OUTLINES OF THE RESEARCH CRUISES

Eiji Inoue and Junsuke Chujo

1. GH 74–3 Cruise: 10–29 June, 1974

The GH 74–3 cruise was carried out to understand the geological structure of the Izu-Ogasawara Arc and Trench and to compile a geological reconnaissance map of the area to the scale of 1 : 1,000,000.

Ship and personnel

The Hakurei-maru was chartered from the Metal Mining Agency for the research cruise. The specifications of the vessel are as follows:—

Length (o.a.)	86.95 m	
Length (p.p.)	77.00 m	
Breadth (mld.)	13.40 m	
Depth (mld.)	5.30 m	
Draft (mld.)	5.00 m	
Gross tonnage	1,821.60 m	
Service speed	15.00 kt	
Trial speed	17.78 kt	
Endurance	15,000 sea-miles	
Complement	55 persons	
Officers and crew	35 persons	
Scientists	20 persons	
Main engine	3,800 ps 230 rpm	1 set
Main generator	600 km	3 set
Propeller	4 bladed variable pitch type	1 set
Special equipment	Bow thruster	1 set

The vessel was commanded by Captain Seiji TOKI with 30 officers and crew.

Table 1 Scientific staff in GH 74–3 cruise.

Name	Organization	Speciality
Eiji INOUE	G.S.J.	Geologist, chief scientist
Eiichi HONZA	G.S.J.	Geologist, air-gun and sampling
Masaaki KIMURA	G.S.J.	Geologist, geological structure
Kouji ONODERA	G.S.J.	Topographer, PDR and sampling
Kiyondo MUKAI	G.S.J.	Topographer, PDR
Yoshihisa OKUDA	G.S.J.	Geologist, air-gun
Makoto YUASA	G.S.J.	Petrologist, sampling
Takemi ISHIHARA	G.S.J.	Geophysicist, NNSS and gravity
Eiichi TOKUYAMA	University of Tokyo	Student
Kantaro FUJIOKA	University of Tokyo	Student
Tohru HOSHINO	Nippon Univ.	Student
Masahiro MINAMISHIN	Kyushu Univ.	Student
Moriyuki NAKAMURA	Kyushu Univ.	Student

The scientific party consisted of eight scientists of the G.S.J. and five students from several universities as listed in Table 1. Eiji INOUE acted as party chief for the scientific group through the cruise. In addition to the above, two journalists from NHK TV and an engineer from Mitsubishi Heavy Industries Ltd. joined the cruise.

Method and survey equipment

In order to understand the outline of the geological structure efficiently, five seismic traverse lines of geophysical surveys were zig-zagged across the Izu-Ogasawara Arc and Trench, and another traverse line was run along the western part of the arc. Sampling of the rocks from ridges and sediments of the abyssal plain was carried out at several places along the traverse lines (Fig. 2).

1) Position fixing and navigation

Satellite and Loran-C navigation system were simultaneously used for the navigation and position fixing of all geophysical lines and sampling stations.

The Navy Navigation Satallite System (NNSS) manufactured by the Magna Vox Company was used for the satellite navigation. With this instrument a satellite position fixing accuracy of 120 feet RMS is obtainable. The system also dead reckons in latitude and longitude based on doppllr sonar or electro-magnetic log and gyrocompass imputs. The results are displayed on the CRT's and printed on the TTY. The system has two magnetic tape transports which automatically log all navigational and geophysical data, i.e. depth, magnetometer and gravity-meter data.

During the cruise the electromagnetic log was mainly used for measuring the ship speed, because of the great depths of water in the area surveyed.

The receiver of Loran C is LR-3 ZA 1 manufactured by the Furuno Electric Co. and an automatic and electronic tracking system. The master station of Loran C is Iojima Island and the slave stations are Okinawa for X lanes and Hokkaido for Y lanes. The outputs of Loran C were recorded on a XY plotter as tracking charts on the scale of 1 : 500,000.

2) Geophysical surveys

The geophysical surveys of the cruise included measurement of gravity anomalies, seismic reflection surveys with air-gun equipment and sub-bottom profiler (3.5 kHz) and bathymetry using a Precision Depth Recorder.

The NS-16 Precision Depth Recorder (PDR) manufactured by the Nippon Electric Co. has the characteristics of 12 kHz ultrasonic frequency, 17° beam width of transducer, 4 kW transmitter output power, and 0–1,000 m, 0–6,000 m and 0–12,000 m range changes. The PDR was operated throughout the cruise and obtained good bathymetric data.

The air-gun equipment manufactured by the Bolt Co. was used for the seismic reflection survey. An air-gun having 120 cubic inch air-firing at 2,000 p.s.i.g., provided the sound source at 5–10 second intervals. The air-compressor of 120 CFM was installed in the stern deck. The signal received by a 15 or 50 element hydrophone array, which was towed for 200 m from the stern, was amplified and band-pass filtered at 50–150 Hz prior to display on the graphic recorder. A surveying speed of 10 knots was adopted. Throughout the cruise the air-compressor sometimes had troubles which occurred mainly in the unloading system when the compressor was used for long operations.

The sub-bottom profiler manufactured by the Raytheon Co. consists of a transducer (model TR-75A, 3.5 kHz ultrasonic frequency, 40° beam width, 200 w input power and

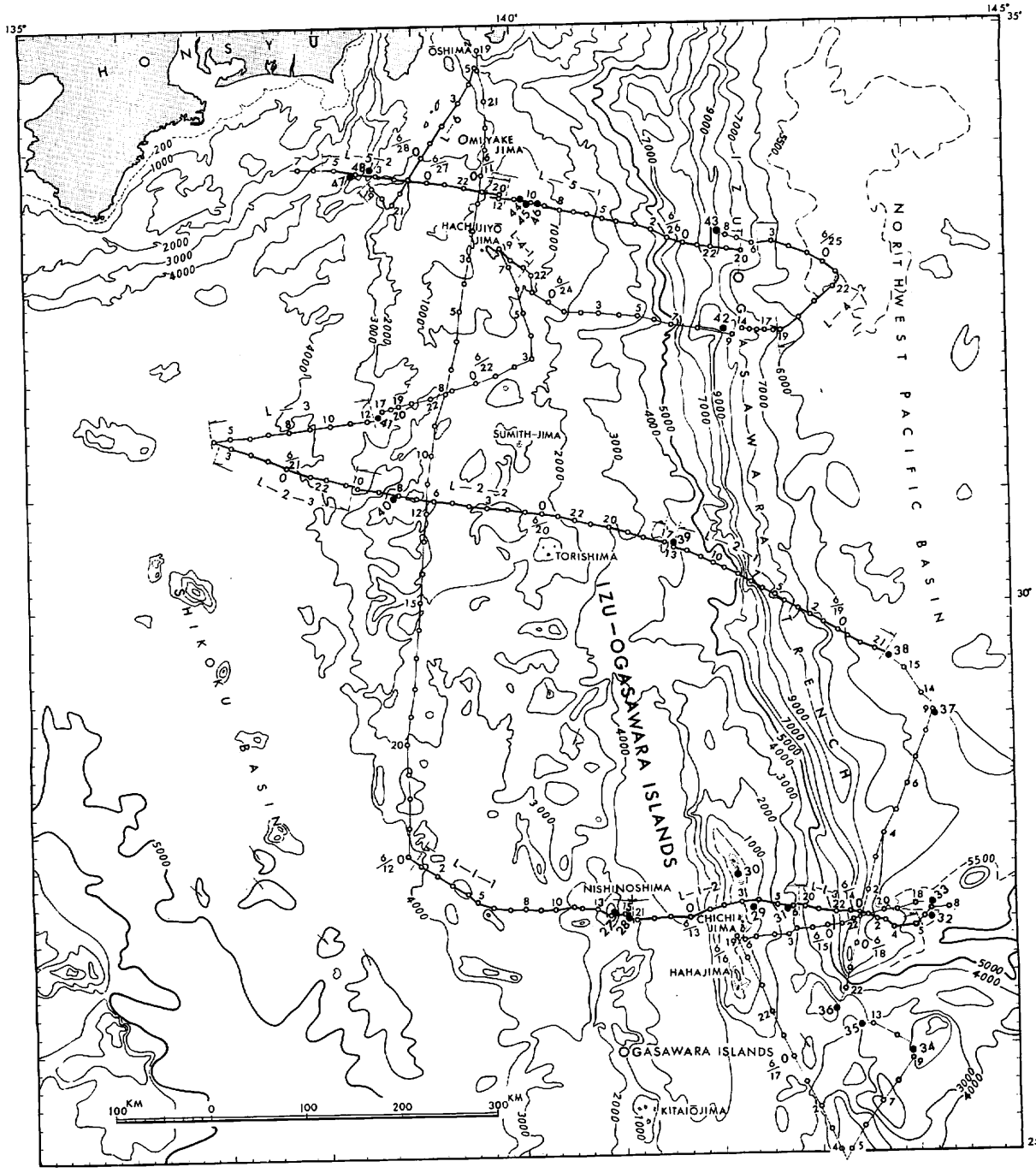

Fig. 2 Seismic traverse lines and sampling stations of GH 74–3 cruise in Izu-Ogasawara Arc and Trench.

10,000 m available depth of water), a transceiver (model PTR-105A), a correlation processor (model CESP-II), a graphic recorder (UGR 196A) and a digitizer (model PDD-200B). The equipment was operated throughout the cruise and provided good records of the seismic profiles of surface sediments.

The air-sea gravity-meter made by Lacoste and Romberg Co. was used for gravity measurement throughout the cruise. The gravity-meter consists of a highly damped, zero-length spring type gravity sensor mounted on a stabilized platform with associated control electronics and a recording system. The meter has an accuracy within 1 milligal at a horizontal and vertical accelation of ± 0.1 g.

3) Sampling operations and samplers

Rock sampling was carried out at the slope or the tops of the ridges with dredges, and soft sediment sampling was made by a piston-corer on the abyssal plain. For rock sampling a cylinder-type dredge and a chain-bag dredge were used. The former is a cylinder of steel, 30 cm in diameter and 90 cm in length and the latter is a cylinder 40 cm in diameter and 60 cm in length with 120 cm of iron net (Fig. 3). In the earlier half of the cruise only the cylinder dredge was used, while the chain-bag dredge was used together with the cylinder-type dredge simultaneously in the latter half of the cruise. The connection of both the dredges is shown in Fig. 3.

Dredging was carried out by No. 1 winch with three strand wire-rope of 12 mm diameter over the gantry at the stern. To prevent the floating of the dredges on the sea bottom, a weight of 260 kg was attached to the front of the dredge.

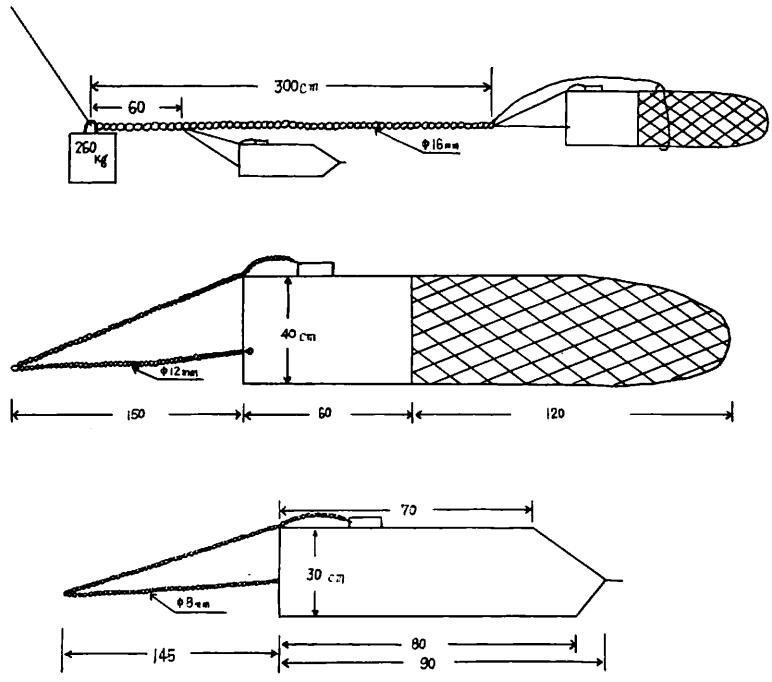

Fig. 3 Dimensions of cylinder-type dredge and chain-bag dredge used in GH 74–3 cruise and connection of both the dredges (drawn by Yasumasa KINOSHITA).

Dredging durations between arrival at the sea bottom and detachment of the dredges required from 8 to 132 minutes, usually between 20 and 40 minutes, in relation to bottom and sea conditions (Table 2). Working time between the dredge lowering and return on board ranged from 24 minutes to 2 hours 47 minutes. The time mostly depended on the depth of water. The common extending speed of the wire-rope was 0.8 m/sec, and the up-pulling speed was 1–1.2 m/sec.

The dredges were always towed from the lower to the upper part of the slopes of the ridges in order to take rock fragments effectively. The vessel ran at 0.5 knots or drifted with the current during the dredging operation. The towing condition and behavior of the dredges on the sea bottom were estimated by observing the tension-meter in the winch control room.

Core-sampling of soft sediments was carried out with a piston-corer of 6 m length, which was operated by No. 2 winch with 12 mm diameter wire-rope through the gallows. The piston-corer is composed of 450 kg weight of lead and 6 m of length of aluminium core barrel with a pilot-corer of 1 m length and a balance (Fig. 4). Coring was carried out at three stations on the deep sea floor and 3.3 m of sediment core was obtained at one of the stations.

The lowering wire-rope speed was 1 m/sec. When the corer approached near the sea floor, the wire-rope was stopped and oriented perpendicular. After the wire-rope was oriented the rope was slowly lowered until the pilot-corer attached to the sea floor. The attachment and detachment of the piston-corer were distinctively recognized on the tension-meter. The up-pulling speed of the wire-rope was 1.5m/sec.

Progress of the work

The Hakurei-maru sailed from Chiba on the 10th of June and sailed west of Nishinoshima Island along the Nishi-Shichito Ridge, recording bathymetry and gravity. The seismic reflection survey, using the air-gun equipment, was commenced west of Nishinoshima and was continued to Futami Port at Chichijima Island along traverse line 1. Rock sampling was carried out at four stations near the volcanic islands of Nishinoshima, Chichijima and Mukoshima. Coring of deep sea sediments was carried out at two stations on the abyssal plain of the Pacific.

On the morning of 15th, the vessel anchored at Futami Port at Chichijima Island for rest of personnel. The vessel left port on the evening of the 16th, and sailed south to the northern margin of the Mariana Trench and changed to a NNE course. The vessel course was planned to obtain geological and geophysical data from the Ogasawara Plateau. However, this project almost failed because of serious trouble with the air-compressor of the air-gun equipment and unsuccessful sampling of rocks from the plateau. After the vessel passed the plateau, successful coring of the deep sea sediments was made at two stations on the abyssal plain of the Pacific.

The vessel took the course of traverse line 2 from the evening of the 18th, passed north of Torishima Island and arrived at the Shikoku Basin for geophysical surveys. Along the traverse line green tuffaceous rocks were dredged from two stations on the slopes of the ridges. The vessel started on traverse line 3 on the morning of the 21st but again there was trouble with the air-compressor. Consequently dredging was only made on the slope of the ridge. On the morning of the 22nd, the vessel reached Konominato Port at Hachijo Island for personnel change. In the afternoon of the 23rd the vessel left port

Table 2 Sampling operation

Date	St. No.	Tool	Area, Topography	Ship positions: Hit Lat. N.	Hit Long. E	Lift off Lat. N	Lift off Long. E	Depth (m): Start	Hit	Lift
Jun. 12	27	D	Southern slope of Nishino-shima	27°13.5′	140°53.6′	27°13.5′	140°53.5′	320	175	165
12	28	D	Eastern slope of Nishinoshima	27°13.0′	141°04.2′	27°13.0′	141°03.7′	2,800	2,705	2,692
13	29	D	Slope off Chichijima Is.	27°17.3′	142°21.0′	27°17.5′	142°21.0′	800	625	610
14	30	P	Abyssal plain east off Chichijima	27°11.0′	144°10.0′	—	—	5,540	5,530	5,530
14	30	D	Col between Mukojima and Yomejima	27°34.1′	142°12.2′	27°34.1′	142°12.2′	127	105	105
14	31	D	Slope east of Chichijima	27°15.2′	142°40.4′	27°15.2′	142°40.7′	3,250	3,220	3,127
17	34	D	Slope of Ogasa-wara plateau	25°55.5′	143°55.0′	25°55.9′	143°56.0′	2,300	2,300	2,280
17	35	D	Col of west of Ogasawara plateau	26°10.5′	143°23.0′	26°10.5′	143°24.0′	2,700	2,640	2,630
18	37	P	Abyssal plain east of Chichijima	29°00.7′	144°12.5′	—	—	5,630	5,580	5,580
18	38	P	ditto	29°31.5′	143°45.0′	—	—	5,600	5,620	5,620
19	39	D	Slope of sea hill east of Torishima	30°32.4′	141°34.0′	30°32.3′	141°34.7′	3,500	3,370	3,360
20	40	Ch D	Slope of sea mount north-west of Tori-shima	30°59.5′	138°46.5′	30°59.5′	138°46.5′	1,880	1,670	1,670
21	41	Ch D	Slope of sea mt. south of Hachijyo	31°41.0′	138°36.0′	31°42.5′	138°36.5	3,200	2,900	2,350
26	44	Ch D	Top of hill south of Mikurajima	33°32.3′	140°06.5′	33°33.1′	140°07.3′	190	180	177
26	45	Ch D	Small cliff south of Miyake	33°30.1′	140°09.5′	?	?		250	168
26	46	Ch D	Slope south of Miyake	33°29.5′	140°16.7′	33°29.3′	140°16.5′	300	225	205
27	48	Ch D	Slope of Zenisu	33°50.0′	138°32.0′	33°48.1′	138°30.5′		1,000	700

log in GH 74–3 cruise.

Time				Dura-tion	Wire-out (m)		Wire angle	Sam-ple No.	Sample	Operator	Remarks
Start	Hit	Lift	Finish		Hit	Lift					
1648	1656	1706	1712	10 min.	250	170	22° ~ 28°	D18	Volcanic sd. Rock	H. HONZA	
1850	1928	1949	2020	21	2,900	2,700	8° ~ 13°	D19	Silty sd. volcanic Rock	M. YUASA	
0839	0909	0920	0932	11	703	625	20° ~ 3°	D20	Volcanic rock	〃	
0920	1052	1052	1225	0	5,584	—	0°	P4	Red clay 0.57 m	K. ONODERA	18 cm core
1321	1330	—	1338	—	130	—	30°	D21	Coral	M. YUASA	
1550	1648	1717	1755	29	3,333	3,146	20° ~ 6°	D22	Sand and mds.	H. HONZA	
0928	1008	1041	1110	33	2,519	—	20°	D23	Calcareous ooze, pumice	M. YUASA	
1406	1443	1518	1551	35	2,816	2,670	18°	D24	Sand and manganese nod.	〃	
0911	1110	1110	1250	0	5,603	5,603	0°	P5	Red clay 3.3 m	K. ONODERA	330 cm core
1600	1800	1800	1935	0	5,655	5,655	0°	P6	Red clay 0.13 m	〃	13 cm core
1313	1455	1514	1600	19	3,650	3,440	14° ~ 15°	D25	Sand and pumice	M. YUASA	
1620	1745	1753	1823	8	2,170	1,833	25° ~ 27°	D26	Calcareous s.s.	〃	
1342	1424	1636	1704	132	3,198	2,402	19° ~ 18°	D27	Silt and pumice	〃	
1318	1325	1338	1344	13	201	201	12°	D28	Coral sponge	〃	
1458	1526	1541	1548	15	250	168	0°	D29	Coral sponge	E. INOUE	
1653	1730	1743	1747	13	280	—	0°	D30	Coral	K. ONODERA	
1542	1636	1723	1740	47	2,020	877	33°	D31	Silt and tuff	M. YUASA	

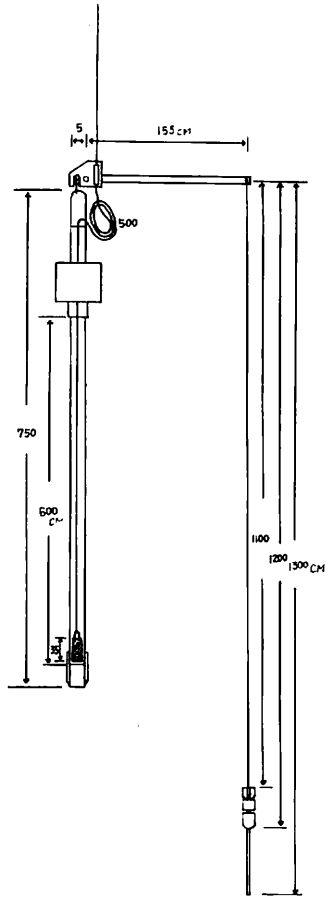

Fig. 4 Piston-corer used in GH 74–3 cruise (drawn by Yasumasa KINOSHITA).

and sailed to the deep trench along traverse line 4, carring out gravity and bathymetry measurements. Testing of No. 1 winch drum was carried out at a depth of 8,780 m in the trench from 0937 to 1338 on the 24th and 9,500 m of wire-rope was extended to the trench bottom. During the test, the deformation of the winch drum was precisely measured.

On the 25th, testing of No. 2 winch drum was carried out at a depth of 9,000 m in the trench with the extension of 3,000 m of wire-rope. Subsequently No. 3 winch was tested at the same place. The wire-rope with the Shipek grab was extended for 11,000 m, but the grab did not reach the trench bottom. The operation of No. 3 winch was satisfactory.

After the tests, the vessel changed course to traverse line 5. A seismic survey was carried out and rock sampling was done at three satations on the ridge south of Miyakejima Island on the 26th.

Further dredging took place at two stations on the northern extension of the Nishi-Shichito Ridge on the 27th and obtained tuffaceous rock fragments. From the last sampling station, the vessel sailed along traverse line 6 to Oshima Island continuing a seismic survey.

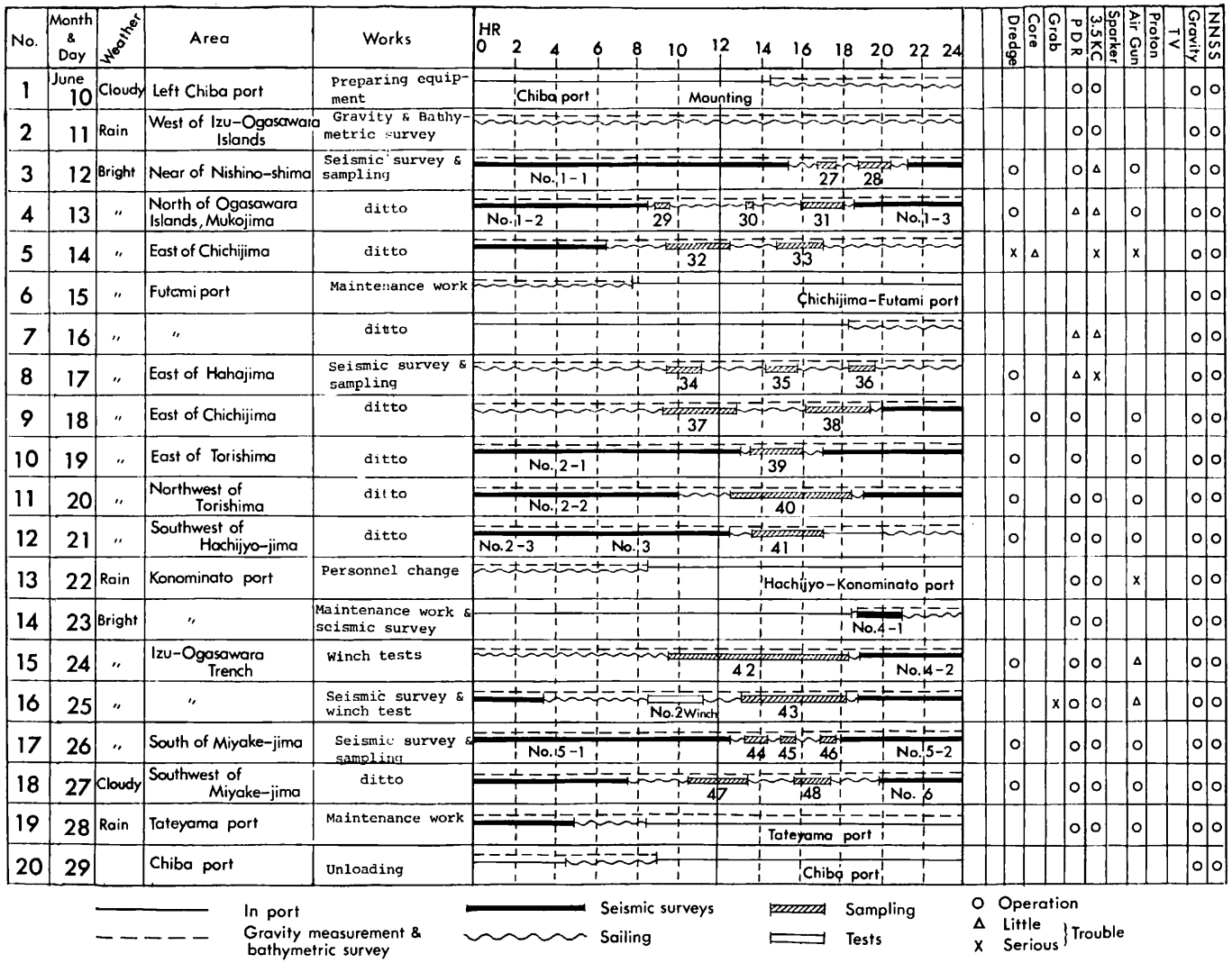

Fig. 5 Progress of GH 74-3 cruise, June 1974.

The vessel anchored at Tateyama Port for maintenance work of the survey equipment on the 28th and arrived at Chiba Port on the 29th.

Throughout the cruise, a total of sailing hours of the vessel was 15 days 2 hours with a total sailing distance of 3,118.5 sea miles. Of the 20 total days of the cruise there were 13 days of research work, 4 days for the maintenance of equipment and 3 days in harbour.

The progress of the cruise is summarized in Fig. 5.

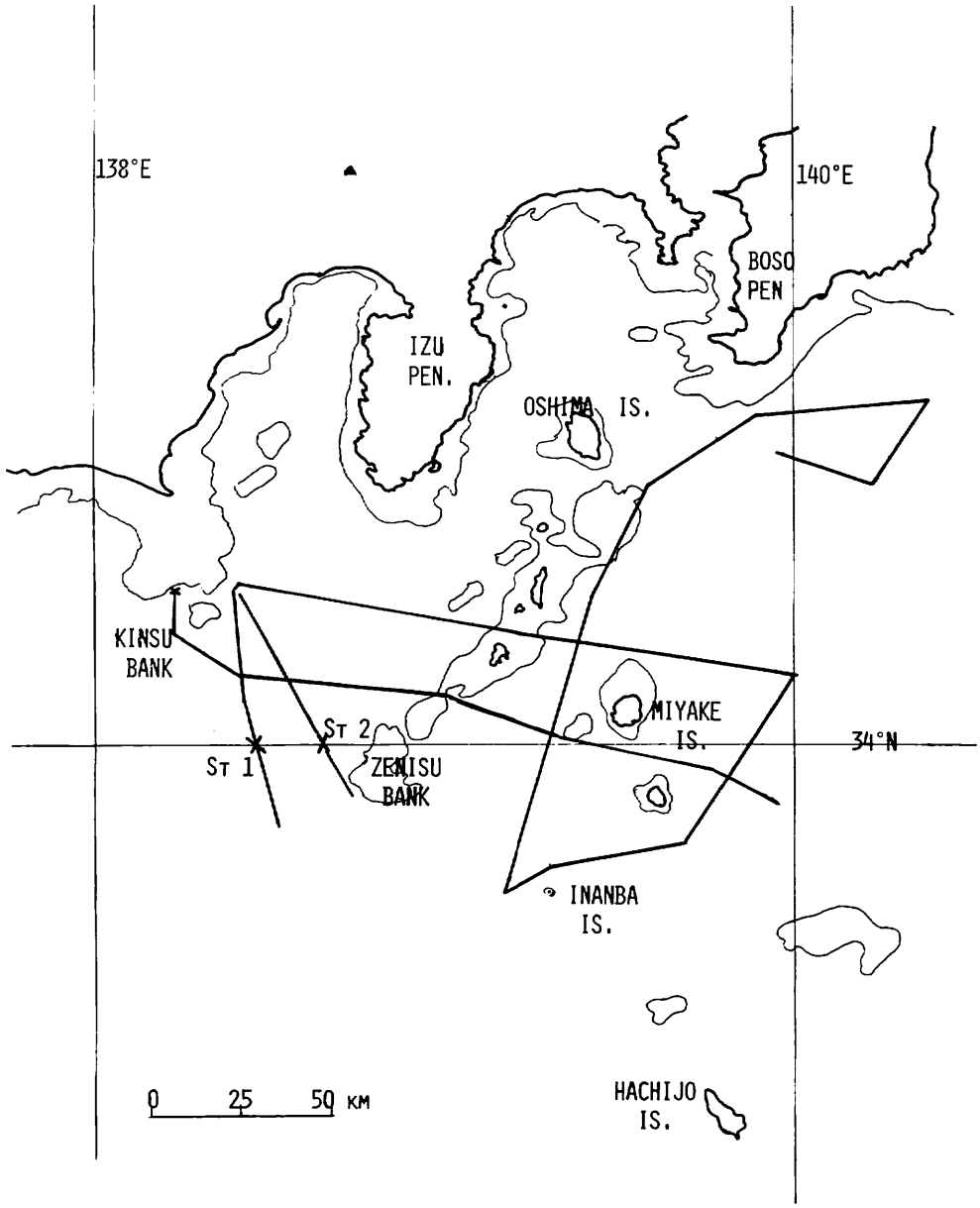

Fig. 6 The area surveyed in GH 74–6 cruise.

Data obtained

PDR and gravity-meter traverses	3,118.7 sea miles
Seismic reflection traverses	1,207.0 sea miles
Total sampling stations	22
Dredge samples	14
Piston-corer samples	3
Sites where no sample were obtained	5

2. GH 74–6 Cruise: 27 October-1 November, 1974

The GH 74–6 cruise was carried out in the area around the Izu-Shichito Islands for the purposes of supplementing the survey of the previous cruise and training foreign students. The area surveyed which is surrounded by latitudes of 35°00′ and 33°40′N and longitudes of 138°40′ and 140°40′E, includes the Izu-Shichito Islands and the Sagami Trough (Fig. 6).

Ship and personnel

The cruise was made by the Hakurei-maru chartered from the Metal Mining Agency. The vessel was manned by captain Seiji TOKI with 32 officers and crew.

Five geologists and geophysicists of the G.S.J. comprised the scientific party of the cruise and were managed by Junsuke CHUJO as shown in Table 3. Fourteen foreign students on board led by Mr. I. HIRANO of the Japan International Co-operation Agency are listed in Table 4.

Method

To supplement the geological investigation of the previous cruise, geophysical traverses and sampling stations were planned as shown in Fig. 6. Five traverses were made; namely, from the west of the Kinsu Shoal to the east of Mikurajima Island, from west of the Zenisu Shoal to the Kinsu Shoal across the Nankai Trough, from the Kinsu Shoal to the east of Miyake Island, from here to Innaba Island and from here to the Boso Peninsula across the Izu-Shichito Ridge and the Sagami Trough.

The geophysical survey includes seismic reflection survey by air-gun equipment, superficial sediment survey using a 3.5 kHz sub-bottom profiler, gravity survey using an on board Sea-air gravity-meter and magnetic survey with a Proton magnetometer.

The samplers used were an Ocean-type grab, a cylinder type dredge and a chain-bag dredge.

Position fixing and navigation

Satellite and Loran C navigation systems were used simultaneously. The equipment and the methods of both the navigation systems are explained later in detail.

Table 3 Scientific staff in GH 74–6 cruise.

Name	Organization	Speciality
Junsuke CHUJO	G.S.J.	Geophysicist, chief scientist
Shuji MARUYAMA	G.S.J.	Mineralogist, sampling
Takemi ISHIHARA	G.S.J.	Geophysicist, NNSS and gravity
Yoshihisa OKUDA	G.S.J.	Geologist, air-gun
Takeo MATSUDA	G.S.J.	Geophysicist, leader of foreign students

Table 4 Foreign students joined GH 74-6 cruise.

Country	Name	Present post
Bangladesh	Mohammed Abdul Ghafur	Geophysicist, Oil and Gas Develop. Corporation, Ministry of National Resources
Burma	U Soe H Laing	Geophysicist, Myanma Oil Corp.
Egypt	Emil Kamel Malak	Geologist, National Research Center, Ministry of Scientific Research and Technology
Egypt	Moustafa Hasanien Yossef Hashad	Geologist, National Research Center, Ministry of Scientific Research and Technology
Indonesia	Mual Halomoan Panggabean	Petroleum Geologist, Exploration and Production Div., Directorate of Oil and Gas, Indonesia
Indonesia	Sani Marzuki	Geophysicist, Geophysic Sec., Explor. Div., Geological Survey of Indonesia
Khmer	Meng Em Khan	Mining Engineer, Geology and Petroleum Services, Ministry of Industry
Korea	Jong Nam Park	Geophysicist, Mineral Inst. of Korea
Libya	Sanousi Sulaiman Kanna	Petroleum Geologist, National Oil Corporation
Malaysia	Chen Shick Pei	Geologist, Geological Survey of Malaysia
Nigeria	Leo Chukwujekwu Okacha	Petroleum Engineer, Federal Ministry of Mines and Power
Peru	Edgar Dimas Valdivia Uiloa	Geologist, Ministerio de Energia y Minas
Philippines	Bassanio Vargas	Geologist, Bureau of Mines
Thailand	Somphong Rodphothong	Geophysicist, Economic Geology Sect., Dept. of Mineral Resources
Viet-Nam	Tran Hoang-Ngoc	Geologist, Directorate of Natural Resources

Progress of the work

During the cruise sea conditions were rough, so that the vessel twice sheltered from gales in Tateyama Port. In addition to the above, troubles with the air-gun equipment often interrupted the seismic survey.

The daily log is as follows;—

Oct. 28	rough condition	1400 started Funabashi Port and sheltered from gale at Tateyama Port.
29	cloud	0530 started Tateyama. Geophysical survey on the traverse line 1 between 1654 and 2354.
30	rain	Sampling work with Ocean-type grab at station 1 between 0800 and 1030. From 1300 rock sampling with dredges at station 2.
31	cloud and gale	Geophysical surveys on the traverse line 4 between 0100 and 0700 and on the traverse line 5 between 0900 and 0930. Sheltered from gale in Tateyama at 2200.
Nov. 1	fine	0730 started Tateyama and 1400 arrived at Funabashi. Unloading work.

A total time of the cruise was 3 days and 7 hours. A total distance of the cruise was

772 sea miles.

Obtained data

Geophysical traverses	376 sea miles
Sampling stations	2
Grab sample	1
Dredge sample	1