core length 778 cm

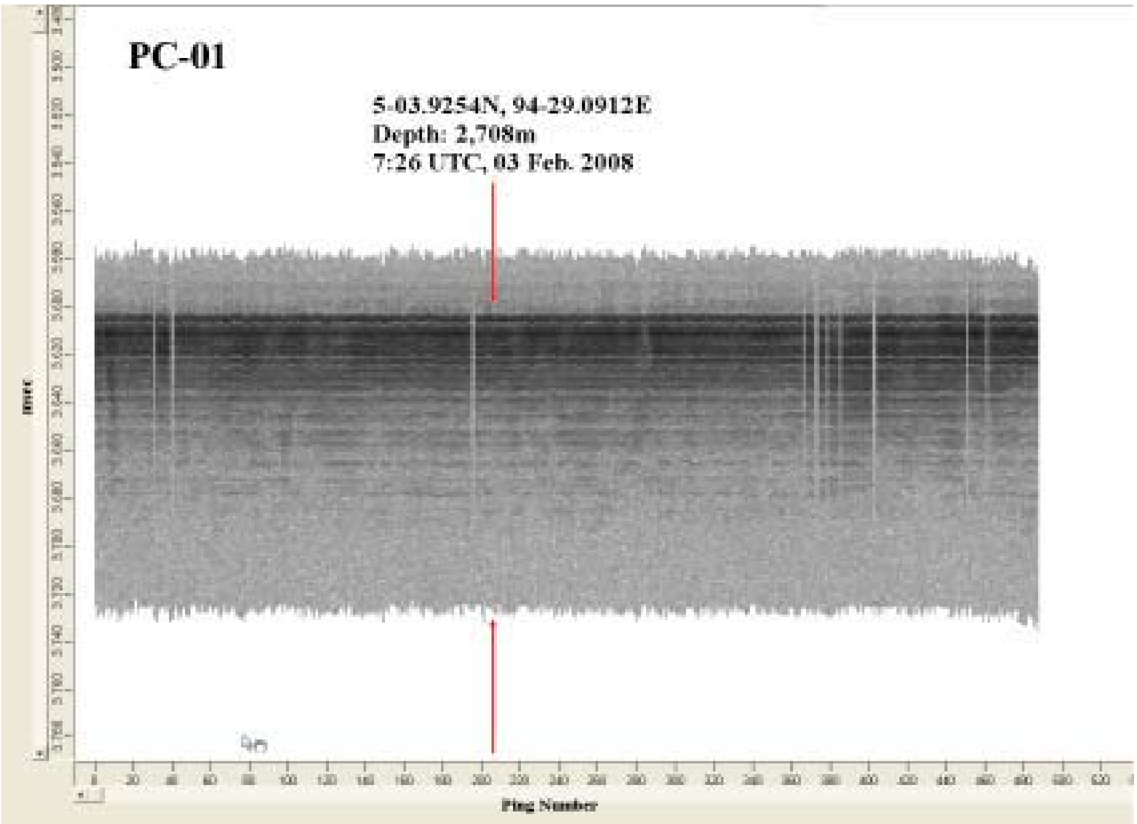



Fig. 7-4-14 Detailed SBP record on the PC-01. The position was same as Stn. 3 of Fig. 7-4-4. Penetration of profile was over 80 ms (two way travel time) around this position.

Generally description is gray to olive black color siltstone with thin fine sand layers. One thick turbidite layer occurs in Section 2 (114.5 cm below the core top). Many sand layers can be observed only below the Section 5 (Fig. 7-4-17). Mostly base contact of the sand layer was characterized by sharp lithological boundary, which overlies siltstone. In contrast, the upper contact is gradually changed to fining and lightning upward.

**PC-02**

Core length 645.5 cm

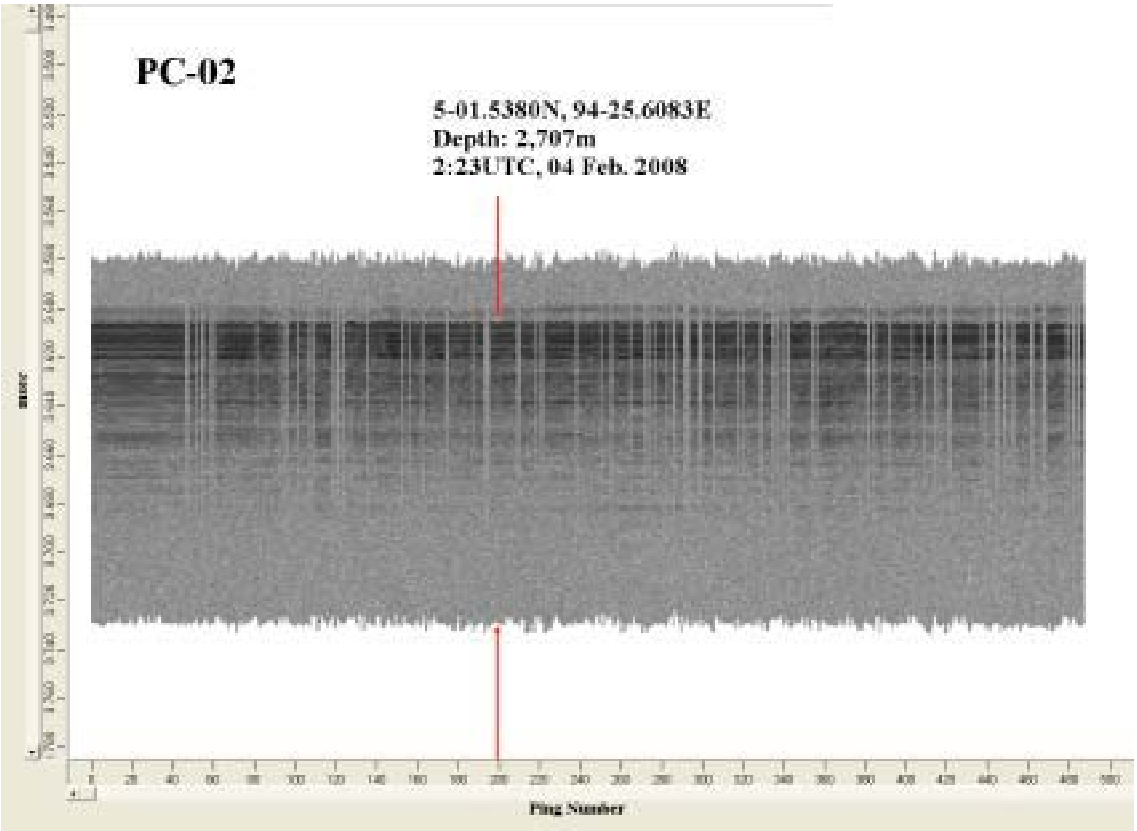



Fig. 7-4-15 Detailed SBP record on the PC-02. The position was same as Stn. 2 of Fig. 7-4-4.

Generally description is gray to olive black color siltstone with thin fine sand layers. Lithological change of PC-02 is roughly similar with PC-01 (correlation of each cores shown in Fig. 7-4-17). Last turbidite layer possibly has been described in PC-01 occurs 9 cm in Section 2 (53 cm below the core top). Many sand layers can be observed only below the Section 4. Upper part of the core was characterized heavily bioturbation.

**PC-03**

Core length 707.4 cm

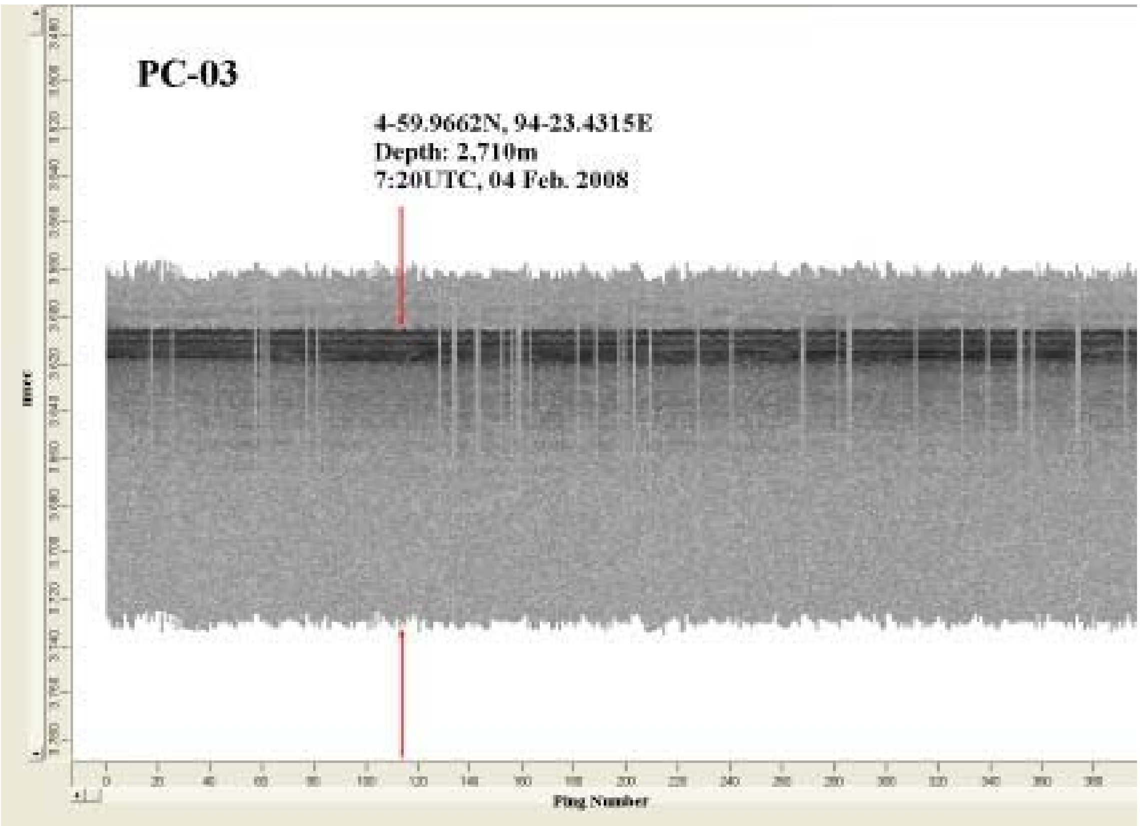



Fig. 7-4-16 Detailed SBP record on the PC-02. The position was same as Stn. 1 of Fig. 7-4-4. The strong reflectors were observed only about 15 ms below seafloor in this position.

Generally description is gray to olive black color siltstone with thin fine sand layers. Last turbidite layer occurs 97.5 cm in Section 1 (97.5 cm below the core top). Many sand layers can be observed only below the Section 4 (Fig. 7-4-17). The thick medium sand layer occurred top of section 7 (612.9 cm below the core top) to base of section 6 (581.2 cm below the core top). The sand layer consisted black color layers.

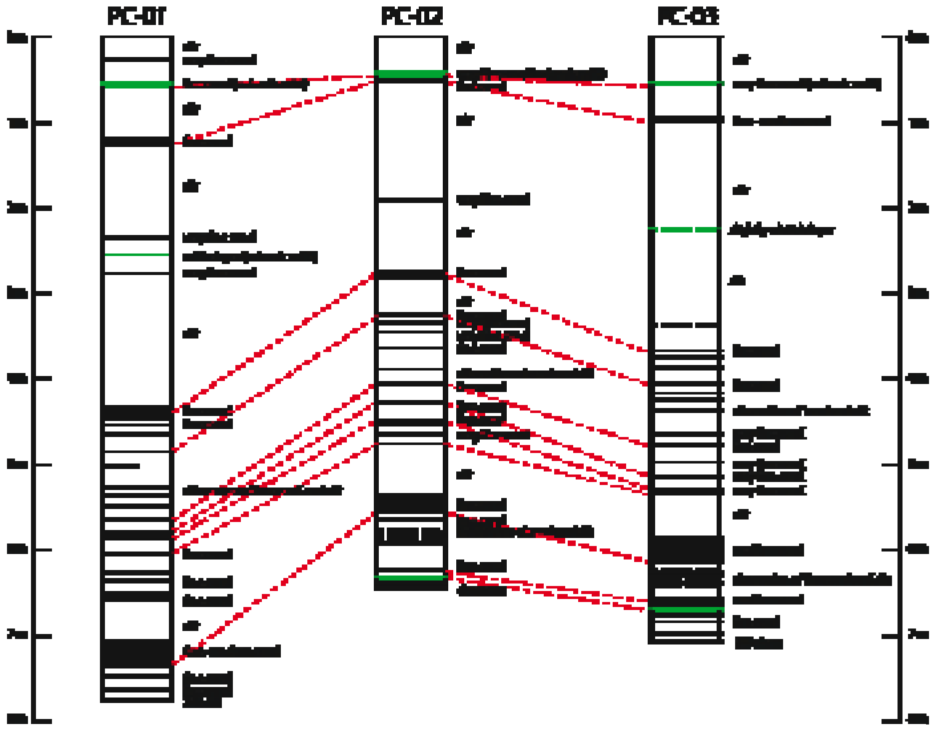



Fig. 7-4-17 Columnar sections of piston cores which are acquired during MR07-07 cruise and their relationship based on the lithology. Detailed core descriptions are shown in appendix on this volume.

We could not find obvious evidences of the collapse of steep cliff along the West Andaman fault in the top of the pilot core. The results indicate that the large collapse of 2004 Sumatra-Andaman earthquake was not occur around the piston core site. In the other hand, many sand layers can be observed the lower part of piston core. In particular, the lower remarkable thick sand layer that correlated each core between 5-7 m below core top has been observed. In the several ten cm below the sand layer, many fining upward cycles were well developed along the West Andaman fault (PC-03). It is concluded therefore, the large rupture or collapse was recorded in the lower part of piston cores. The events, which shallower sand sediments have been transported into the Aceh basin, were completely decreased at upper part of the piston cores. More detailed descriptions and detailed study of age controls are necessary.

### 7.4.5 Future works

We will start collaboration study between GSJ-AIST and BPPT. Detailed core descriptions and following work will plan in a few years.

C-14 dating (AIST)

Detailed core description with Tephra chronology (AIST, BPPT)

Magnetic susceptibility (Y.Suganuma, University of Tokyo)

Magnetic properties (Y. Suganuma, University of Tokyo)

### References

Seeber, L., Mueller, C., Fujiwara, T., Arai, K., Soh, W., Djajadihardja, Y. and Cormier, M., Accretion, mass wasting, and partitioned strain over 26 Dec 2004 Mw9.2 rupture offshore Aceh, Northern Sumatra., 2007, EPSL, doi: 10.1016/j.epsl.2007.07.057.

Soh et al., Cruise Report on NT05-02 “Survey off northwest Sumatra Island”, 2005.

## 7.5 Argo plofiling float deployment

(1) Personnel

| | |
|---|---|
| Nobuyuki Shikama | (JAMSTEC): Principal Investigator (not on board) |
| Kanako Sato | (JAMSTEC): not on board |
| Mizue Hirano | (JAMSTEC): not on board |
| Tomohide Noguchi | (MWJ): Operation leader |
| Masatomo Hisazumi | (MWJ): Technical Staff |

(2) Objective

The objective of deployment is to clarify the structure and temporal/spatial variability of water masses in the Indian Ocean such as the subsurface salinity maxima.

The profiling floats launched in this cruise measure vertical profiles of temperature and salinity automatically every ten days. The data from the floats will enable us to understand the phenomenon mentioned above with time/spatial scales much smaller than in previous studies.

(3) Method

We launched APEX floats (Table 7.5-1), manufactured by Webb Research Ltd. Each float equips an SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

The floats usually drift at a depth of 1000dbar (called the parking depth), diving to a depth of 1500dbar and rising up to the sea surface by decreasing and increasing their volume and thus changing the buoyancy in ten-day cycles. During the ascent, they measure temperature, salinity, and pressure. They stay at the sea surface for approximately nine hours, transmitting the CTD data to the land via the ARGOS system, and then return to the parking depth by decreasing volume. The status of floats is shown in Table 7.5-2.

(4) Data archive

The real-time data are provided officially via the Web site of Global Data Assembly Center (GDAC: http:///www.usgodae.org/argo/argo.html, http://www.coriolis.eu.org/) in netcdf format. The Argo group in JAMSTEC (http://www.jamstec.go.jp/ARGO/J-ARGO/) also provide the real-time quality controlled data in ASCII format.

Table 7.5-1 Deployments of the floats

| Date YYYY/MM/DD | Time UTC | Latitude | Longitude | Type |
|---|---|---|---|---|
| 2008/02/09 | 05:18 | 3° 36.72'S | 93° 00.80'E | Argos S/N 3335 |
| 2008/02/09 | 11:17 | 4° 18.25'S | 94° 00.33'E | Argos S/N 3338 |
| 2008/02/11 | 05:41 | 5° 00.34'S | 95° 03.79'E | Argos S/N 3336 |

Table 7.5-2 Status of floats

| | |
|---|---|
| Float Type | APEX floats manufactured by Webb Research Ltd. |
| CTD sensor | SBE41 manufactured by Sea-Bird Electronics Inc. |
| Cycle | 10 days (approximately 9 hours at the sea surface) |
| ARGOS transmit interval | 30 sec |
| Target Parking Pressure | 1000dbar |
| Sampling layers | 105 (1500,1450,1400,1350,1300,1250,1200,1150,1100,1050,1000, 980,960,940,920,900,880,860,840,820,800,780,760,740,720,700,680, 660,640,620,600,580,560,540,520,500,490,480,470,460,450,440,430, 420,410,400,390,380,370,360,350,340,330,320,310,300,290,280,270, 260,250,240,230,220,210,200,195,190,185,180,175,170,165,160,155, 150,145,140,135,130,125,120,115,110,105,100,95,90,85,80,75,70,65, 60,55,50,45,40,35,30,25,20,15,10,4dbar or surf) |

## 7.6 Lidar observations of clouds and aerosols

(1) Personnel

Nobuo Sugimoto, Ichiro Matsui, Atsushi Shimizu (National Institute for Environmental Studies, not on board), lidar operation was supported by GODI.

(2) Objectives

Objectives of the observations in this cruise is to study distribution and optical characteristics of ice/water clouds and marine aerosols using a two-wavelength lidar.

(3) Measured parameters

- Vertical profiles of backscattering coefficient at 532 nm
- Vertical profiles of backscattering coefficient at 1064 nm
- Depolarization ratio at 532 nm

(4) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 30 mJ per pulse at both of 1064 and 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 20 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a transient recorder and stored on a hard disk with a computer. The lidar system was installed in a container which has a glass window on the roof, and the lidar was operated continuously regardless of weather. Every 15 minutes vertical profiles of four channels (532 parallel, 532 perpendicular, 1064, 532 near range) are recorded.

(5) Results

Figure 1 is a quick look showing atmospheric structures revealed by lidar observations. Around February 8 there was a dense cloud layer at 5 km altitude accompanied by precipitation. In the upper troposphere there were cirrus clouds and highest one was observed at 16 km altitude. Aerosol mixing layer with the depth of 1-2 km was observed throughout the cruise, and there was no signature of non-spherical particles in the layer.

(6) Data archive

- raw data

  lidar signal at 532 nm

  lidar signal at 1064 nm

  depolarization ratio at 532 nm

  temporal resolution 15min/ vertical resolution 6 m

  data period (UTC): 2/1 22:30 ～ 2/2 8:00, 2/5 6:30 ～ 2/11 16:00, 2/13 16:00 ～ 2/14 8:00

- processed data

  cloud base height, apparent cloud top height

  phase of clouds (ice/water)

  cloud fraction

  boundary layer height (aerosol layer upper boundary height)

  backscatter coefficient of aerosols

  particle depolarization ratio of aerosols

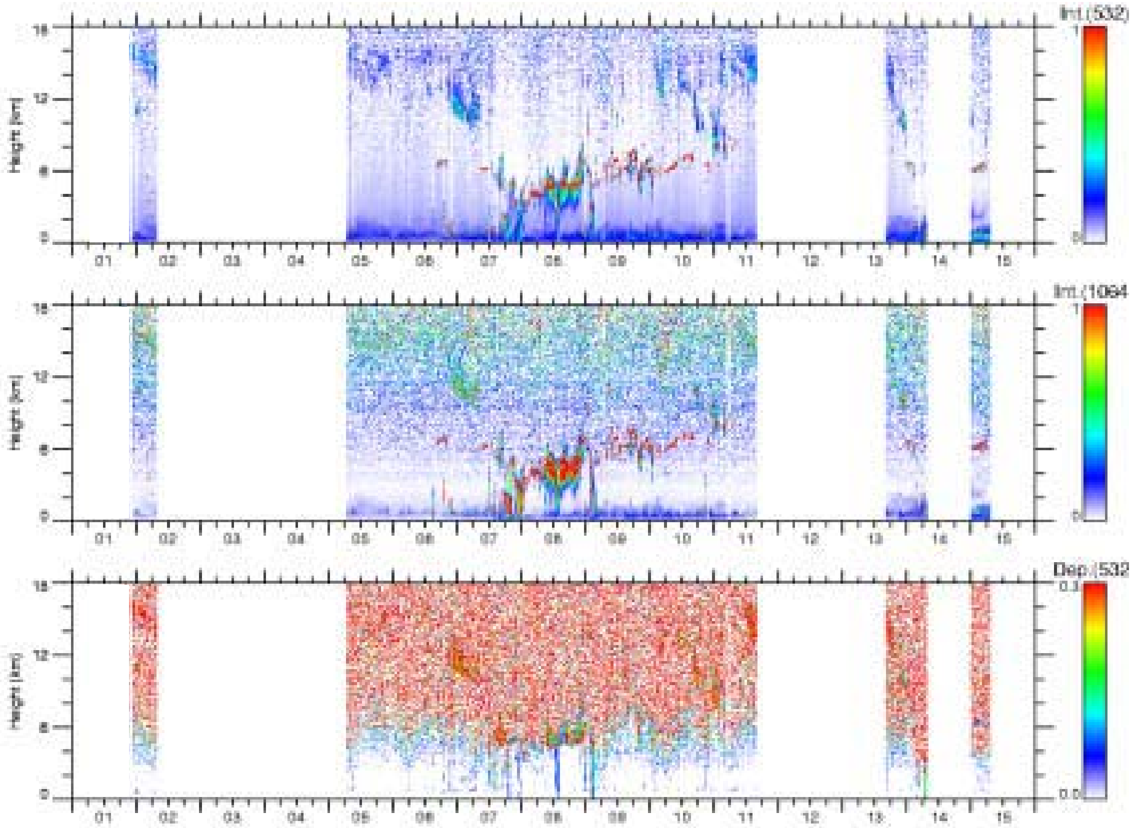



Figure 1: Time-height indication of (top) backscatter intensity at 532 nm, (middle) backscatter intensity at 1064 nm, and (bottom) volume depolarization ratio at 532 nm. Horizontal axis indicates day of February 2008 in UTC.

## 7.7 Rain Sampling for Stable Isotopes

(1) Personnel

Kimpei Ichiyanagi (JAMSTEC) (Not on board)

(2) Objective

To determine the spatial distribution of isotopic composition of rainfall on the Ocean

(3) Method

Rainfall samples are collected in 6cc glass bottle with plastic cap. Isotopic compositions for hydrogen and oxygen in rainfall are determined by the Isotope Ratio Mass Spectrometry (IRMS).

(4) Preliminary results

During this cruise, we collected 5 samples in total. Table 1 lists the date and location of rainfall samples. Analysis will be done after the cruise.

(5) Data archive

Original samples will be analyzed by IORGC. Inventory and analyzed digital data will be submitted to JAMSTEC Data Management Office.

Table 1 Dates and locations to show when and where rain water were sampled.

| Sample No. | Date (UTC) | Location (lat/lon) | Rain (mm) |
|---|---|---|---|
| 001 | 19:30, February 01 | 1-52.5N, 102-22.8E | 4.4 |
| 002 | 01:10, February 08 | 1-42.2N, 090-03.1E | 0.8 |
| 003 | 03:10, February 09 | 3-36.1N, 093-00.5E | 1.2 |
| 004 | 05:12, February 09 | 3-36.5N, 093-00.7E | 0.4 |
| 005 | 07:50, February 14 | 3-23.6N, 100-24.6E | 6.6 |

## 7.8 Kuroshio flux buoy moorings

(1) Personnel

| | |
|---|---|
| Hiroshi Ichikawa | (JAMSTEC): Principal Investigator (Not on board) |
| Masanori Konda | (JAMSTEC): Oceanographer |
| Hiroyuki Tomita | (JAMSTEC): Oceanographer |
| Katsuhiro Nomura | (JAMSTEC): Oceanographer |
| Nakano Yoshiyuki | (JAMSTEC): Oceanographer |
| J. Michel Strick | (NOAA/PMEL): Engineer |
| Brent Justin Pounds | (NOAA/PMEL): Engineer |
| Hirokatsu Uno | (MWJ): Technical Leader |
| Keisuke Matsumoto | (MWJ): Operation Leader |
| Tomohide Noguchi | (MWJ): Technical Staff |
| Ayumi Takeuchi | (MWJ): Technical Staff |
| Shinsuke Toyoda | (MWJ): Technical Staff |
| Hiroki Ushiromura | (MWJ): Technical Staff |
| Tatsuya Tanaka | (MWJ): Technical Staff |
| Katsunori Sagishima | (MWJ): Technical Staff |
| Masanori Enoki | (MWJ): Technical Staff |
| Wataru Tokunaga | (GODI): Technical Leader |
| Kasuho Yoshida | (GODI): Technical Staff |

(2) Objective

It is very important to understand impact of the air-sea heat exchange at the sea surface. The heat release from the ocean to the atmosphere in the Kuroshio Extension region is almost the largest in the global ocean, and therefore, it can affect the mid-latitude air-sea interaction. However, the amount of the heat flux and the variation of it in this region both are not understood well due to the lack of observations. The most probable way to monitor the temporal and spatial variation of the heat flux in this region should be the remote sensing technique, while the validation of the surface heat flux in this region has not been done well. Then it is very important to validate and improve the accuracy of the satellite-derived surface heat flux in the Kuroshio Extension region. The continuous observation of oceanic and meteorological parameters in the boundary layer can be achieved by the surface mooring buoy system.

K-TRITON is developed based on the concept of m-TRITON designed by MARITEC(Marine Technology Center)/JAMSTEC, considering the information derived by the one year mooring at JKEO, which is presently operated by TAO-based buoy under the Implementation Agreement between JAMSTEC and NOAA/ PMEL (National Oceanic and Atmospheric Administration/ Pacific Marine Environmental Laboratory) in the US. K-TRITON is expected to provide the validation data in the various climatic conditions including the winter time surge condition, which is very hard to measure by the ship observation. Buoy observation at JKEO also contributes to the global buoy observation network program, OceanSITES. K-TRITON buoy has been successfully deployed during this R/V MIRAI cruise (MR07-07 Leg3). We did not recover JKEO buoy in this cruise because of bad weather condition. We measured the temperature and salinity profiles by XCTD (XCTD-1) beside JKEO and K-TRITON buoys. We have sampled the surface water by bucket sampler to measure the surface water salinity and the pCO2.

A surface drifter, Surface Contact Thermodynamics and Dynamics (SCoTD) drifter, which is a novel instrument to follow ocean surface wave measuring near-surface and interfacial water temperature, air-sea net heat flux and solar radiation, has been released from R/V MIRAI just after the deployment of K-TRITON was successfully completed. The SCoTD drifter is expendable device, and has a mass of approximately 400g, an outer diameter of 33cm and height approximately 3cm.

(3) Method

(3-1)The K-TRITON buoy observes oceanic parameters and meteorological parameters as follows:

| | |
|---|---|
| Meteorological parameters: | wind speed, direction, air temperature, relative humidity, shortwave radiation, longwave radiation |
| Oceanic parameters: | water temperature, conductivity and pressure |
| Other parameter: | $pCO_2$ |

Details of the instruments used on the K-TRITON buoy are summarized as follows:

<u>Oceanic sensors</u>

1) CT (Conductivity-Temperature meter, Sea Bird Electronics Inc.)

SBE-37 IM Micro CAT

| | |
|---|---|
| A/D cycles to average: | 4 |
| Sampling interval: | 600sec |
| Measurement range, Temperature : | -5～+35 deg-C |
| Measurement range, Conductivity : | 0～+7 S/m |

2) CTD (Conductivity-Temperature-Depth meter, Sea Bird Electronics Inc.)

SBE-37 Micro CAT

| | |
|---|---|
| A/D cycles to average: | 4 |
| Sampling interval: | 600sec |
| Measurement range, Temperature : | -5～+35 deg-C |
| Measurement range, Conductivity : | 0～+7 S/m |
| Measurement range, Pressure : | 0～full scale range |

3) TD (Temperature and Depth meter, Sea Bird Electronics Inc.)

SBE-39 IM

| | |
|---|---|
| Sampling interval: | 600sec |
| Measurement range, Temperature : | -5～+35 deg-C |
| Measurement range, Pressure : | 0～full scale range |

<u>Meteorological sensors</u>

1) Relative humidity/air temperature (Star Engineerings Co.)

MODEL ASIMET

Sampling interval: 60sec

2) Shortwave radiation (Star Engineerings Co.)

MODEL AMIMET

Sampling interval: 60sec

3) Longwave radiation (Star Engineerings Co.)

MODEL AMIMET

Sampling interval: 60sec

4) Wind speed/direction (Star Engineerings Co.)

MODEL ASIMET

Sampling interval: 60sec

<u>Other instrument</u>

1) pCO2 (Mutsu Institute for Oceanography/JAMSTEC)

Original Model

Sampling interval: 4 times a day at every 3 days

<u>Data logger and ARGOS transmitter</u>

1) Data logger

I/O: RS485 has controlled of meteorological sensors.

RS232C has controlled of Inductive modem.

2) ARGOS transmitter

Hourly averaged data are being transmitted through ARGOS transmitter in real time.

(3-2) Details of the SCoTD drifter size and physical parameters to be measured

<u>Size</u>

Outer diameter 33cm, height 3cm, weight 400g (without antenna)

<u>Measured parameters</u>

1) Near-surface and interfacial water temperature
2) air-sea net heat fluxes
3) surface net solar irradiance

(4) Results

Location of deployment of K-TRITON is as follow:

| | | |
|---|---|---|
| Nominal location | 38.0N, 146.5E | |
| ARGOS PTT number | 30601 | |
| Deployed date (UTC) | 29 Feb. 2008 | |
| Exact location | 38°04.8240' N | 146°25.2092' E |
| Depth | 5,407 m | |

Location of the release of the SCoTD drifter is as follow

| | | |
|---|---|---|
| Release date (UTC) | 29 Feb. 2008 | |
| Release location | 38°05.9717' N | 146°28.1137' E |

(5) Data archive

Hourly averaged data of K-TRITON will be transmitted via ARGOS satellite data-transmission system in real time. These data will be archived at the JAMSTEC Yokosuka Headquarters. And the data will be distributed world wide through internet from the JAMSTEC web site (http://www.jamstec.go.jp/).

(6) Photos

1) Details of surface buoy of the K-TRITON buoy is summarized as follows

| | |
|---|---|
| Total Height | : 5.5m |
| Diameter | : 1.9m |
| Weight [in Air] | : 1,000kg |
| Total Buoyancy | : 4,000kg |

K-TRITON buoy

2) A photo of the SCoTD drifter in the package

The SCoTD drifter

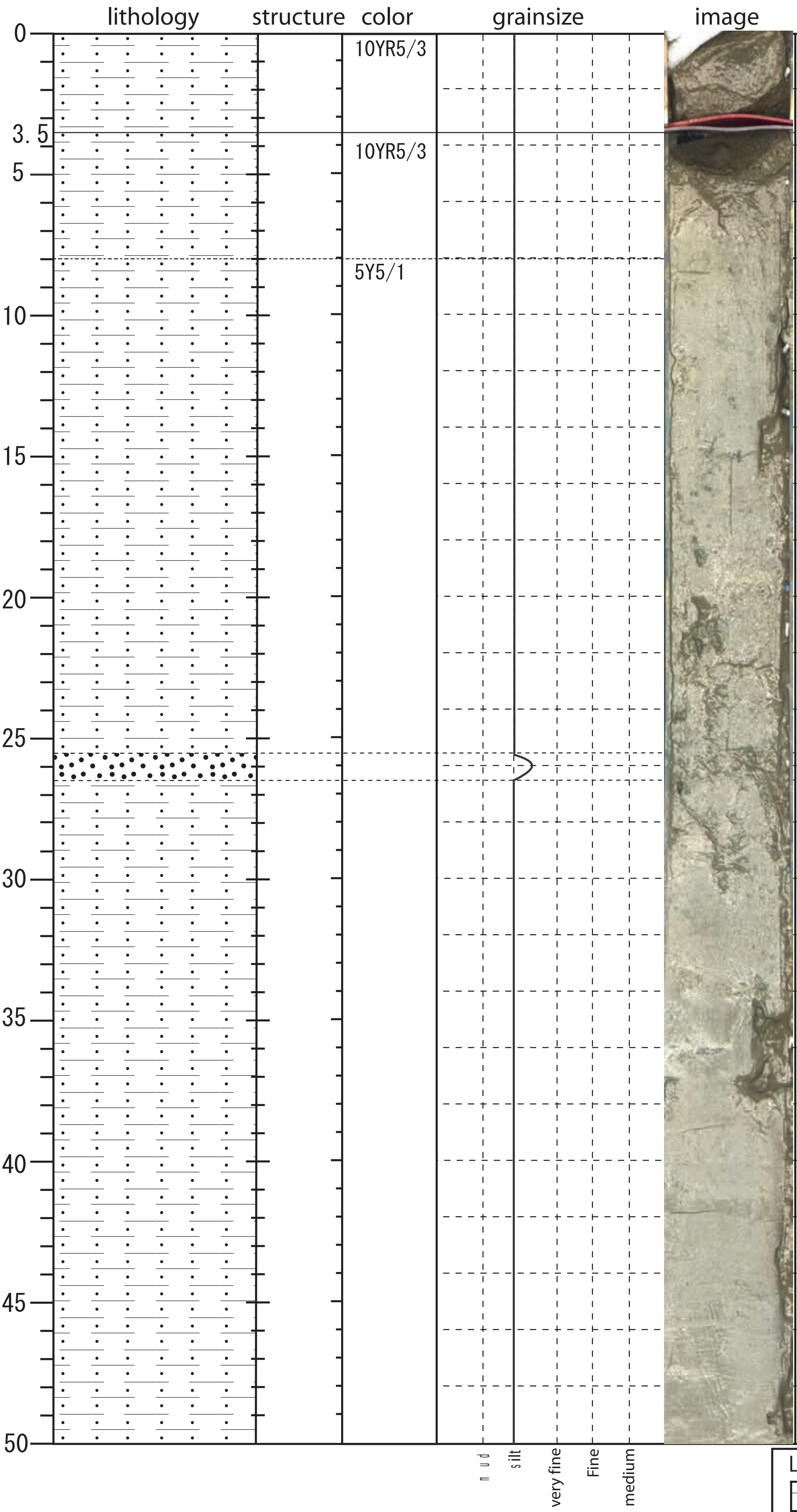
**Appendix**

1. Core log (of Piston core observations)

1. Core log (of Piston core observations)

**CORE LOG** Core No. MR07-07 PC-01 Section No. Section 1 sheet 1 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




0-8cm Dull yellowish Brown silt (10YR 5/3)

3.5cm Core broke

8cm Color Change

8-25.5cm Gray Silt (5Y5/1)

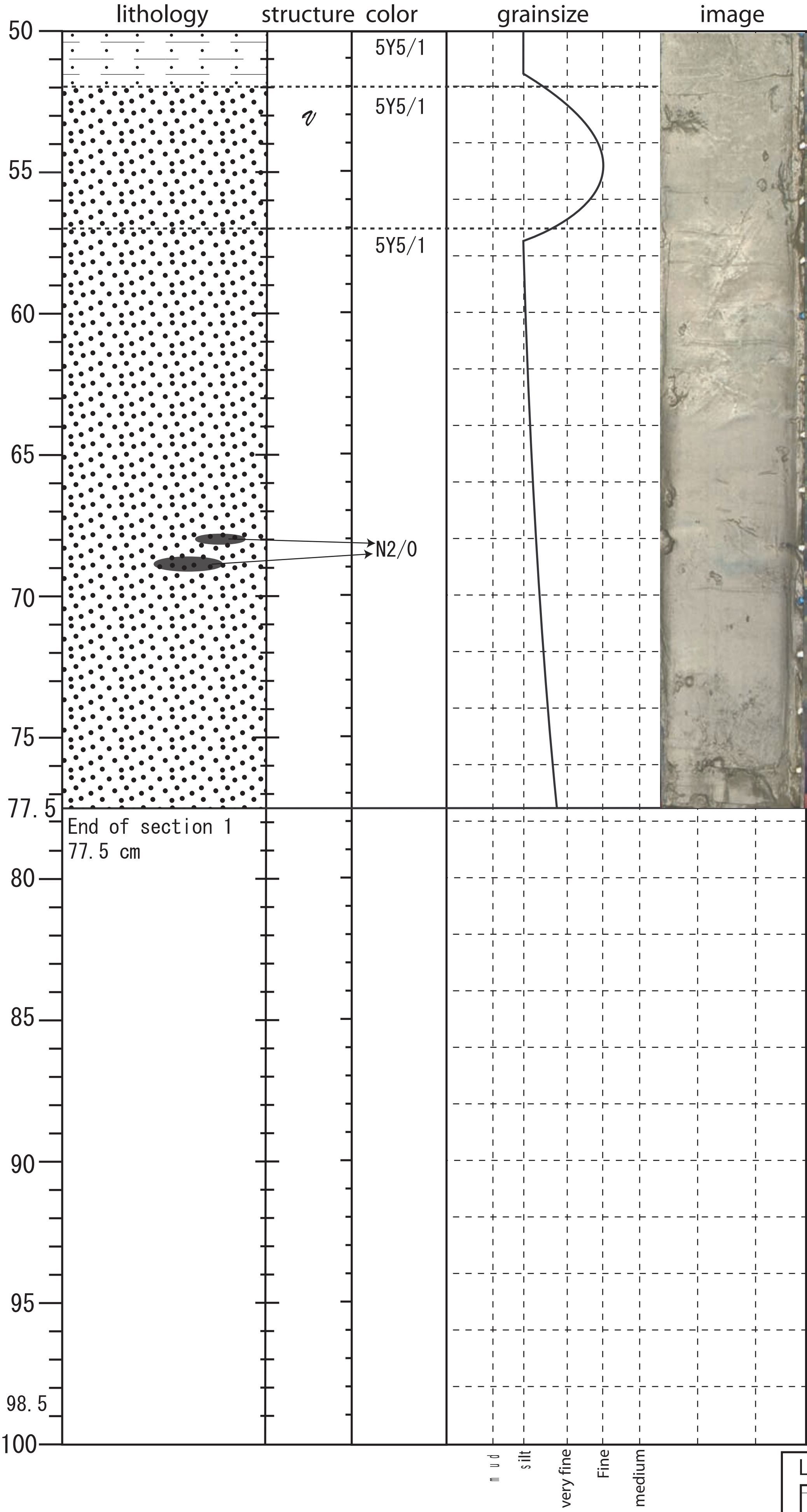
25.5 - 26.5cm Slightly coarser grained layer. Foraminifera abundant

26.5-77.5cm Gray Silt (5Y5/1)

Legend:
- Silt
- Sand
- Ⓣ Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

CORELOG Core No. MR07-07PC01 Section No. 1 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




(52 - 57) Fine sand layer boundary is not clear (volcanic ash ?)

57-77.5 Very fine sand gradually fining upward

68,69cm Black color layer(6- 7 mm)(N2/0)

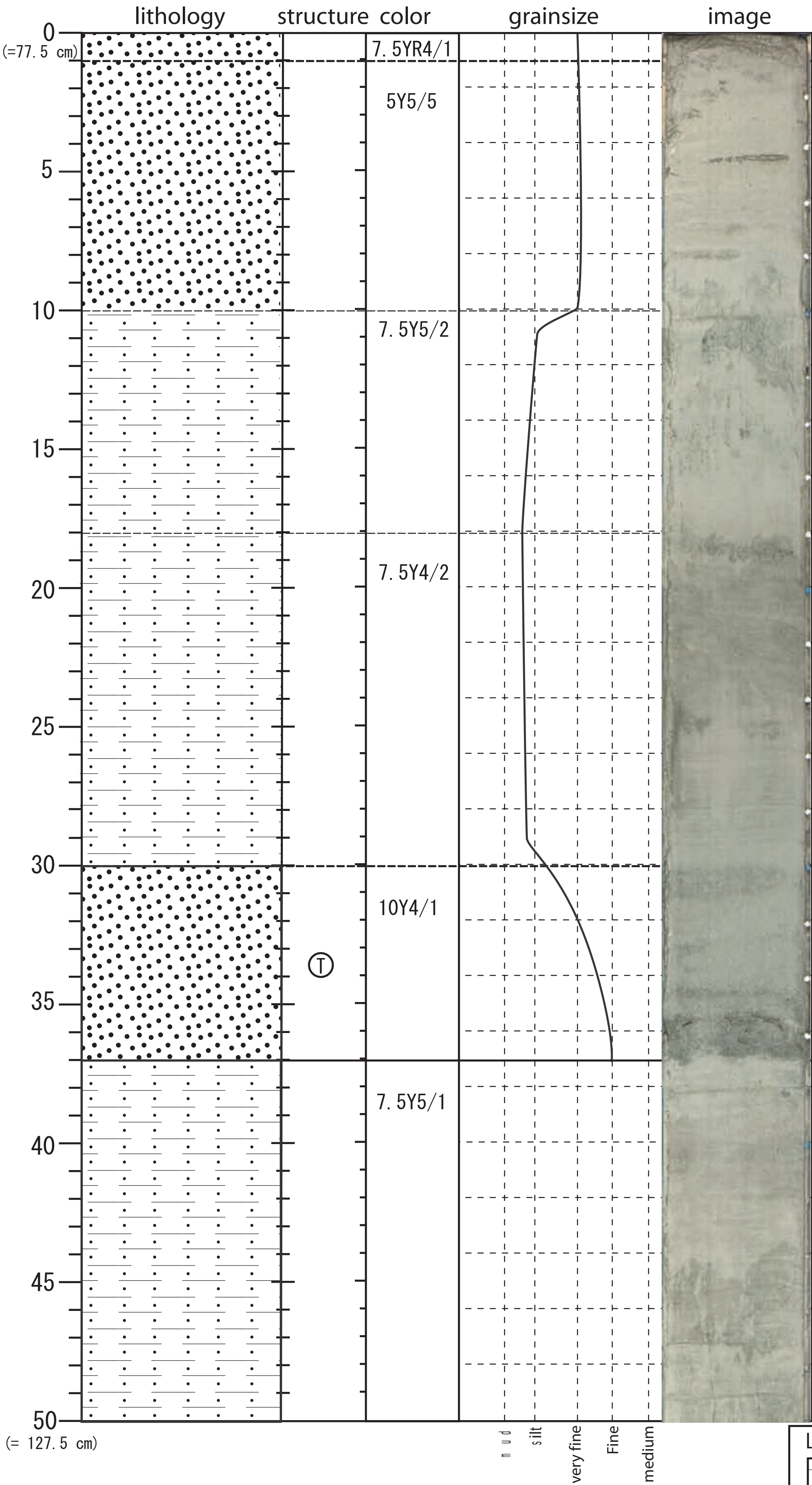
Major Lithology : Faintly laminated very fine sand to silt

Legend:

- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 2 sheet 1 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




0-1cm brownish grey very fine sand

1-10cm grey very fine sand

10cm border unclear

10-18cm Greyish olive silt

18cm border unclear

18-30cm geyish olive muddy silt

Turbidite mud ?

30-37cm Grey fine sand (10Y4/1)

37cm base, sharp boundary

37-50cm grey muddy silt

Black color bioturbation ?

Legend:

- Silt
- Sand
- T Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 2 sheet 2 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W

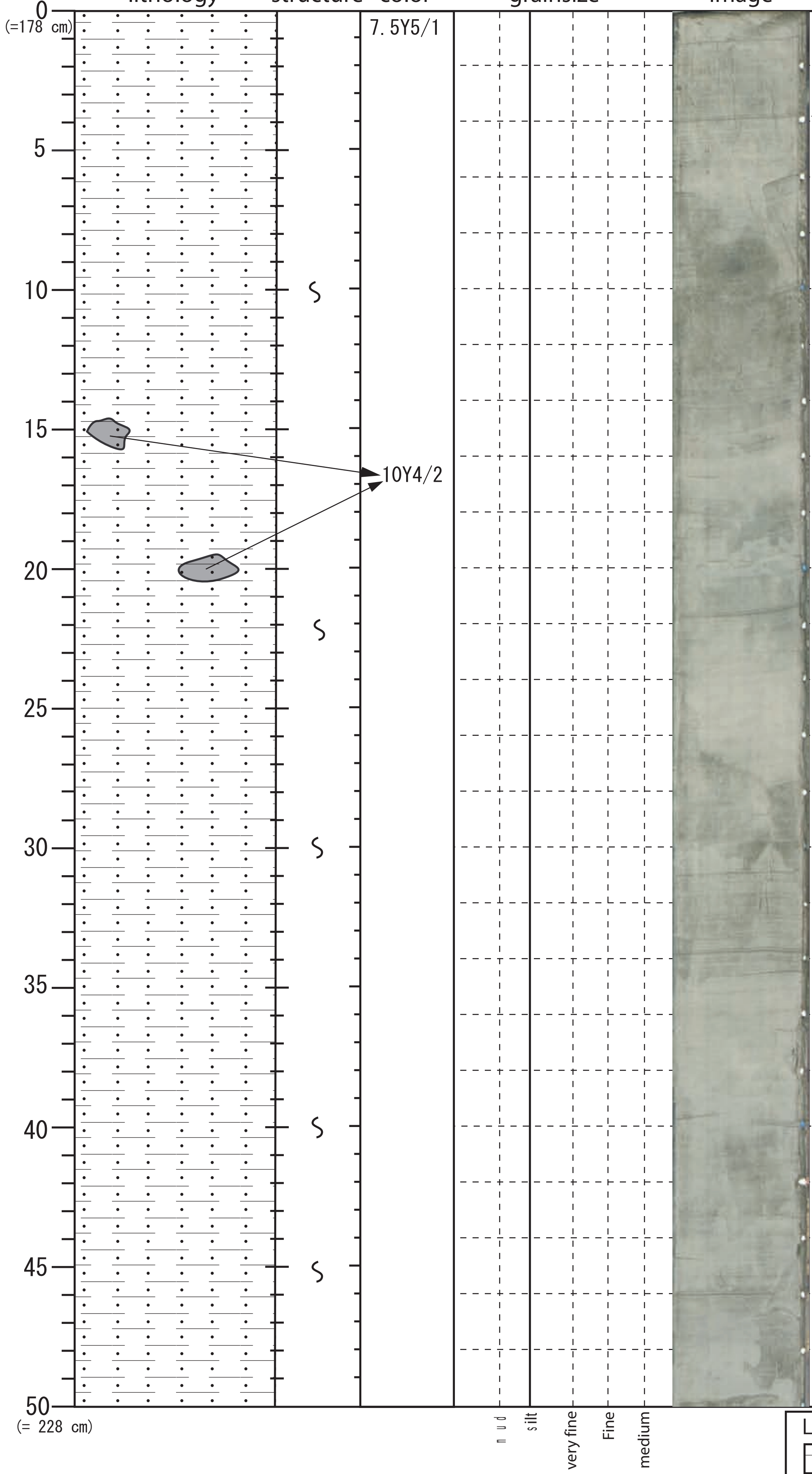
| depth (cm) | lithology | structure | color | grainsize | image | description |
|---|---|---|---|---|---|---|
| 50 (=127.5cm) | Silt | | 7.5Y5/1 | |  | 50-100.5 grey muddy silt (black color bioturbation ?) |
| 55 | Silt | | | | | |
| 57 | Silt | Bioturbation | | | | |
| 60 | Silt | | | | | |
| 65 | Silt | Bioturbation | | | | |
| 70 | Silt | Bioturbation | | | | |
| 75 | Silt | | | | | |
| 80 | Silt | Bioturbation | | | | |
| 85 | Silt | | | | | |
| 87-88 | Silt with sand patch | Bioturbation | | | | (87-88cm)Fine sand patch |
| 90 | Silt | | | | | |
| 95 | Silt | | | | | |
| 98.5 | Silt | | | | | |
| 100 | Silt | | | | | |
| 100.5 | End of section 2 (=178 cm) | | | | | |

grainsize: mud, silt, very fine, Fine, medium

Legend: Silt, Sand, Turbidite, Volcanic Ash, Bioturbation, Lamination

CORELOG Core No. MR07-07 PC-01 Section No. 3 sheet 1 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




0-50cm gray muddy silt with bioturbation (7.5Y5/1)

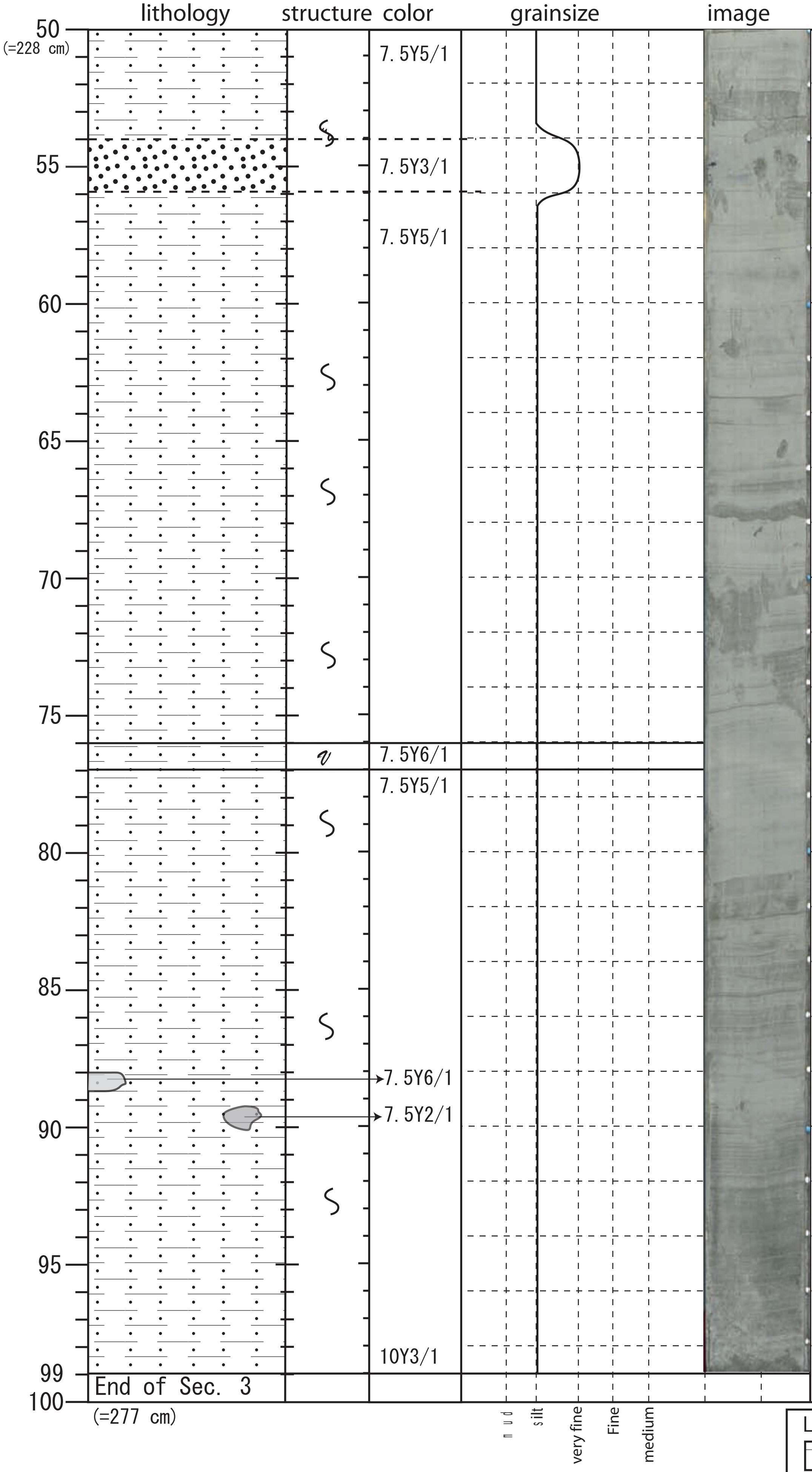
Olive grey bioturbation (10Y4/2)

Legend:

Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 3 sheet 2 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




54-56 cm very fine sand
Irregularly unclear boundary

76-77 Grey Whitish layer)
Volcanic Ash ?

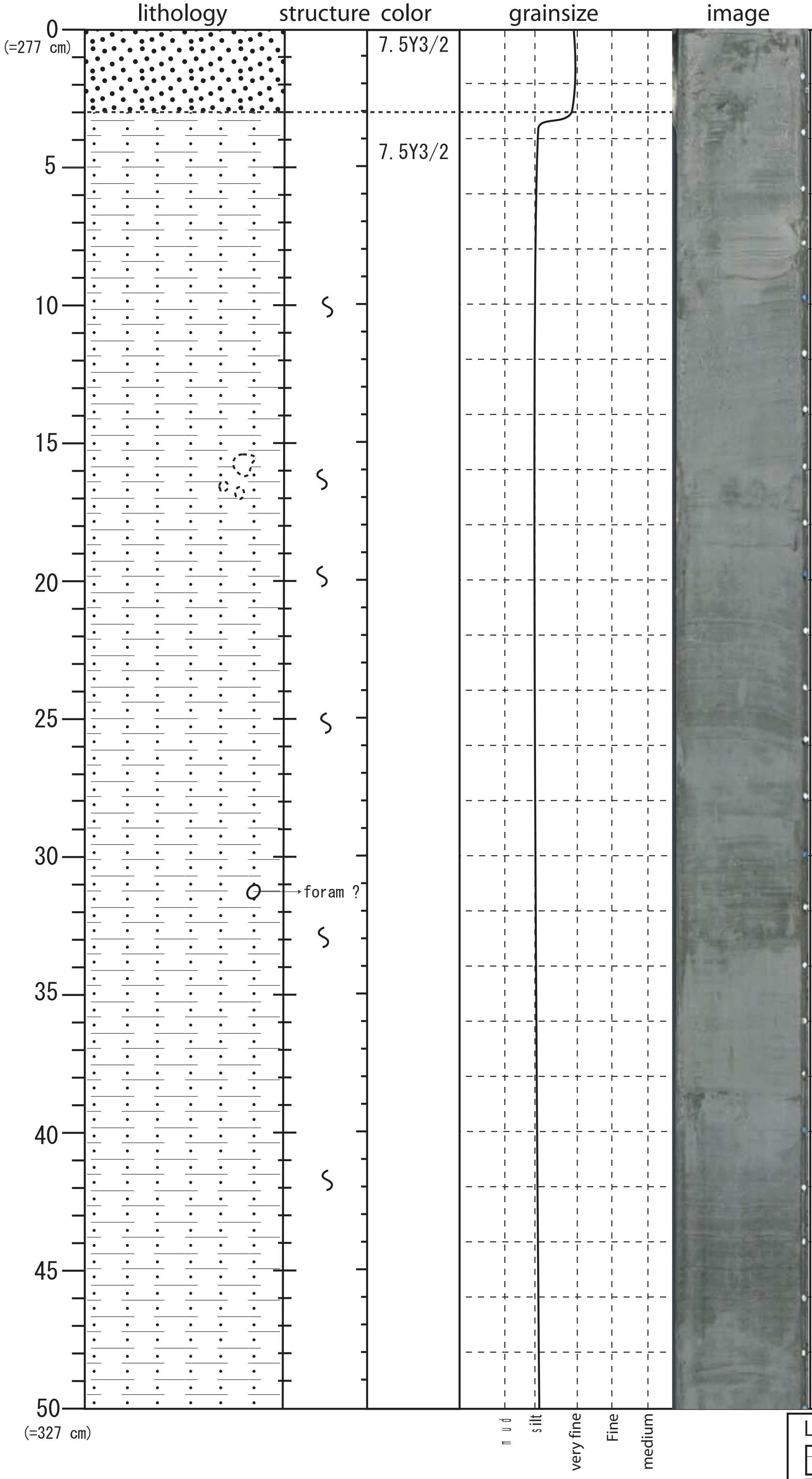
Color gradually change

89cm grey (whitish patch)
90cm grey (black patch)

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

CORELOG Core No. MR07-07 PC-01 Section No. 4 sheet 1 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




0-3cm olive black
very fine sand
3cm unclear boundary

3-50cm olive black Silt

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 4 sheet 2 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W

| lithology | structure | color | grainsize | image | description |
|---|---|---|---|---|---|
| 50 (=327cm) | | 7.5Y3/2 | | | 50-76cm Olive black silt |
| 55 | | | | | 56cm fragment : Foram ? |
| 60 | | | | | |
| 65 | | | | | |
| 70 | | | | | |
| 75 | | 7.5Y3/1 | | | color gradually change lighting upward |
| 80 | | | | | |
| 85 | | 7.5Y3/2 | | | 84-85 : olive black silt layer |
| | | 7.5Y2/2 | | | 85-101: Black silt |
| 90 | | | | | |
| 95 | | | | | |
| 98.5 | | | | | |
| 100 | | | | | |
| 101 | | | | | |

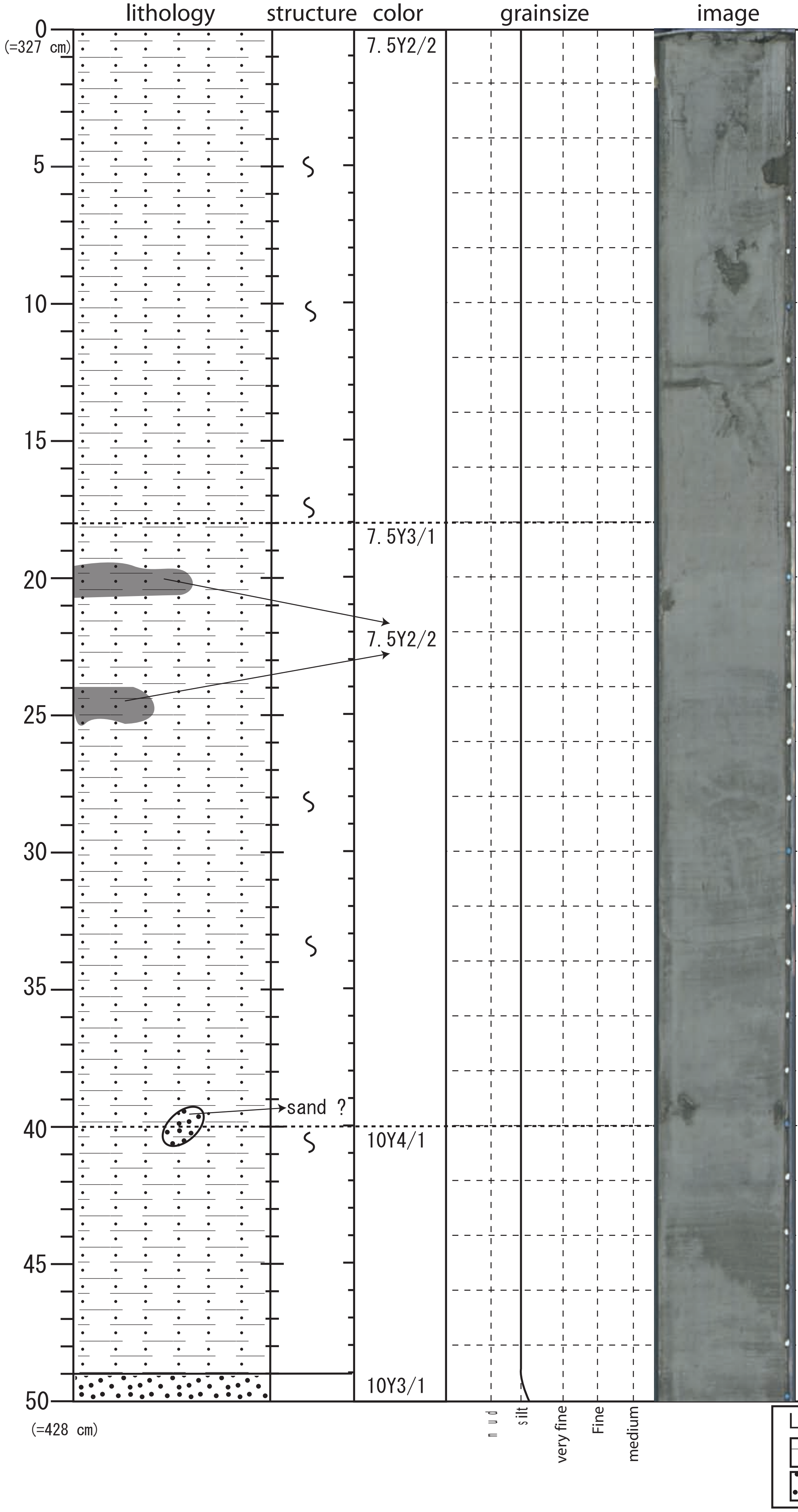
end of section 4 (= 378 cm)

Grainsize scale: mud, silt, very fine, Fine, medium

Legend:
- Silt
- Sand
- Ⓣ Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

C O R E L O G Core No. MR07-07 PC-01 Section No. 5 sheet 1 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




0-40cm olive black silt

18cm Olive Black Silt

Dark color layer around
20 & 25 cm (Olive black:7.5Y2/2)

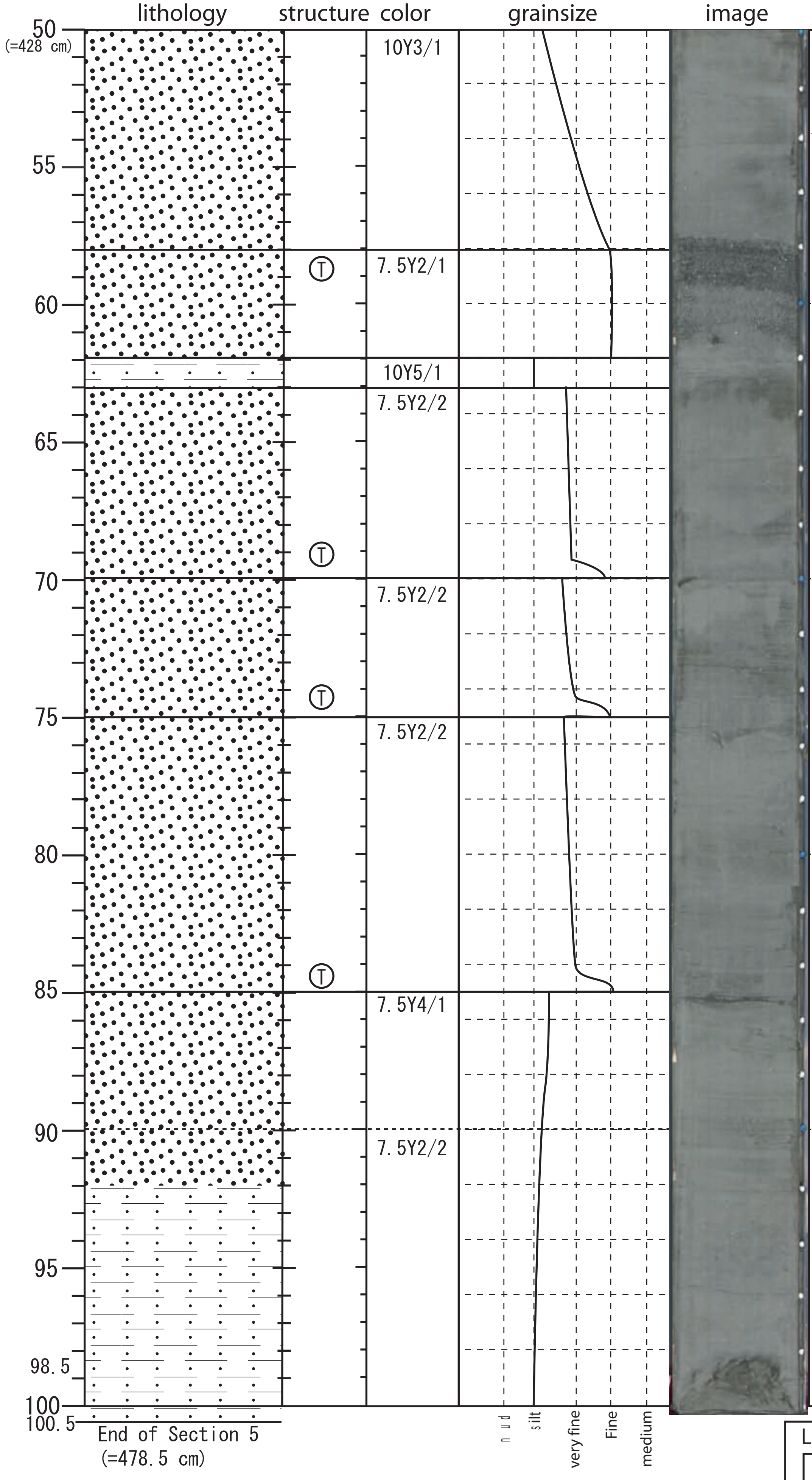
40-49cm gray silt

49-50cm olive black
very fine sand

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

MR07-07 PC-01 5 2 2 W

February 6th, 2008 Arai / Udrekh




49-58cm Olive black (10Y3/1) very fine sand.

58-62cm black (7.5Y2/1) fine sand

62-63cm gray (10Y5/1) silt

63-70cm Olive black (7.5Y2/2) very fine sand

70cm fine sand layer (less than 1 cm)

70-75cm olive black (7.5Y2/2) very fine sand (laminated)

75cm fine sand layer (less than 1 cm)

75-85cm olive black (7.5Y2/2) very fine sand (laminated)

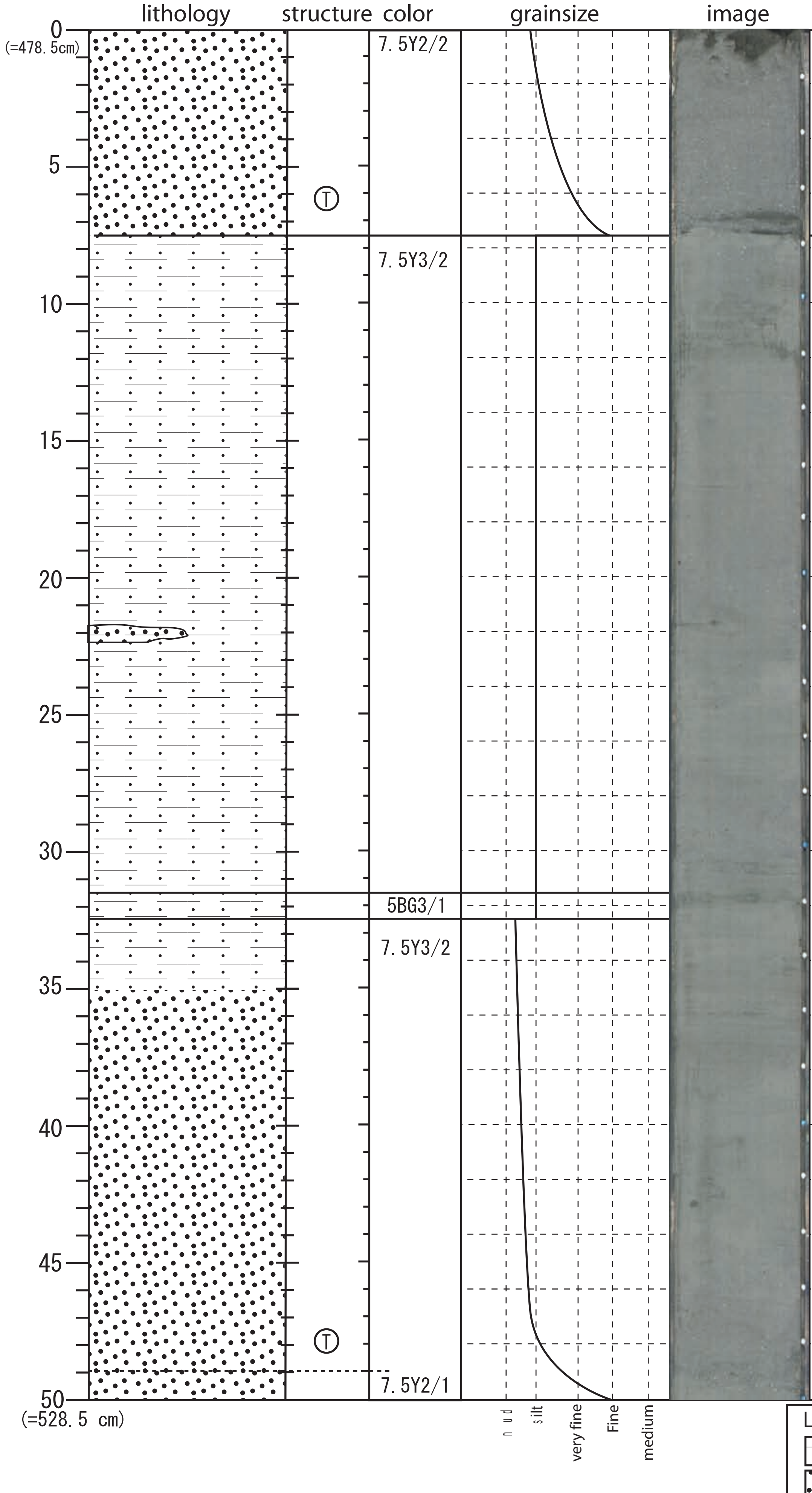
85cm fine sand layer (less than 1 cm)

90cm gradual color change grey to black coarsing upward muddy silt to very fine sand

Legend:
- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

CORELOG Core No. MR07-07 PC-01 Section No. 6 sheet 1 of 2

Date February 6th, 2008 Described by Arai / Udrekh Archive/Working W




0-7.5cm Fining upward, olive black (7.5Y2/2) fine sand to silt

7.5cm sharp boundary
7.5-31.5cm olive black (7.5Y3/2) Silt

22cm uncontinuous fine sand layer, only 2-3 mm

31.5-32.5cm greenish layer
Dark bluish gray (5BG3/1) silt

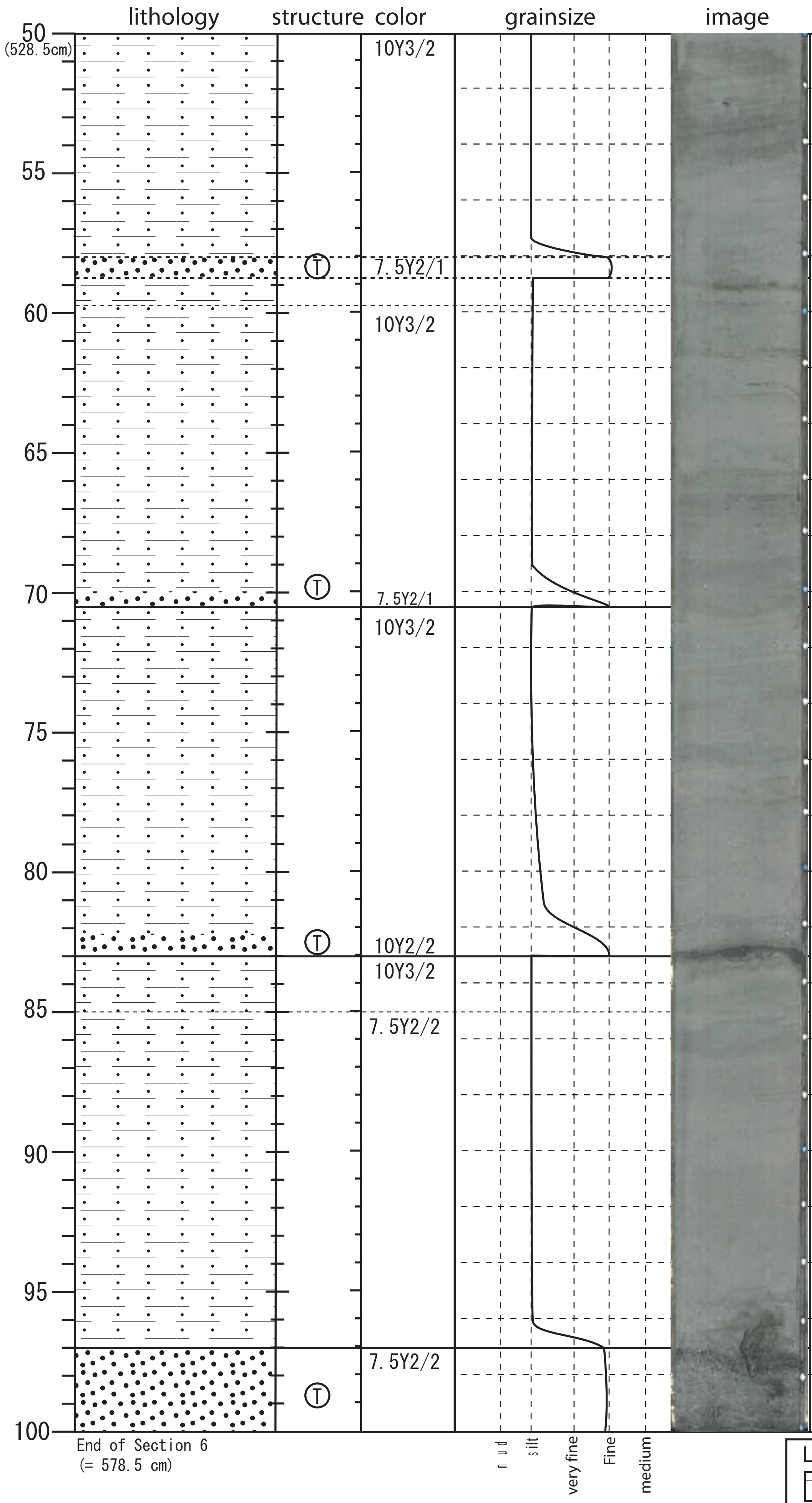
32.5-49cm fining upward, fine sand to muddy silt (7.5Y3/2)

49-50cm black (7.5Y2/1) fine sand layer
50cm sharp boundary

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 6 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




50-58cm Olive black silt

58cm base fine sand just few mm

58-70.5cm olive black silt with greenish layer at 59.6 cm

70-80cm color & graind changes gradually (fining and lightning upward) from olive black silt to black fine sand (less than 1cm)

83cm undulated sharp boundary

85-97cm olive black silt

85cm color boundary, change from 10Y3/2 to 7.5Y2/2

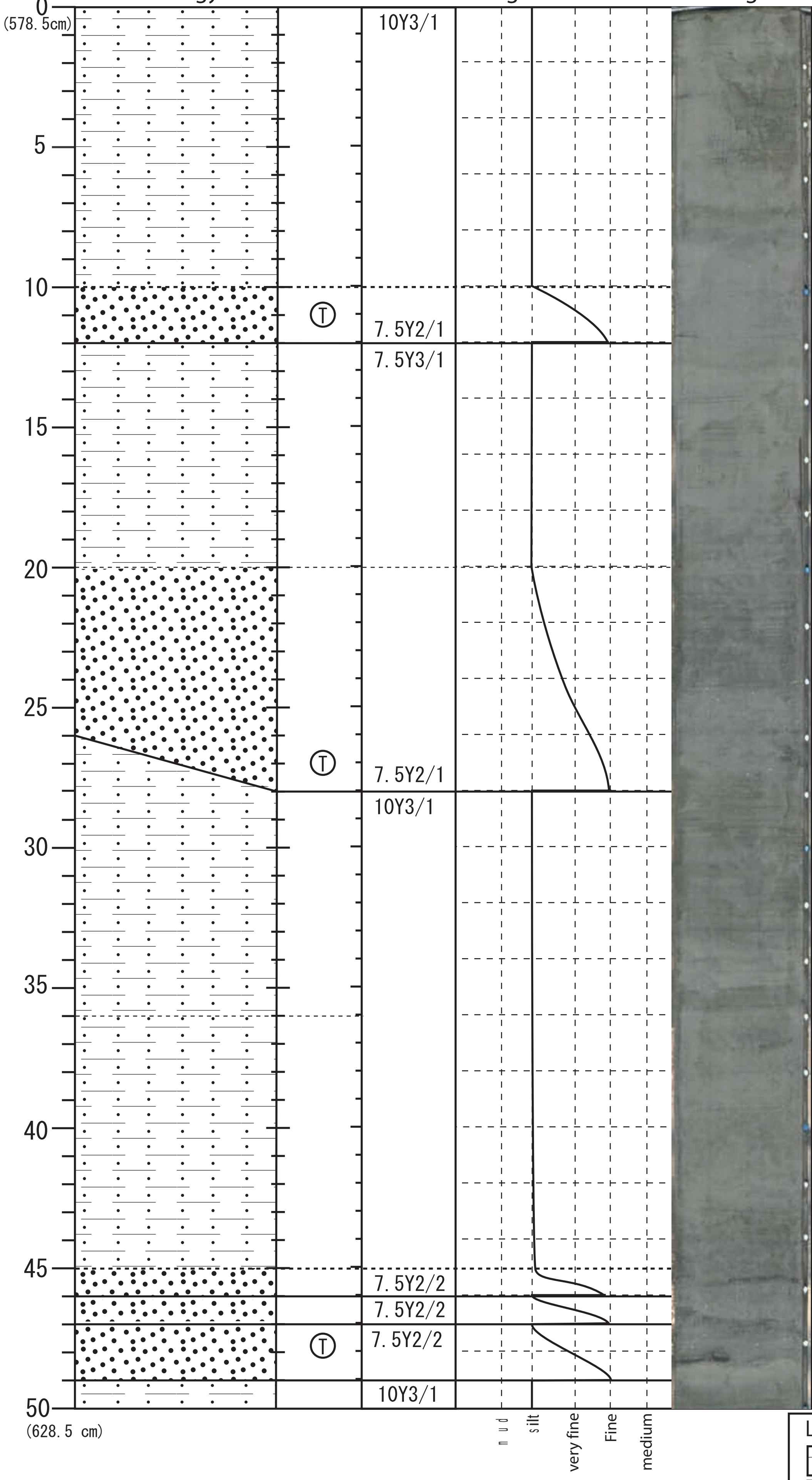
97-100 Black fine sand

Legend:
- T Turbidite
- Silt
- Volcanic Ash
- Bioturbation
- Sand
- Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 7 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W

lithology structure color grainsize image




0-10cm olive black silt
0 - 12 color change gradually from olive black to black.
graind size is also fining upward from fine sand to silt

10-12 cm black fine sand
12 cm sharp boundary
12-20 cm olive blak silt

gradual color change
20-30cm black fine sand
grain size is fining upward

26/28-46cm gradual color & structure change from olive black silt to olive black sand (10Y3/1 to 7.5Y2/2)
grain size is fining upward

36cm color contact

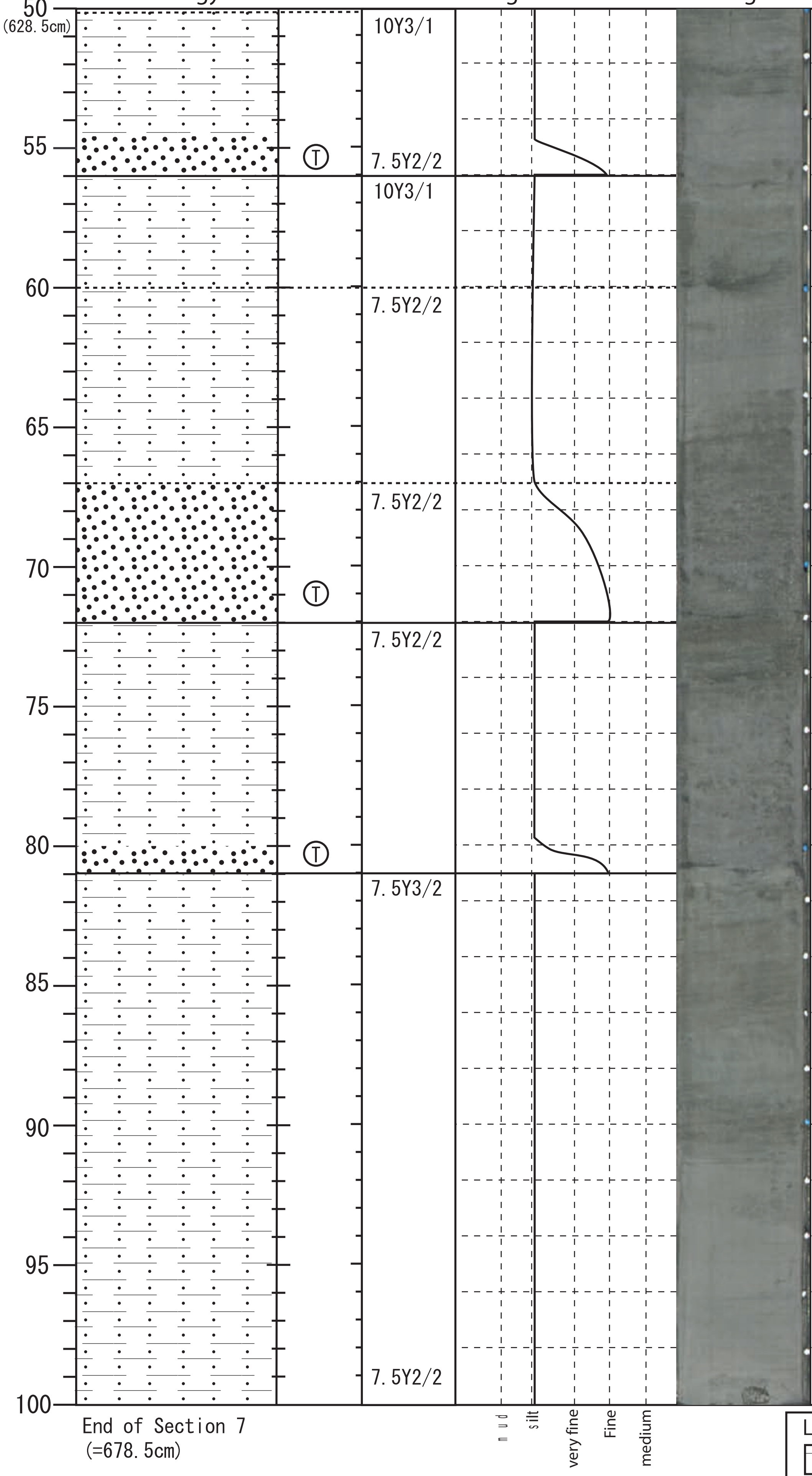
46-47cm olive black fine sand layer fining upward
47-49cm olive black fine sand layer fining upward
49-50 olive black silt

Legend:
Silt
Sand
T Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 7 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W

lithology structure color grainsize image




50cm gradual color change
olive black '10Y3/1 to
olive black 7.5Y2/2

55-56 base : fine sand layer
laminated

60cm color contact. Gradual
color change fro 10Y31 to
7.5Y2/2

67-72cm olive black fine sand

72-81cm olive black silt

81cm base thin fine sand layer

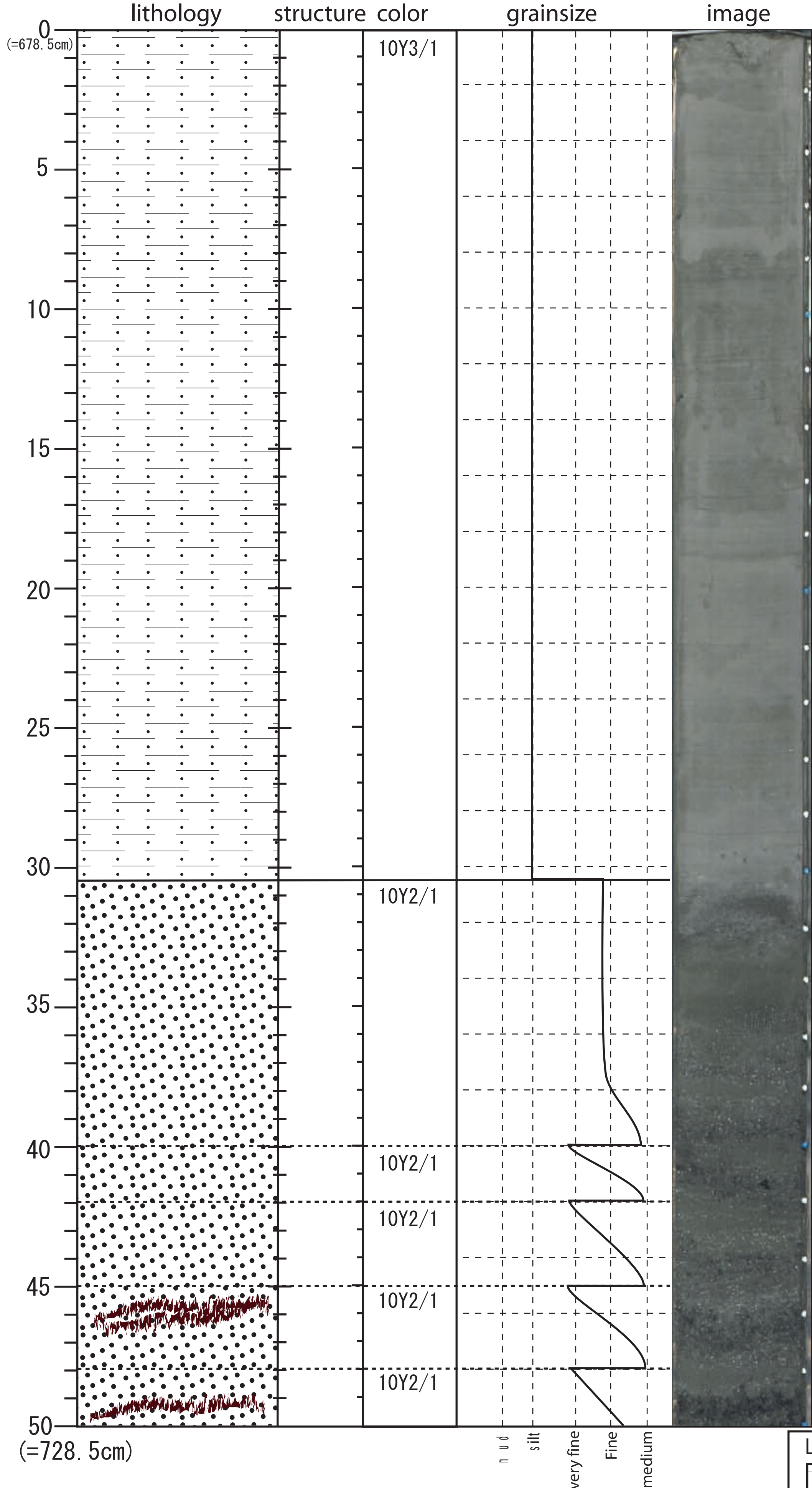
81-100 silt
color change from
dark bluish silt to
olive black (slightly dark)
laminated silt

End of Section 7
(=678.5cm)

Legend:
- Silt
- Sand
- T Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 8 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-30.5cm olive black silt
laminated

30.5-40cm black sand.
Grainsize changes
from fine to medium.

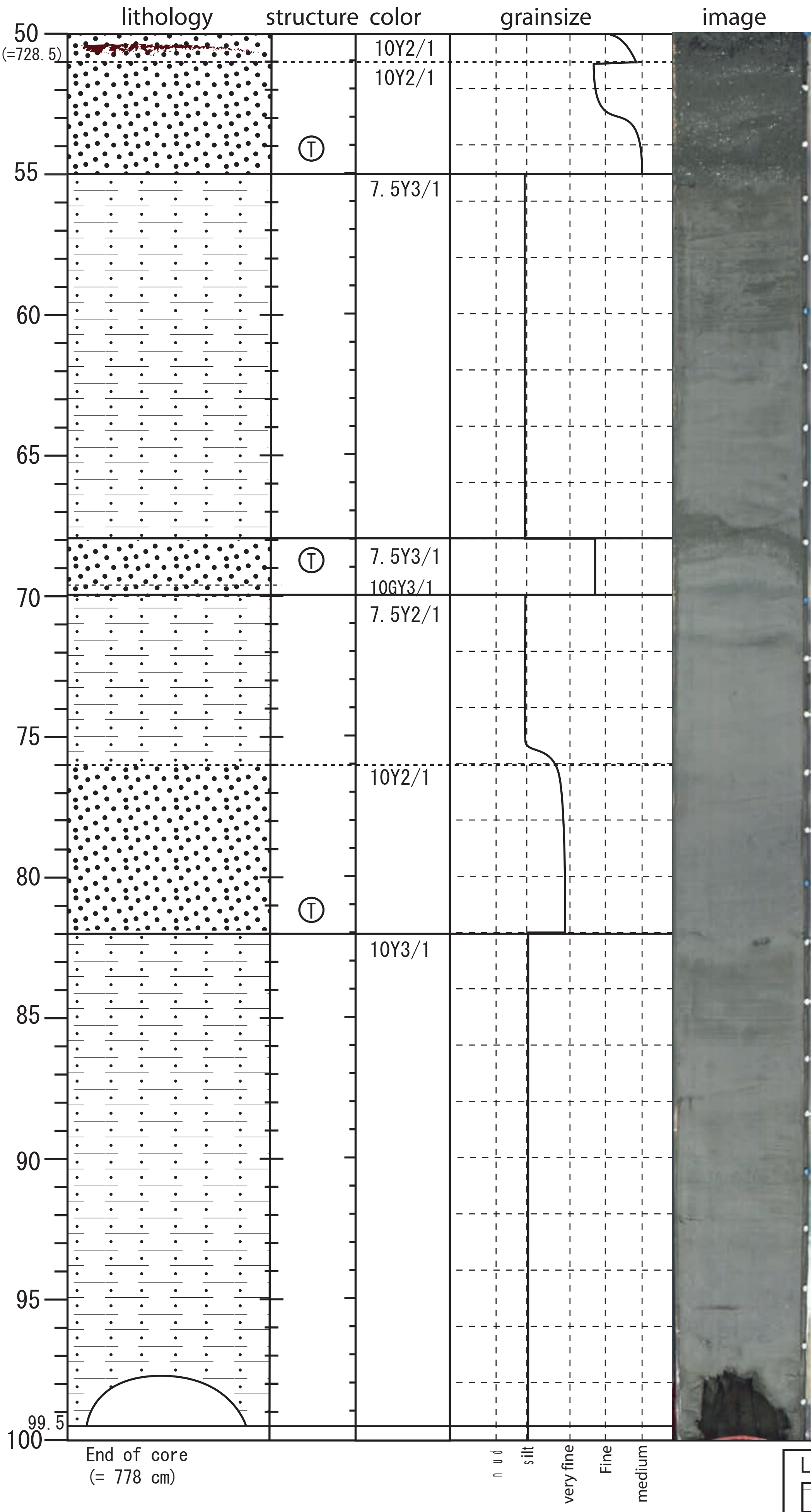
40-42cm alteration from fine
to medium sand
42-45cm alteration from fine
to medium sand
45-48cm alteration from fine
to medium sand
46-47, 49-51 abundance of black
color material.

49-51cm alteration from fine
to medium sand

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-01 Section No. 8 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




(continuation from sheet 1)

51-55 black fine to medium sand

55 sharp boundary

55-68cm olive black silt (laminated)

61cm slightly blocked layer

68-70cm olive black fine sand
black greenish grey color on
the base

70-76cm black silt (laminated)

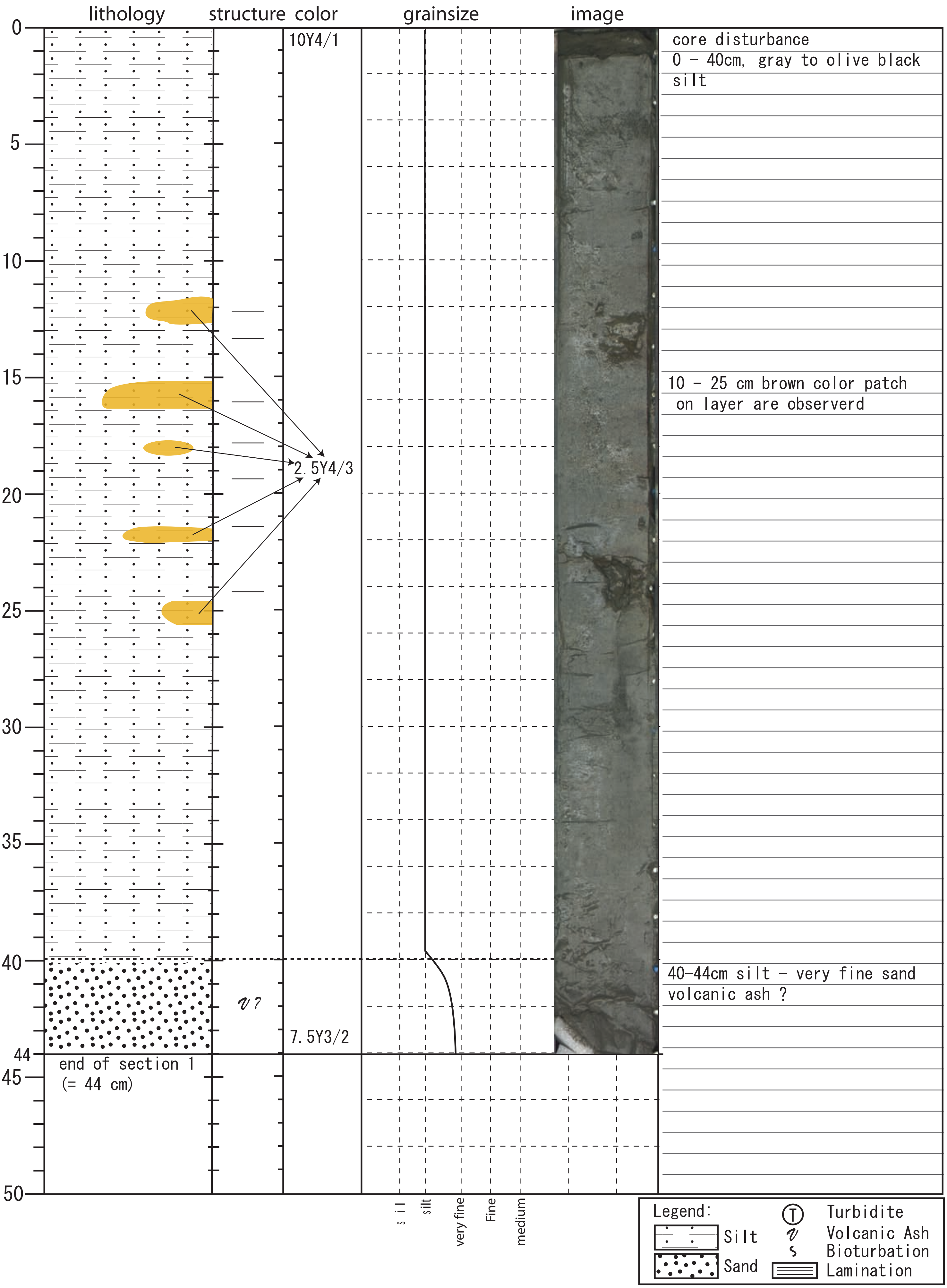
76-82cm black very fine sand

82-99.5cm olive black silt
(laminated)

Legend:
- Silt
- Sand
- Ⓣ Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

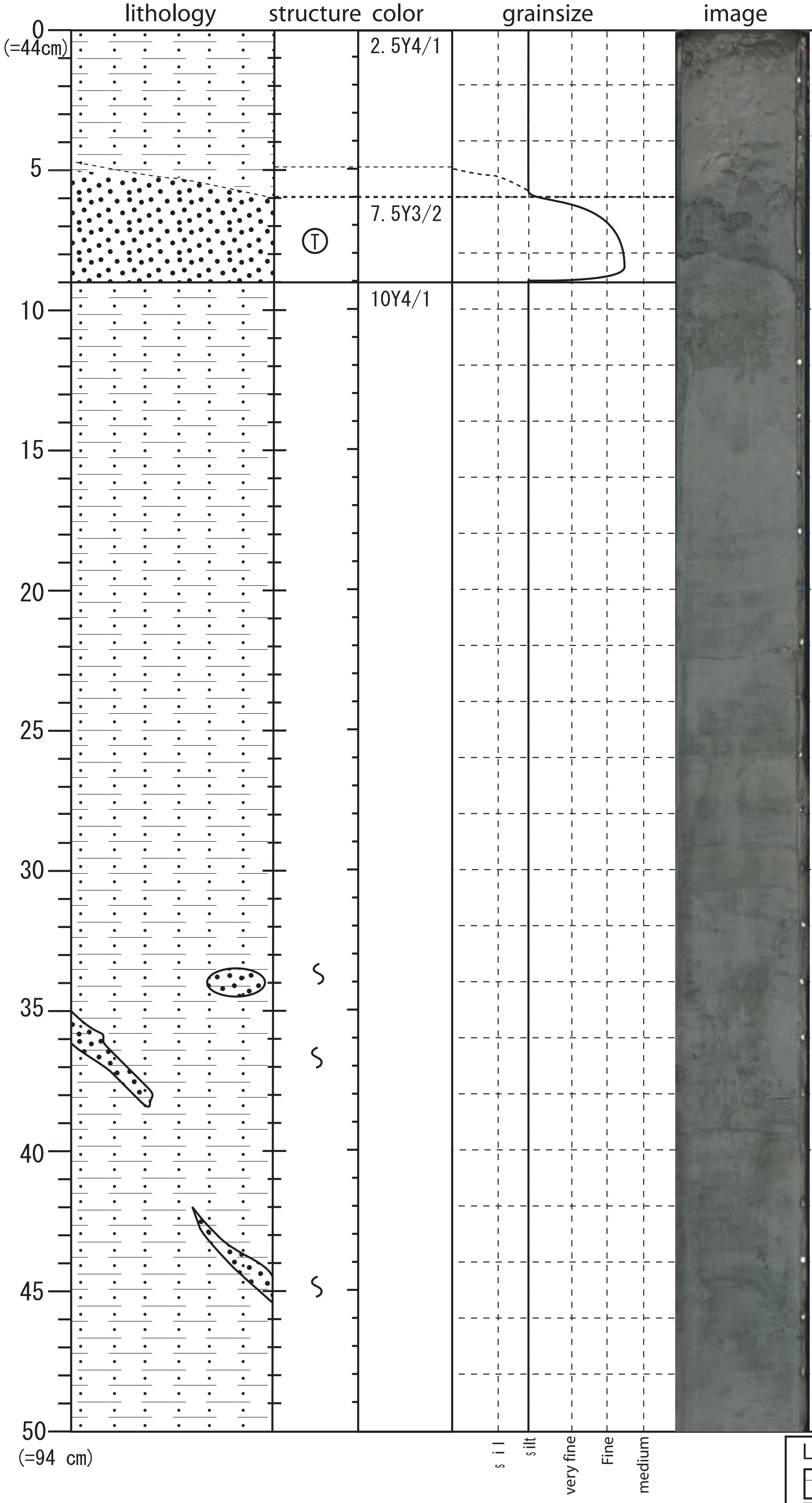
**CORE LOG** Core No. MR07-07 PC-02 Section No. 1 sheet 1 of 1

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W



**CORE LOG** Core No. MR07-07 PC-02 Section No. 2 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-6cm yellowish gray silt

6cm irregular boundary

9cm sharp boundary

9-50cm gray silt

37-46cm bioturbation ?

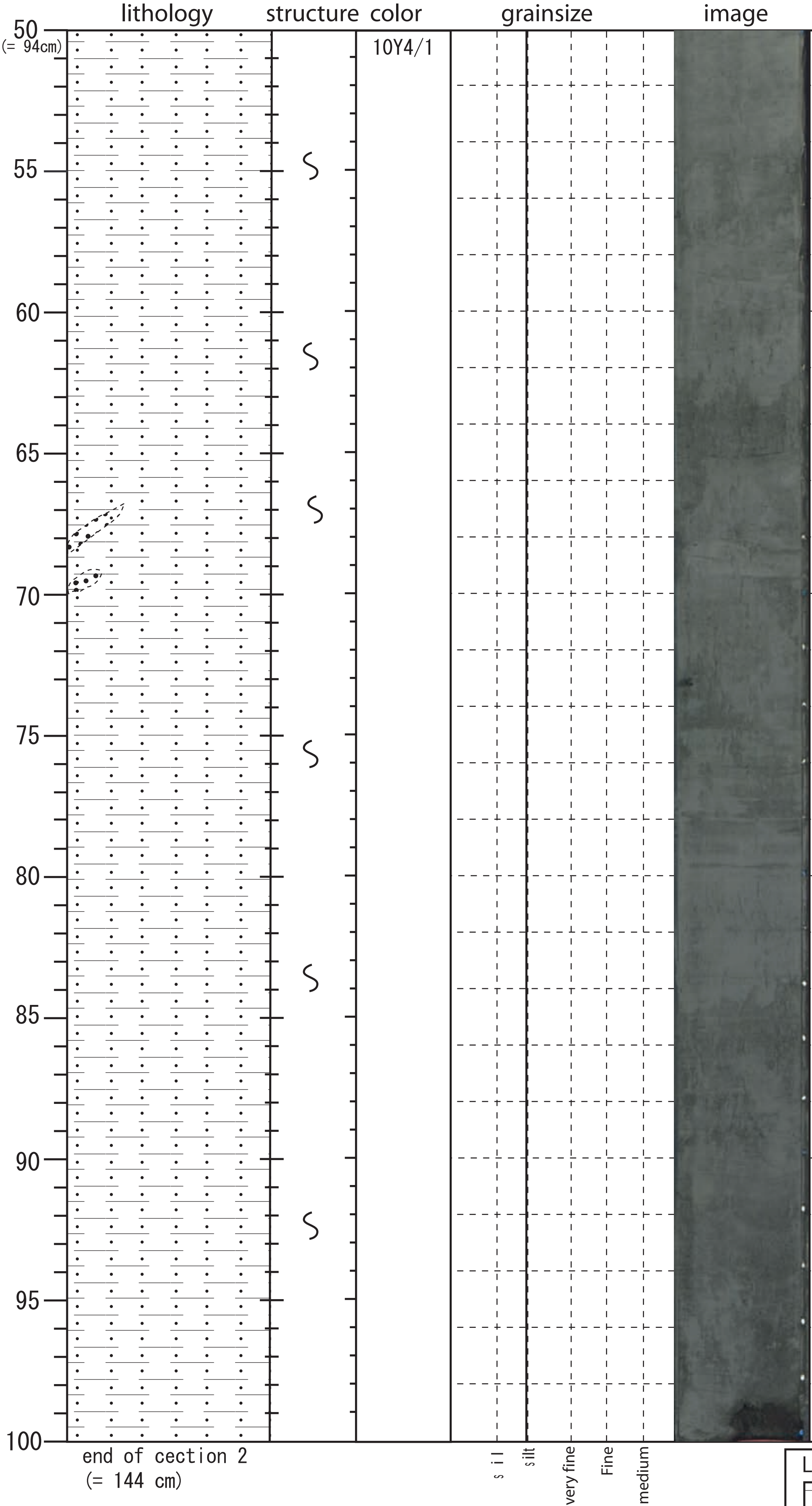
sand size grain patch

Legend:

- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

CORE LOG Core No. MR07-07 PC-02 Section No. 2 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W



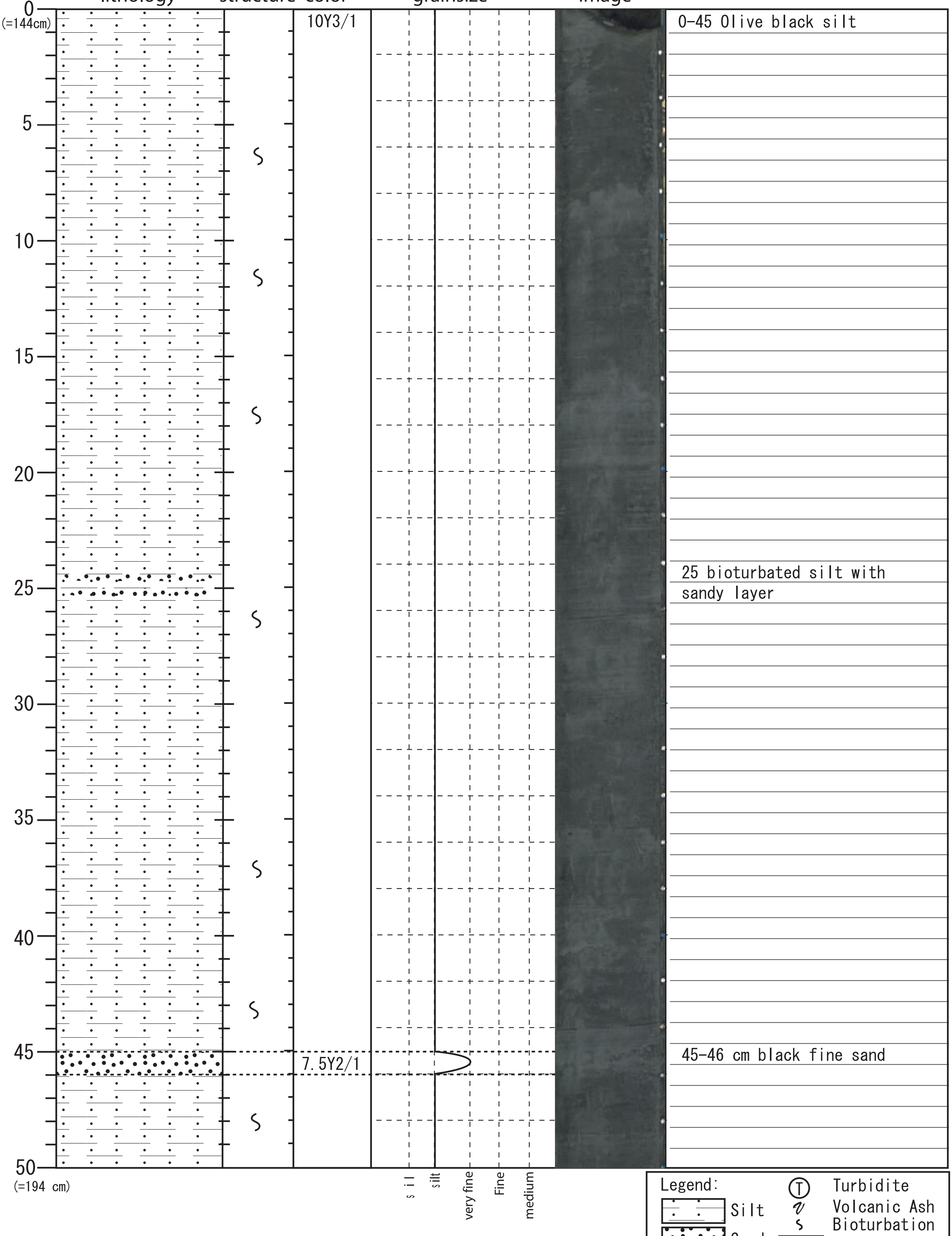

50-100 bioturbated grey silt with sand patch

68 & 70 cm bioturbated with sand patch

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 3 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W



**CORE LOG** Core No. MR07-07 PC-02 Section No. 3 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W

| lithology | structure | color | grainsize | image | |
|---|---|---|---|---|---|
| 50 (= 194cm) – 100.7 | | 10Y3/1 | |  | 50-100.7 olive black silt (bioturbated silt with sandy layer) |

Depth scale: 50 (= 194cm), 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 100.7

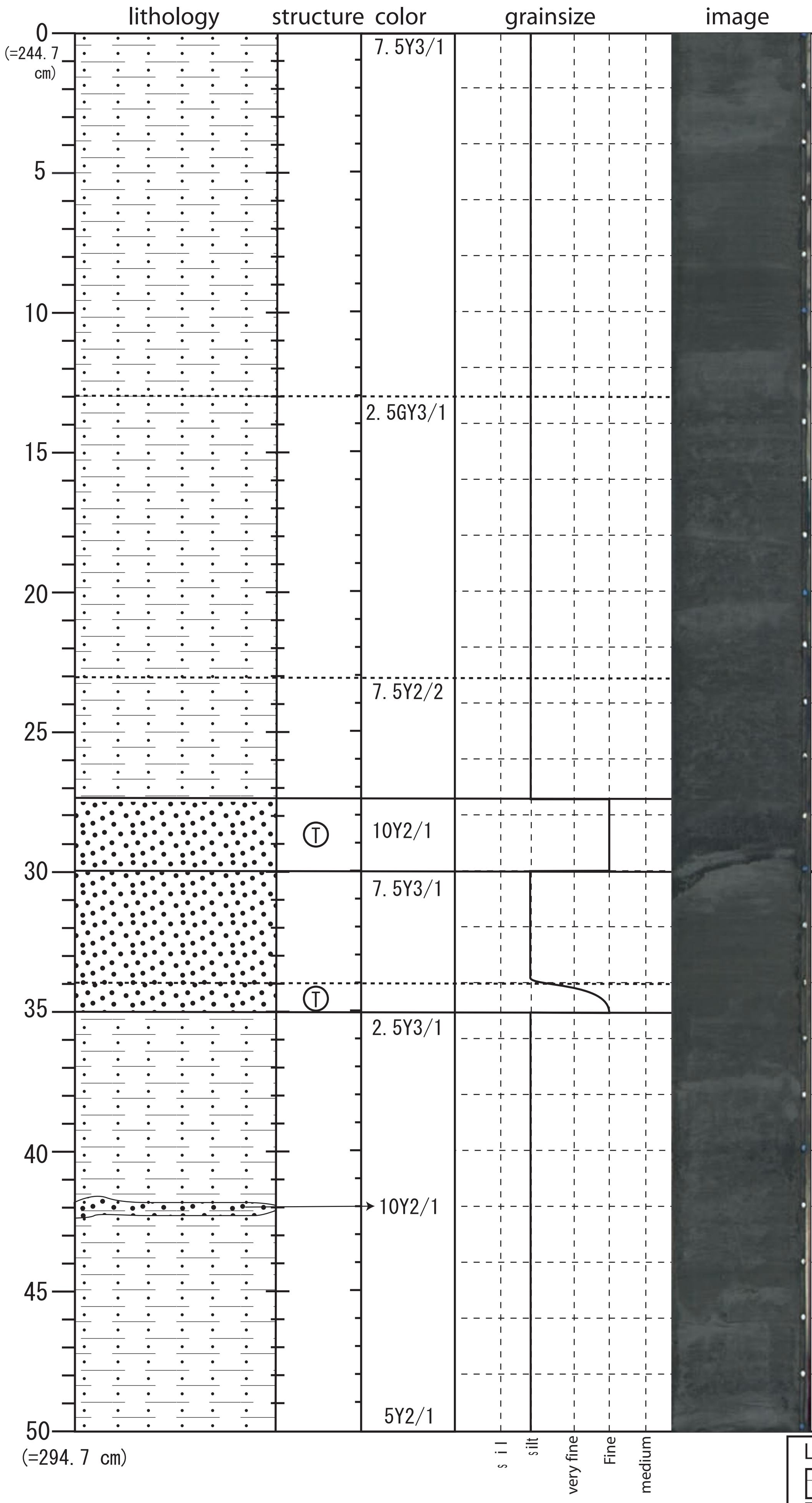
end of section 2
(= 244.7 cm)

Grainsize: s i l, silt, very fine, Fine, medium

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 4 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-28.5cm olive black silt

13cm color change
olive black silt (2GY3/1)

23cm color change
olive black silt (7.5Y2/2)

28.5-30cm black fine sand

30-35cm fining upward from
olive black fine sand to silt

35cm irregular sharp boundary

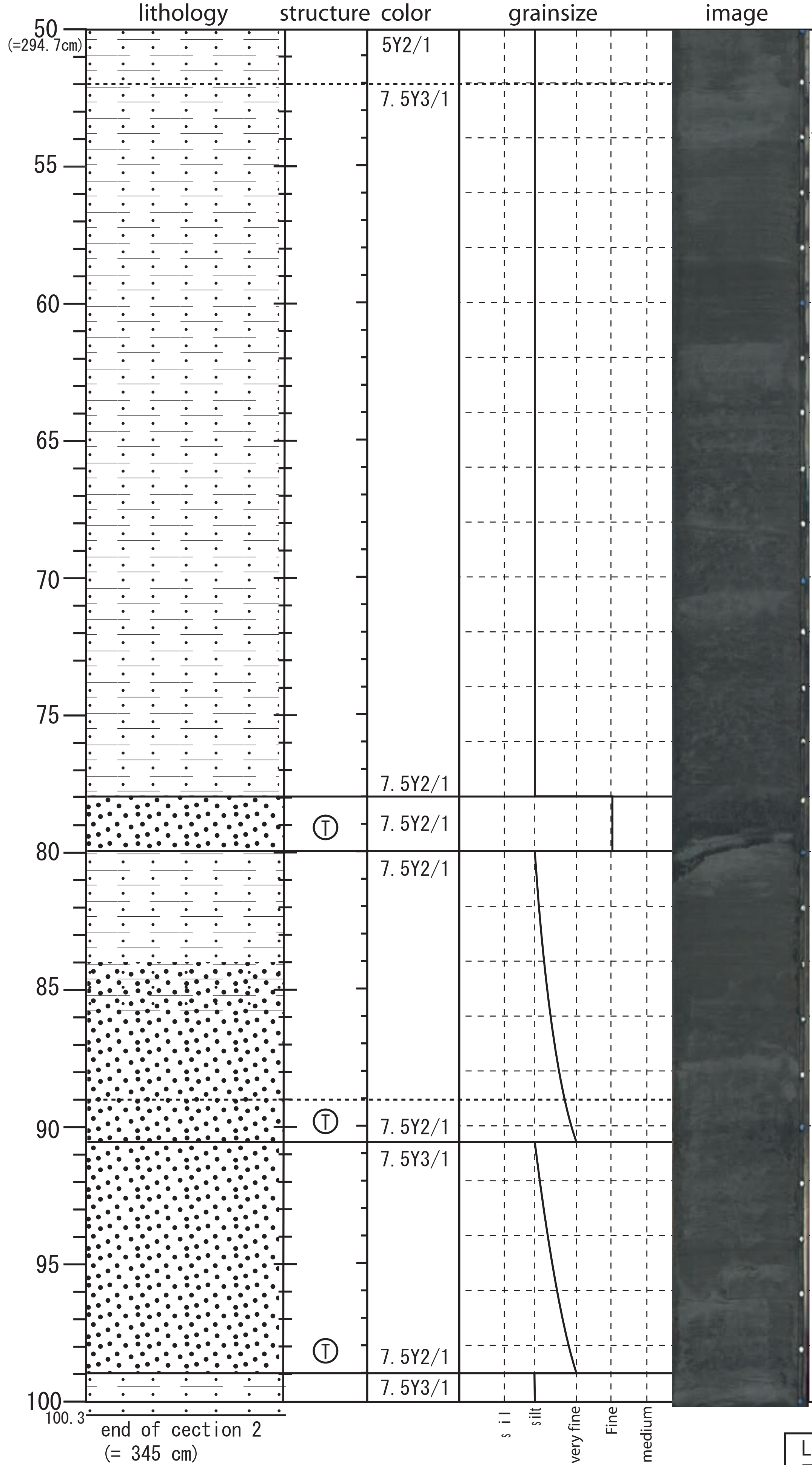
35-50cm darking downward
from dark olive grey silt
(10Y2/1) to black silt (5Y2/1)

42cm black layer (bioturbated)

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

CORE LOG Core No. MR07-07 PC-02 Section No. 4 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




52cm color contact

52-78cm lighting upward from black silt to olive black silt (7.5Y2/1 to 7.5Y3/1)

78-80cm black fine sand

80cm sharp boundary

80-90cm lighting upward from black to olive black sand & fining upward

89cm unclear boundary

90.5cm modeartly sharp boundary

90.5-99cm lighting and fining upward from black sand to olive black silt

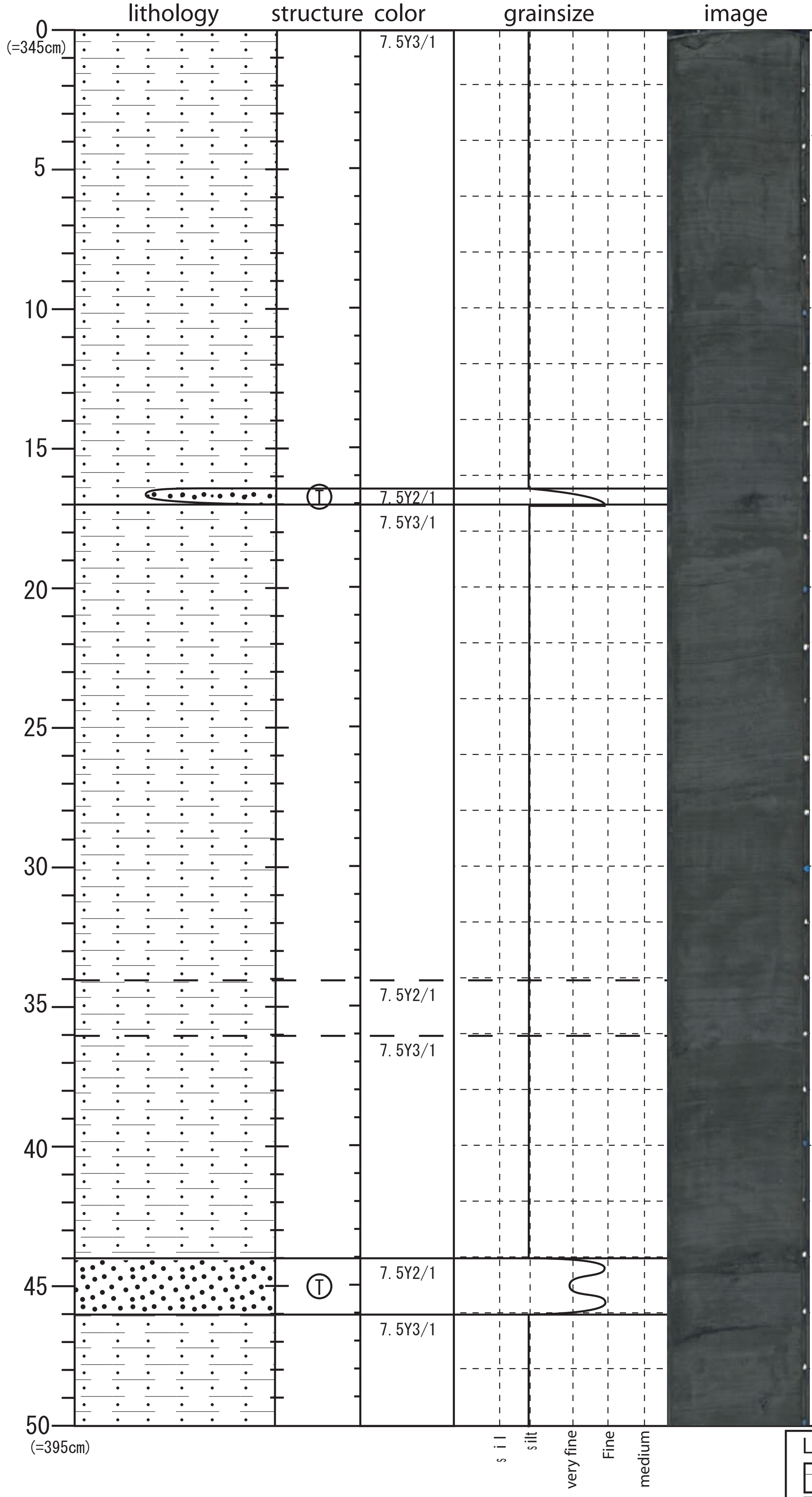
98-100.3cm olive black silt

Legend:

- Silt
- Sand
- (T) Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 5 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-17cm olive black silt

17cm black fine sand (lens shape)

17-34cm olive black silt

34cm color boundary

34-36cm black silt

36cm color boundary

36-44cm olive black silt

44-46 black very fine - fine sand

top and base is slightly coarsed grain

46-50cm olive black silt

50 cm color contact

Legend:

- Silt
- Sand
- T Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

CORE LOG Core No. MR07-07 PC-02 Section No. 5 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W

| lithology | structure | color | grainsize | image | description |
|---|---|---|---|---|---|
| 50 (=395cm) – 61 Silt | | 7.5Y2/1 | silt | | 50cm color contact<br>50-61cm black silt |
| 61–62 Sand | | 7.5Y2/1 | Fine | | 61-62cm black sand |
| 62–68 Silt | | 7.5Y3/1 | silt | | 62-70cm color change from olive black to black silt (lighting upward) |
| 68–70 Silt | | 7.5Y2/2 | silt | | |
| 70–82 Silt | | 7.5Y3/1 | silt | | |
| 82–83 Sand | | 7.5Y2/1 | Fine | | 82-83cm black sand |
| 83–92 Silt | | 7.5Y3/1 | silt | | 83-100.5cm color change from olive black to black silt (lighting upward) |
| 92–100.5 Silt | | 7.5Y2/1 | silt | | |

Depth scale: 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 100.5

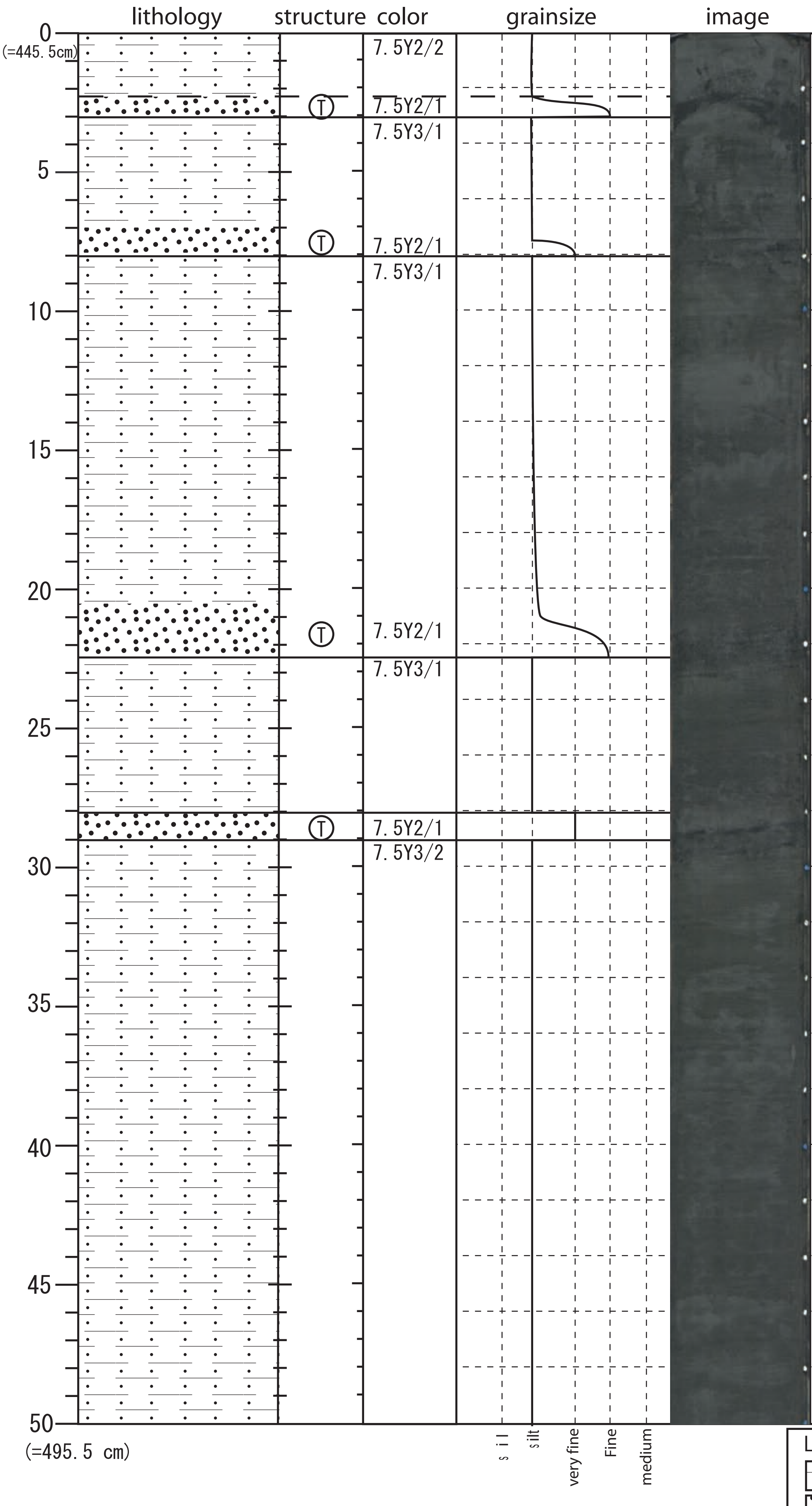
end of section 2 (=445.5 cm)

Grainsize: s i l, silt, very fine, Fine, medium

Legend: Silt, Sand, Turbidite, Volcanic Ash, Bioturbation, Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 6 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-2.5cm olive black silt

2.5-3cm black fine sand layer (less than 1 cm)

3-8cm olive black silt with black very fine sand layer on bottom (few mm thick)

8-22.5cm olive black silt to black fine sand (fining and lighting upward

22.5-28cm olive black silt

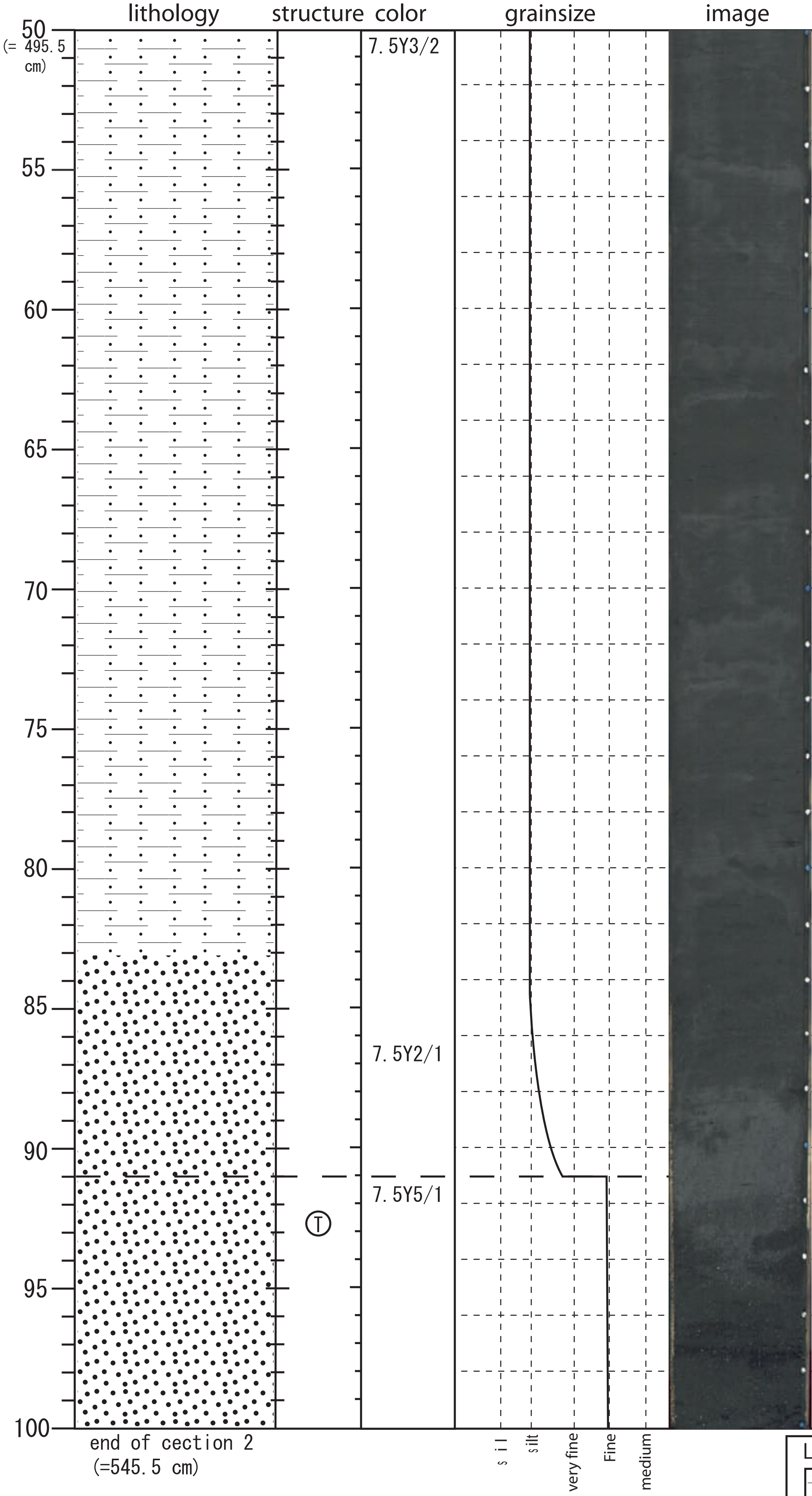
28-29cm black very fine sand layer

29-50cm olive black silt

Legend:
- Silt
- Sand
- (T) Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 6 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W



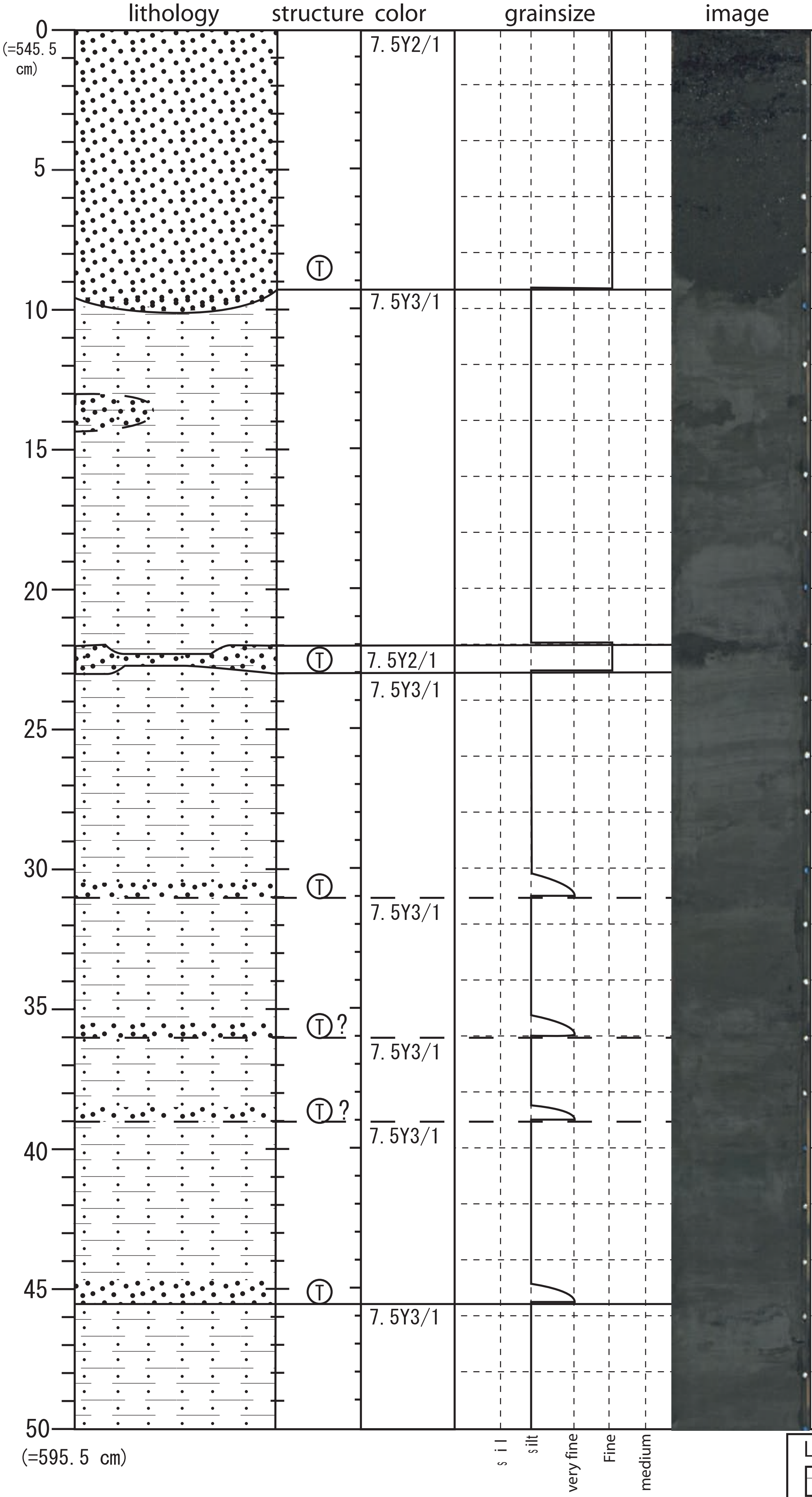

50-91cm olive black silt to black very find sand (fining and lighting upward). Sand grain increasing downward from 83cm

91-100cm black fin sand with mica ?

Legend:
- Silt
- Sand
- Ⓣ Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 7 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-9.5cm black fine sand (upper part include black material)

9.5-22cm olive black silt lightning upward

13.5-14.5cm very fine sand patch (bioturbation ?)

22-23cm black fine sand

23-31cm olive black silt

31cm thin sand layer (few mm)

31-36cm olive black silt

36cm thin sand layer (few mm)

36-39cm olive black silt

39cm thin sand layer (few mm)

36-45.5cm olive black silt

45.5cm thin sand layer (few mm) bioturbated

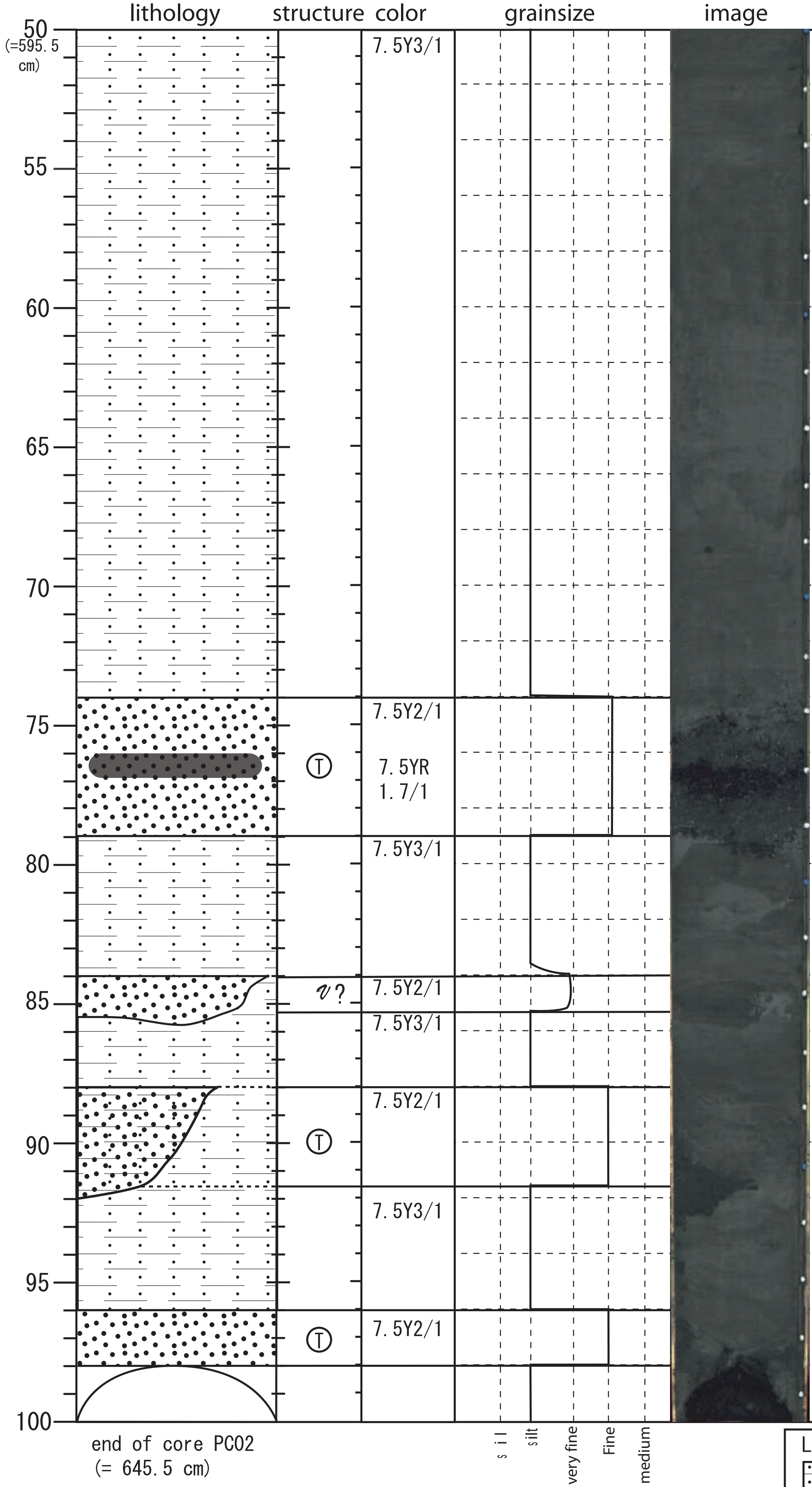
45.5-50cm olive black silt

Legend:

- Silt
- Sand
- T Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-02 Section No. 7 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




50-74cm olive black to black silt (lightning upward)

74-79cm black fine sand

76-77cm black material layer

79-100cm olive black silt

84-86cm whitsh color volcanic ash ?

88-92cm, 96-98 black fine sand layer/patch, lens shape

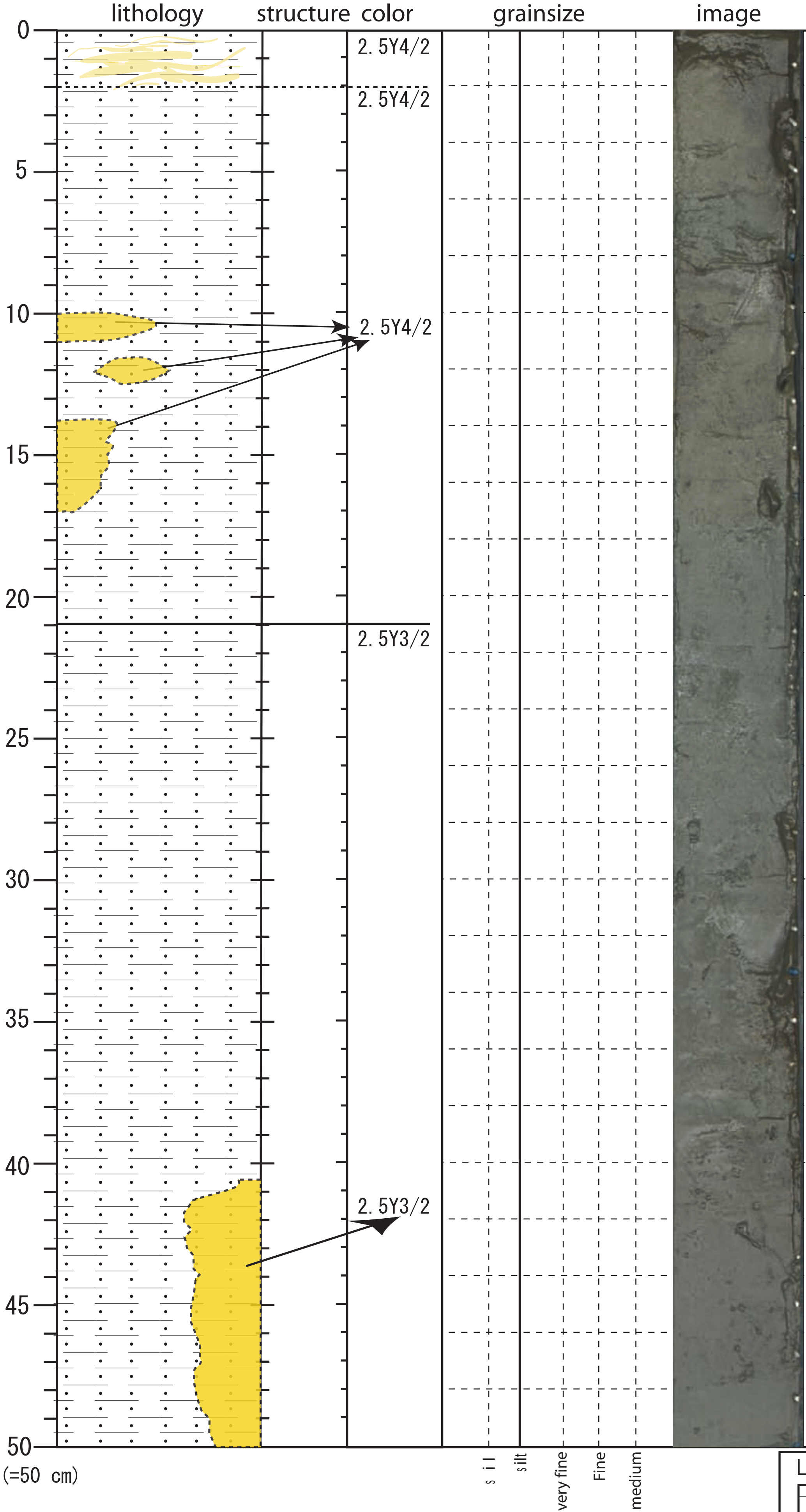
end of core PC02 (= 645.5 cm)

Legend:

- Silt
- Sand
- T Turbidite
- v Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-03 Section No. 1 sheet 1 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




0-2 cm brown soupy sediment

4-21 cm dark greyish yellow silt. Core top soupy

4-21 cm dark olive brown silt

21 cm color change boundary

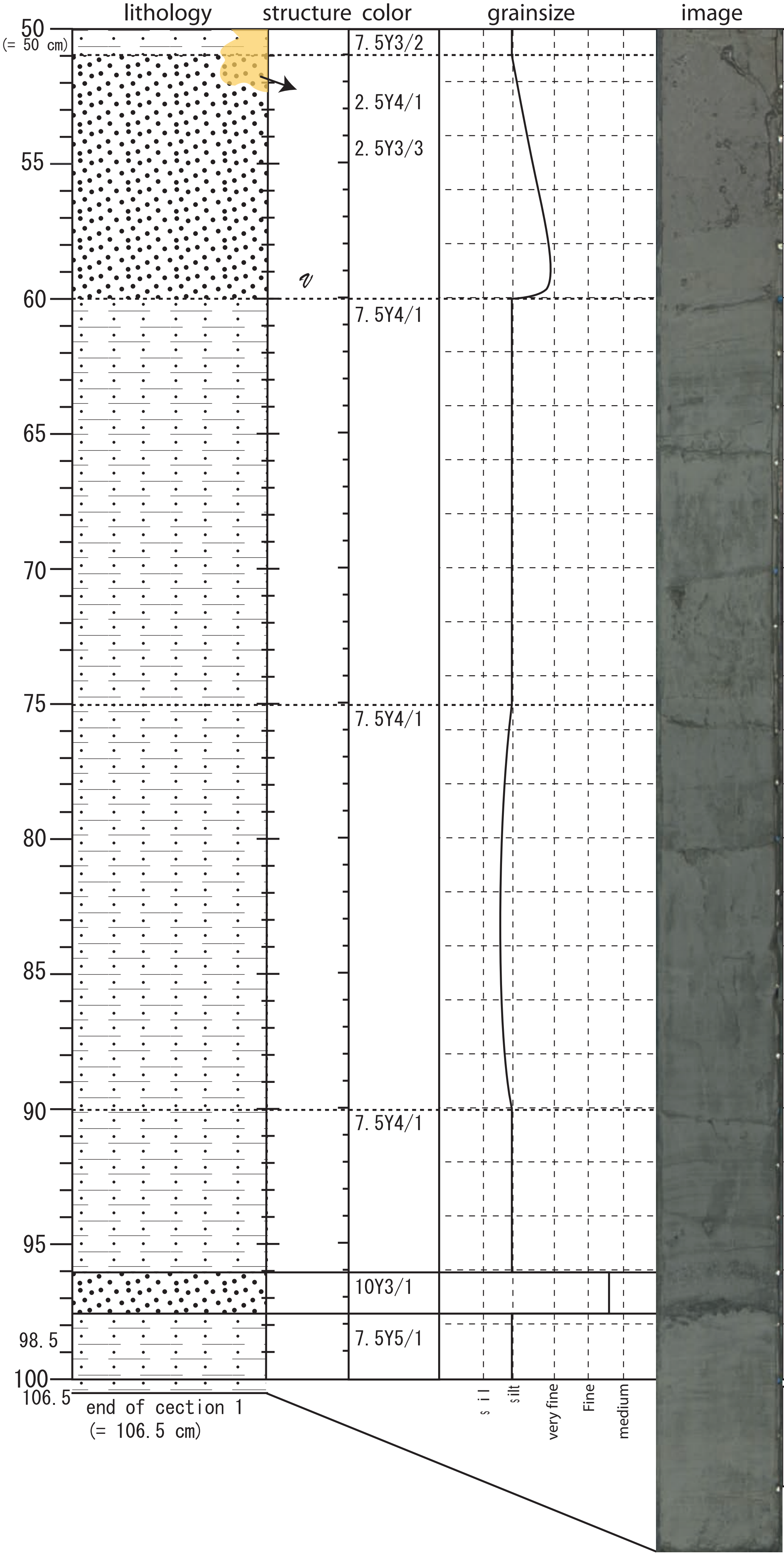
21-50 cm Olive black silt

41.5-50cm dark olive brown (irregular brown patch)

Legend:
- Silt
- Sand
- Ⓣ Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-03 Section No. 1 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




50-51cm Olive black silt
51cm gradual grain size change
51-60cm yellowish grey very fine sand
Volcanic Ash ?

60cm gradual grain size change
60-75cm grey silt

75cm grain size gradually change
75-90cm grey muddy silt

90cm grain size gradually change

96cm moderate sharp boundary
96-97.5cm olive black fine-medium sand
97.5-106.5cm grey silt

Legend:
- Silt
- Sand
- Turbidite
- Volcanich Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07 PC-03 Section No. 2 sheet 1 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W

| lithology | structure | color | grainsize | image | |
|---|---|---|---|---|---|
| 0 (=106.5 cm) – 50 (=156.5 cm) | S (bioturbation at ~9, 19, 28, 41, 48 cm) | 7.5Y5/1 | silt |  | 0-50cm grey silt<br>heavily bioturbation |

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 (=156.5 cm)

Grainsize scale: sil, silt, very fine, Fine, medium

Legend: Silt, Sand, Ⓣ Turbidite, Volcanic Ash, Bioturbation, Lamination

CORE LOG Core No. MR07-07 PC-03 Section No. 2 sheet 2 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W

| lithology | structure | color | grainsize | image | |
|---|---|---|---|---|---|
| 50 (=156.5 cm) | | 7.5Y5/1 | |  | 50-100cm gray silt<br>heavily bioturbation |
| 55 | S | | | | |
| 60 | | | | | |
| 65 | S | | | | |
| 70 | | | | | |
| 75 | S | | | | |
| 80 | | | | | |
| 85 | | | | | |
| 90 | | | | | |
| 95 | | | | | |
| 98.5 | | | | | |
| 100 | | | | | |

end of cection 2
(= 206.5 cm)

Grainsize scale: sil, silt, very fine, Fine, medium

Legend:
Silt
Sand
Ⓣ Turbidite
Volcanic Ash
S Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-03 Section No. 3 sheet 1 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W

| lithology | structure | color | grainsize | image | |
|---|---|---|---|---|---|
| Silt (0 (=206.5 cm) – 50 (=256.5 cm)) | S (bioturbation at ~9, ~18, ~28, ~41, ~48 cm) | 7.5Y4/1 | |  | 0-50cm grey silt<br>heavily bioturbation<br>color gradually change<br>lighting upward<br>foram (white ?) |

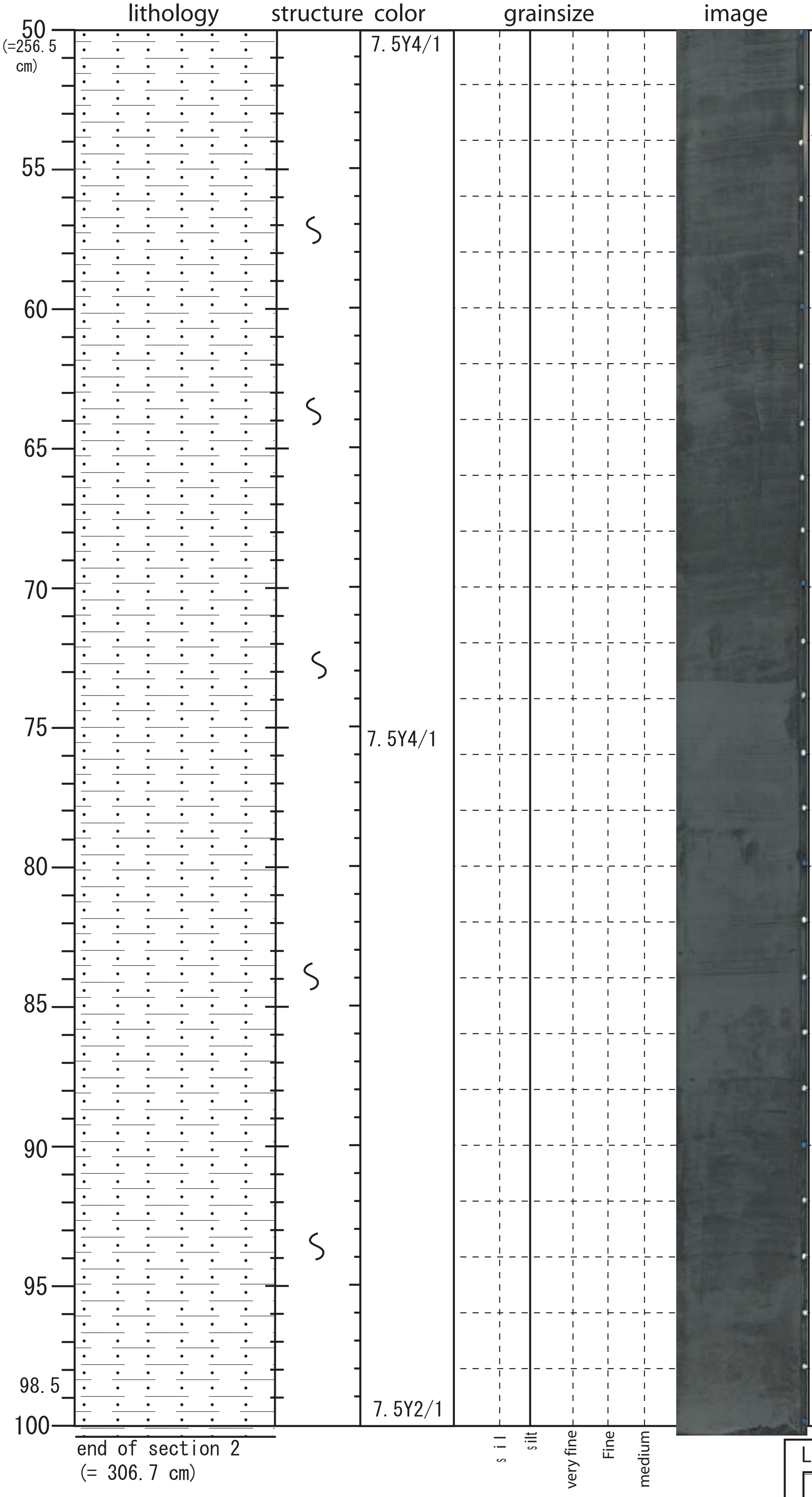
Depth scale: 0 (=206.5 cm), 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 (=256.5 cm)

Grainsize scale: sil, silt, very fine, Fine, medium

Legend: Silt, Sand, Ⓣ Turbidite, Volcanic Ash, Bioturbation, Lamination

**CORE LOG** Core No. MR07-07 PC-03 Section No. 3 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W

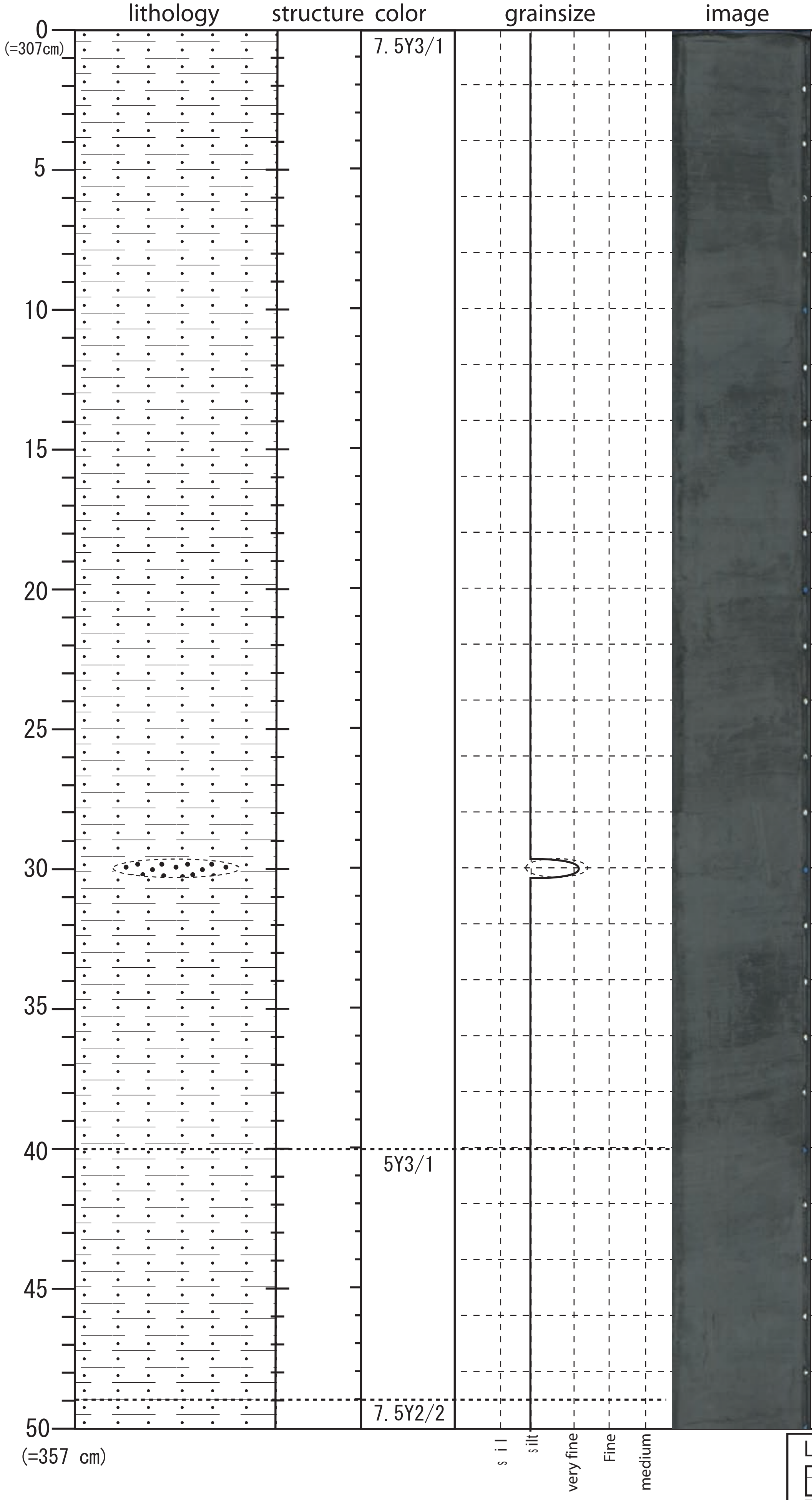



50-100cm gray silt
heavily bioturbation
color change gradually from
grey to black

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07 PC-03 Section No. 4 sheet 1 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




0-40cm olive black silt

30cm 0-5mm thin slighly coarse grain (lens layer)

40cm slighly light color change

40-50cm olive black silt

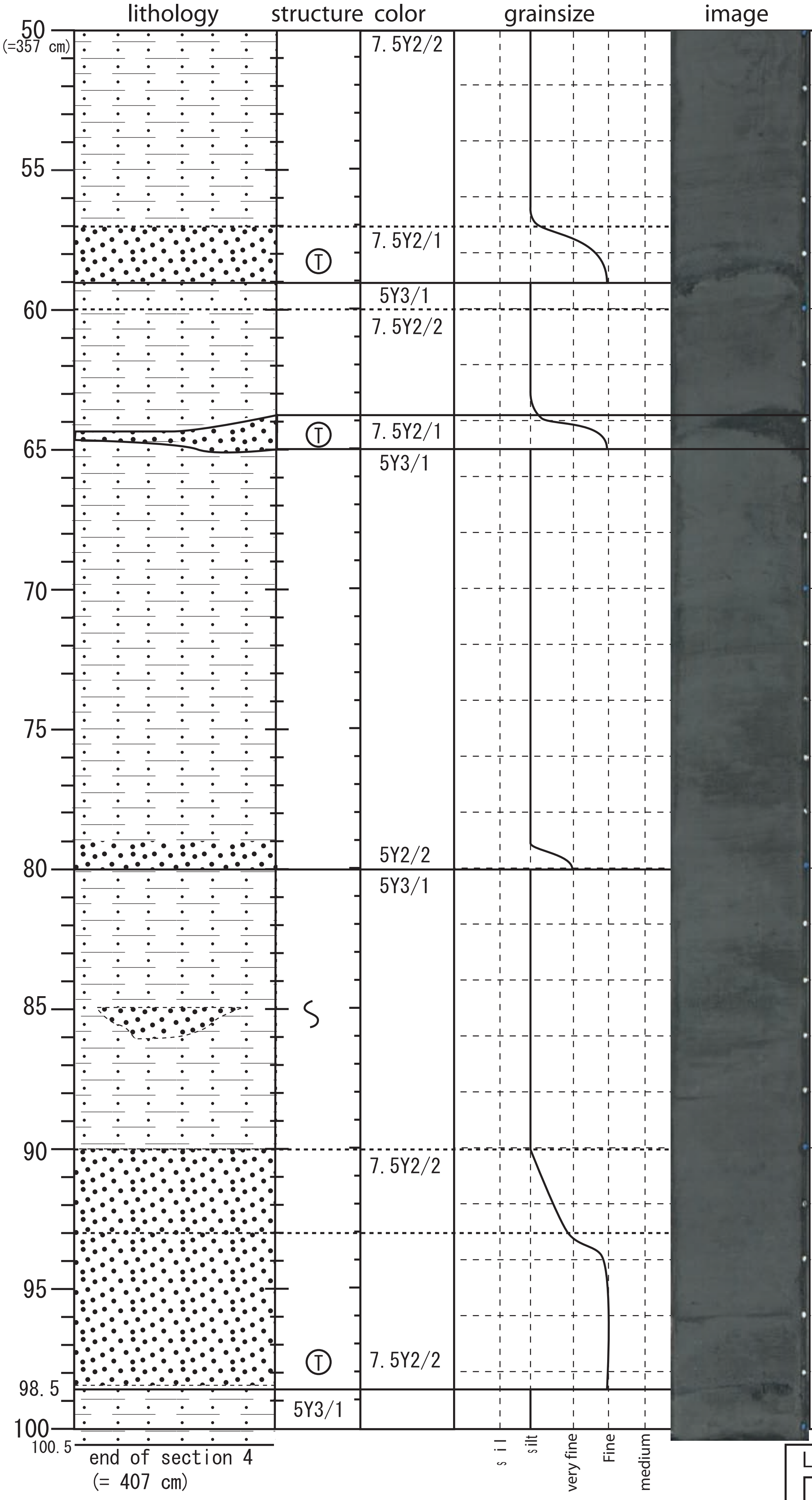
49cm color change

49-50cm olive black silt

Legend:
- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

CORE LOG Core No. MR07-07 PC-03 Section No. 4 sheet 2 of 2

Date February 8th, 2008 Described by Arai / Udrekh Archive/Working W




50-57cm olive black silt
50-59cm fining upward and lighting upward

57-59cm black fine sand
59cm irregular sharp contact
57-59cm black fine sand
59cm irregular sharp contact
59-64cm lighting upward and fining upward black silt to olive black silt
64-65cm black fine sand
65-80cm olive black silt to black silt (fining upward & lighting upward)

80cm moderate sharp contact
80-98.5cm olive black silt to black fine sand (lighting upward & fining upward)

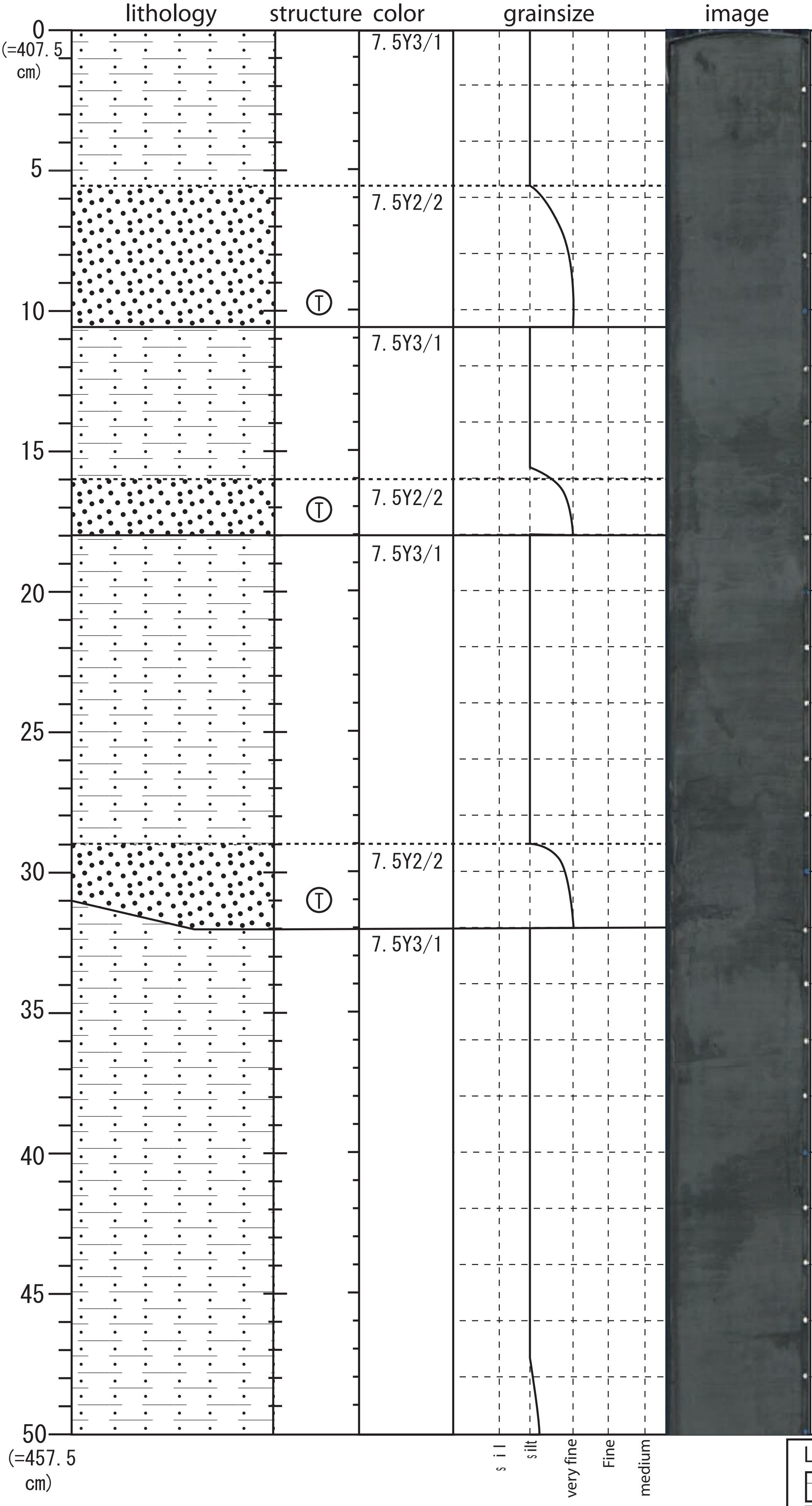
86cm bioturbation

98.5-100.5cm olive black silt

Legend:
- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07PC03 Section No. 5 sheet 1 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




0-10.5cm olive black silt to black sand (fining upward & lighting upward)

5.5cm gradually boundary

10.5cm sharp contact

10.5-18cm olive black silt to very fine black sand (fining upward & lighting upward)

16cm gradually boundary

18cm sharp contact

18-31/32cm olive black silt to very fine black sand (fining upward & lighting upward)

29cm gradually boundary

31/32cm sharp contact

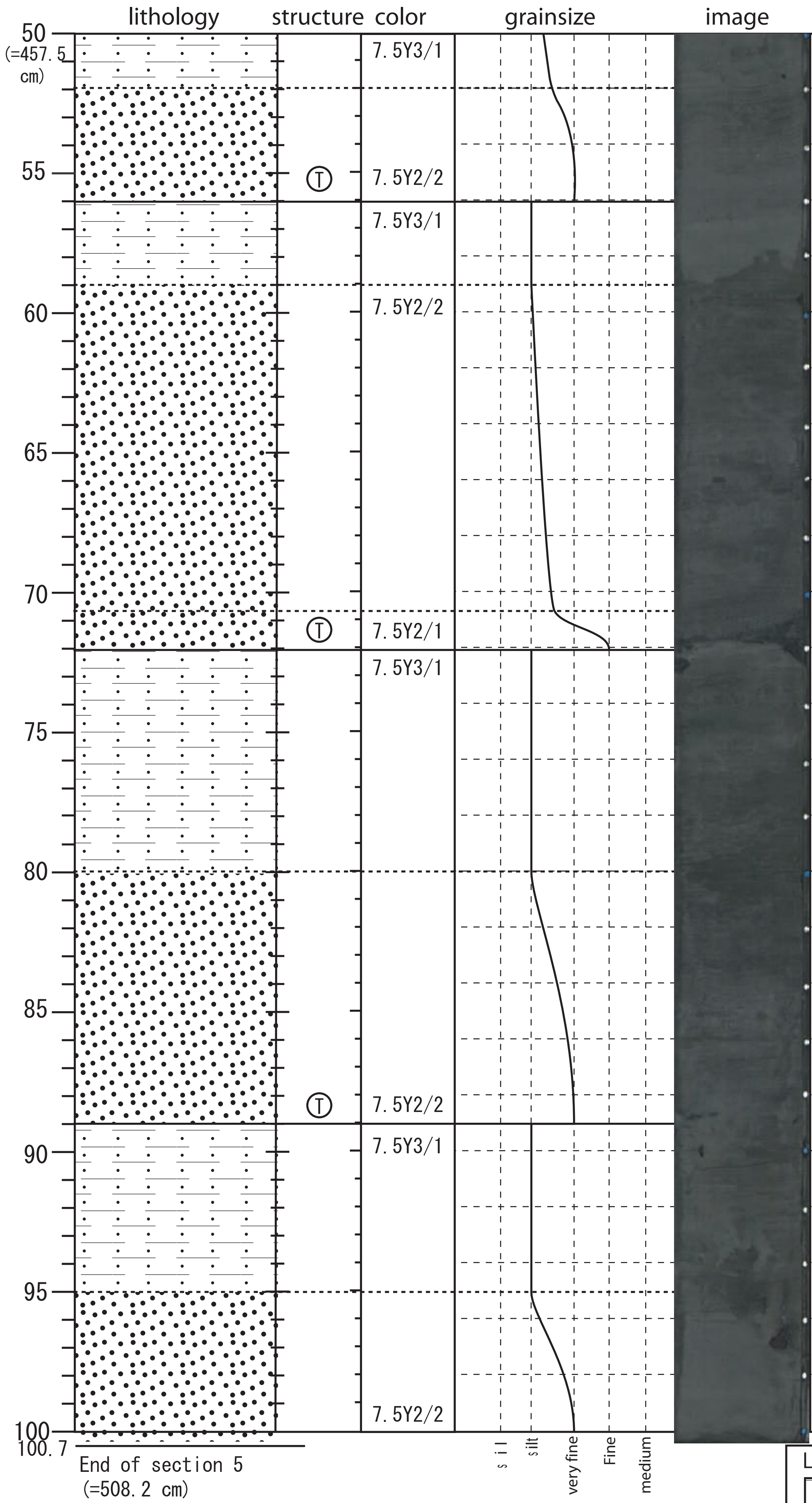
31/32-56cm olive black silt to very fine black sand (fining upward & lighting upward)

Legend:

- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

CORE LOG Core No. MR07-07PC03 Section No. 5 sheet 2 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




50-56cm olive black silt to very fine black sand (fining upward & lighting upward)

56cm sharp contact

56-59cm olive black silt to very fine black sand (fining upward & lighting upward)

59cm gradual color change

59-72cm very fine black sand to fine black sand (fining upward & lighting upward)

72cm sharp contact

72-89cm very fine black sand to fine black sand (fining upward & lighting upward)

80cm gradual color change

89cm moderate sharp contact

89-100.7cm very fine black sand to fine black sand (fining upward & lighting upward)

95cm gradual color change

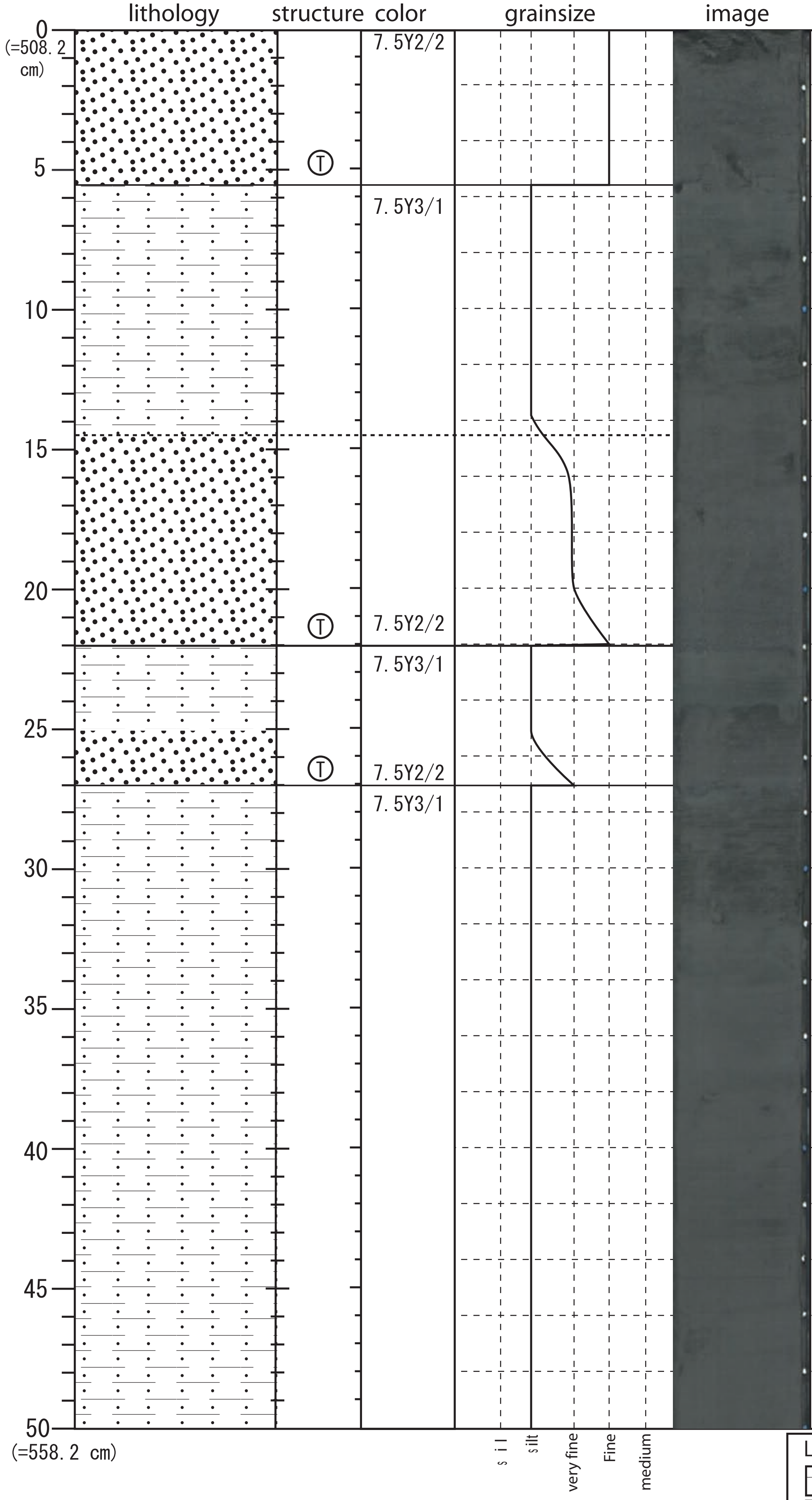
End of section 5 (=508.2 cm)

Legend:

T Turbidite
Volcanic Ash
Bioturbation
Silt
Sand
Lamination

**CORE LOG** Core No. MR07-07PC03 Section No. 6 sheet 1 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




0-5.5cm olive black
very fine sand
(fining upward &lighting upward)

5.5cm moderate sharp boundary
5.5-22cm olive black silt to
very fine / fine sand
(fining upward &lighting upward)

14.5cm gradually change

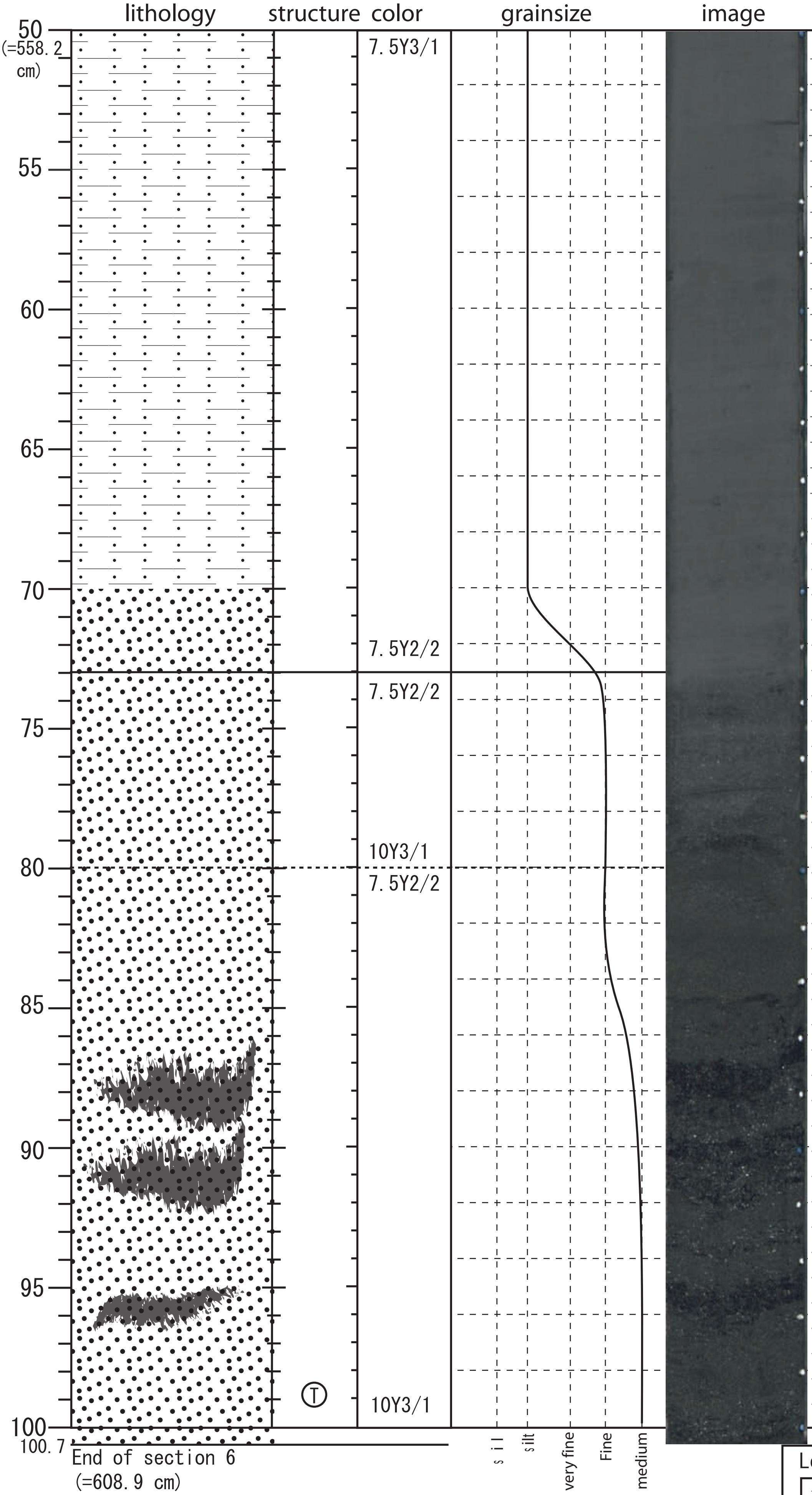
22cm sharp contact
22-27cm olive black silt to
very fine sand
(fining upward &lighting upward)

27cm moderate sharp boundary
27-50cm olive black silt

Legend:
Silt
Sand
T Turbidite
Volcanic Ash
Bioturbation
Lamination

CORE LOG Core No. MR07-07PC03 Section No. 6 sheet 2 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




50-73cm olive black silt to fine sand (color gradually change lightning upward, fining upward)

73cm moderate sharp

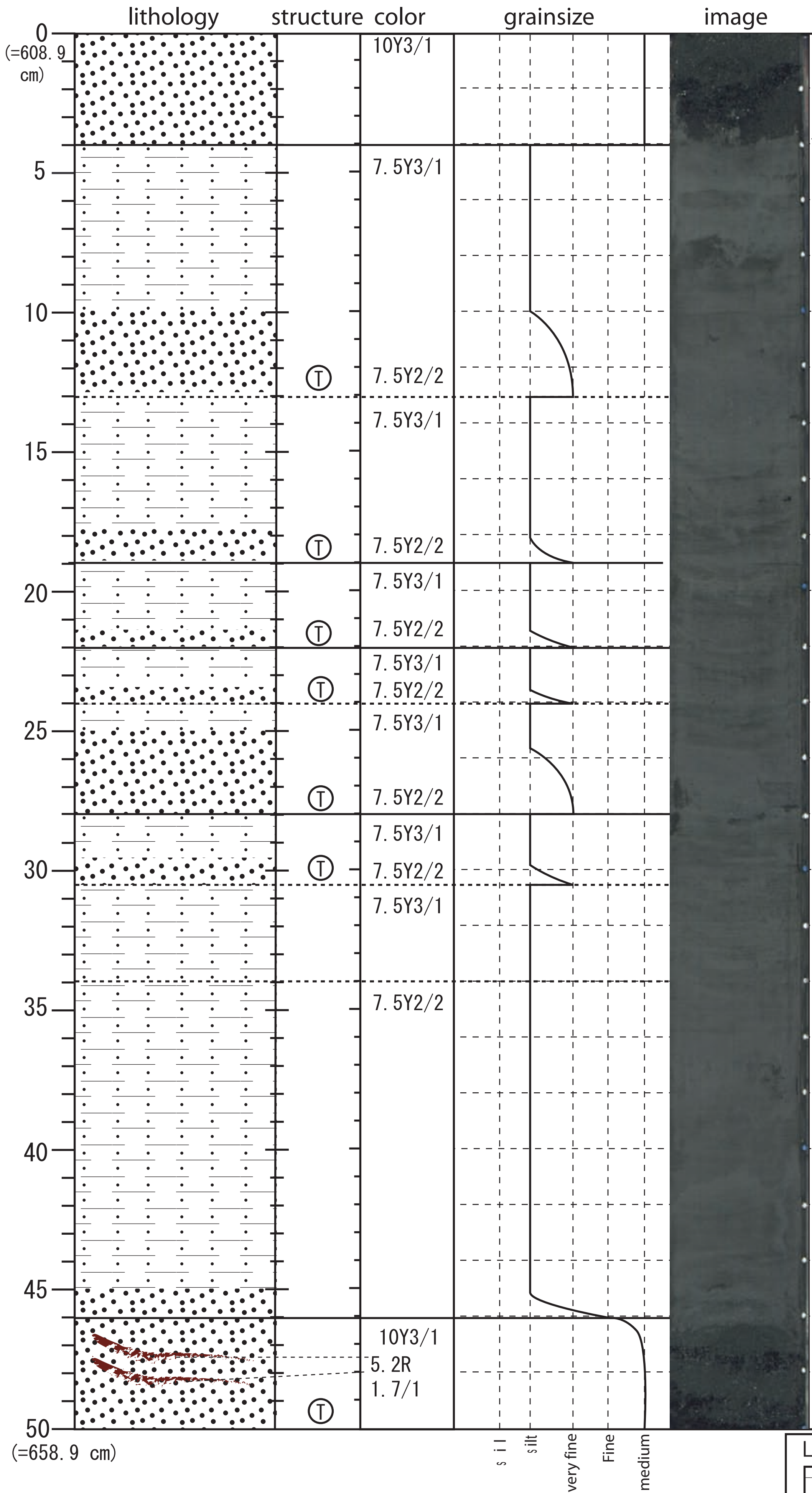
73-100.7cm olive black fine sand to medium sand with blacked layer (mica ? black minerals ?)

End of section 6 (=608.9 cm)

Legend: Silt, Sand, Turbidite, Volcanic Ash, Bioturbation, Lamination

CORE LOG Core No. MR07-07PC03 Section No. 7 sheet 1 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




0-4cm olive black medium sand

4cm sharp boundary
4-13cm olive black silt to very fine sand (lighting and fining upward)

13cm sharp boundary
13-19cm olive black silt to very fine sand on the base (lighting and fining upward)

19cm sharp boundary
13-19cm olive black silt to very fine sand on the base (lighting and fining upward)

19-22cm
22-24cm
24-28cm
28-30.5cm
olive black to fery vine sand fining upward-lighting upward

30-34cm olive black silt

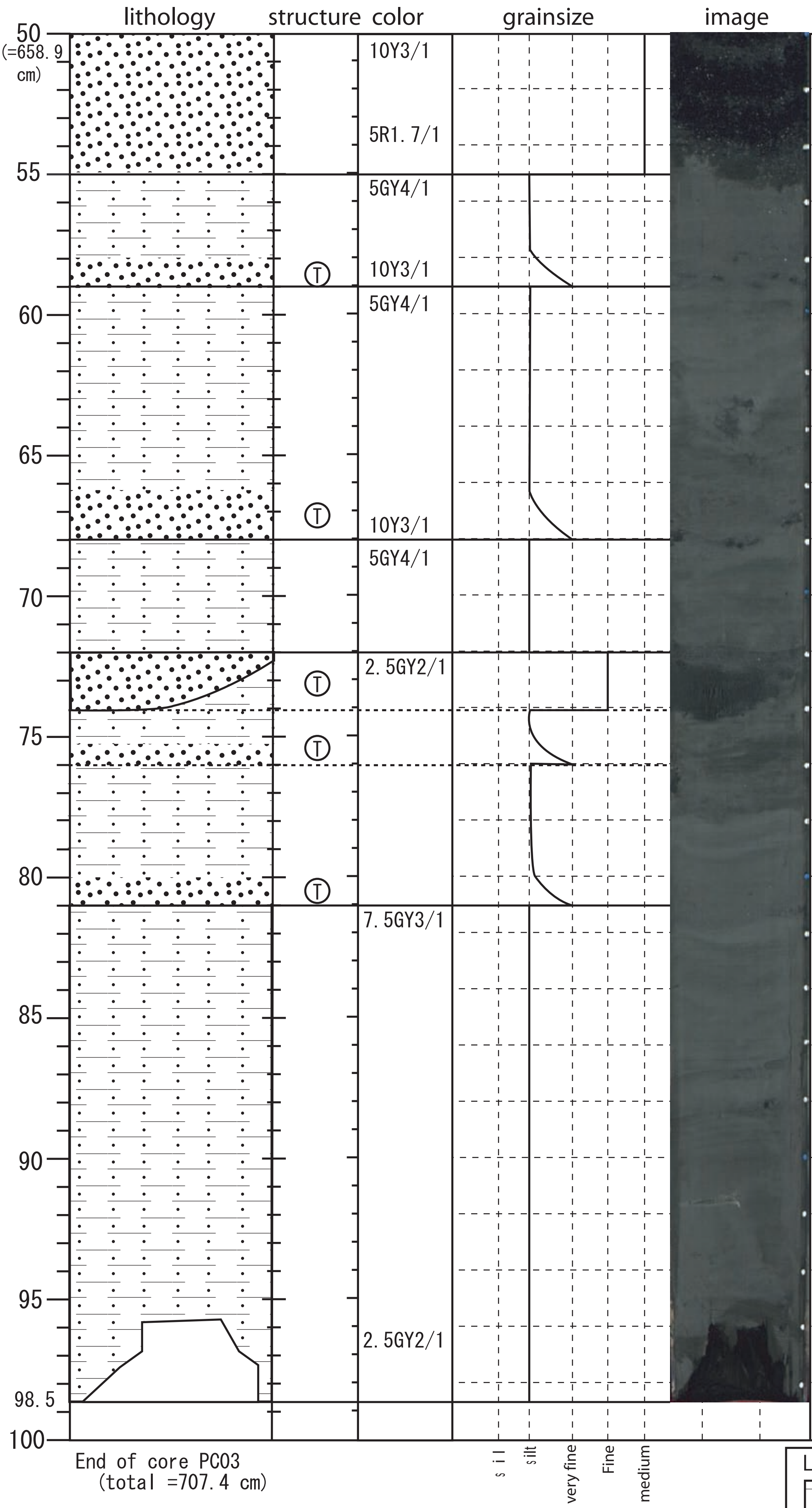
34cm color change boundary
34-46cm olive black silt (7.5Y2/2)

46cm sharp contact
46-50cm olive black medium sand with redish black layer

Legend:
Silt
Sand
Turbidite
Volcanic Ash
Bioturbation
Lamination

**CORE LOG** Core No. MR07-07PC03 Section No. 7 sheet 2 of 2

Date February 9th, 2008 Described by Arai / Udrekh Archive/Working W




50-55cm medium sand with black layers

55cm sharp contact

55-59cm silt to very fine sand (fining & lighting aupward)

59cm sharp contact

59-68cm dark olive grey silt to olive black very fine sand (fining & lighting aupward)

59-68cm dark olive grey silt

72-74cm iregularly sharp boundary, black fine sand

74-76cm dark olive grey silt to olive black very fine sand (fining & lighting upward)

76-81cm dark olive grey silt to olive black very fine sand (fining & lighting upward)

81-98.5cm dark olive silt (lighting upward)

Legend:
- Silt
- Sand
- T Turbidite
- Volcanic Ash
- Bioturbation
- Lamination

**CORE LOG** Core No. MR07-07PL01HAND1 Section No. 1 sheet 1 of 1

Date February 11th, 2008 Described by Arai / Udrekh Archive/Working W

| Depth (cm) | lithology | structure | color | grainsize | image | description |
|---|---|---|---|---|---|---|
| 0 | | | 2.5Y5/2 | |  | 0-2cm dark greyish yellow silt foraminifera abundant. |
| 2 | | | | | | 2cm color boundary |
| 5 | | | 2.5Y4/3 | | | 5 & 8cm black colorlayers in the brown silt |
| 10.5 | | | 2.5Y4/4 | | | 10.5-30cm grey silt |
| 29 | | | 7.5Y5/1 | | | |
| 30 | End of core PL01Hand1 | | | | | |

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Grainsize: sil, silt, very fine, Fine, medium

Legend: Silt, Sand, Turbidite, Volcanic Ash, Bioturbation, Lamination

CORE LOG Core No. MR07-07PL02HAND1 Section No. 1 sheet 1 of 1

Date February 11th, 2008 Described by Arai / Udrekh Archive/Working W

| depth (cm) | lithology | structure | color | grainsize | image | description |
|---|---|---|---|---|---|---|
| 0 | Silt | | 2.5Y3/3 | |  | 0-2cm dark olive brown with black silt color layer |
| 10.5 | | | 7.5Y4/2 | | | 10.5cm sharp color boundary |
| | | | | | | 10.5-30cm grayish olive silt to gray silt (color gradually change) |
| 30 | | | 7.5Y5/1 | | | |
| 30 | End of core PL02hand1 | | | | | |

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Grainsize scale: sil, silt, very fine, Fine, medium

Legend: Silt, Sand, (T) Turbidite, Volcanic Ash, Bioturbation, Lamination

**CORE LOG** Core No. MR07-07PL03HAND1 Section No. 1 sheet 1 of 1

Date February 11th, 2008 Described by Arai / Udrekh Archive/Working W

| Depth (cm) | lithology | structure | color | grainsize | image | description |
|---|---|---|---|---|---|---|
| 0 | | | 2.5Y4/3 | |  | 0-2cm olive brown very fine sand |
| 2 | | | 10Y4/2 | | | 2cm sharp boundary |
| | | | | | | 2-29cm yellowish brown silt with black color layers |
| 10 | | | 7.5Y4/2 | | | color gradually schange |
| 28 | | | 7.5Y5/1 | | | |
| 29 | End of core PL03hand1 | | | | | |

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Grainsize: s i l, silt, very fine, Fine, medium

Legend:
- Silt
- Sand
- Turbidite
- Volcanic Ash
- Bioturbation
- Lamination