REPORT
ON
THE COOPERATIVE STUDY PROJECT
ON THE DEEPSEA MINERAL RESOURCES
IN SELECTED OFFSHORE AREAS OF THE SOPAC REGION

(VOLUME 3)

SEA AREA OF
THE FEDERATED STATES OF MICRONESIA

February 28, 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN OIL, GAS AND METALS NATIONAL CORPORATION

PREFACE

In response to a request by the South Pacific Applied Geosciences Commission (SOPAC), the Government of Japan has undertaken marine geological and other studies relating to mineral prospecting to assess the mineral resources potential of the deep sea bottom in the offshore regions of the SOPAC member countries. Implementation of the survey has been consigned to the Japan International Cooperation Agency (JICA). Considering the technical nature of geological and mineral prospecting studies, JICA commissioned the Japan Oil, Gas and Metals National Corporation (JOGMEC) to execute the survey.

The survey will be undertaken for two terms of three years (a total 6 years) starting from the fiscal year 2000. This is the third year of the Phase 2 of Stage II, and the survey was carried out in the Exclusive Economic Zone of the Federated States of Micronesia.

The JOGMEC dispatched the Hakurei Maru No.2, a research vessel for investigating deep sea mineral resources, to the survey area for 13 days from April 30, 2005 to May 12, 2005, completing the survey on schedule with the cooperation of the government of the Federated States of Micronesia.

The present report sums up the results of this year survey and results of past two years in the Exclusive Economic Zones of the Federated States of the Micronesia.

We wish to extend our sincere gratitude to all persons concerned, particularly to the staff of the SOPAC Secretariat, Government of the Federated States of Micronesia, as well as the Japanese Ministry of Foreign Affairs, the Ministry of Economy, Trade and Industry, Consulate-General of Japan at Hagatna and the Japanese Embassy in the Federated States of Micronesia.

February 2006

Japan International Cooperation Agency
Vice President in Charge Tadashi Izawa

Japan Oil, Gas and Metals National Corporation
President Isao Kakefuda

ABSTRACT

The joint study program for the deep-sea mineral resources in the exclusive economic zone (EEZ) of the SOPAC member countries started in 1985 and the survey scheme of Phase 2, Stage II of the joint study program was agreed between Japanese executing agency and SOPAC in February 2003. It is the third year of the program and the survey was conducted in Seamount MC12 and Seamount MC13 of the EEZ of the Federated States of Micronesia for assessing potentiality of cobalt rich manganese crust (hereafter referred as "manganese crust") resources and for understanding environmental aspects.

Although Seamount MC12 and Seamount MC13 were selected in 1997 and 1998 as the potential area for manganese crust resources among the 13 seamounts surveyed by previous years the distribution and occurrence of manganese crust in these two seamounts have not been fully understood. In the survey of this year, for efficiently assessing the manganese crust resources by understanding factors affecting their occurrences, such as features of seamount slopes, nature of bedrock and water depth, seafloor observation by Finder-Installed Deep-Sea Camera (FDC) was conducted prior to Arm Dredge (AD) sampling based on the information obtained by previous year. The AD sampling sites were efficiently decided based on this information.

The survey, consisting of a total of three track lines (13.52km in total) of seafloor observation by FDC (two in Seamount MC12 and one in Seamount MC13) and AD sampling of 18 sites (16 sites in Seamount MC12 and two sites in Seamount MC13) was carried out during the period from April 30 to May 12, 2005 (eight days for actual survey). In addition to them, for the environmental survey, sea water sampling at one site by Rosette Sampler (RO) and unconsolidated sediments sampling at two sites by Multiple Corer (MC) in each of both seamounts were conducted during that survey period.

Even though a certain area is shown to be acoustically monotonous, the seafloor observation by FDC in the same area gives more detailed and direct information concerning various features of the sea bottom, such as seafloor topography, nature of bedrock and occurrence of manganese crust beyond the resolution limit of Multi-narrow Beam Echo Sounder (MBES) survey. AD sampling was carried out based on information of the seafloor observation by FDC.

By the results of the survey, the occurrences of hydrogenetic manganese crust were confirmed in the two seamounts: one is the area of 60km long with maximum width of 20km on the north slope of east-west trending ridge of Seamount MC12 and the other is the area of 10km x 6km at maximum on the summit of east-west trending Seamount MC13. Since the distribution and occurrence of manganese crust are affected by factors such as direction and declination of slope, small scale topography of seafloor, type of substrate and water depth, the area with well developed manganese crust may be further limited even within the two seamounts.

The manganese crust of Seamount MC12 (13 AD sites) shows average grades of 0.35%Co, 0.24%Ni and 0.33ppmPt, while that of Seamount MC13 (5 AD sites) shows average grades of 0.34%Co, 0.28%Ni and 0.19ppmPt.

By the environment survey, basic data to understand the present condition of the seafloor environment was obtained in both areas of Seamount MC12 and Seamount MC13.

The diversity of distribution and occurrence of manganese crust affected by the factors such as direction of slope, small scale topography of seafloor and water depth shown by the survey of this year suggest that the optimal survey for assessing potentiality of manganese crust is achieved by systematic method combining interpretations of acoustic survey with information of seafloor observation by FDC for subsequent AD sampling.

It is preferable to carry out systematic sampling survey in Seamounts MC12 and MC13 for accurate estimate of the manganese crust resources. In the EEZ of the Federated State of Micronesia, the survey of seamounts is considered to be conducted in the survey scheme given above.

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Chapter 1 Outline of the Survey

1-1 Survey Title

Joint Basic Study for the Development of Mineral Resources in the Exclusive Economic Zone of the Federated States of Micronesia, Fiscal Year 2005

1-2 Survey Area

The survey scheme was decided in accordance with the joint study program for deep sea mineral resources in the exclusive economic zone (EEZ) of the SOPAC member countries agreed upon by the Japanese executing agency and the South Pacific Applied Geoscience Commission (SOPAC) on February 27, 2003. Based on this, two survey areas for this year, connecting the points shown below, were decided in March, 2005 (Figure 1-1).

Seamount MC12			Seamount MC13		
	Latitude	Longitude		Latitude	Longitude
1	9° 28′ N	145° 43′ E	1	10° 33′ N	144° 43′ E
2	9° 28′ N	146° 30′ E	2	10° 33′ N	145° 14′ E
3	9° 05′ N	146° 30′ E	3	10° 10′ N	145° 14′ E
4	9° 05′ N	145° 43′ E	4	10° 10′ N	144° 43′ E
1	9° 28′ N	145° 43′ E	1	10° 33′ N	144° 43′ E

1-3 The Purpose of the Survey

The purpose of the survey are to assess the potentiality of cobalt rich manganese crust (hereafter referred to as "manganese crust") and to understand environmental characteristics in Seamount MC12 and Seamount MC13 located within the EEZ of the Federated States of Micronesia.

1-4 Duration of the Survey

Survey cruise: April 30, 2005 to May 12, 2005

(13 days including moving and stopping at port, Table 1-1 and Table1-2)

Analysis and other work: April 1, 2005 to February 28, 2006

1-5 Survey Participants

Negotiators for the Agreement

Japanese Participants

Yoshitaka HOSOI (Technical Development Department, JOGMEC)

Hiroyuki YASUNO (Mineral and Natural Resources Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry)

Masayoshi KAMEYAMA (Technical Development Department, JOGMEC)

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Natsumi KAMIYA (Head of JOGMEC Canberra Office)

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Tania T. TAGICAKIBAU (The Republic of the Fiji Islands)

Bhaskar Rao (The Republic of the Fiji Islands)

Meita BEIABURE (The Republic of Kiribati)

Alfred SIMPSON (Niue)

Alfred SIMPSON (SOPAC Secretariat)

Russell HOWOITH (SOPAC Secretariat)

Crstelle PRATT (SOPAC Secretariat)

Nobuyuki OKAMOTO (SOPAC Secretariat)

Survey Planning

Nibuyuki Okamoto (JOGMEC)

Bhaskar Rao(SOPAC)

Mathew Chigiyal(The Federated States of Micronesia)

Participants of Field Survey

Naoaki Tomizawa	DORD, Leader	ShinkaiYamamoto	OED
Nadao Saito	DORD	Yoshikazu Yoshino	OED
Norikiyo Sugiura	DORD	Masahiro Hamazaki	OED
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Ryoichi Takatori	DORD	Ryutarou Nakauchi	OED
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Kazuyuki Kadoshima	DORD	Tatsuo Fukuhara	OED
Makoto Ujihara	DORD		
Akinori Uchiyama	DORD		
Tomoki Miyamukai	DORD		

DORD: Deep Ocean Resources Development Co., Ltd.

OED: Ocean Engineering Development Co., Ltd.

In addition to them, Mr. Paulino James, National Oceanic Resource Management Authority, the Federated States of Micronesia (NORMA) participated in the survey.

The survey cruise was conducted using the R/V No.2 Hakurei Maru, owned by JOGMEC and operated by Captain Morio Endo and other 34 crewmembers.

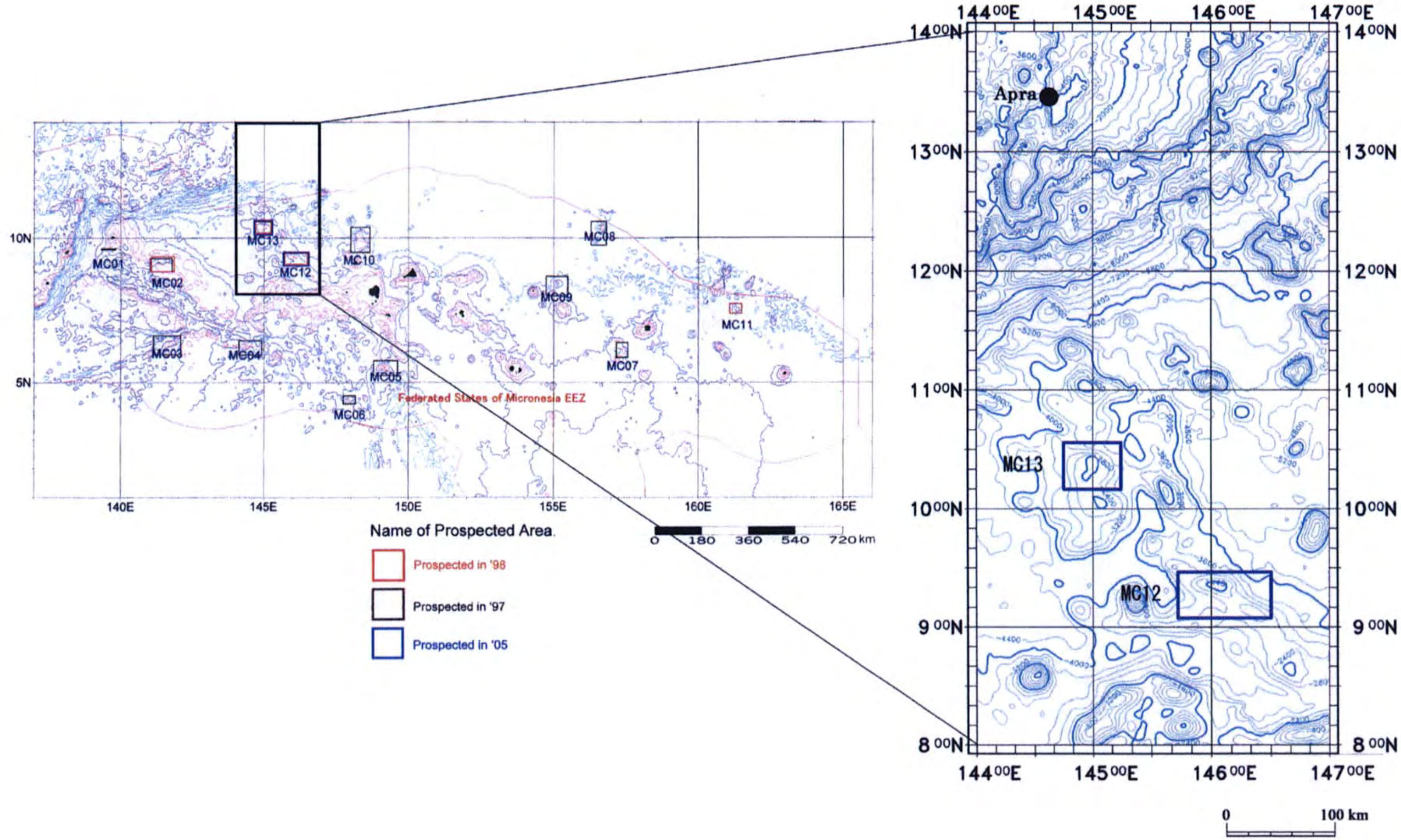


Figure 1-1 Location Map of the Survey Area

Table 1-1　Survey Achievements

Survey Schedule				
	Depart from Guam	5/2　11:00		
	Arrive at MC12	5/3　09:20		
	Start survey	5/3　09:20		
	Finish survey	5/10　15:22		
	Leave MS13	5/10　15:30		
	Arrive at Guam	5/11　10:00		
	Total days of survey	8 days		
Survey Achievements				
Survey Area		MC12	MC13	2 seamounts
Sampling	Number of Sampling Sites AD	16	2	18
	Sample Amount (kg)	920.6	98.9	1019.5
	crust (kg)	310.0	70.4	380.4
	rock (kg)	583.0	20.8	603.8
	etc. (kg)	27.6	7.7	35.3
	Number of Sampling Sites RO	1	1	2
	Number of Sampling Sites MC	2	2	4
	Sample Amount (kg)	21.4	15.6	37.0
Sea Floor Observation	Number of Sampling Line FDC	2	1	3
	Survey distance, km	10.93	2.59	13.52
	number of photograph	387	100	487
	movie file	14.0GB	3.7GB	17.7GB
CTD Measurements	FDC	2	1	3
	RO	1	1	2
	MC	1	1	2
Acoustic Sounding	MBES (15.5 kHz) n.m	250.4	51.7	302.1
Data Processing	MBES CDR Drawings	1 CDR bathymetric map Track line Map , Bathymetric map , Acoustic reflection map etc.		

Table 1-2 Records of Survey Schedule

Days		Date		Area	Survey Work	Bathymetric Survey	Remarks
1		4/30	Sa				Staying at Guam
2		5/1	Su				Staying at Guam
3		5/2	Mo				11:00 Depart from Guam
4	1	5/3	Tu	MC12	RO sampling 1 site MC12RO01 MC sampling 2 sites MC12MC01,02	90.1n.m(MC12)	
5	2	5/4	We	MC12	Sea Floor Obser vation 2 Lines MC12FDC02, MC12FDC03	28.5n.m(MC13)	
6	3	5/5	Th	MC13	RO sampling 1 site MC13RO01 MC sampling 2 site MC13MC01, MC13MC02 Sea Observation 1 line MC13FDC02	0n.m	
7	4	5/6	Fr	MC12	AD sampling 4 sites MC12AD15,AD16,AD17,AD18	16.8n.m(MC12)	
8	5	5/7	Sa	MC12	AD sampling 4 sites MC12AD19,AD20,AD21,AD22	51.8n.m(MC12)	
9	6	5/8	Su	MC12	AD sampling 4 sites MC12AD23,AD24,AD25,AD26	66.5n.m(MC12)	
10	7	5/9	Mo	MC12	AD sampling 4 sites MC12AD27,AD28,AD29,AD30	25.2n.m(MC12)	
11	8	5/10	Tu	MC13	AD sampling 2 sites MC13AD15,AD16	23.2n.m(MC13)	
12	9	5/11	We				10:00 Arrive at Guam
13	10	5/12	Th				Stay at Guam

1-6 Survey Apparatus and Equipments

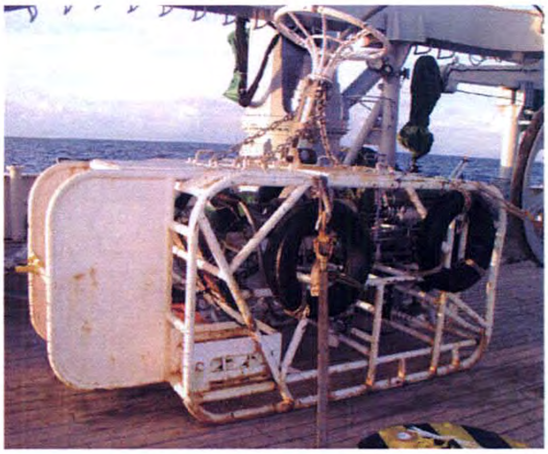
Major apparatus and equipments used during the survey are shown on Table 1-3 and their photographs are given in Figure 1-2.

Table 1-3 Survey Apparatus and Equipments

Category	Survey Method	Survey Apparatus and System	Abbreviation	Remarks
Positioning	Satellite Navigation	Global Positioning System GPS+GLONASS	GPS	
Sea Bottom Topography and Geological Survey	Acoustic: Acoustic Sounding Bathymetry	Multi-narrow Beam Echo Sounder Narrow Beam Echo Sounder	MBES NBS	
	Acoustic: Subsurface Geological Structure	Narrow Beam Sub-Bottom Profiler	nSBP	
	Magnetic Survey	Proton Gradio Meter	PGM	Toward Type
	Seawater Survey	Conductivity, Temperature and Pressure Measuring System	CTD	
	Light Transmission Survey	Transmission meter	TR	
	Sampling	Large Gravity Corer	LC	
		Arm Dredge	AD	
Environmental Survey	Sampling	Multiple Corer	MC	Soil Survey
		Rosette sampler	RO	Water Survey
Sea Floor Observation	Photograph	Deep Sea Camera		with LC or MC
	Photograph and VCR	Finder-Installed Deep-Sea Camera	FDC	
Data Recording and Processing	On-line Functions	Data Processing System	DPS	
	Date Storage Functions	Sensor CPU		
	Off-Line Functions	File Server CPU		
	↓	Host CPU		
	Track Line Maps etc.,	EWSCPU		
	Data Analysis	LAN, PC, ICM		

AD(Arm Dredge)

Pinger



FDC(Finder-Installed Deep-Sea Camera)

CTD(Conductivity, Temperature and Depth Profiling System)

Deep Sea Camera

RO(Rosette sampler)

MC(Multiple Corer)

Figure 1-2 Photographs of Survey Equipments

Chapter 2 Survey Method

2-1 Survey Plan

The joint study program for the deep sea mineral resources in the exclusive economic zone (EEZ) of the SOPAC member countries was started in 1985 and the survey scheme of Stage II, Phase 2 of the joint study program was agreed between Japanese executing agency and SOPAC in February 2003. It is the third year of the program and according to its Scope of Work, the survey of this year (2005) was conducted in the EEZ of the Federated States of Micronesia.

In the EEZ of the Federated States of Micronesia, surveys including bathymetric survey (MBES), seafloor observation (FDC), sampling (AD, CB, LC) were conducted for assessing the potentiality of manganese crust resources in 1997 and 1998. Based on these surveys, seamounts MC12 and MC13 were selected to be potential for manganese crust. For this reason, the survey of 2005 was conducted in the areas of seamounts MC12 and MC13 aiming at assessing the potentiality of manganese crust resources and collecting data of environmental characteristics for understanding the environmental impact of mining in future. Since the survey cruise of this year was restricted in a short period of time, a priority was given to seamount MC12 where better exposure of the bedrock was expected.

2-2 Survey Method

Complementary topographic survey (MBES), seafloor observation (FDC) and sampling (AD) were conducted for assessing the potentiality of manganese crust of seamounts MC12 and MC13, and seawater and sediment samples were collected (RO and MC) for environmental survey in the same seamounts.

The surveys of previous years showed that the distribution of manganese crust tend to be controlled by topography of seamount and water depth. In the survey of this year, for efficient AD sampling, seafloor observation was conducted prior to sampling to obtain information concerning topography of seamount slope, condition of bedrock exposure and occurrences of manganese crust respect to water depth.

The FDC track lines were set in two locations in seamount MC12, one along ridge and the other along valley, and another site in deeper part of seamount MC13. Based on the information of seafloor observation along these lines together with seafloor observation information of previous years, the sites of the AD sampling were decided (Table 2-1).

2-3 Positioning of the Vessel

Since determining the precise location of the vessel and sampling site is key factor for seafloor mineral resources project, three GPSs (Global Positioning System), each of which is equipped at different site of the vessel, are installed on the R/V No.2 Hakurei-maru. For positioning of the vessel, the GPS installed on the bridge is used. While, for drawing track lines of FDC and AD during towing, the positions of the FDC and the AD were obtained based on the GPS data at the stern of the vessel, calculated by Pythagorean Theorem from the water depth measured by the acoustic sounding and the cable length, under the assumption that the FDC and the AD were located directly behind the vessel. The positions of the RO and the MC sampling sites were obtained using the GPS installed near starboard crane at the time of the sampler reaching the see bottom and the water depth was obtained by the acoustic sounding.

The geodetic coordinates used for the positioning were WGS84. For recording various events of survey equipments, UTC was used.

2-4 Bathymetric Surveys (MBES)

Bathymetrical survey was carried out over E-W directed parallel track lines of 1nm intervals with vessel speed of 10~12 knots and sounding by MBES was made every 8~12 seconds.

2-5 Seafloor Observation (FDC)

For the purposes of studying occurrences of manganese crust, seafloor observation was conducted towing FDC (Finder-installed Deep-sea Camera). All along the track lines, TV images were recorded by digital recorder and still pictures of the seafloor were taken.

2-6 Sampling (AD)

The efficient sampling by AD (Arm Dredge) was conducted considering the condition of weather and sea state.

2-7 Numbering of Survey Lines and Samples

Numbering system for sampling sites and track lines are as follows.

The number starts from two digits of the year (e.g. Year 2005 is shown as 05) and S (S denotes SOPAC Micronesia) and followed by used equipments and number of sampling site or FDC track line. AD sampling site and FDC track line are numbered sequentially from the survey of previous years.

AD sampling site: 05SMC12AD01 (AD01 sampling site of Seamount MC12)

FDC track line: 05SMC12FDC02 (FDC02 track line of Seamount MC12)

Track line of bathymetric survey: 05S and followed by degree and minute of latitude of track line.

2-8 Laboratory Works

For further investigation of collected samples by AD, various laboratory works, such as chemical analyses, microscopic observation of polished section and X-ray deflections analyses for manganese crust and microscopic observation of thin section, bulk chemical analyses and fossil studies for rocks were conducted (Table2-1).

2-9 Processing and Analyses of Survey Data

The processing and analyses of the acoustic survey data were carried out mainly through on-line and off-line functions of the data recording, and processing procedure devices on board the ship are shown in Figure 2-1. A part of the data processing and comprehensive analyses were done after the cruise.

2-10 Environmental Survey

The environmental survey, consisting of seawater sampling by Rosette Sampler (RO) and bottom sediments sampling by Multiple Corer (MC), was conducted as a baseline study of future impacts of deep sea mining on the surrounding environment.

Table 2-1 Samples undertaken for Laboratory Works

Area	Sampling Site	Water Depth (m)	Sample Sub-number	Sample	Thickness of Manganese Crust (cm)	Identification Number							
						Rock Seample						Manganese Oxide	
						Thin Section	Chemical Analysis	Fossil Determination in Unconsolidated Material	Microfossil Determination in Limestone	Fossil Determination in Limestone	XRD	Polished Thin Section	Chemical Analysis
MC12	05SMC12AD15	2,437	a1	Manganese Crust	7								CM01
			a2		9								CM02
			a3		14+								CM03
													CM04
													CM05
													CM06
													CM07
												PS01	
												PS02	
												PS03	
												PS04	
											XRD01		
									FR01				
	05SMC12AD16	2,004	a1	Manganese Crust	8								CM01
			a2		11+								CM02
			a3										CM03
													CM04
													CM05
													CM06
												PS01	
												PS02	
												PS03	
												PS04	
											XRD01		
	05SMC12AD17	1,772	a1	Manganese Crust	4+								CM01
	05SMC12AD18	1,368	c3	Reef Limestone (rudstone)	Coating					FRC01			
	05SMC12AD19	1,873	a2	Manganese Crust	7+								CM01
			a3	Manganese Crust	3								CM02
	05SMC12AD20	1,562	a1	Manganese Crust	0.5								CM01
				Pelagic Limestone (packstone)					FR01	FRC01			
			c1	Reef Limestone	Coating ?					FRC02			
	05SMC12AD22	1,822	a1	Manganese Crust	3.5+								CM01
	05SMC12AD25	2,221	c1	Calcareous Conglomerate	Coating				FR01	FRC01			
	05SMC12AD28	1,858	a1	Manganese Crust	1								CM01
	05SMC12AD29	2,385	a1	Manganese Crust	5(8)								CM01
			a1	Calcarious Sandstone	5(8)				FR01				
			a2	Manganese Crust	3.5						XRD01	PS01	CM02
			a3		14+								CM03
													CM04
													CM05
													CM06
			a4		10+								CM07
													CM08
													CM09
												PS06	
												PS07	
											XRD03		
			c2,c3	Reef Limestone	Coating				FR02	FRC01			
			c4	Calcarious Congl.(grainstone?)	Coating				FR03				
	05SMC12AD30	2,370	a1	Manganese Crust	3								CM01
			a2		1								CM02
					2.5								CM03
	05SMC12MC01	3,315	0.10~0.11	Calcarious Sandstone	—			FS01					
	05SMC12MC02	2,481	0.10~0.11	Calcarious Sandstone	—			FS01					
MC13	05SMC13AD15	1,724	a1	Manganese Crust	1								CM01
				Siltstone					FR01				
				Limestone					FR02				
			—	Filling Material of Cavity ?	—	TS01					XRD01		
	05SMC13MC01	2,358	0.10~0.11	Calcarious Sandstone	—			FS01					
	05SMC13MC02	3,163	0.10~0.11	Calcarious Sandstone	—			FS01					
MC12	05SMC12AD16	2,004	c2	Aphyric Basalt	—	TS01	CA01						
			—	Strongly altered Rock	—						XRD02	PS05	CM07
	05SMC12AD19	1,873	c1	Aphyric Basalt	—	TS01	CA01						
	05SMC12AD27	2,209	c2	Tuffcious Siltstone	—						XRD01		
			c3	Gravel in Calcarious Congl.	—	TS01	CA01						
	05SMC12AD28	1,858	c2	Altered Basalt	—						XRD01		
	05SMC12AD29	2,385	c6	Aphyric Basalt	—	TS01	CA01						
MC13	05SMC13AD16	2,061	c1	Basalt	—	TS01	CA01						
	Total Number of Samples					6	5	4	8	5	8	12	33

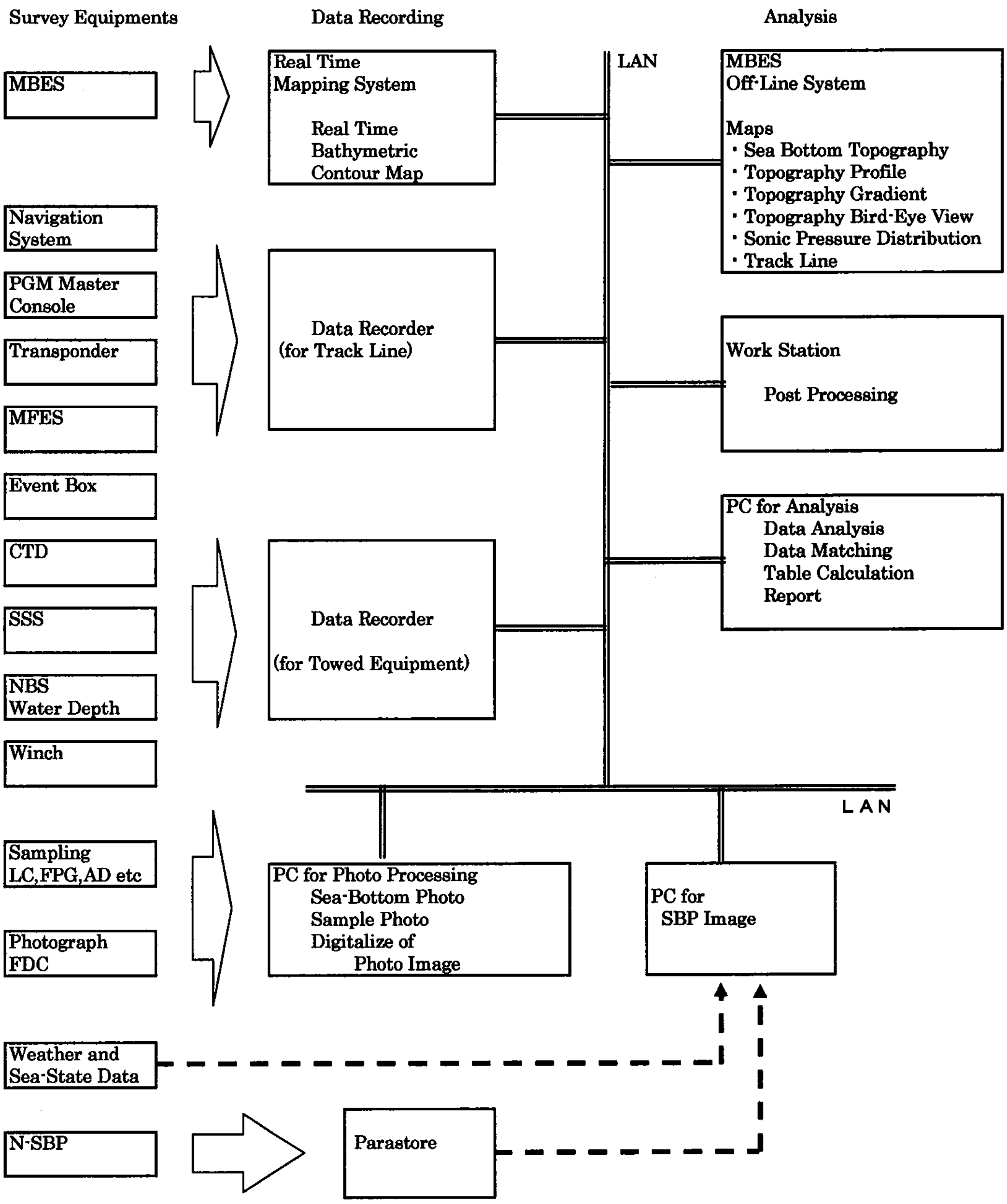


Figure 2-1 Flow of Data Processing and Analysis

Chapter 3 Survey Results

Although the survey of this year was conducted in seamount MC12 and Seamount MC13, a priority was given for the survey of seamount MC12 which showed potentiality of manganese crust resources with larger size and better exposure of bedrock based on the results of bathymetric survey of the previous year (Table 2-1).

3-1 Seamount MC12

3-1-1 Outline of Seamount MC12

The area including Seamount MC12 has an extension of 80km in east-west direction and 40km in north-south direction located with its center at 9-20N and 144-05E. Seamount MC12 with summit depth of 1,141m rises 2,800m from the seafloor. Although reef limestone occurs on the summit, it does not have flat summit. Instead, the seamount has east-west trending ridge of 60km long and 20km maximum wide with steep north and south slopes.

3-1-2 Survey results of Previous Years

In the previous survey of 1998, bathymetry by MBES, seafloor observation by FDC and samplings by AD, CB and LC were conducted over Seamount MC12 (Table 4-1).

The bathymetric survey showed a high intensity of acoustic reflection covering area of the seamount from the summit to about 2,500m depth and manganese crust was collected within this area. Thickness of the manganese crust varies depending on depth and locality in seamount ; that is 1.5 to 2cm in the summit area, more than 3cm on the upper slope and 18 to 19cm on the middle to lower slope. Average thickness of the manganese crust of Seamount MC12 is 4cm with maximum thickness of 19cm and thick manganese crust tend to occur on the north facing slope of the seamount. Average grades of 0.38%Co, 0.27%Ni and 0.27ppmPt were obtained from 11 samples of Seamount MC12. The upper part of the seamount is covered by reef limestone and the middle to lower slope consists of hyaloclastite and basalt. Because the seamount has ridge shape, unconsolidated sediments rarely occur in the areas of the summit and slopes, and they tend to occur in the foot area with gentle slope.

3-1-3 Survey results of This Year

The survey results of previous years suggested that the distribution and thickness of manganese crust in Seamount MC12 tend to be controlled by the factors such as water depth and locality in seamount.

In the survey of this year, for the efficient AD sampling work to assess the potentiality of manganese crust, seafloor observation by FDC was conducted prior to AD sampling to understand various aspects possibly controlling the occurrences of manganese crust such as detailed topographic features of slopes, microtopography that can not be shown by the bathymetric survey, situation of bedrocks and occurrences of manganese crust respect to water depth.

The seafloor observation was conducted along two FDC lines each of which was set along ridge and valley on the north facing slope of Seamount MC12 respectively. Considering the results of seafloor observation of this year and the last year, the 16 sites of AD sampling were determined (Table 2-1 and Figure 3-1-1).

(1) Seafloor Observation by FDC (Figure 3-1-2)

1) 05MC12FDC02: along the ridge on the northern slope of Seamount MC12,
from 1,180m to 2,630m depth, 4.4nm long.

The seafloor observation was conducted downward from the east-west trending ridge of the summit to the lower slope in NNE direction along a small ridge branching off from the summit ridge.

From 1,180m to 1,280m depth, in the summit area, corroded bedrock similar to limestone was observed at outcrop rate of 55%. Although black surface was observed, botryoidal texture was not observed and, instead, corrosion texture was more clearly observed suggesting occurrence of only manganese oxides coating. On the foot of slopes, talus deposits of possibly limestone were observed. At 1,478m depth, bedrock covered by manganese crust with botryoidal texture started to occur. In the relatively flat area of 1,520m to 1,560m depth, a widespread occurrence of unconsolidated sediments is observed, occasionally showing stripe pattern with a trend along the direction of slope which probably reflects the seafloor structure. Further down to 1,520m to 2,130m depth, the bedrock covered by manganese crust with botryoidal surface continues at outcrop rate of 90%. The bedrock shows rounded massive structure and covered by manganese crust of botryoidal texture. At the seafloor deeper than 2,130m depth, as the slope gradually becomes gentle, a distribution of unconsolidated sediments becomes more predominant and thicker, instead the exposure of the bedrock becomes scarce. As the slope dips more steeply from 2,260m depth, the exposure of bedrock covered by manganese crust with botryoidal surface appears at outcrop rate of 75%. From 2,540m depth, the slope gradually becomes gentle and the seafloor is entirely covered by unconsolidated sediments.

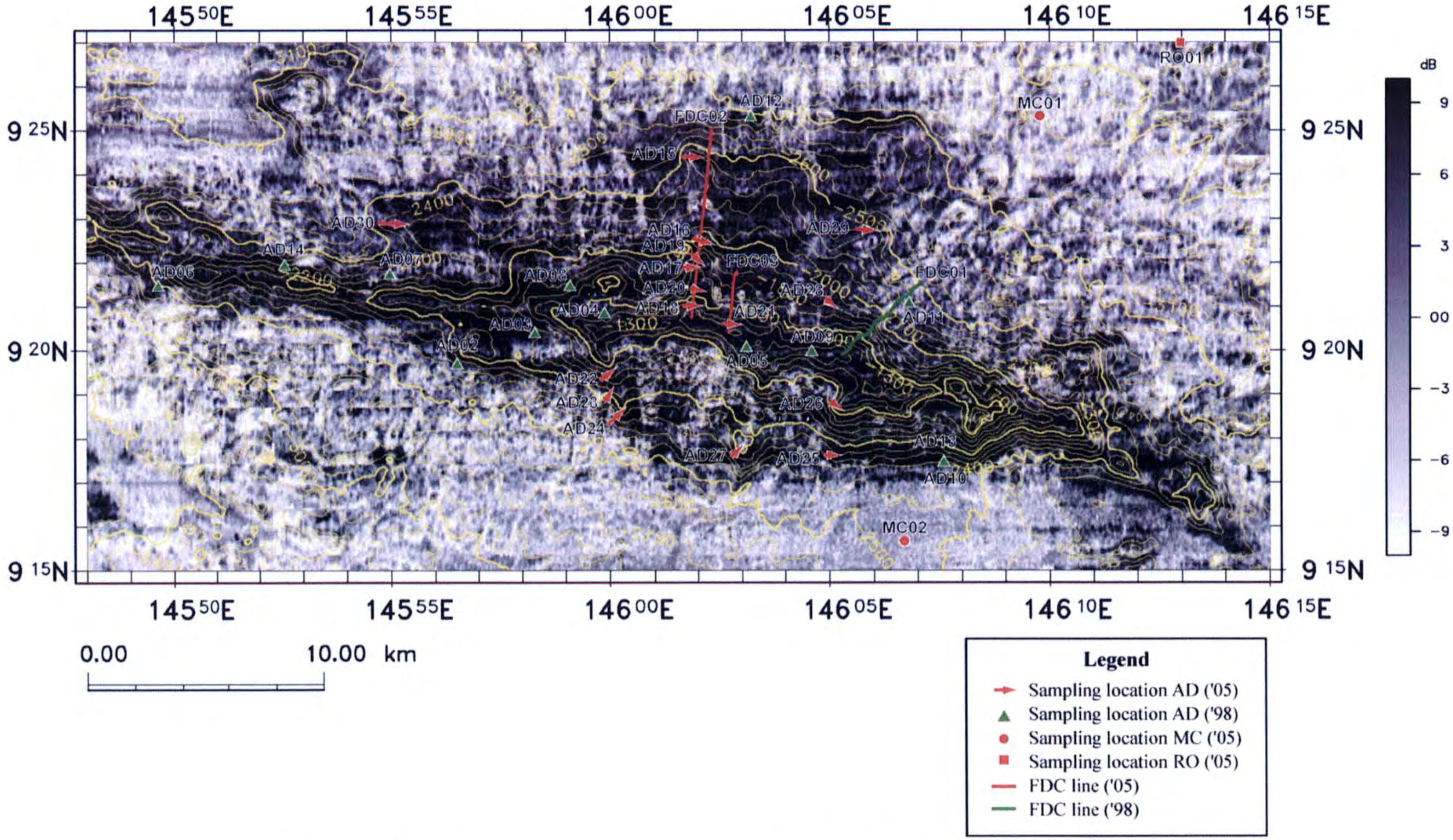


Figure 3-1-1 Bathymetric Map、Acoustic Reflection Intensity Distribution and Location Map of Sampling Sites (Seamount MC12)

2) 05MC12FDC03: concaved zone on the north facing slope of MC12 area, from 1,200m to 1,500m depth, 1.5nm long.

The FDC line of 05MC12FDC03 was set along concaved zone (valley) being immediateeast of and almost parallel to 05MC12FDC02 line. The seafloor observation was conducted downward along the concaved zone.

In the upper part of the line (1,200m to 1,300m depth), bedrock similar to limestone with rounded surface by corrosion is observed at outcrop rate of 85%. From the appearances of the surface, manganese crust seems to scarcely occurs. At 1,409m depth, the bedrock covered by manganese crust with botryoidal surface is observed. Around 1,416m depth, talus deposits consisting of cobbles and boulders of similar to limestone occur filling the concaved topography.

From 1,425m to 1,460m depth, bedrock occurs partly covered by unconsolidated sediments at outcrop rate of 75%. The bedrock, covered by manganese crust with botryoidal surface, does not show rounded surface and it appears to be volcanic rocks.

At depth more than 1,460m, as the slope becomes gentle, the distribution of unconsolidated sediments becomes widespread and the outcrop rate of bedrock decrease to 10%. However, the occurrences of botryoidal surface of bedrock suggest continuous occurrence of manganese crust covering the bedrock.

The following are revealed by the FDC Survey in this year:

1) Even though the certain area is shown to be acoustically monotonous by MBES acoustic survey, the seafloor observation by FDC in the same area gives much detailed information concerning exposure of bedrock beyond resolution limit of MBES (50m square at 1,500m depth). Consequently, the seafloor observation provides useful and accurate information for planning AD sampling site.

2) Over the ridge, the distribution of unconsolidated sediments is controlled by angle of slope. If it is steep, poor distribution of unconsolidated sediments promote growth of manganese crust.

3) In the valley, the high reflection intensity area, shown by dark color on the acoustic intensity map, does not always represent exposure of the bedrock covered by manganese crust. The talus deposits consisting of cobbles and boulders are also represented by high reflection intensity on the acoustic intensity map.

4) Seafloor observation by FDC provides information on distribution of manganese crust.

5) Combining the information obtained by seafloor observation with bathymetric and acoustic reflection maps, it is possible to efficiently determine AD sampling site.

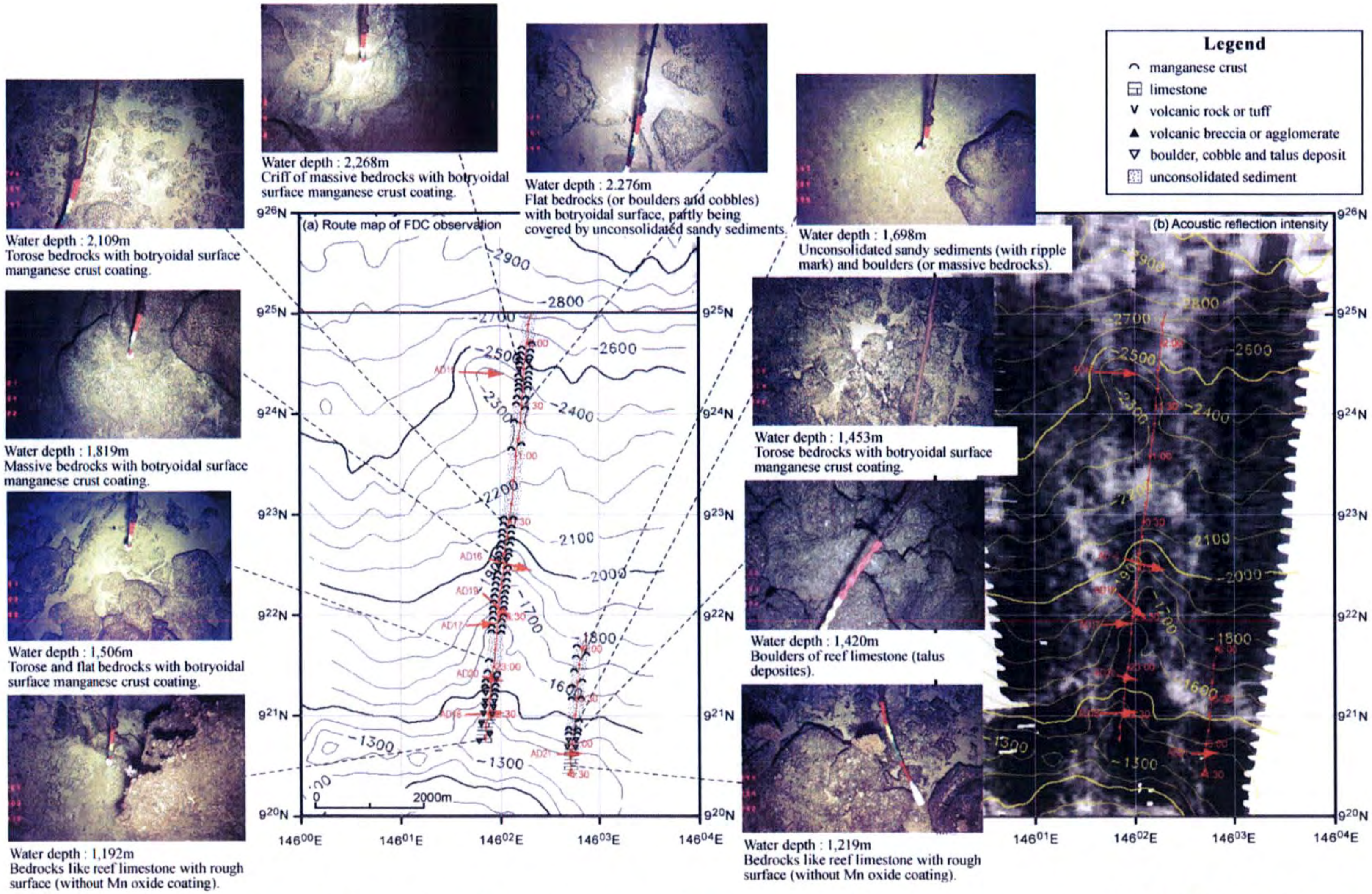


Figure 3-1-2 Seafloor Aspect and Acoustic Reflection Intensity (05SMC12FDC02, 03)

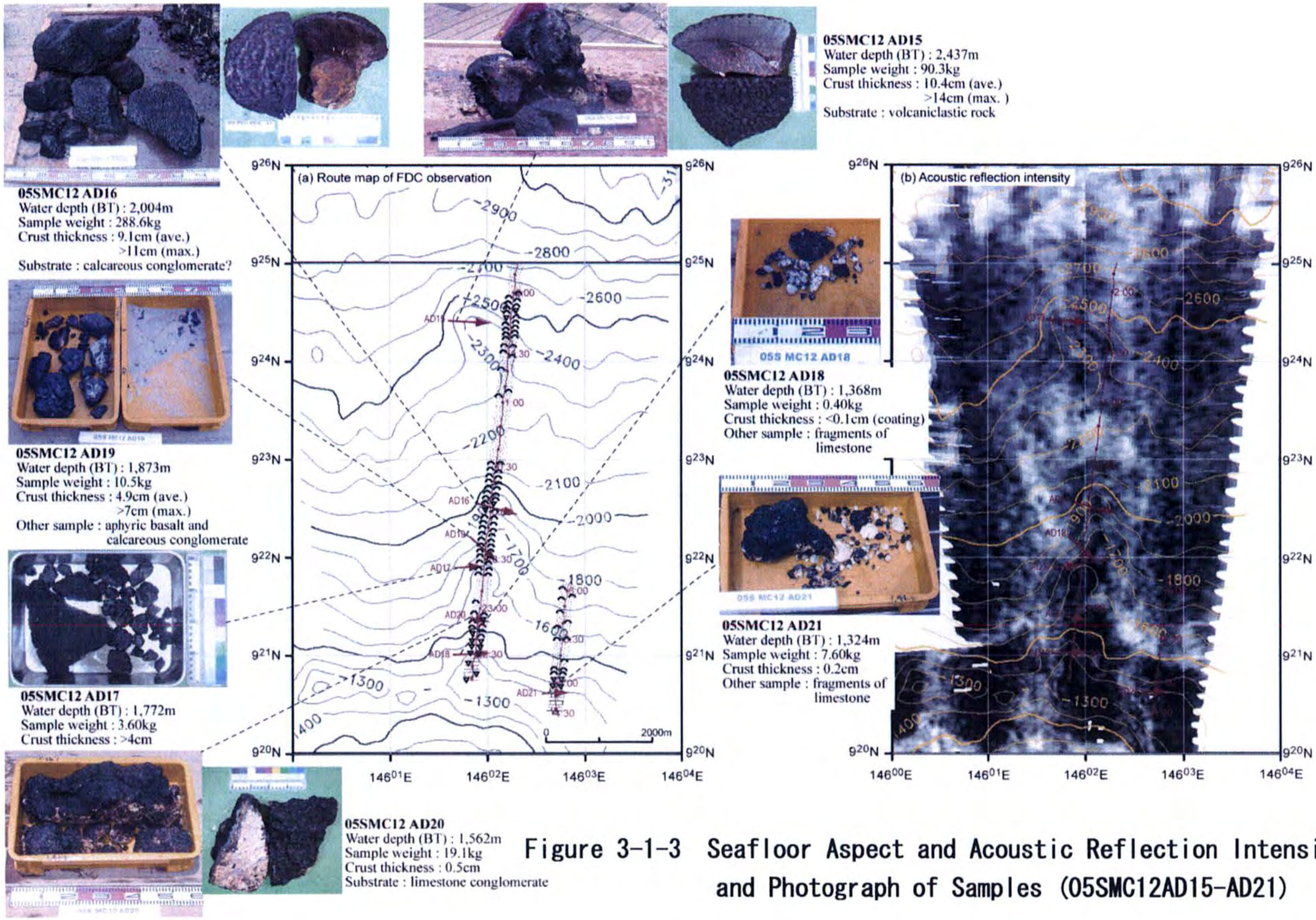


Figure 3-1-3 Seafloor Aspect and Acoustic Reflection Intensity and Photograph of Samples (05SMC12AD15-AD21)

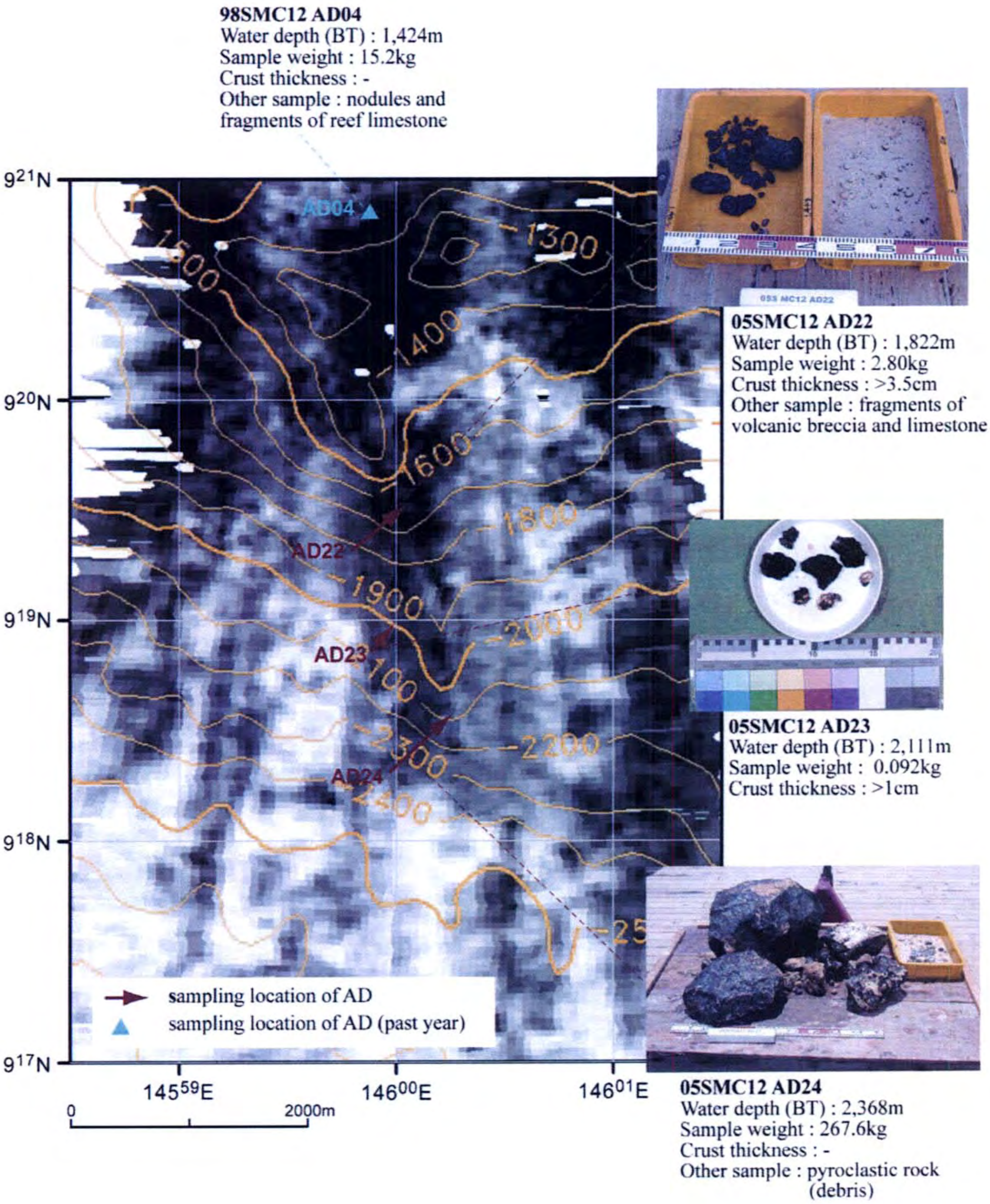


Figure 3-1-4 Acoustic Reflection Intensity and Photograph of Samples (05SMC12AD22–AD24)

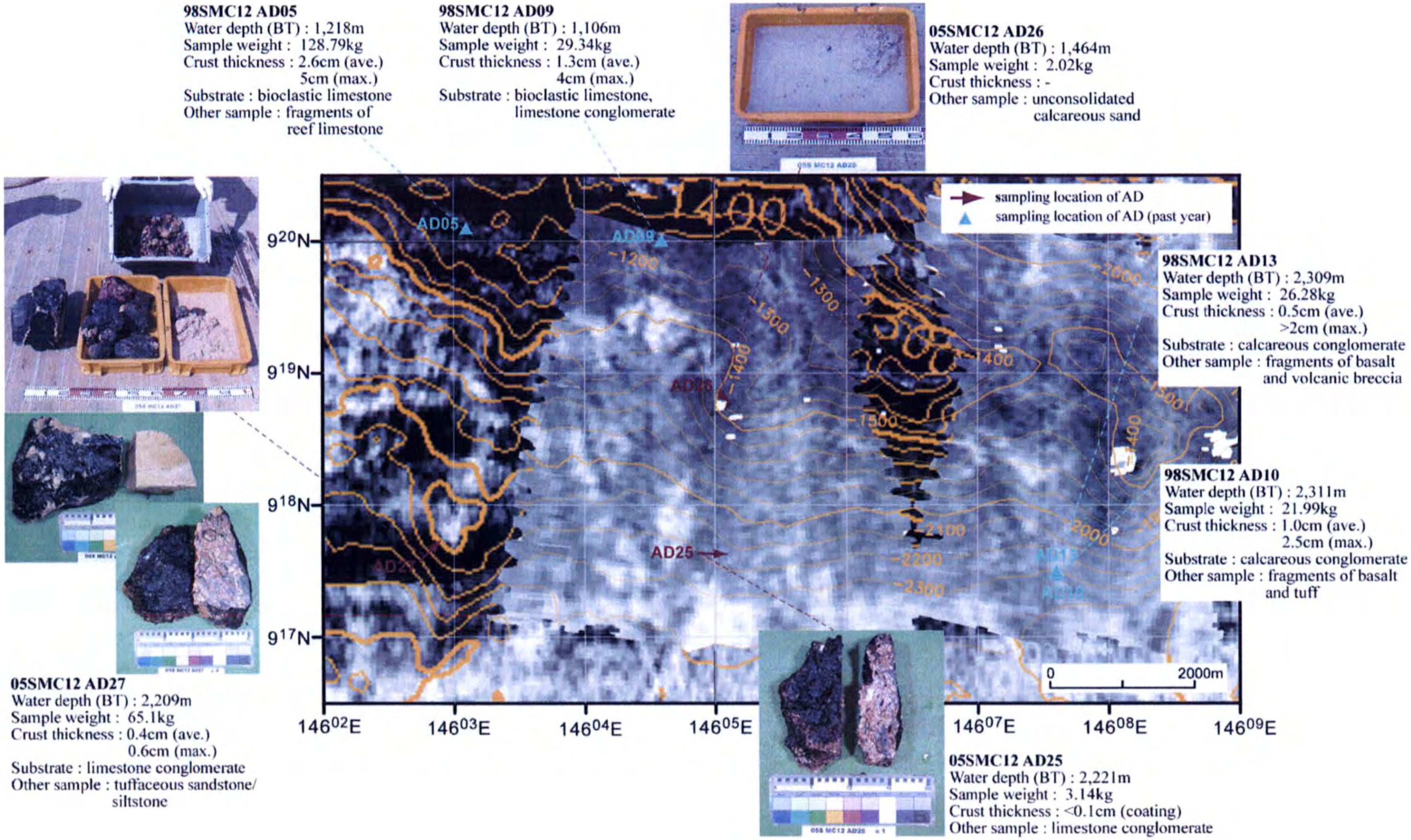


Figure 3-1-5 Acoustic Reflection Intensity and Photograph of Samples (05SMC12AD25-AD27)