Chapter 2 Survey Methods

2-1 Survey Plan

This is the second year of the six years, consisting of two phases of three year, SOPAC program and deep-sea mineral resources in the Republic of Fiji Island was studied. The target of this year is hydrothermal mineralization

In the EEZ of the Republic of the Fiji Islands, the past studied have shown occurrences of hydrothermal mineralization, such as White Lady site, Pere Lachaise field, SO99 site, along the Central Spreading ridge of the North Fiji Basin. These mineral showings occur along the North-South trending axial valley of the Central Dome, near the Tripe Junction of the Central spreading Ridge. In the SOPAC grogram of year 1999, topographical survey was conducted in the area covering the Central Dome (Area1). Further, seafloor observation by FDC (Finder installed Deep-sea Camera) was conducted as a reconnaissance survey for the drilling survey by BMS (Benthic Malticorer System) within the Area1 covering the SO99 site, where known to be gentle topography with relatively high density of a distribution of hydrothermal mound. Although the drilling survey based on the reconnaissance survey was planed during the Leg 2 of the SOPAC program of year 1999, the drilling operation in the area was hampered by bad weather.

Based on the information obtained in 1999, the survey of this year was concentrated on drilling program by BMS in the area covering the SO99 site, aiming at understanding of the potentially of hydrothermal mineralization of the area. Topographic and magnetic surveys and sampling by LC (Large Corer) was, also, conducted.

In addition to above mentioned hydrothermal mineralization survey, environmental survey was conducted for understanding the environmental impact in the area of hydrothermal activity. Rosette sampler (RO), Multiple Corer (MC) and LC were used collecting seawater and unconsolidated sediments in this survey.

2-2 Numbering

The numbering system for sampling sites is as follows.

[For BMS and LC sampling points]: Year - SF - Equipment used - Sampling No.

S denotes SOPAC, F denotes Fiji. Sampling sites were numbered sequentially from the previous year (1999) regardless of areas.

Examples: 01SFBMS06 (for BMS: Drilling was conducted at five locations in 1999)

01SFLC07 (for LC: LC sampling was conducted at six locations in 1999)

[RO and MC sampling sites]: Year - SF – Equipment used - Sampling No.

RO and MC sites were numbered sequentially from 01

Example: 01SFRO01 (for RO)

01SFMC01 (for MC)

[Topography and Magnetic survey track line]: Year-SP-Month-Day-SF-Track line number.

Example: 01SP1230SFLine350

2-3 Position Locating

The position of the survey vessel was determined by GPS (Global Positioning System). Because sending commands and power supply from the vessel to BMS are done through a cable including optical fiver lines, the location of the ship is critical during the long period of drilling operation. For maintaining the good location of the vessel during the drilling operation, DPS (Dynamic Positioning System) was used. The location of drilling site was determined by reading the GPS installed at the stern of vessel when BMS touches the sea floor, and water depth was determined by acoustic sounding. For drawing track line of BMS during towing, the position of the BMS was obtained based on the GPS at the stern of vessel, calculated by Pythagorean theorem from the water depth measured by the acoustic sounding and the cable length, under the assumption that the BMS was located directly behind the vessel.

The positions of the LC, MC and RO sampling sites were obtained from the ship's position at the time of the sampler reaching the see bottom and the water depths were obtained from the acoustic sounding.

The geodetic coordinates used for the positioning were WGS84 and Vanuatu time (11 hours ahead of GMT) was used during the survey.

2-4 Topographic and Magnetic Surveys

Seafloor topographic survey was carried out over parallel track lines of 2nm intervals with vessel speed of 10~12 knots. Sounding by MBES was made every 8~12 seconds and every 8 seconds by NBS. During MBES topographic survey, acoustic reflection intensity from the seafloor can be obtained. Surface section of the seafloor was surveyed parallel with the topographic survey.

Magnetic survey was carried out simultaneously with topographic survey for the purpose of understanding the magnetic structure of the survey area in order to obtain information useful for mineral prospecting. PGM sensor was towed from the stern in order to avoid the magnetic effect of the ship. The distance between the ship and the sensor was 770m. Total magnetic intensity was measured every 6 seconds at 0.1 γ resolution. The measured data were recorded in on-line computer at every 10 seconds and processed.

2-5 Sampling

Drilling using the BMS and LC sampling were conducted for hydrothermal mineralization survey to evaluate potentiality of the area The drilling operation was conducted whenever possible over area of ore showing consisting of hydrothermal mound and alteration zone to know the vertical and lateral extension of ore zone. LC was used only when weather was bad for drilling operation and samples of surface collected by LC were supplementary used for estimating the distribution of mineralized zone. Based on the results of the seafloor observations by FDC of 1999 program and the high-resolution camera installed to BMS, targets of drilling sites were decided

2-6 Processing and Analysis of Survey Data

The processing and analysis of the acoustic survey data were carried out mainly through on-line functions and off-line functions of the data recording and processing device on board. A flow sheet of processing and analysis is shown in Figure 2-6-1. A part of the data processing and comprehensive analysis were done after the cruise.

2-7 Laboratory Work

Various laboratory works were conducted for the samples collected by BMS and LC. Thin sections were prepared and chemical analyses were conducted for basalt samples. For ore samples polished thin sections were prepared and assaying was done. The altered samples were examined by X-ray diffraction.

2-8 Environmental Survey

2-8-1 Objectives

The environmental survey was conducted as a baseline study of the area to predict the magnitude of mining impacts on the deep-sea environment. The objectives of this survey were to understand 1) the distribution of water quality and microorganism (hereafter, it is called the water quality–microorganism survey) and 2) the chemical properties of sediments and distribution of benthic organisms (hereafter, it is called the sediment–benthic survey).

2-8-2 Parameters

2-8-2-1 Water quality–microorganism survey

The following parameters were measured with a CTD meter and transmissometer mounted at the rosette water sampler.

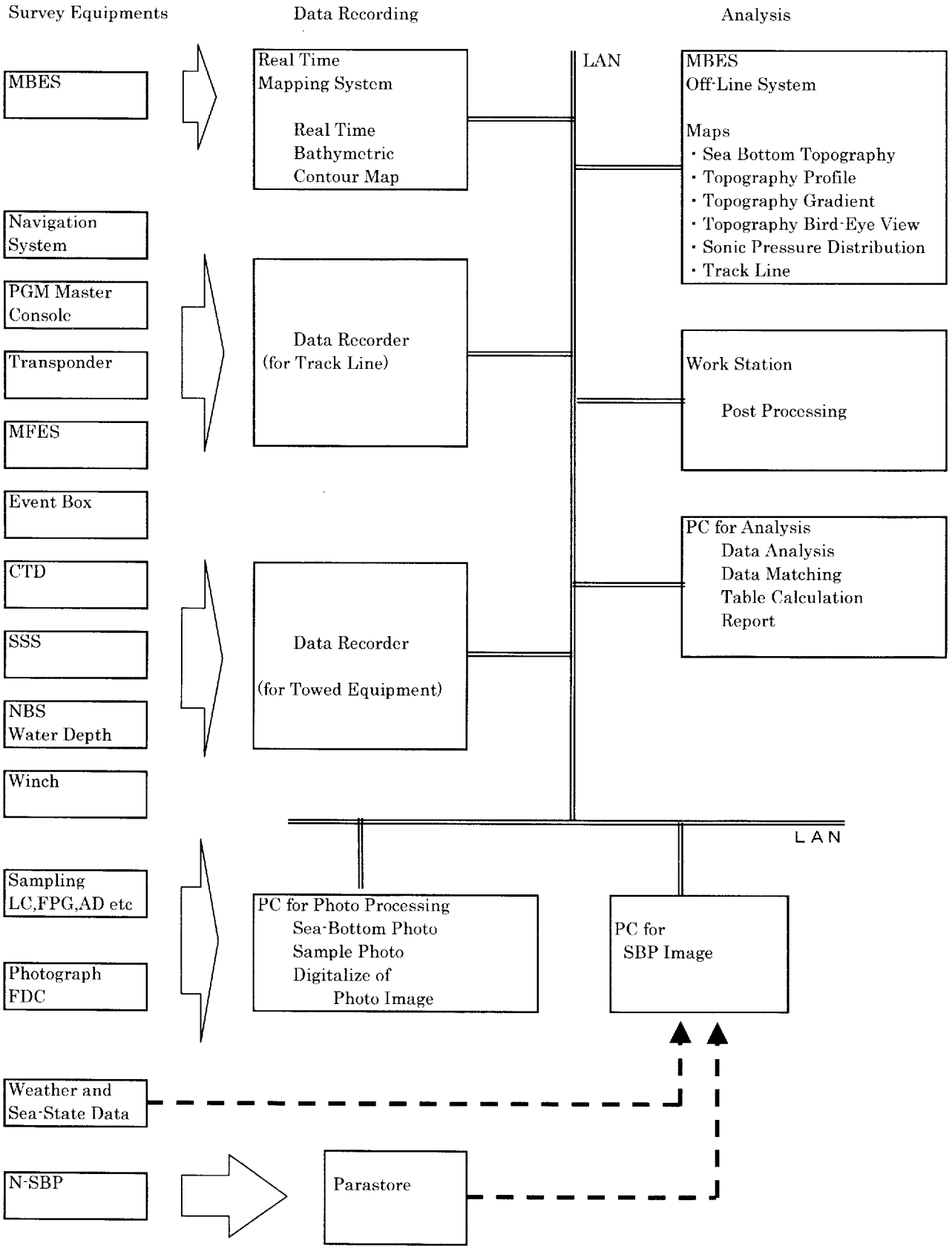

Figure2-6-1 Data Processing and Analysis Flow Sheet

(1) Physical property : water temperature, salinity, and light transmission

(2) Water quality : methane and suspended solid

(3) microorganism : bacterioplankton

2-8-2-2 Sediment–benthic organism survey

The following parameters were measured using a multiple corer.

(1) Chemical composition of sediment : total sulfide (T-S) and total organic carbon (TOC)

(2) Benthic organisms : sedimentary bacteria and meiobenthos

2-8-3 Methods

2-8-3-1 Measurement, sampling and sample processing

(1) Water quality–microorganism survey

Water temperature, salinity, and light transmission were measured by a CTD meter (Sea-Bird: model 9plus) and transmission meter (Marine System Technology: Model 1060ss/1M). The measurements were conducted from the sea surface to 10m above the seafloor. The lowering velocity of these instruments was 0.5 m/s, and the data was collected every 1/10 second.

Samples for both water quality and bacterioplankton analysis were collected at 300, 250, 100, 50, 10m above the sea bottom using a rosette water sampler with niskin bottles (1.7L) (Table 2-8-3-1).

(2) Sediment–benthic organism survey

Samples for this survey were collected using a multiple corer. In order to avoid hitting gravels, which obstruct corers to penetrate into sediments smoothly, the number of corers was reduced from eight to four. The obtained samples were sliced every 1-cm from surface to 10-cm depth of the sediments, and then those were treated in accordance with the manuals described in Table 2-8-3-1.

Table 2-8-3-1 Sample processing and preservations

Subject	Sample processing and preservation
Methane	**Fixed by mercury (Ⅱ) chloride saturated solution, Refregerated**
Suspended Solid	**Filterd by Glass Fiber Filter (GF/F), Freezed**
Bacterioplankton	**Preserved by gultarldehide (1% v/v) and Dyed by DAPI (1ì g/ml), Filterd by nucleopore filter (0.2ì m) , Mount on the slide glass**
Total Sulfide	**Fixed by Zinc ammine, Refregerated**
Total Organic Carbon	**Freezed**
Sedimentary Bacteria	**Preserved by gultarldehide (1% v/v), Refregerated**
Meiobenthos	**Sliced into 5 or 10 layers with every 1cm. Preserved with neutlized formalin (10% v/v) and dyed using Rose Bengal Refregerated**

2-8-3-2 Analysis

(1) Study of water quality – microorganism

1) Methane

Samples were fully purged by helium (He) and trapped in a concentration tube, then, methane was measured using gas chromatography (Shimazu GC-14BS).

2) Suspended Solid

Suspended solids trapped on a Glass Fiber Filter (GF/F) were measured after being dried until the weight became constant in a heating chamber.

3) Bacterioplankton

Bacterioplankton on an nuclepore filter (pore size: 0.2 μm) were stained with DAPI and counted under an epifluorescence microscope.

(2) Study of sediments – benthic organism

1) Total Sulfide

Fixed samples were filtered with a Glass Fiber Filter (GF/F), and the substances, remained on the filter, were distilled under an acidic condition with H_2SO_4. The solution obtained through titration was re-fixed with zinc acetate dihydrate (10%) and then titrated with sodium thiosulfate pentahydrate (1/100N). Finally, the data obtained through titration were standardized into the unit of dry weight using the water contents measured in the previous procedure so as to

determine the total sulfide.

2) Total Organic Carbon, inorganic carbon and total nitrogen

After samples were dried, the total carbon and total nitrogen (TON) were measured using a CHN analyzer (Yamagimoto MT-5). Inorganic carbons were removed from the dried samples with 4N hydrochloric acid, and the treated samples were re-dried and weighed as the organic carbon. The inorganic carbon was obtained as the difference between total carbon and organic carbon.

3) Sedimentary Bacteria

Sediment samples (1g) were put into plastic sterile tubes (10ml) and mixed with a 5ml of bacteria-free seawater. A 20kHz ultrasonic probe was then inserted into the sediment, and samples were sonicated for 45 seconds. After the sonication, the solutions were stained with DAPI (final concentration: 1 μg/ml) and filtered using nuclepore filter (pore size: 0.2 μm). The trapped sediments were mounted on a slide glass, and bacteria were counted with the aid of an epifluorescence microscope.

4) Meiobenthos

Collected samples were sieved by 500 and 32 μm- mesh-sieve. Organisms were identified and counted under microscope observation.