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R/V Mirai Cruise Report

MR13-E02 leg2

Survey of REY-rich mud around Minami-Torishima Island.

December 10 to 24, 2013

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

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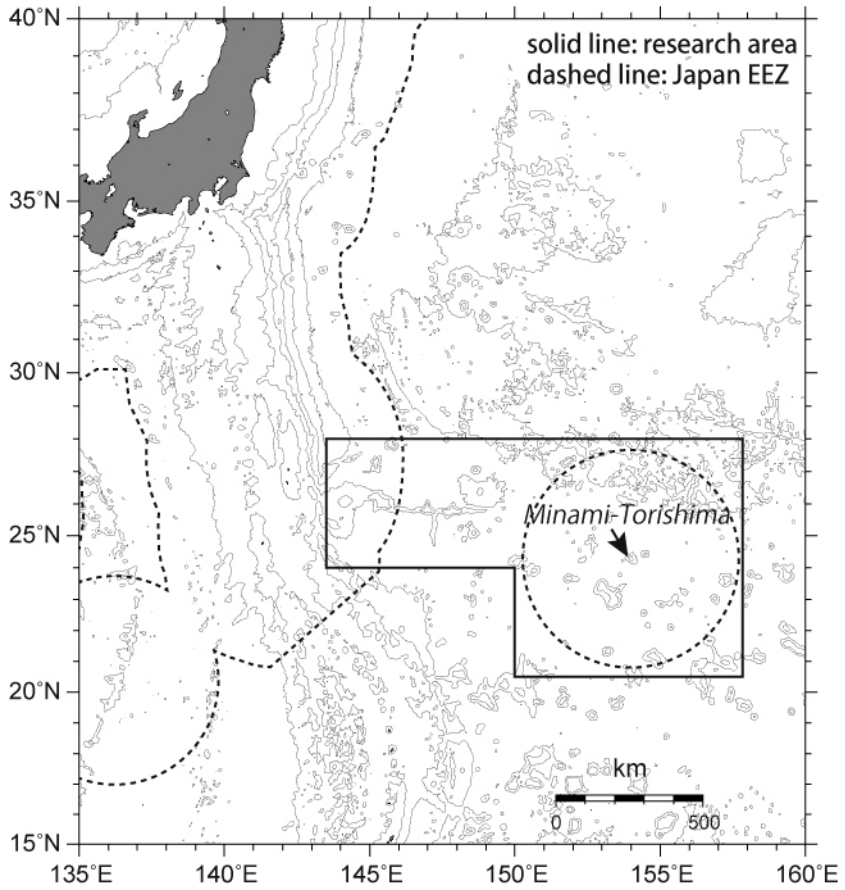
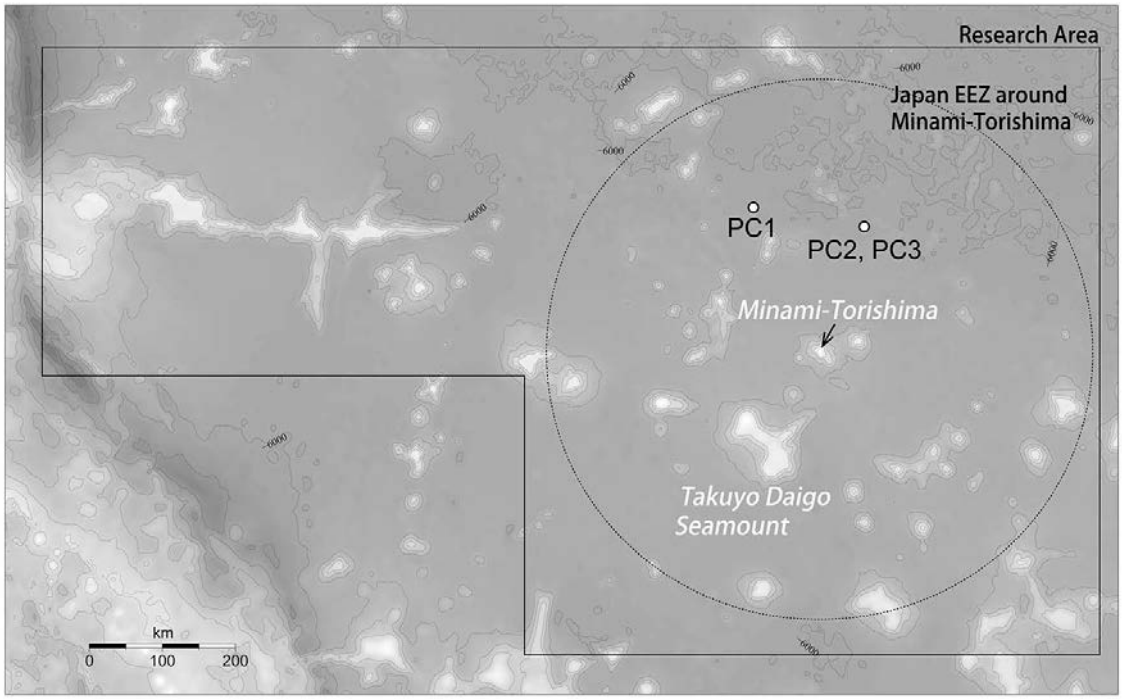
1. Cruise Information

Cruise ID: MR13-E02 leg2
Name of vessel: R/V Mirai
Title of the cruise: Survey of REY-rich mud around Minami-Torishima Island.
Title of proposal: Survey of REY-rich mud around Minami-Torishima Island.
Cruise period: Dec. 10 to Dec. 24, 2013
Ports of call: Naha (Naha city) to Sekinehama (Mutsu city)
Research area: Off Minami-Torishima Island (Marcus Island)
Research Map





* Coordinates of the sites are confidential matter.

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3. Observation

3.1 Objectives & Background

Kato et al. (2011) reported that rare-earth elements and yttrium rich mud (REY-rich mud) is widely spread in the Pacific Ocean. In January 2013, Submarine Resources Research Project, JAMSTEC had carried out the research cruise KR13-02 to obtain sediment cores around Minami-Torishima island in Japanese exclusive economic zone (EEZ). In these cores, we confirmed extremely REY-rich mud in shallow sub-seafloor off south Minami-Torishima (press release, 2013).

Our objective in this cruise was to carry out a reconnaissance investigation of REY-rich mud off north and east of Minami-Torishima where we had never explored. Concretely, (1) Obtain sub-bottom profiler data throughout the cruise in the research area to confirm sub-seafloor sedimentary sequences and (2) Collect sediment core samples to examine abundance of rare earth elements.

Kato, Y., Fujinaga, K., Nakamura, K., Takaya, Y., Kitamura, K., Ohta, J., Toda, R., Nakashima, T. and Iwamori, H. (2011): Deep - sea mud in the Pacific Ocean as a potential resource for rare - earth elements. *Nature Geoscience*, **4**, 535 - 539. doi: 10.1038/NGEO1185.

JAMSTEC and The University of Tokyo: Discovery and distribution of mud containing very high concentrations of rare earth elements and yttrium around Minami-Torishima Island (Minami-Torishima Survey Cruise), Press Release on March 21, 2013.

3.2 Methods & Instruments

3.2.1 Sub-Bottom Profiler

The sub-bottom profiler was used throughout the cruise in the research area to confirm sub-seafloor sedimentary sequences such as chert layer, and for determination of coring site.

3.2.2 Piston Corer

Piston core sampler system (PC) consists of the weight, duralumin pipes (5m-long per pipe), trigger which works as the balance and a pilot core sampler. The polycarbonate liner tube (5m-long per tube) is installed inside the duralumin pipe. The inner diameter (I.D.) of liner tube is 74mm. The outer diameter of the main winch wire is 17mm.

In this cruise, 1.5t and 2.36t weight were used. The total length of duralumin pipes and liner tubes were 15m. The pipe length was decided based on the results of site survey data. The long and sharp bit was used at the end of the pipes to promote penetration of the PC. We used a 74mm (I.D.) Long Type Pilot Corer (called 74 corer) for a pilot core sampler. The total weight of the PC system is approximately 1.7t or 2.6t in water. The constructions of the each PC system in this cruise are showed in fig. 1 and 2. We used normal type piston which was composed of brass body. To reduce backpressure during coring to prevent liner tube deformation, the piston O-ring (size: P63) was reduced to one or removed.

The polycarbonate tubes we used as liner tube were annealed before cruise. When we divide the core in half, non-anneal polycarbonate tubes have transformation internally. However, annealing polycarbonate tubes can lessen transformation.

After deployment the PC, the swell compensator was started at wire out 200m water depth. After that, winch was gradually increased to the speed of 1m/s. The winch was stopped at a depth about 100m above the seafloor for 3 minutes to reduce some pendulum motion of the PC system. After that, the wire was stored out at the speed of 0.3~0.5m/s. When the wire tension decreased suddenly by the loss of the weight, we confirmed the PC hit the bottom. After that, the winch was immediately stopped and winched up at the speed of 0.2m/s until the tension gauge indicated the PC was completely lifted off the bottom. After leaving the bottom, the winch speed was at the maximum speed (1.2m/s).

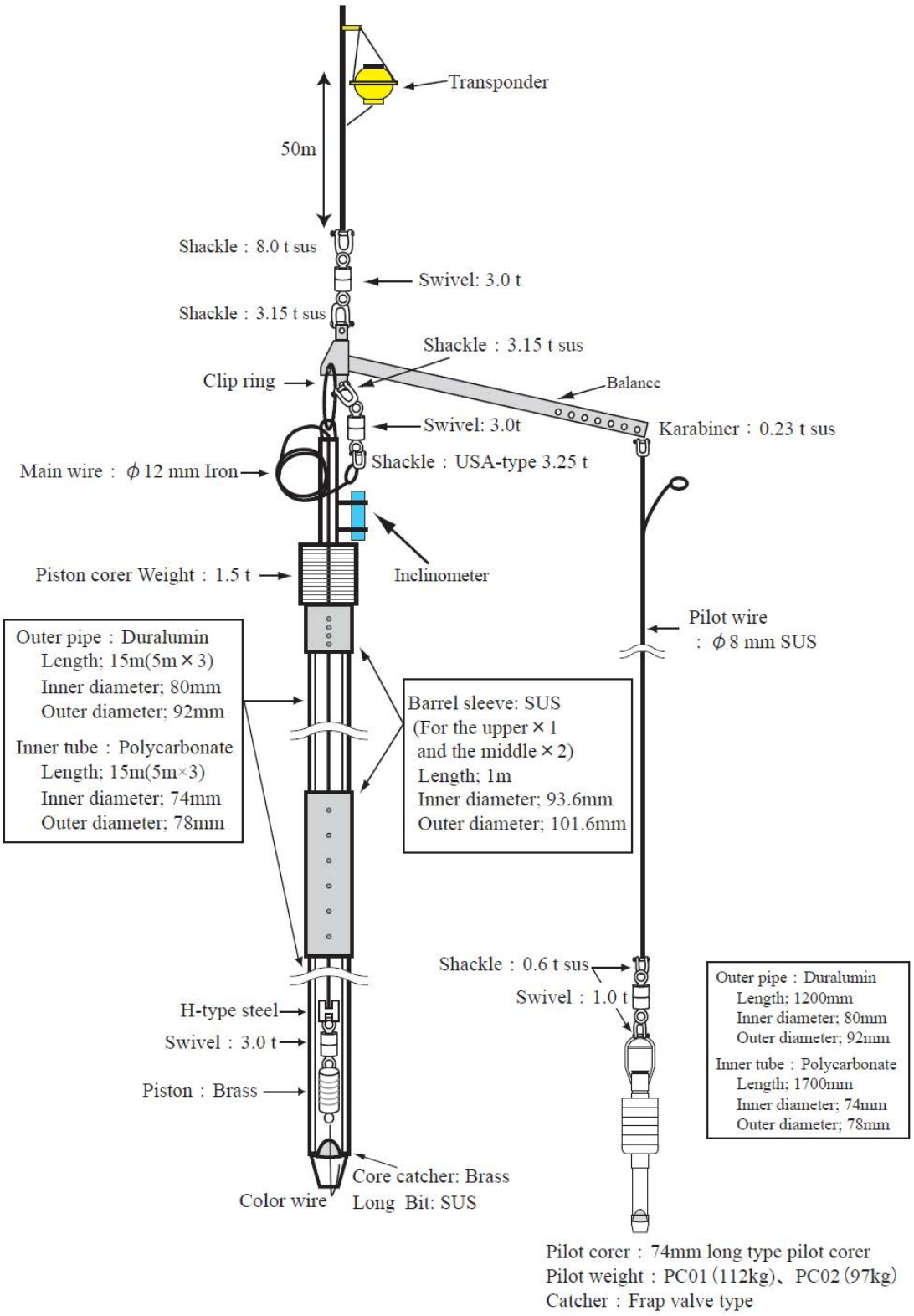


Fig.1 Piston corer system with 1.5t weight in MR13-E02 leg2.

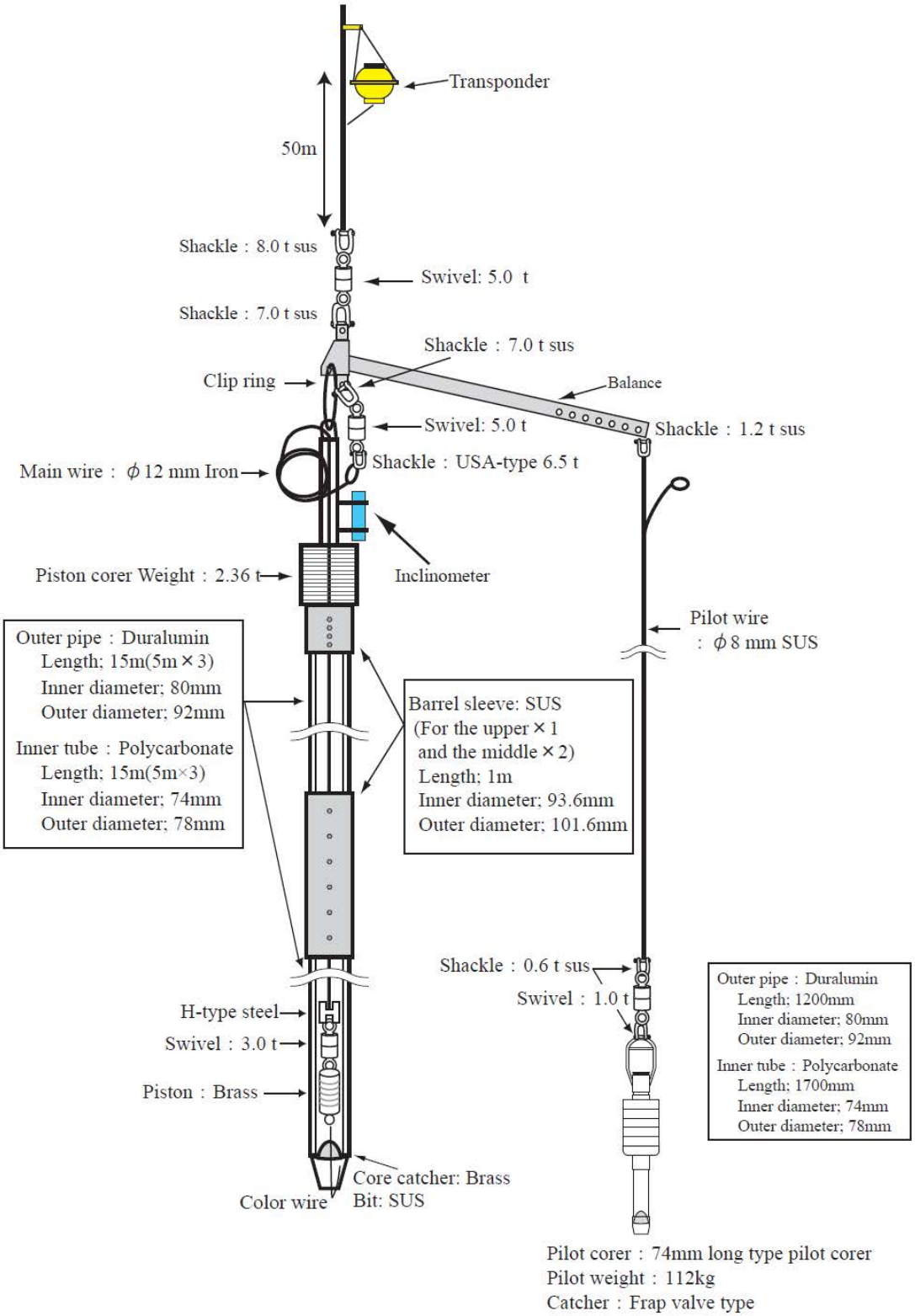
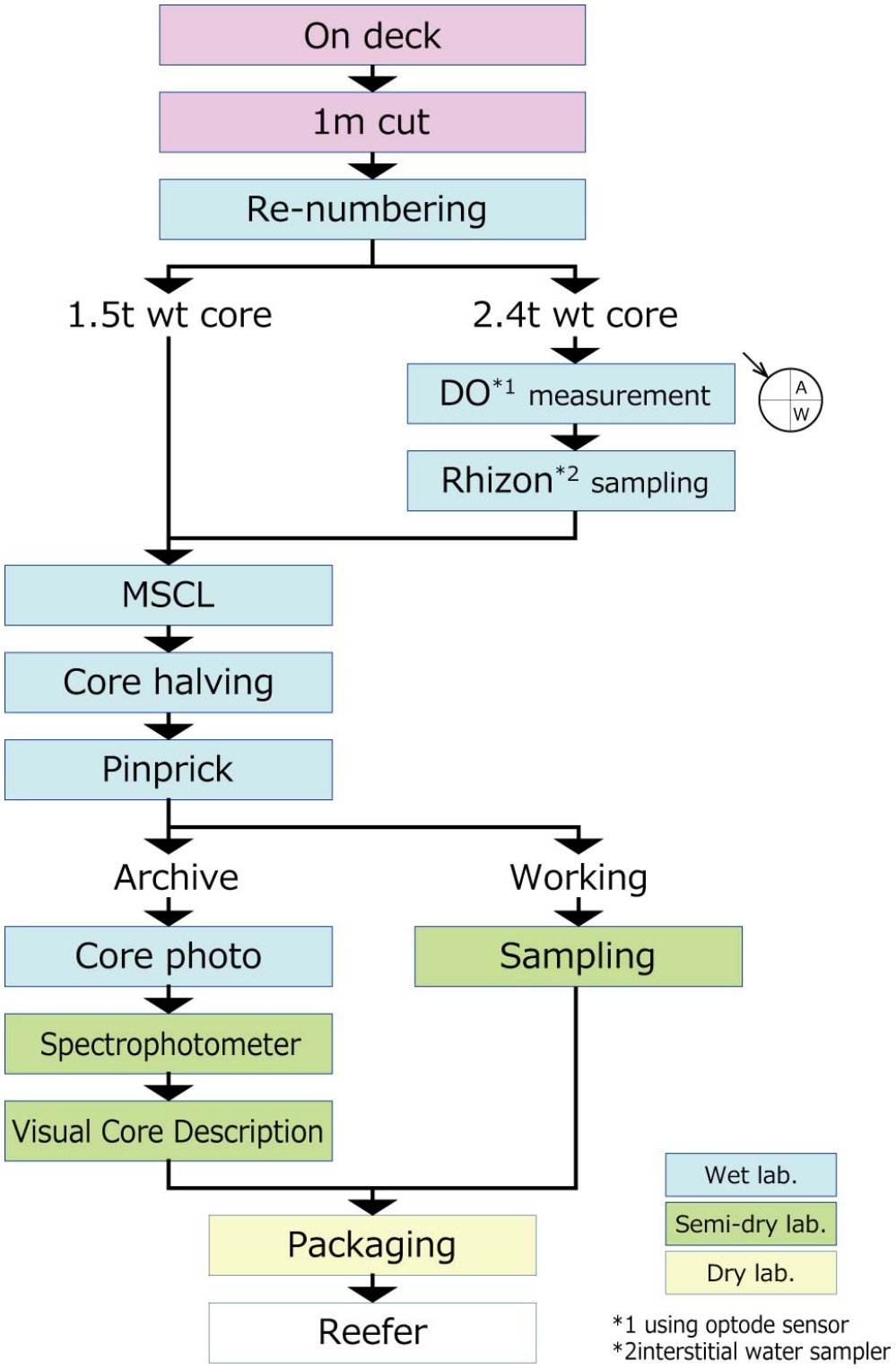


Fig.2 Piston corer system with 2.36t weight in MR13-E02 leg2.

3.2.3 Core Flow



3.2.4 Multi-Sensor Core Logger (MSCL)

We used the GEOTEK multi-sensor core logger (MSCL) system onboard R/V Mirai, to obtain some physical properties of sediment cores before core halving. The MSCL has the sensors of gamma-ray attenuation (GRA), P-wave velocity (PWV), and magnetic susceptibility (MS). Whole-core samples are used for the logger measurements.

In order to equalize sediment temperature with room temperature, whole-core samples are kept in the laboratory one night. Measurements are conducted on the cores every 1 or 2 cm.

GRA is 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 Cesium-137 (^{137}Cs) with energies principally at 0.662 MeV. The photon of gamma ray is collimated through 5 mm diameter in rotating shutter at the front of the housing of ^{137}Cs. The photon is absorbed the core. 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 coefficient similar to common minerals and is used as the mineral phase standard. Pure water is substituted 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 pure water. GRA was measured with 10 seconds counting.

PWV is 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 pulse frequency.

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

After MSCL measurement, whole-core samples are longitudinally cut into Working and Archive halves by a splitting devise and a nylon line.

3.3 Preliminary Results

We obtained 7 sediment cores at 6 sites. The detail is confidential matter.

4. Notice of Using

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.