# Chapter 2 Survey Methods

## 2-1 Survey Procedure

The survey of this year is the first year of Stage II Phase 2 Program started from the year 2003, and the ship survey was carried out for the understanding of deep sea mineral resources potential within the Exclusive Economic Zone (EEZ) of the Republic of Kiribati.

The cobalt crust survey within the EEZ of the Republic of Kiribati had been carried out for three years in the past, in 1987 (in the area of the Phoenix Islands, 5 seamount), in 1989 (in the area of the Line Islands, 6 seamount), and in 1991 (in the area of the Gilbert Islands: 5 seamount), and a total of 16 seamounts in the three areas were covered by the surveys.

The SE01 Seamount, surveyed this year, consists of a group of seamounts and the seamount located in the southeastern part (with summit depth of 1,260m) had been surveyed in the year 1991 by acoustic soundings and Arm Dredge (AD) sampling. All of the nine samples obtained by AD sampling at eight points showed only thin-coated cobalt crust, with thickness less than 1mm.

The other seamount of the SE01 Seamount, located in the northwestern part (summit depth: 1,150m) has not been surveyed yet, and survey of this seamount was conducted this year. Acoustic sounding surveys mainly by MBES (acquisition of bathymetric data, acoustic pressure data, and so on) and AD sampling in the rock-exposed area were carried out for assessing the potentiality of cobalt crust.

## 2-2 Numbering

(1) Numbering of Track Lines

The track lines of acoustic soundings (NBS, PDR, SBP, MFES) were numbered such as 03S1201A or 031201B for identification of the date and the order of work. For nighttime cruising, "N" was added at the end of numbers such as 03S1201N. In above cases, "03" indicates the fiscal year of the survey (2003), "S" denotes SOPAC, "1201" shows month and date (December 1), and "A" and "B" are the order of track line on that date.

(2) Numbering of Samples

Each sampling was numbered beginning from the survey year (2003), followed by name of seamount (SE01) and sampling equipments (AD: arm dredger and MC: multiple corer), and sequential number following after the previous survey was put at

the end. In the previous survey, eight samplings were made by AD, thus the AD sampling for this year starts from 03SE01AD09. The MC sampling has not been conducted in the past so that the sample number starts from 03SE01MC01.

### 2-3 Ship Positioning

All through the survey, ship positions were determined by global positioning system (GPS).

The locations of sampling points, bottom touch locations of AD and MC, were determined by GPSs, respectively, set at the stern and beside the gallows. The water depth of sampling points was determined by MBES.

The ship clock was adjusted to local time (GMT + 12 hours) and the coordinate system used during the survey was WGS84.

### 2-4 Bathymetric and Acoustic Surveys

The bathymetric survey and acoustic surveys of seamount were conducted at cruising speed of 10 to 12 knot per hour and the acoustic sounding data was obtained during the cruise. The MBES (frequency 15kHZ) sounding was carried out at every 8 to 16 seconds and at every 12 seconds for NBS (frequency of 30KHZ). During the bathymetric survey of MBES, acoustic reflection intensity of the seafloor was recorded to map the acoustic pressure distribution.

### 2-5 Surface Sediments Survey

The survey of sub-surface sediments was carried out by SBP (frequency 3.5KHZ) on all the track lines simultaneously with bathymetric survey. From the patterns of SBP profiles, basic acoustic information on seafloor surface sediments such as thickness of uppermost transparent layer and acoustic stratigraphic types were obtained. These data were read at every 5 minutes and the distribution maps of SBP types and thickness of the uppermost transparent layers were drawn.

### 2-6 Sampling

Arm Dredge (AD: 8 sampling points) was used for collection of cobalt crust samples, and Multiple Corer (MC; 4 sampling points) was used for sediments samples

### 2-7 Sample Processing, Analysis and Storage

Description of collected samples was conducted on board. After the cruise, laboratory work, such as microscopic observation, bulk chemical analysis, identification

of fossils, was conducted and the rest of samples were kept in storage.

## 2-8 Processing and Analysis of Survey Data

Data processing and analysis were conducted following the flow chart shown in Fig 2-8-1. Preliminary processing and analysis were conducted on board. Part of data processing left undone on board and comprehensive analysis were continued after the cruise, and the results were compiled in this report.

## 2 - 9 Environmental Survey

(1) Objectives

An environmental survey was conducted as a baseline study to understand environmental situation of present day for future evaluation of potential mining impacts on the deep-sea environment. In this survey, properties of the sediment and distributions of benthic organisms were examined. These properties of the sediments are the key parameters affecting the habitat conditions of benthic organisms.

(2) Study Subjects

1) Sediment Properties

i. Water content, ii. Specific Sediment Gravity, iii. Total Organic Carbon, iv. Total Nitrogen, v. Sediment Particle Size Distribution

2) Benthic Organisms

i. Meiobenthos, ii. Macrobenthos

(3) Methods

1) Observations, Sampling and Sample Processing

A multiple corer equipped with acrylic tube cores (inner diameter: 95 mm) was used to collect sediment samples. A single core was used for both the analysis of specific sediment gravity as well as sediment particle size distribution. Duplicate cores were used for other sediment properties analyses. The cores were sliced at every 1 cm from the surface to 5 cm depth for all analyses. Analysis of water content, specific sediment gravity and sediment particle size distribution were additionally carried out for the sediments at depths of 10 cm and 20 cm at all stations and the sediments at 30 cm depth at station 03SE01MC01. For the benthic organism analysis, duplicate cores were used and sliced at every 1 cm from the surface to 5 cm depth. After slicing, prior to analysis, each sample was processed as described on the Table 2-9-1.

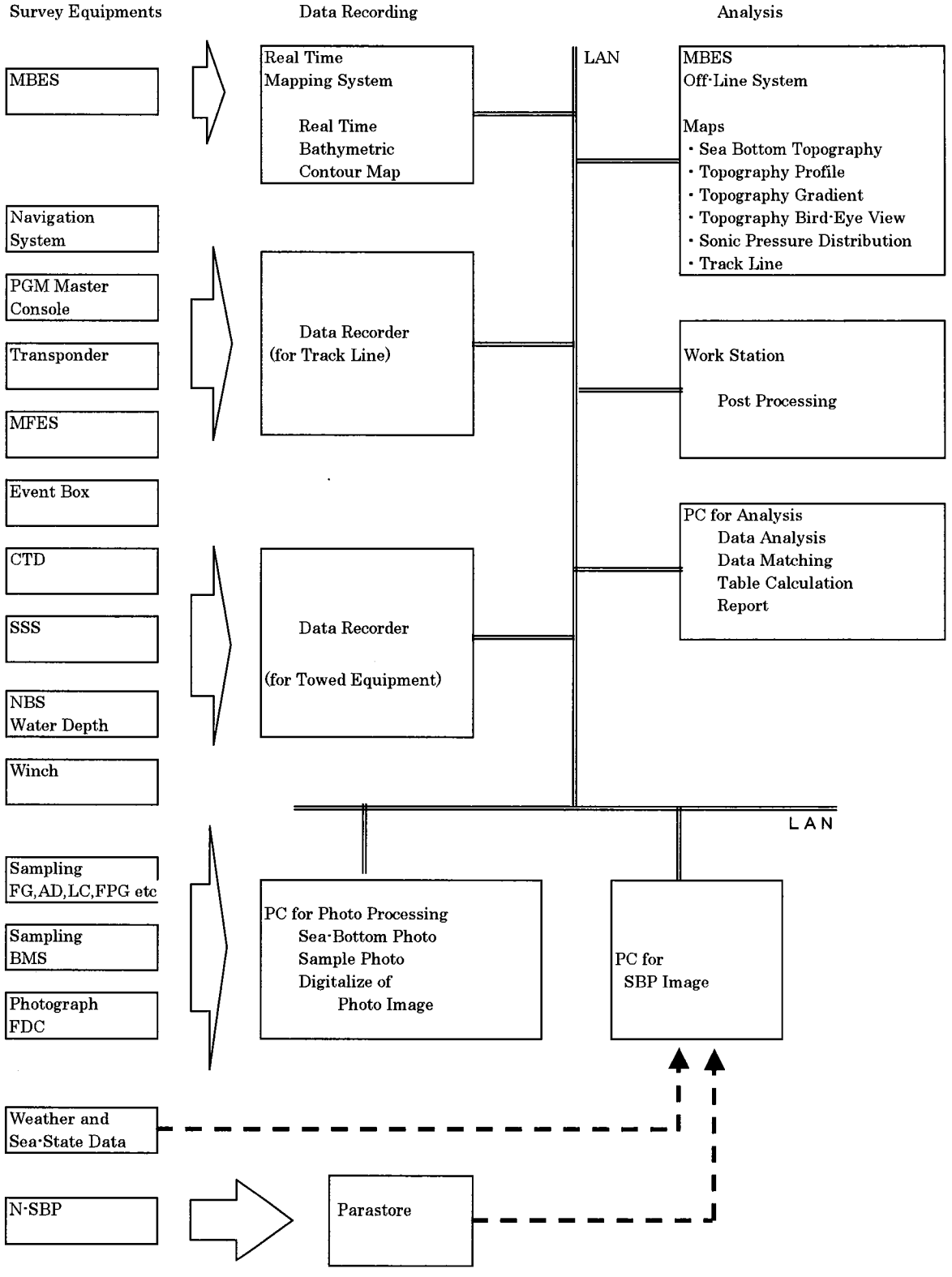


Fig. 2-8-1 Data Processing and Analysis Flow Sheet

## Table 2-9-1 Analyses, Sample Processing and Preservation

| Study Subjects | Number of cores | Sample processing and preservation |
|---|---|---|
| 1)Sediment Properties | | |
| i.Water content | 2 | Sliced into 5 layers at every 1 cm, plus 10 cm, 20 cm, 30 cm* and then kept frozen until the analysis |
| ii.Specific Sediment Gravity | 1 | Sliced into 5 layers at every 1 cm, plus 10 cm, 20 cm, 30 cm* and then kept frozen until the analysis |
| iii.Total Organic Carbon | 2 | Sliced into 5 layers at every 1 cm and then kept frozen until the analysis |
| iv.Total Nitrogen | 2 | Sliced into 5 layers at every 1 cm and then kept frozen until the analysis |
| v.Sediment Particle Size Distribution | 1 | Sliced into 5 layers at every 1 cm, plus 10 cm, 20 cm, 30 cm* and then kept refrigerated until the analysis |
| 2)Benthic organisms | | |
| i.Meiobenthos | 2 | Sliced into 5 layers at every 1 cm, fixed and stained with neutralized formalin (10% V/V) with Rose Bengal and then kept refrigerated until the analysis |
| ii.Macrobenthos | 2 | Sliced into 5 layers at every 1 cm, fixed and stained with neutralized formalin (10% V/V) with Rose Bengal, and then kept refrigerated until the analysis |

*only MC01

2) Analysis

a. Sediment Properties

・Water content

After measuring the wet weight (WW) of a suitable amount of the sediments, they were dried in an oven at 50℃, and then measured again to obtain the dry weight (DW). Water content of the sediments (WC) was calculated according to the following formula.

$WC(\%)=(WW-DW)/WW\times100$

・Specific Sediment Gravity

The sediments were dried in an oven at 110℃, and then ground with a mixer.

The specific gravity of the sediments was then determined using a picnometer.

・Total Organic Carbon and Total Nitrogen

After the sediments were dried in an oven at 50℃, they were transferred into a combustion dish. A suitable amount of 4N HCl was then added and the samples were dried up in a dessicator to remove inorganic carbon. Subsequently, total organic carbon and total nitrogen were determined using a CHN analyzer (YANAGIMOTO Model MT-5).

・Sediment Particle Size Distribution

Particle size distribution of sediments was determined using a MICROTRAC (NIKKISO Model MT300). The determination range of particle diameter was 0.02～1400μm.

b. Benthic Organisms

Generally, benthic organisms are categorized by size. In coastal studies, a mesh size of 500μm or 1000μm is used to set the lower size limit of macrobenthic organisms, while in deep-sea studies, a mesh size of 32μm is used as lower size limit for meiobenthic organisms. But since deep-sea benthic organisms show the tendency to be smaller than coastal organisms, meiobenthic and macrobenthic fauna was separated by using a smaller mesh size of 300μm in present studies.

・Meiobenthos

Materials were stained with Rose Bengal, and then sieved at 32 μm and 300 μm mesh sizes. Organisms, which passed through the 300 μm mesh and remained after sieving at 32 μm, were identified and individuals were counted. Foraminifera were excluded from the quantitative analysis, as they are fragile and difficult to count.

・Macrobenthos

Materials were stained with Rose Bengal, and then sieved at a mesh size of 300 μm. Organisms that remained on the mesh were identified and individuals were counted. As for the meiobenthos samples, faunal groups (Foraminifera and Porifera), that were difficult to count, were excluded from the quantitative analysis.