

I. OUTLINE OF THE GH97 AND GA97 RESEARCH CRUISES ON THE TOKAI OFFSHORE AREA

Makoto Yuasa and Yukinobu Okamura

Introduction

This report represents the onboard research results of two cruises concerning to the AIST special research programs of "Marine Geological Investigation of Tokai Offshore Area" and "Estimation Method for Submarine Active Faults." Research area for the former program is continental shelf and upper continental slope around Izu Peninsula and off Hamamatsu, and that for the latter is lower continental slope area of Suruga Bay and Kumanonada Sea. As both areas were located side by side, the research cruises were conducted interdependently. Here we call both areas "Tokai offshore area."

The Tokai offshore area is estimated to be the seismic focal area of the Tokai Earthquake which is expected to occur in the near future. The seismic fault models have been proposed for the Tokai Earthquake. No models of earthquake fault, however, take the geological structure of the area into account because of the paucity of information of submarine geology. On the other hand, meanders of the Kuroshio current are often observed in this area. Accordingly, the sedimentary records of the area is very important to the change of the Kuroshio current accompanied with global environmental change and the materials circulating mechanisms in the ocean around Japanese islands.

Since 1974, the Geological Survey of Japan has carried on marine geological and geophysical surveys to accumulate and offer the information of marine geological data around Japan from the view points of preservation, ocean space utilization, and guarantee of submarine mineral resources. Marine geologic mapping is a main program of Marine Geology Department, GSJ to achieve the above purpose.

The goals of our research on the Tokai offshore area are as follows:

(1) To make marine geologic maps of "Enshunada Sea" and "Suruga Bay" based on the seismic profiling and sampling works off Tokai area.

(2) To make sedimentological maps of the above areas based on the sediment analysis.

(3) To elucidate the seismotectonics of the Tokai offshore area.

(4) To elucidate the material circulation and paleoenvironmental change of the area.

Those above are important goals to Japan in providing basic information useful for the elucidation of active geological structure, the exploitation of marine mineral resources, the utilization of ocean space and other various activities. Especially, if we

Keywords: marine geology, seismic survey, Tokai Offshore Area, Izu Peninsula

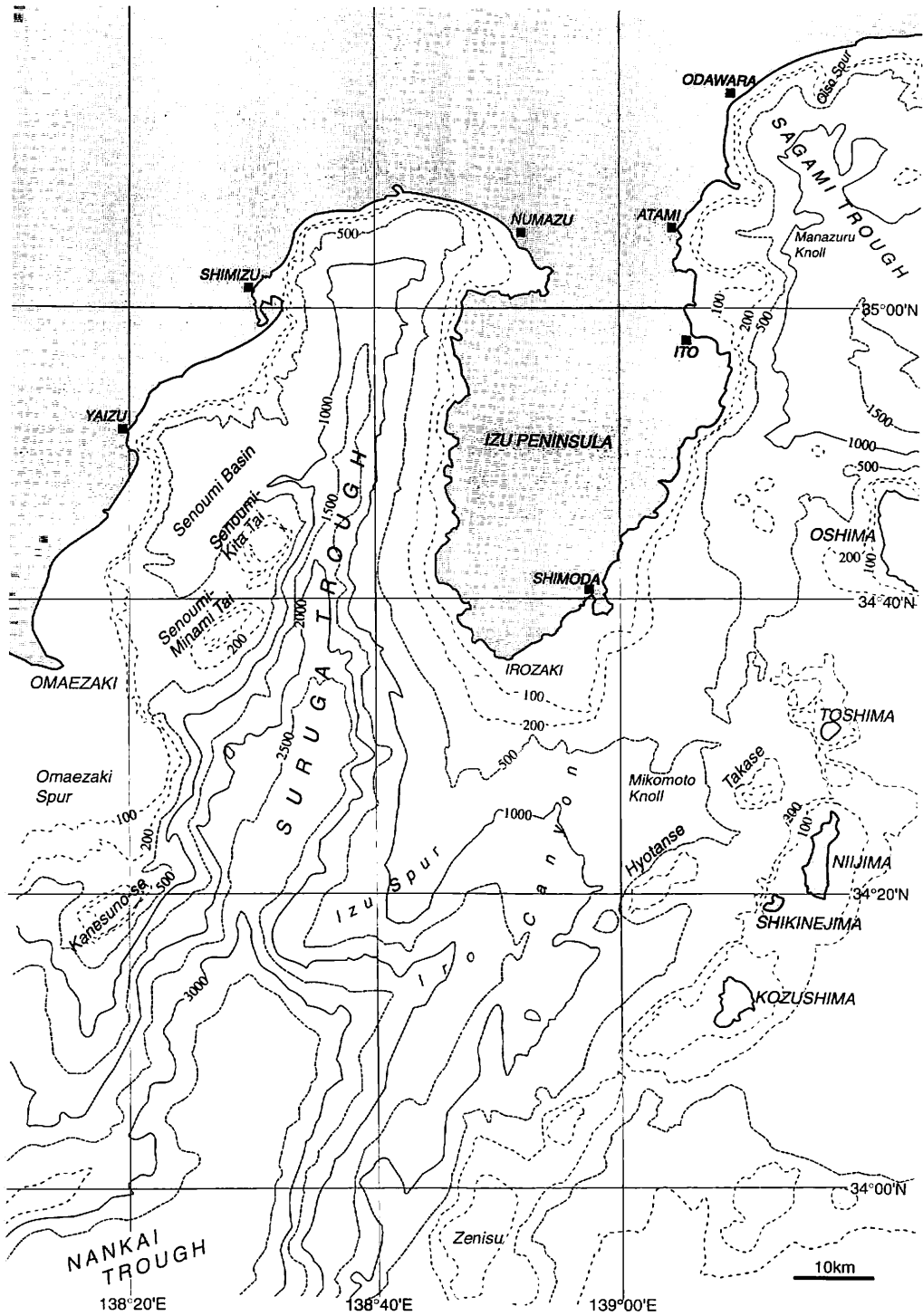


Fig. I-1 Submarine topographic map of the eastern part of the research area.

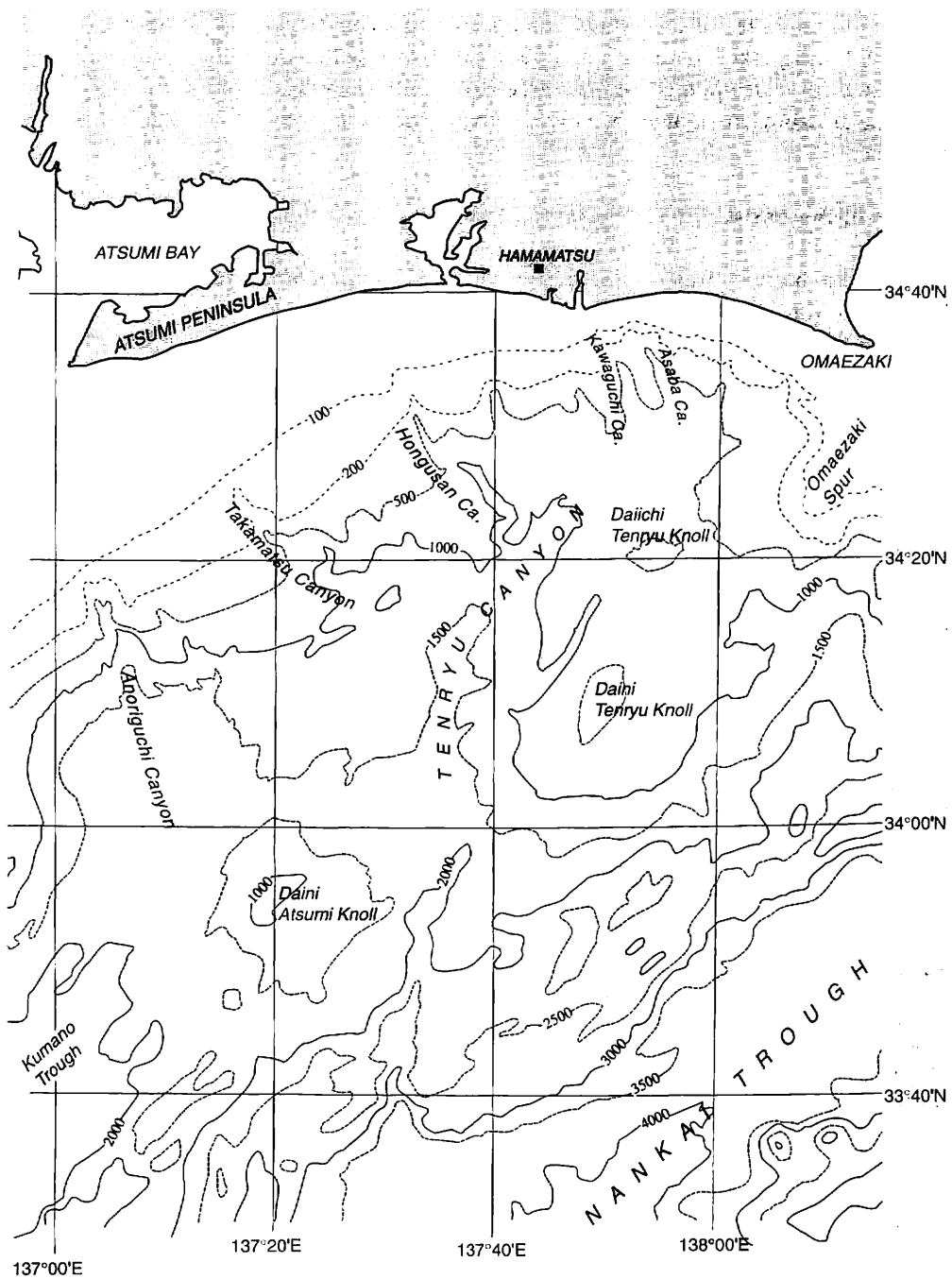


Fig. I-2 Submarine topographic map of the western part of the research area.

are able to know precisely the position and scale of the earthquake fault of “the Tokai Offshore Earthquake” based on the geological and sedimentological mapping, the confidence for earthquake damage prediction will increase. From the analysis of sediment distribution we may be able to predict the recurrence cycle of earthquake in this area.

Outline of the cruise

GH97 Cruise

The research cruise was carried out by the R/V Hakurei-maru for forty days from April 11 to May 20. During the cruise, the ship entered to Shimizu Port from April 29 to May 2 for supplement of oil, water and foods, and exchange of researchers. Tables I-1 and I-2 show the list of onboard researchers and the research cruise log of the GH 97 cruise.

Table I-1 Participants aboard the Hakurei-maru for GH97 Cruise.

Makoto YUASA	Marine Geol. GSJ	Chief researcher, sampling
Takemi ISHIHARA	Marine Geol. GSJ	Gravity and geomagnetic survey
Fumitoshi MURAKAMI	Marine Geol. GSJ	Seismic survey
Yukinobu OKAMURA	Marine Geol. GSJ	Seismic survey
Shin'ichi KURAMOTO	Marine Geol. GSJ	Seismic survey
Ken IKEHARA	Marine Geol. GSJ	Sampling
Hajime KATAYAMA	Marine Geol. GSJ	Sampling
Osamu ISHIZUKA	Chemistry, GSJ	Sampling
Masato JOSHIMA	Res. Consult. GSJ	Geomagnetic survey, heat-flow mes. and deep-tow survey
Yoshiki SAITO	Marine Geol. GSJ	Sampling
Masatoshi KOMIYA	Fuel Res., GSJ	Sampling
Kohsaku ARAI	Marine Geol. GSJ	Seismic survey
Wytze van der Werff	STA Fellow, GSJ	Guest researcher, seismic survey
Research Assistant		
Yuduru YAMAMOTO	Tsukuba University	
Shigeyuki TABARA	Ryukyu University	
Yumi HATTA	Hiroshima University	
Hajime HAMADA	Kumamoto University	
Motoi MATSUHASHI	Akita University	
Kumiko KITABAYASHI	Yamagata University	
Eiji TOMINAGA	Shizuoka University	
Eiji YAGI	Kochi University	
Iduru KOGAME	Hokkaido University	
Akio YAMAOKA	Shizuoka University	
Kazutaka KUWABARA	Kumamoto University	

Table 1-2 Cruise log of GH97 cruise. Symbols showing kinds of works are as follows; G: grab sampling, D: dredge, P: gravity coring, M: multi-channel seismic reflection survey.

GH97 Cruise Log 1 Tokai Offshore Area

Date/ Weather	Area	Work	Survey Line and Site
April 11 bc, 17.0°C	Tokyo Bay and Sagaminada Sea	Departure from Funabashi Port Seismic reflection survey	L114,113 Funabashi Port 0 Departure 18
April 12 bc, 14.0°C	East off Izu Peninsula	Seismic reflection survey and sampling work (G)	Site 55, 40, 30, 21, 14, 11, 9, 8, L 108, 2, 3, 4, 5, 6, 7, 8, 109, 110, 111 22 16 7 55 36 34 2 53 5 30 33 22 14 2 54 0 24 33
April 13 bc, 19.0°C	East off Izu Peninsula	Seismic reflection survey and sampling work (G)	Site 1, 2, 3, 5, 4, 6, 7 L 9, 10, 11, 12, 13, 14, 112, 113 39 34 34 51 45 46 34 27 15 3 2 51 8 18 4 0
April 14 bc, 17.0°C	East off Izu Peninsula	Seismic reflection survey and sampling work (G, P)	Site 56, 41, 31, 22, 15, 12, 10, 30, L STM-1, -2, -3, -4, -5, -6 4 11 56 44 33 50 55 30 20 31 21 9 1 51 11 33 P 50 M
April 15 o, 13.5°C	Izu Pen. ~ Nijijima Is.	Seismic reflection survey and sampling work (G)	Site 13, 16, 23, 24, 17, L 15, 16, 17, 18, 19, 20, 21 M 21 15 18 21 13 52 47 39 34 38 38 34
April 16 bc, 13.0°C	Near Nijijima ~ Kozu Is.	Seismic reflection survey and sampling work (G)	Site 42, 32, 33, 34, 25, 35, 45, 46, 47, 62, L 23, 22, 21, 22, 23, 24 12 12 9 4 19 13 2 55 35 46 5 19 34 30 18 28 26 20 3 54 52
April 17 c, 15.5°C	Suruga Bay, off Shimizu ~ Tago	Seismic reflection survey and sampling work (G)	Site 63, 48, 36, 27, 26, 18, 13.5, 20, 29, 39, L 23, 22, 21, 20, 18, 17, 16, 106 35 34 20 9 11 42 51 16 30 42 9 58 40 34 44 7 6 19 40 50 14
April 18 o, 16.0°C	Suruga Bay, off Shizuoka ~Ormaezaki	Seismic reflection survey and sampling work (G)	Site 77, 89, 101, 112, 102, 90, 78, 65, 64, 49, L 27, 118, 117 56 58 46 39 15 0 49 40 26 33 11 14 23 10 53 43 27 19 8 50 59 56
April 19 bc, 16.0°C	South off Izu Pen. ~ West off Kozu Is.	Seismic reflection survey and sampling work (G)	Site 111, 110, 98, 99, 100, 88, 75, 76, L 25, 26 59 20 58 30 45 58 6 32 32 51 26 58 13 21 28 51 14
April 20 bc, 15.0°C	Suruga Bay ~ North of Izu Is.	Seismic reflection survey and sampling work (G, D)	Site 61, 60, 59, DA, 44, DB, DC, DD, 43 L IZM-1, -2, -3 8 48 44 20 30 43 1 20 27 9 30 13 8 52 0 41 29 55 M

Table I-2 (Continued)

GH97 Cruise Log 2 Tokai Offshore Area

Date/ Weather	Area	Work	Survey Line and Site	2	4	6	8	10	12	14	16	18	20	22	
April 21 bc, 17.0°C	South off Izu Pen. ~ West off Kozu Is.	Seismic reflection survey and sampling work (G)	Site DE, 87, 74, DF, 73, 58, 57	33			9 14	34 42	2 42	29 42	36	30 57	33	2	
April 22 c, 16.0°C	South and west off Izu Pen.	Sampling work (G) and seismic reflection survey	Site 86, 85, 72, 71, 70, 69, 54, 53, 68, 81, L 28, 32, 107,	22			6 32	54 28	17 19	10 10	17 17	4 51	18	21	
April 23 bc, 19.2°C	Suruga Bay	Seismic reflection survey and sampling work (G, P)	Site 302, 19, 28, 37, 38, 50, 51, L 29, 30, 31	9			16 48	18 58	47 36	16 48	31 26	55 30	3	7	
April 24 bc, 15.0°C	South off Izu Pen.	Seismic reflection survey and sampling work (G, D)	Site 120, 97, 96, 84, DG, L 115, 116	33			45		12	53	5	38	21	7	
April 25 bc, 15.0°C	Suruga Bay ~ South off Izu Pen.	Seismic reflection survey and sampling work (G, P)	Site 109, 119, 303, 127, 118, L 34, 33, 29, 28	58			30	7	14	14	10	13	49	0	
April 26 bc, 17.0°C	Suruga Bay	Seismic reflection survey and sampling work (P, RC, D, G)	Site 304, RCH, 66, 52, 67, 80, 79, DI, 91, L 109, 110, 34	25			9	48	32	29	51	22	5	42	
April 27 bc, 17.0°C	South off Izu Pen. ~ Suruga Trough	Seismic reflection survey and sampling work (G)	Site 108, 107, 95, 84, 83, 82, 94, L SGM-1, -2, -3	25			53	17	56	41	44	58	37	18	
April 28 r, 15.5°C	Suruga Trough	Seismic reflection survey and sampling work (G)	Site 135, 134, 124, 123, 133, 132, 122, 121, 131, 130, 129, L 38, 37, 36,	27			47	42	29	12	56	1	39	21	3
April 29 bc, 16.5°C	Suruga Bay, Shimizu Port	Seismic reflection survey and arriving in Shimizu Port	L 35, 108	32			7	56	36	18	3	6	45	26	
April 30 c, 22.0°C	Shimizu Port	Preparing the next leg													

Table 1-2 (Continued)

GH97 Cruise Log 3 Tokai Offshore Area

Date/ Weather	Area	Work	Survey Line and Site	2	4	6	8	10	12	14	16	18	20	22
May 1 c. 20.0°C	Shimizu Port	Preparing the next leg		Shimizu Port										
May 2 bc, 17.0°C	Shimizu port and Suruga Bay	Departure from Shimizu Port and seismic reflection survey	L SGM-4, -5, -6, -7	0 24 M										
May 3 o, 16.0°C	Off Omaezaki	Seismic reflection survey and sampling work (RC.G)	Site RC-J, 92, 104, 103, 113, 114, 115 L 111, 23, 112	20	39	50	12	12	1	46	48	25		
May 4 o, 17.5°C	Off Omaezaki	Seismic reflection survey and sampling work (G)	Site 93, 105, 106, 116, 125, L SGM-8, -9, -10, -11	46	38	35	50	6	23	43	56	21	1	M
May 5 c, 19.0°C	Off Omaezaki	Seismic reflection survey and sampling work (G)	Site 117, 126, 136, 137, L 36.5, 39, 40, 41	30	9	21	40	20	19	46	21			
May 6 bc, 20.0°C	Off Omaezaki, Kanesunose Bank	Seismic reflection survey and sampling work (RC.G)	Site 158, 147, 146, 157, 156, 145, RC-K, 144, L 41, 40.5, 42, 43	31	7	58	34	18	32	0	52	55	37	
May 7 bc, 21.0°C	S'W area of Kanesunose Bank	Seismic reflection survey and sampling work (P.G)	Site 305, 306, 169, 168, 167, L 113, 114, 41	32	41	3	27	41	35	10	37	6	20	
May 8 r, 20.0°C	Off Lake Hamana and Tenryu-gawa r.	Seismic reflection survey and sampling work (G)	Site 138, 149, 148, 159, 171, 170, 182, L 102, 103, 104, 105, 106, 107, 108, 42, 43	26	4	53	25	22	52	49	17			
May 9 c, 16.0°C	Off Atsumi and Shima pens.	Seismic reflection survey and sampling work (G)	L 44, 45, 46, Site 193, 204, 203, 213, 223, 232, 240, 247, 253, L 64, 65, 66, 68	31	1	141	21	58	38	18	55	37	7	
May 10 bc, 19.0°C	Kumano Trough and Shima Pen.	Seismic reflection survey and sampling work (P.G)	Site 307, 262, 260, 261, 257, 258, L 63, 61	28	33	3	40	5	34	9	39	50	M	

Table 1 2 (Continued)

GH97 Cruise Log 4 Tokai Offshore Area

Date/ Weather	Area	Work	Survey Line and Site	2	4	6	8	10	12	14	16	18	20	22	
May 11 c. 21.0°C	Off Shima Pen. and Enshunada Sea	Seismic reflection survey and sampling work (G)	Site 250, 251, 252, 245, 246, 238, 239, L 57, 56, 55, 54				14 1	29 52	10 16	34 42	55 0	14 21	36 33		
May 12 bc. 21.0°C	Off Shima Pen. and Enshunada Sea	Seismic reflection & deep-tow surveys and sampling (P, G)	Site 308, 237, 228, 229, L 54, 53, 52, 111, 60				2 27	56 3	Deep-tow 13	1 41	16 0	37 21	33		
May 13 c. 19.0°C	Off Atsumi Pen. and Enshunada Sea	Seismic reflection & deep-tow surveys and sampling (P, G)	Site 309, 230, 231, L 55, 56				13 32	Deep-tow 4	8 11	10 7	44 31	33	M		
May 14 o. 20.0°C	Off Hama- matsu and Enshunada Sea	Seismic reflection survey and sampling work (P,G)	Site 310, 222, 221, 208, 218, 217, 207, 196, 197, L 45, 46				23 35	P 9	35 4	0 34	4 35	25 18	30	M	
May 15 o. 18.5°C	Off Hama- matsu and Enshunada Sea	Seismic reflection survey and sampling work (G)	Site 199, 210, 209, 220, 219, L 51, 50, 49, 48				45 21	49 28	17 48	54 54	40 28	52 19	54 24	52 19	27
May 16 r. 20.0°C	Off Hama- matsu and Enshunada Sea	Seismic reflection survey and sampling work (P,G)	Site 311, 180, 192, 191, 179, 312, 166, L 43.5, 44, 45, 46, 48				7 30	P 43	17 6	42 25	55 26	59 31	4 5	32 13	24
May 17 o. 18.0°C	Off Hama- matsu and Enshunada Sea	Seismic reflection & deep-tow surveys and sampling (G)	Site 198, 184, 185, 186, 174, L 47, 51				21 28	Deep-tow 40	30 13	44 26	22 50	24 49	4		
May 18 bc. 18.5°C	Omaezaki Spur, Nankai & Suruga troughs	Seismic reflection survey and sampling work (G, MC)	Site 165, 154, 155, 313, 314, L SGS-1, -2, 114, 33, 166, 115, 25, .5, 75				21 44	32 59	24 48	6 6	41 4	16 3	MC 50		
May 19 o. 18.0°C	Between Izu Pen. and Toshima Is	Seismic reflection survey and sampling work (D)	Site DL, DK				47 12	2 12	29						
May 20	Tokyo Bay Funabashi Port	Arriving in Funabashi Port and landing	Arrival in Funabashi Port 10:00												

Field survey was conducted as the combination of seismic and other geophysical surveys during the night cruising time and sampling works in day time. Deep-tow survey was operated during day-time for the reason of winch operation and manpower while at work.

We collected about 5600 km of single-channel seismic data and about 720 km of 48-channel seismic data from the area during the cruise. At the same time with seismic survey, geomagnetic survey was conducted by using proton magnetometer. Three measurement lines by deep-towing were taken from the Enshunada Sea. Gravity measurement was continued by the onboard gravimeter through the cruise.

The ship collected 234 grab, core and dredge samples of which 207 were grab samples, 12 large diameter gravity cores, 2 multiple cores, 3 rock cores, and 10 dredge samples.

The cruise was uneventful except two minor incidents. Seismic survey was stopped at one night by the propeller trouble and sampling work was stopped from May 8 afternoon to 9 morning by strong wind.

GA97 Cruise

The cruise was carried out by the Asia-maru belonging to Dokai Tugboat Co. for 19 days from July 30 to August 17. The list of onboard researchers and the research cruise log of the GA97 cruise are shown in Tables I-3 and I-4.

During the first leg of the cruise from July 31 to August 3, submarine topographic survey was carried out on the area of Kumano Trough and Nankai Trough by the long-range side-scan sonar "IZANAGI." On August 4, the ship entered to Matsuzaka Port for changing the equipment and exchange of some researchers. After that, single-channel seismic reflection surveys at night and grab sampling works at day time were continued till August 10. During the leg, as the crane for sampling work was damaged, the ship entered to the Omaezaki Port for repair on August 6. The ship entered again to the Omaezaki Port for supplement on August 10. During the last leg, seismic survey in night and sampling works in day time were repeated from August 10 to 13 like the

Table I-3 Participants aboard the Asia-maru for GA97 Cruise.

Yukinobu OKAMURA	Marine Geol. GSJ	Chief researcher, seismic survey
Shin'ichi KURAMOTO	Marine Geol. GSJ	Seismic survey
Ken IKEHARA	Marine Geol. GSJ	Sampling
Kohsaku ARAI	Marine Geol. GSJ	Seismic survey
Research Assistant		
Tohru NAKASONE	Kawasaki Geological Engineering Co.	
Ikuko KUBO	Chiba University	
Miwa SASAKI	Chiba University	
Jun'ichi OKUYAMA	Chiba University	
Jiro HIRAMURA	Kyushu University	
Shinji YONESHIMA	University of Tokyo	
Teddy PARA	University of Tokyo	
Tohru SHIMIZU	Kanazawa University	
Yoshinori KIKUCHI	Kumamoto University	
Takayuki MURAKAMI	Kumamoto University	

Table I-4 Cruise log of GA97 cruise.
 Symbols are the same as Table I-2.

GA97 Cruise Log 1 Off Tokai and Kumano

Date/ Weather	Area	Work	Survey Line and Site	2	4	6	8	10	12	14	16	18	20	22
July 30 a, 25.0°C		Departure from Yokosuka Port												
July 31 o, 26.5°C	Kumanonada Sea	Seismic reflection survey and Seid- scan sonar	L1											
Aug. 1 bc, 29.5°C	Kumanonada Sea	Seismic reflection survey and Seid- scan sonar	L2, L3											
Aug. 2 b, 30.0°C	Kumanonada Sea	Seismic reflection survey and Seid- scan sonar	L4, L5											
Aug. 3 bc, 29.5°C	Kumanonada Sea	Seismic reflection survey and Seid- scan sonar	L6, L7											
Aug. 4 bc, 31.5°C	Off Tokai	Arriv. in and depart. from Matsuzaka Port, and seismic reflection survey	L 61, 60, 59, 110											
Aug. 5 r, 28.5°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 143,142,153,141, 140, L 23, 22, 21, 20, 18, 17, 16, 106											
Aug. 6 o, 27.0°C	Off Tokai	Arriving in Omaezaki Port, and seismic reflection survey	L 106, 107,											
Aug. 7 c, 27.0°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 172,183,194,205,2 15,214,224,225,234,233 L 58, 62											
Aug. 8 bc, 29.5°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 254,259,255,249, 248,241,242,243,235, 236L 104, 105, 106, 56											

Table I-4 (continued)

GA97Cruise Log 2 Off Tokai and Kumano

Date/ Weather	Area	Work	Survey Line and Site	2	4	6	8	10	12	14	16	18	20	22
Aug. 9 b. 29.0°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 212, 211, 200, 201, 176, L 108, 109			44, 56, 11, 30, 33, 33, 4, 46	56, 5, 40, 8, 26, 5, 8, 31, 0, 8, 4, 1, 3, 6	29, 38, 3, 4, 4, 6	29, 38, 3, 4, 4, 8	18, 03				
Aug. 10 bc. 30.0°C	Off Tokai	Omaezaki Port, and seismic reflection, sampling work (G)	Site 139, L 102, 103, 105			45		35	00	14, 26, 44	10			
Aug. 11 bc. 29.0°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 256, 244, 227, 226, 216, 206, 195, 173, 160 L 104.5, 54.5, 53.5, 52.5, 51.5, 50.5, 49.5			55	27	22	22	53	20	30	18	51, 03, 55
Aug. 12 b. 29.0°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 161, 150, 139, 151, 162, 175, 187, 188, 176, L 115, 116			00	09, 28, 30	29	34	49	05	24	48	11, 29, M
Aug. 13 bc. 29.5°C	Off Tokai	Seismic reflection survey and sampling work (G)	Site 152, 163, 164, 177, 178, 190, 189, 200, 201, 202			00	06, 07, 09	17	24	29	32	35	48	56, 12, M
Aug. 14 b. 28.5°C	Kumanonada Sea	Seismic reflection survey												
Aug. 15 bc. 26.5°C	Kumanonada Sea	Seismic reflection survey												
Aug. 16 o. 26.0°C	Kumanonada Sea	Seismic reflection survey												
Aug. 17 c. 27.5°C	Matsuzaka Port	Rigging off												

middle leg. Finally multi-channel seismic reflection survey was carried out in the Kumanonada Sea from the night of August 10 to the morning of August 16.

About 980 km of single-channel seismic data and about 130 km of 48-channel seismic data were collected from the area during the cruise. Geomagnetic survey and gravity measurement were not conducted during this cruise. The ship collected 56 grab samples.

Although the timing of this cruise was chosen for stable weather and calm sea, a cold front and typhoon sometimes influenced the survey. Sampling work and multi-channel reflection survey have not been carried out as originally planned.

Acknowledgment

We acknowledge with deep gratitude the cooperation to our research cruises generously extended by the local government of the Shizuoka Prefecture and the fisheries cooperatives of the survey areas.

During the cruises, Captain K. Tamori and crew of R/V Hakurei-maru, and Y. Yamaguchi and crew of Asia-maru helped the research.

We deeply acknowledge the above persons.