

Preliminary Report
of
The Hakuho Maru Cruise KH-71-1

January 21—March 25, 1971

East Mariana, Caroline
and Philippine Basins

Ocean Research Institute

University of Tokyo

1973

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by
the Scientific Members of the Expedition
edited by
Yoshihumi TOMODA

1973

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1. Scientists Aboard the Hakuho Maru for the Cruise KH-71-1

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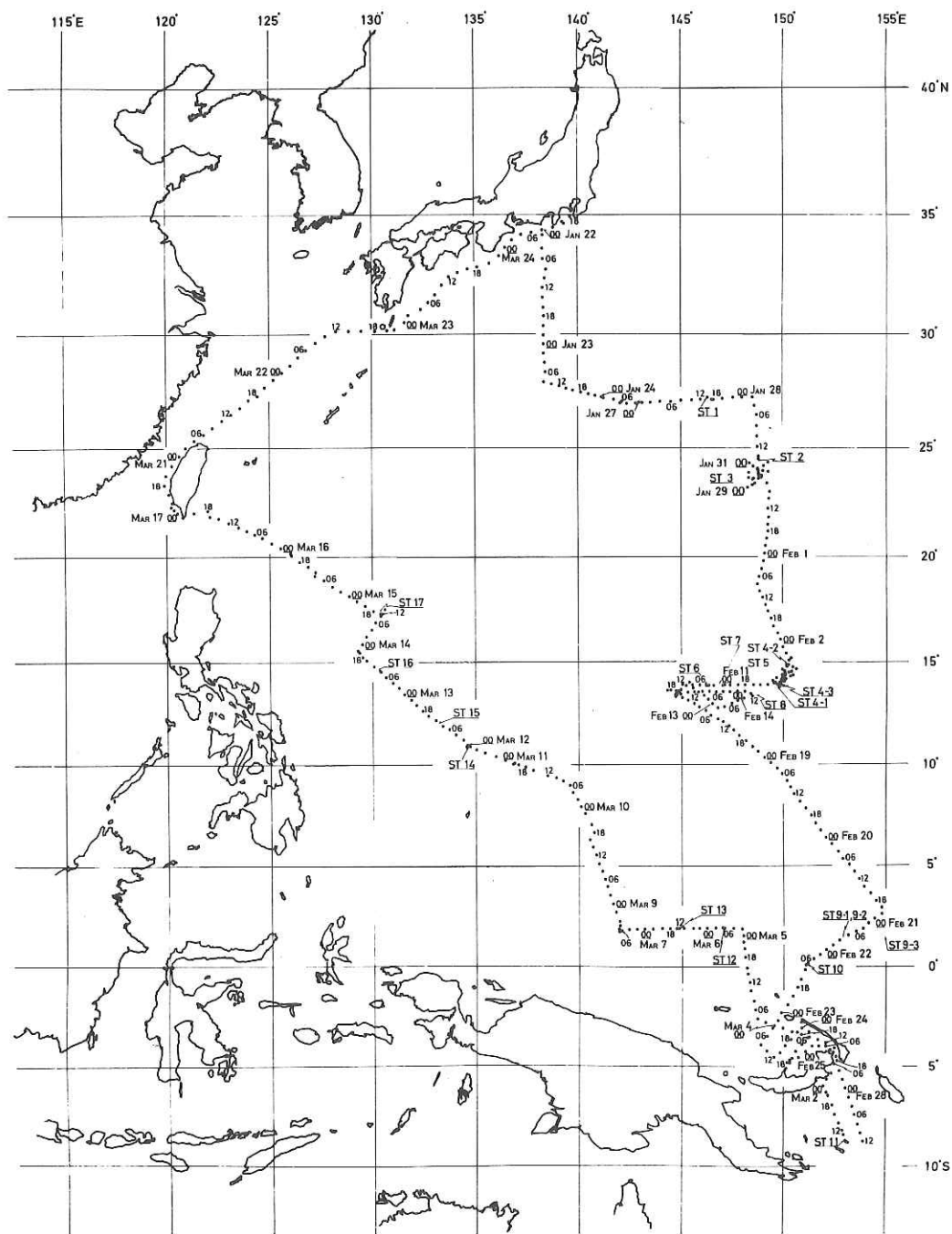
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(under the contract with Okanishi Dynamite Co.)

Remarks: * From Feb. 15 to Mar. 25
 ** From Jan. 21 to Feb. 15

2. Index Map of the Cruise



3. List of Research Stations (KH-71-1 Cruise)

Station no.	Position		Date	Time Start or Obs. Hit End	Depth (m) Echo- soun- der	Research & Observations	
	Lat.	Long.				Corr.	
1	27° 12.4'N	146° 16.0'E	JAN. 27	14:16-15:32-17:42	5500	5534	Dredge Haul (Pipe dredge) → 100 kg of surface sediment (brown clay with volcanic ash) collected
2	24° 27.0'N	148° 48.0'E	28	14:54-16:13-18:00	5700	5741	Piston Coring → failed & Corer lost
3-1	23° 49.5'N	148° 42.0'E	29	09:08-10:41-11:50	1220	1213	Dredge Haul (Chain-bag dredge) → failed & lost
3-2	23° 48.2'N	148° 43.8'E	29	12:20-13:00-13:50	1050 1500	1045 1490	Deep-sea Camera → photos of rocks were taken
3-3	23° 49.0'N	148° 46.5'E	30	09:39-10:21-12:20	1050	1045	Dredge Haul (Chain-bag dredge) → several hundreds kgs (89 pieces) of Mn-coated limestones collected
3-4	23° 49.5'N	148° 46.5'E	30	13:00	1060	1055	Deep-sea Camera → photos of the flat-top surface taken
4-1	13° 55.5'N	149° 43.6'E	FEB. 02	17:08	5790	5834	Nansen cast
*	see detailed descriptions in the following chapter		03 ~ 09				Seismic exploitation using OBS & a sono-radiobouy by means of arti- ficial explosions of 1 ton powder
4-2	14° 51.3'N	150° 12.6'E	04	22:00	5790	5834	STD
4-3	13° 59.0'N	149° 50.2'E	05	20:00	5790	5834	STD
5	14° 00.6'N	149° 44.9'E	09	16:05-19:30-23:30	5790	5834	Deep-sea Camera → failed

Station no.	Position		Date	Time		Depth (m)	Research & Observations
	Lat.	Long.		Start	Obs. or Hit End	Echo- soun- der	
6	13° 53.4N	146° 17.5E	FEB. 11	08:10-12:49-14:04		4120 4117	Dredge Haul (Pipe dredge) →several pieces of gravels & pebbles collected
7	13° 55.5N	146° 53.5E	11	-20:47-		8000 8165	Dredge Haul (Pipe dredge) → failed
8	13° 25.0N	148° 41.7E	13	13:15-15:22-18:25		5680 5719	Piston Coring → failed
9-1	01° 25.8N	152° 57.5E	21	10:05-11:05-13:35		3810 3805	Piston Coring → 965 cm of calcareous ooze (with brown clay) collected
9-2	01° 27.0N	152° 57.5E	21	12:45	-16:00	3830 3822	Nansen cast
9-3	01° 28.0N	153° 53.5E	21	16:08	-17:06	3830 3822	STD
10	00° 09.8N	151° 11.5E	22	09:00-10:30-12:00		5685 5728	Piston Coring → failed
*	03° 01.8S	150° 52.1E	23	22:02	-23:20	1190 1190	Biological Sampling
11	08° 44.8S	153° 01.1E	MAR. 01	18:10-20:00-21:00		2740 2733 2950 2944	Deep-sea Camera → bottom sediment with ripple marks taken
12-1	01° 52.0N	147° 02.3E	05	07:25-08:44-09:50		4500 4509	Piston Coring → 886 cm of calcareons brown clay collected
12-2	01° 53.0N	147° 02.0E	05	10:14-		4520 4529	Piston Coring (large diameter) →564 cm of calcareons brown clay collected
12-3	01° 53.5N	147° 06.0E	05	13:44-15:31-17:00		4550 4559	Dredge Haul (Pipe dredge) → failed
12-4	01° 52.5N	147° 01.0E	05			4490	STD
13-1	01° 53.1N	144° 56.4E	06	07:17-08:35-09:45		4522 4531	Piston Coring → 769 cm of calcareons brown clay collected

Station no.	Position		Date	Time		Depth (m)	Research & Observations
	Lat.	Long.		Start	Obs. or Hit End	Echo- soun- Corr. der	
13-2	01° 54.6N	144° 53.2E	MAR.06	09:53-12:25	14:50	4350 4355	Dredge Haul (Pipe dredge) → 140 kgs of surface brown clay collected
*	see detailed descriptions in the following chapter		07 ~08				Seismic exploitation using OBS & sono-radiobouy with VITYAZ : explosives shot by Vityaz
*	10° 02.2N	136° 59.5E	10	20:20	-21:33		Biological Sampling
14-1	10° 52.0N	134° 37.6E	11	09:48-11:20	13:00	2510 2496	Dredge Haul (Chain-bag dredge) → blocks of Mn-coated tuffs & other types of rocks collected
14-2	10° 52.4N	134° 43.4E	11	14:50-15:25	16:15	800 799	Dredge Haul (Chain-bag dredge) → a piece of non-reef coral
14-3	10° 52.3N	134° 38.4E	11	17:43-18:28	19:30	1930 1918	Dredge Haul (Chain-bag dredge) → failed
14-4	10° 53.1N	134° 43.5E	11	20:35	-21:45	~1000	Deep-sea Camera → failed & lost
15	12° 03.6N	130° 10.8E	12	09:10-10:48	12:28	5700 5739	Piston Coring → 697 cm of reddish brown clay collected
16	14° 39.9N	130° 12.9E	13	09:07-10:42	12:15	5650 5689	Piston Coring → failed
*	15° 29.1N	129° 16.8E	13	20:15	-21:33		Biological Sampling
17	17° 18.3N	130° 20.5E	14	12:10-13:55	15:30	6050 6106	Piston Coring → failed
*	20° 04.1N	125° 59.1E	15	20:17	-21:30		Biological Sampling

4. Measurement of Gravity, Magnetic Force and Bathymetry

by

Y. Tomoda, J. Segawa and T. Takemura

Gravity, magnetic total force and depth of water were continuously measured throughout this cruise. Gravity was measured by two sets of T.S.S.G. vibrating-string gravity meters directly connected to a ship-board computer FACOM 270-20 which automatically processes the gravity data on the on-line real-time basis. The gravity values were calibrated at piers of Harumi, Tokyo; Apra, Guam and Rabaul, New Britain using a LaCoste-Romberg land gravimeter G-124.

In the East Caroline Basin (Fig. 4-1) a comparison measurement was carried out between the T.S.S.G. of the Hakuho Maru and the Graf-Askania sea gravimeter installed on board the R.V. Vityaz of the Academy of Sciences, U.S.S.R. directed by the chief scientist, Dr. G.B. Udintiev. In order to avoid errors caused by the Eötvös effect, both ships cruised abreast with each other with the same heading and at the same speed for 6 hours on the 6th and 7th of March 1971 from 1°54'N, 144°36'E to 1°47'N, 141°55'E. The Vityaz was about 0.9 nautical miles off the portside of the Hakuho Maru. As the bottom was flat and its gravity values were also very smooth, this difference in the ships' positions were negligible for comparison. Results obtained are represented in Table 4-1. The average difference between the results of the two gravity meters for 6 hours was only 1.8 mgal, indicating strikingly good agreement.

On a seamount east off the northern end of the Mariana trench, an areal distribution of gravity and magnetic force together with depth of water was measured in detail. A name "Syunsetsu" was tentatively proposed for this seamount, but has not been officially approved yet. Results of these observation including those in other areas will be published elsewhere.

Table 4-1. Results of comparison measurement made with the T.S.S.G. and the Graf-Askania sea gravimeter.

Time (UT + 10h)	Observed gravity		Difference (mgal)	Sounding (meters)	
	Vityaz	Hakuhō		Vityaz	Hakuhō
17-00	978142	978143	-1	4285	4350
10	143	139	4	4350	4390
20	143	139	4	4373	4400
30	142	138	4	4406	4410
40	140	132	8	4425	4430
50	139	138	1	4430	4440
18-00	137	135	2	4450	4450
10	136	136	0	4456	4470
20	136	133	3	4464	4490
30	137	133	4	4480	4470
40	138	137	1	4474	4470
50	149	139	1	4436	4400
19-00	140	133	7	4330	4340
10	136	134	2	4462	4460
20	134	129	5	4462	4470
30	134	133	1	4466	4470
40	134	133	1	4472	4480
50	134	129	5	4436	4440
20-00	134	133	1	4420	4440
10	134	133	1	4415	4440
20	132	126	6	4426	4450
30	133	131	2	4442	4450
40	134	130	4	4418	4440
50	135	130	5	4408	4410
21-00	135	134	1	4410	4420
10	133	131	2	4406	4410
20	133	132	1	4388	4400
30	134	135	-1	4383	4390
40	138	138	0	4363	4370
50	139	139	0	4360	4370
22-00	139	135	4	4354	4360
10	138	135	3	4330	4340
20	136	133	3	4324	4320
30	137	133	4	4314	4310
40	136	135	1	4294	4300
50	136	134	2	4266	4280
23-00	136	133	3	4220	4240
10	136	137	-1	4205	4210
20	137	138	-1	4136	4140
30	137	138	-1	4104	4100
40	137	138	-1	4064	4060
50	137	139	-2	4033	4060
00-00	978137	978138	-1	4036	4060
10	138	138	0	4030	4050
20	139	139	0	4008	4030
30	139	142	-3	3998	3990
40	140	computer stop		3948	3950
50	140			3920	3920
01-00	142			3840	3840
10	140			3814	3820
20	138			3780	3780
30	136			3768	3750
40	134			3728	3740
50	134			3710	3710
02-00	136			3688	3700
10	136			3654	3650
20	136			3632	3640
30	136			3610	3620
40	137			3570	3600
50	138			3532	3550
03-00	138			3390	3510
10	140			3394	3470
20	140			3284	3410
30	141			3235	3430
40	144				3290
50	144			3096	3190

Table 1 (continued)

Time (UT + 10h)	Observed gravity		Difference (mgal)	Sounding (meters)	
	Vityaz	Hakuhō		Vityaz	Hakuhō
04-00	144			3003	3150
10	146			2932	3050
20	148			2890	2970
30	149			2893	2920
40	150			2855	2900
50	change of speed			2830	2870
05-00				2835	2870
10				2820	2820
20	149			2804	2800
30	148	145	3	2790	2780
40	148	144	4	2775	2750
50	148	150	-2	2770	2740
06-00	148	147	1	2757	2740
10	148	145	3	2740	2730
20	change of speed			2732	2710
30				2720	2710
40				2680	2700
50				2670	2670

Average difference (Vityaz minus Hakuhō) = +1.8 mgal

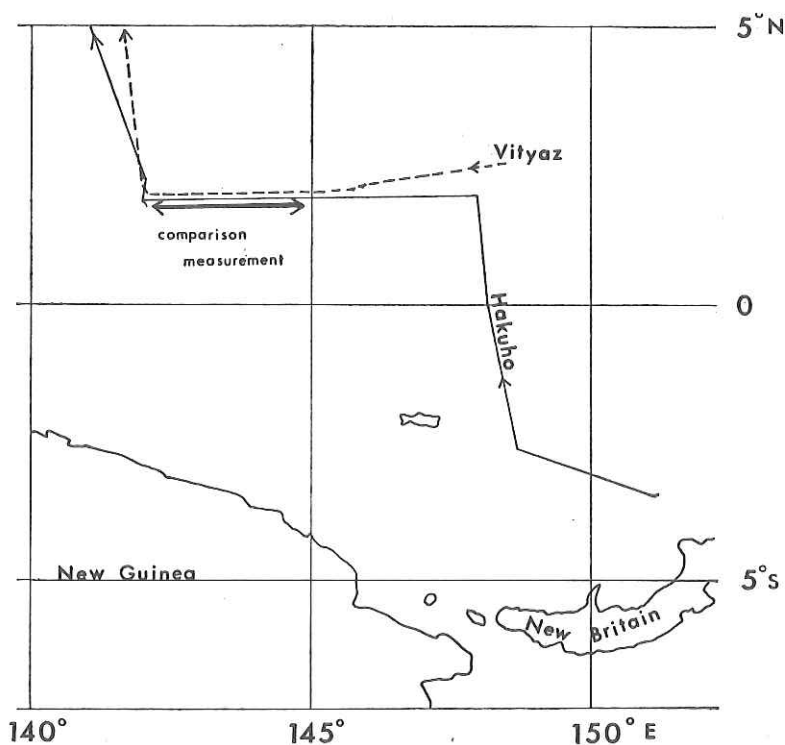


Fig. 4-1. Ship's tracks of the R.V. Hakuhō Maru and the Vityaz at the East Caroline Basin

5. Explosion Seismological Observation by Ocean Bottom Seismographs

5.1. Purposes of the ocean bottom seismograph

by

H. Shimamura and T. Asada

The present authors started the project to investigate the arc-trench system as well as the ocean ridge system by means of ocean bottom seismographs in 1969. Seismicity and source mechanisms of earthquakes have a key to study the new global tectonics, but up to the present earthquakes occurring beneath the sea bottom have been observed only in the land. By the use of ocean bottom seismograph, it becomes possible to observe much more earthquakes which occur in the vicinity of interesting regions in the sea such as trenches, ridges or other places. The precise observation on the seismicity and the source mechanisms will enable us greatly to discuss the physical mechanism of the tectonics of the trench and the ridge. The present authors made eight ocean bottom seismographs (OBS) and have operated them seventeen times for the observation of natural earthquakes at the Japan Sea and the Pacific Ocean.

Another purpose of the OBS is the explosion seismology at sea. Explosion seismology at sea is easier in choosing points of explosions and observations than that on land. Ambient seismic noise at the sea bottom is small according to our experience, say 1 to 4 μ km/sec for the frequency range of 2 to 15 Hz, therefore we hoped that the OBS would detect the signals of explosions better than hydrophones which are not so effective in detecting seismic signals because of rather high ambient noise. Besides, the two ship method which was invented twenty years ago is more

laborious and more expensive than the operations of the OBS. Explosion seismology at sea, especially the observation of long shots for the investigation of the deeper mantle is largely useful in studying the tectonic process of the sea floor.

5.2. Instrumentation of ocean bottom seismographs

The OBS's which were constructed by the present authors are small in size and weight. Its volume is about 20 liters and the weight is 50 kg in air. The smallness in size and weight becomes important when the several OBS's are operated by a small boat or when the OBS's are set or pulled up in bad sea condition. Also the smallness of OBS can reduce the load of mooring system, and diminish the danger of being lost. The OBS's are designed to work at any position at the sea bottom, which serve to simplify the buoy system.

The pressure cases of the OBS's are made of high-tension aluminum. The maximum operation depth is 10000 m. Because we used the aluminum pressure case for the first time, we tied a rope around the case in order to pull up the case itself when shackle arms are broken because of electro-chemical corrosion between the shackle arm made of aluminum and the shackle made of steel. No erosion was found in the parts, so the rope was not necessary. However, the short rope worked as a tailfin of the OBS, and controlled the attitude of landing and the fin was upside (Fig. 5-1). This fact will in future help to make the tape transport of the OBS simpler.

The OBS is shown in Fig. 5-2. From left to right, quartz timer, tape transport, seismic sensor suspended by a gimbal mechanism and alkaline-manganese battery for one week operation. Electrical circuits are above the tape

transport. The circuit diagram is shown in Fig. 5-3. The natural frequency of the seismic sensor is 4.5 Hz, and the sensitivity is 1 V/cm/sec. The tape transport adopts direct recording (DR) system, and its tape speed is 1 mm/sec. It can record the frequency range from 0.2 to 100 Hz with the peak S/N value of 48 dB at 10 Hz. The tape wound on a 5 inch reel runs for seven days. It is important for instruments used in the sea within pressure cases to save the electrical power consumption. For that purpose the AC bias for the direct recording is taken from the tachogenerator of the frequency servo micromotor of the tape transport. The total power consumption is 420 mW.

The OBS cited above is designed mainly for microearthquake and ultra-micro-earthquake survey and it is also suitable for experiments of explosion seismology for short or intermediate (within in 200 km) profile. But for deep earthquakes or teleseismic observation or for explosion of long distance, the OBS is rather unsuitable because of short recording time and of higher recording frequency range. The present authors are constructing a new OBS suitable for such purposes. The new OBS has just the same size as the old one, but the recording band width is from 0.04 to 20 Hz and runs for 48 days. One vertical and two horizontal seismometers with natural frequency of 1 Hz are used in the new OBS.

The detection capability of OBS is restricted by the noise generated in the OBS and/or the ground noise at the sea bottom. Among the noises generated in OBS, the mechanical noise of the tape transport picked up by the seismic sensor is in general larger than the electrical noise of the circuit, especially for the frequency range higher than 5 Hz. A special suspension of the tape transport is used for interception of mechanical noise to reduce the noise less than $1 \mu \text{ kine}_{p-p}$ (2-15 Hz) at the conversion of ground motion. According to our experience, the mechanical noise

is always less than the ground noise at the sea bottom, although the ground noise is much smaller than that on land. In order to insulate the mechanical noise the present authors made two types of new suspension of the tape transport for this cruise, both are rubber suspension but the one utilizes the rubber plate in a torsional mode and another in a compressional mode. The results show that the former is slightly better in intercepting the mechanical noise probably because the natural frequency of the suspension is lower.

5.3. Mooring system and the buoy technology

The present authors have adopted the anchored buoy mooring system and are planning to use new systems without using surface buoys. Fig. 5-4 shows the anchored buoy mooring system used in this cruise. Anchors were not used, one reason is to simplify the operation of setting seismometers, and another reason is to avoid the danger of the break of mooring rope when the anchor is caught in pulling up the OBS. The main buoy consists of spherical buoys for fishery use whose diameter is 30 cm, tied each other by an abaca rope. The reasons to use chained small buoys and not to use a large main buoy are to see the rope tension by counting the number of buoys remaining on the sea surface, and to avoid losing OBS by the break of one main buoy. The mooring system has been simplified and decreased in its size because the OBS is small and weighs light.

The main rope consists of nylon rope and polypropylene rope. The nylon rope is used in the upper 50 to 70 % of the main rope because it is strong compared with its diameter. Diameters of the nylon ropes are 8 mm (whose breaking strength in tension is 1.5 ton), 10 mm (2 ton) and 12 mm (3 ton). The ropes with larger diameter are selected to be used just

beneath the main buoys. The polypropylene rope is used in the lower part of the main rope, in order to avoid to be seized by something at the sea bottom because polypropylene rope has a positive buoyancy. Diameters of the polypropylene rope is 10 mm (1.2 ton), 13 mm (2 ton) and 16 mm (3 ton). The 16 mm polypropylene ropes are used at the lowest part of the main rope. The volume of the ropes to set the OBS at the 6000 m depth is about 2m x 2m x 40 cm. The scope of the main rope (the rope length divided by the depth of sea) is usually 1.2 to 1.3.

In setting the OBS, the buoys are lowered from the ship at first, then the main rope is let out from the ship running at the speed of 3 to 6 knots, and at the last the chain and the OBS are let free to sink. The running speed of the ship in releasing the main rope was tried up to 6 knots, but the operation was far from dangerous. It took about 70 minutes at the 5800 m depth and about 40 minutes at the 2800 m depth in this cruise. Because this type of operation to set the OBS is the first experience for the Hakuho Maru, the time to set the OBS can be shortened easily in the future operation.

On the Eauripik ridge two OBS's tied with 800 m polypropylene rope were set by this method. After the first OBS was let free, the process to let out the 800 m polypropylene rope was done without any change compared with that of the main rope, because the speed of sinking of the OBS was less than 1 m/sec. The distance of two OBS's measured by the difference of arrival times of the water sounds from explosions was about 600 m, which was enough to enhance the S/N ratio and increase the capability of phase detection.

The OBS's were pulled up by a winch or a capstan drum. The time for pulling up OBS was shortened to a considerable degree by omitting anchor and separating ring. Table 1 shows an example of the time table recorded during the operation. We can know what time does the OBS reach the bottom by reproducing the magnetic record of the OBS after

retrieval onto the ship. Fig. 5-8 shows examples of the reproduced record of the OBS at lowering down to the sea bottom. We can also know the speed of sinking of the OBS because it soon reaches the terminal speed. The speed is 40 to 80 cm/sec, depending upon the length and diameters of the ropes connected with the OBS. For example, on the Eauripik ridge the mooring system depicted in Fig. 5-4(b) was used. The first OBS sank at the speed of 46 cm/sec and the second one, 72 cm/sec. The second OBS passed the first one though it was let free 10 minutes after the first one was. The reason is that the load for the first OBS is larger than the second one because the load for the first one includes the long main rope.

When the bottom of the sea is soft, the 80 % of the volume of the OBS is in the mud, which is known by the stain of the rope wound around the OBS.

In this cruise two methods to launch the OBS mooring system were tried for comparison. One method was the buoy first anchor last method described above. Another method was to launch from the OBS to the buoys by the use of a winch. The preparation to wind the ropes on the winch drum is necessary for this method. All the instruments used in the sea had been launched by this method in Japan. The buoy first anchor last method was first tried by Dr. K. Takano and the present authors in November, 1969. The experiment shows that the sinking speed and the shock at reaching the bottom of the OBS is sufficiently low to allow the safe operation of the instruments. The present authors had adopted the buoy first anchor last method since then, but also another method had been used in some cases because of the convenience of the research vessel. But we had no chance to compare the two methods at the same time.

In the cruise KH-71-1 we had the first opportunity to compare the two methods of launching, and to check the difference in the operational time, the quantity of operational work and the shock at reaching the bottom because several OBS's were to be set at the same depth.

It took 2 hours and 35 minutes for the operation of the launching by the use of the second method (OBS first buoy last), though it took 1 hour and 13 minutes for the operation shown in the Table 5-1. The depth of the sea, the conditions of weather and sea, the mooring system and the OBS were similar in both cases. The time does not include the time to wind all of ropes on the winch, which is about 3 hours.

The amount of the work of the officers and crews during the launching is bigger in the second method not only because of the longer working time but also because of the requirement to keep the rope not to be too slant by conning the ship.

The magnitude of the shock received by the OBS could not be measured quantitatively because the recording system of the OBS was saturated because the system has a high sensitivity. But the shocks delivered neither on the ship nor reaching the bottom have caused any undesirable influence upon the function of the OBS.

It will be concluded that the buoy first anchor last method of launching is better because of faster and simpler operation. As the sinking speed of the OBS is small, the shock of the landing of OBS on the bottom is small.

Formerly the present authors were anxious how much was the difference of position of the OBS from the planned position when the buoy first anchor last method was adopted, and also about the accuracy of the very position where the OBS was set. The accuracy in the first meaning is in general not a serious seismological problem if the OBS does not drift during the lowering more than several kilometers. Scanty data are available up to the present where does the OBS reach the bottom between the place where the buoys were launched and the place where the OBS was launched from the ship.

Though the existence of the ocean current makes the situation complicated, the present authors think that the point of reaching the bottom is far nearer to the place

where the OBS was launched than the place of buoys launching. By our experiences the accuracies in the first meaning are within 3 km from the scheduled point at sea of 5800 m depth.

The accuracy of the second meaning is much important for seismology. But it has been known that the position is decided during the retrieval of the mooring system because we can know the direction and the inclination of the main rope which is tighten for the retrieval. Therefore the accuracy depends on the accuracy of the ship positioning. For seismological aim the accuracy is preferable if the satellite navigation system is adopted.

One of the important functions of the mooring system for OBS is to intercept the noise caused by movements of surface buoys and/or ropes to be transferred to the OBS. But in the Mariana Explosion the mooring systems of station C and B sometimes went wrong in preventing the noise which are probably due to movements of surface buoys during bad weather condition (in which the wind speed exceeds 15 m/sec). The OBS C recorded terrible noises occasionally, but the OBS C' did not record any particular noise throughout the observation. The present authors think that the reason of the failure is that the two weights (20 kg) tied to the chain between the main rope and the OBS's were too light. Therefore an improvement was made at the Eauripik Explosion by adopting a noise damping chain with weights (Fig. 5-4(b)). The results are very good though the test is not sufficient for the extremely bad weather and sea conditions.

5.4. Observation of explosion by the ocean bottom seismographs

Explosion seismological experiments were done twice within the cruise KH-71-1. The one is on the Mariana basin and another is on the Eauripik ridge. The former series of the experiments are denoted as the Mariana Explosion, which was done in early February, 1971. The

second is named as the Eauripik Explosion, which was done under the cooperation of the research vessel Vityaz (Institute of Oceanology, Vladivostok, U.S.S.R.) in early March, 1971. The details of the explosions are described in the preceding report of this paper, therefore this report relates only to the observational results of the OBS.

Fig. 5-5 shows the geometry of the sites of the OBS's and the explosions in the Mariana Explosion. The maximum span is about 150 km. Fig. 5-6 shows those of Eauripik Explosion whose maximum span is about 65 km.

At the Mariana Explosion the five OBS's and two radio sonobuoys are deployed. Among the five OBS's, four belong to the present authors and one to Hokkaido University. At the station C two OBS's were set by a main rope tied with a 800 m polypropylene rope, and the OBS's are called as C and C' where C is a nearer one to the main rope. At station A, B and H the OBS's named as A, B and H were set respectively among which H was the OBS belonged to the Hokkaido University.

At the Eauripik Explosion four OBS's (D, E, E' and H) and one radio sonobuoy were set by the Hakuho Maru and one OBS by Vityaz. The OBS's D, E and E' belong to the present authors and H belongs to the Hokkaido University. At station D two OBS's D and H tied with a polypropylene rope 1000 m long, were set where H was a nearer one to the main rope. At station E, OBS E and OBS E' tied with polypropylene rope 1000 m long were set where E is nearer to the main rope. At station O which was the center of stations D and E, the OBS of Vityaz was set by the use of the anchored buoy mooring system using steel wire ropes instead of ropes of high polymer chemicals. A radio sonobuoy belonged to the O.R.I. was set by vicinity of the buoy of the OBS of Vityaz, which drifted slowly to the east due to the current.

After retrieval of the OBS, the magnetic tapes are reproduced on the Hakuho Maru. At first monitor records are made on the recording papers where signals have passed through integration circuit. Then the records for analysis

are reproduced on the paper records and transferred to the compilation magnetic tapes at the same time.

Results of the observations show that the ambient noises at the ocean bottom is much lower than those of the ordinary station of land. The noise is rather stationary and its level is less than $2 \mu \text{ kine}_{p-p}$ (at frequency of 2 to 15 Hz) for all stations, both in the Mariana Explosion and in the Eauripik Explosion. Although the weather condition and the sea condition were changed to a considerable degree, for instance the wind speed changed from 2 m/sec to 15 m/sec in the period of mooring at the Mariana Explosion, the ambient noises recorded by the OBS scarcely showed any change and any correlation with the weather condition.

Table 5-2 shows the time table when the OBS's started to record (on the ship), when they reached the bottom, when they left the bottom and when they stopped recording.

Some natural earthquakes were observed both in the Mariana Explosion and in the Eauripik Explosion in addition to the explosions. Examples are shown in Fig. 5-7. Earthquakes whose S-P times are less than 20 seconds are also observed in the Mariana Explosion, which means that these earthquakes occurred within a hemisphere having a radius of about 160 km. It is very much interesting that these earthquakes occurred beneath the ocean basin and not beneath the trench or the deep seismic plane. Detailed discussions about the observed natural earthquakes will be published later.

The Mariana Explosion is the first explosion seismological experiment at sea utilizing OBS in Japan. This experiment was also a preliminary experiment of a longshot across the ocean bottom whose span is about 2000 km as well as a study of the velocity structure beneath the Mariana basin.

Consequently to probe the detection capability of the OBS for explosions is an important purpose of the experiment.

Although the present authors have not finished the analysis of all the explosion records recorded with the OBS, the detection capability of the OBS has been found to be surprisingly big compared with hydrophone observations done up

to the present or with observations which were made on the land. For instance, explosions of 0.4 kg charge and 1.0 kg charge were detected clearly at the epicentral distances of more than 20 and 50 km, respectively. Examples of explosion records taken with the OBS are shown in Fig. 5-9. Fig. 5-9(a) shows the record of a 1 kg charge taken at a distance of 31 km. The P_n wave was clearly recorded as the onset. The wave W_1 is the direct water wave and W_3 is the twice reflected water wave (at the sea bottom and the sea surface). Fig. 5-9(b) shows the record of a 0.4 kg charge at 19 km. The onset of the ground wave, the water wave W_1 and W_3 were clearly recorded also.

Discussions on the amplitudes of the ground waves of the explosions at sea cannot be similar to those on the land, because maximum amplitudes of the ground waves of records are masked by water waves which have larger amplitudes than the ground waves. Therefore discussions on the amplitudes are made by use of the amplitudes of the onset wave groups, which are measured as the maximum amplitudes of wave groups which came within one second from the onset of the ground waves.

Fig. 5-10 shows the amplitudes of the onset wave groups, which were read from the records of the Mariana Explosion. The charge weight of these records was 1.0 kg. The ambient noise of the sea bottom was quite small throughout the experiment, whose value was about $1.6 \mu \text{ kine}_{p-p}$ at the frequency range of 2-15 Hz. The level of ambient noise during the Eauripik Explosion was nearly the same as that during the Mariana Explosion. These noises are as small as those recorded at the most quiet places on the land, for example, in the Matsushiro vault.

The ground waves of 1 kg charge weight can easily be observed at an epicentral distance exceeds 50 km by the OBS's. Even at more than 90 km the 1 kg explosions were clearly recorded by the OBS's. Precise discussion on the detection capability is difficult. One reason is the fluctuations in the efficiencies of explosions, burning speeds of explosives, bubble frequencies and so on. Another reason

is that the detection capability does not simply related to the S/N ratio, which we can easily know by figures. In some cases we can read the onsets of the seismic signals with ease even when the S/N ratio of the onset is less than 2 or 1.5, because of the differences of frequencies or phases between the signals and the noises. On the other hand we cannot pick up the very point of the onset accurately in the case where S/N ratio exceeds 2 or 3 in certain cases especially when the dominant frequency of the noise is the same as that of the onset. It can be concluded anyway that the onset of the ground wave from explosions of 1 kg charge weights will be detected accurately at epicentral distances more than 50 km by the OBS. Similarly 0.4 kg charges will be detected by the OBS at distances more than 20 km.

Broken lines in Fig. 5-10 show the inclination of amplitude decay due to geometrical spreading in a flat layer, and which leaves the effect of attenuation of waves out of account. Because the explosives transmit and the OBS's observe seismic signals not at a frequency but at wide frequency band, so it is difficult to count the effect of attenuation in.

Fig. 5-11 shows the detection capability as functions of charge weights and epicentral distances. Open circles indicate that the seismic signals at those points were detected without ambiguities, which mean that the accuracies of the readings in time are within 1/10 sec. Arrows show that the explosions with the farthest epicentral distances in the explosion experiments were easily detected by the OBS, and the limits of the detection capabilities should extend towards larger distances to a considerable extent. We regret that we should have made trial of larger spans of explosions.

In Fig. 5-11 the detection capability of hydrophones shown by Raitt (1952) is also illustrated. The relation between the maximum range and the charge weights shown by Raitt has been ascertained by various observers and it has been revealed that the range given by Raitt is really the maximum value for hydrophones when the conditions are very good.

The detection capability of the OBS's is safely concluded

to be more than five times better than that of hydrophones in respect of epicentral distances, and in many cases more than 7 or 10 times better. In point of charge weights the difference is much serious because the charge weights is in proportion to the secondary power of the distances. This fact becomes important especially in the case of longshot. We think that the longshot at the ocean floor is capable only by the OBS's.

Another strong point of OBS in the explosion seismology at sea compared with hydrophones is seen in Fig. 5-14, which illustrates the travel time curves of observation by hydrophones. Because the hydrophones are suspended near the sea surface, the R wave (bottom reflected water wave) and the D wave (direct water wave) are apt to mask the onsets of the ground waves, G_1 and G_2 , for these water waves have large amplitudes compared with ground waves. But when we observe by OBS the ground waves come faster than R or W waves even for very small epicentral distances.

Fig. 5-12 and Fig. 5-13 show the reduced travel time curves obtained from the Mariana Explosions obtained at the sites A and C, respectively. At site A velocities of 4.95, 6.62 and 8.06 were clearly found. At site C those of 5.06, 6.55 and 8.24 were found. Generally speaking the Mariana basin studied by this experiment has a slightly inclined normal oceanic structure. Interpretation and discussion of these results will be published in near future.

In conclusion we can say that OBS is a most powerful tool for explosion seismology in the sea. Especially for longshots or for explosion study on the ocean-continent transitional zone where crustal thickness is larger than that of ocean floor, OBS is superior to hydrophones. We will study the bottom of the lithosphere and the ocean-continent transitional zone by use of OBS in future.

5.5. A note on the OBS built by the Hokkaido University

by
N. Sakajiri

Instrument; OBS (Ocean Bottom Seismograph) consists of pressure vessel, geophone, crystal clock, amplifiers, tape recorder and batteries as shown in Fig. 5-16.

Pressure vessel; It has 900 mm-inside length, 147 mm-inside diameter and 40 kg weight, and is 6000 m water proof.

Geophone (GEOSPACE, GSC 8D MODEL L-4B); The natural frequency is 4.5 Hz and coil resistance is 1350 ohms. It is suspended by a two-axis gimbal to keep it vertical, as shown in Fig. 5-17.

Crystal clock; Time signals of second, minute and hour are taken out of SEIKO 952 TF7.

Amplifiers; The amplifier system form of one pre-amplifier, three attenuators and three main amplifiers having various gains. The maximum gain is 90 db, median gain is 42 db and the minimum gain is 30 db.

Tape recorder; This is adopted the 4-channel direct recording method. The mechanism and specification of tape recorder are shown in Fig. 5-18.

Batteries; Two 6 V-batteries (8 Ah) are used for the tape recorder and three 6 V-batteries (3.5 Ah) for the amplifiers and crystal clock.

Play back system; By using a 4-channel audio tape recorder, the original tape is transcribed to another tape in FM recording system at the 125 times of the original recording speed. The transcribed tape is then reproduced at the 1/16 times tape speed. The reproduced signals are recorded with a pen recorder at the 7.8 times of the original time scale.

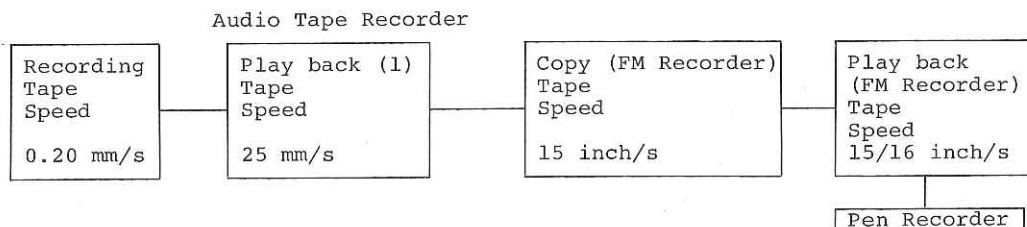


Table 5-1. Time tables of the launching and retrieval operations at the Mariana Explosion.
The buoy-first anchor-last method was used.

RECORD OF THE LAUNCHING OF OBS A AT MARIANA EXPLOSION

DATE : FEB. 4, 1971. DEPTH : 5860 m VESSEL : HAKUHO-MARU

TIME	OPERATIONS	COMMENTS
00 ^h .00 ^m .00 ^s	Initiation of the operation	
	Lowering of small spherical buoy	
00.00.35	Lowering of the radio beacon transmitter	
00.01.15	Lowering of the radar reflector buoy	
00.02.00	Lowering of the main buoy	
	Start to lower the main rope	
00.10.00	End of 12mm Nylon rope (600m)	swivel connection
00.15.50	End of 12mm Nylon rope (600m)	swivel connection
00.24.45	End of 12mm Nylon rope (1000m)	swivel connection
00.32.30	End of 12mm Nylon rope (800m)	swivel connection
01.01.58	End of 8mm Nylon rope (3400m)	swivel connection
01.06.25	End of 12mm Polypropylene rope(500m)	swivel connection
01.11.32	End of 16mm Polypropylene rope(400m)	swivel connection
	Start to lower the first chain	30m chain with two weights
01.12.59	Launching of the OBS	
	End of the operation	
(Relative time of 01.12.59 was 14h34m25s, Feb. 4, 1971)		
17h21m01s	the OBS reached the sea bottom	*known after retrieval
(absolute time)		

Duration of the sinking of the OBS ; 2h46m36s (9996 sec)
Mean velocity of sinking ; 58 cm/sec

RECORD OF THE RETRIEVAL OF OBS A AT MARIANA EXPLOSION

DATE : FEB. 7, 1971. DEPTH : 5860 m VESSEL : HAKUHO-MARU

TIME	OPERATIONS	COMMENTS
00 ^h .00 ^m .00 ^s	Initiation of the operation	
	Retrieval of small spherical buoy	
00.03.	Retrieval of main buoy	*the operation was somewhat
00.05.	Initiation of pulling up the main rope	retarded because the ropes
00.25.	End of 12mm Nylon rope (600m)	were interwind.
00.41.	End of 12mm Nylon rope (600m)	
01.02.	End of 12mm Nylon rope (1000m)	
01.16.	End of 12mm Nylon rope (800m)	
02.24.	End of 8mm Nylon rope (3400m)	
02.31.	End of 12mm Polypropylene rope (500m)	
02.36.	End of 16mm Polypropylene rope (400m)	
02.37.	Retrieval of weights	
02.39.	Retrieval of the OBS onto the deck	*70% of the OBS was in the mud
		known from the stain of rope
		around the OBS

(Relative time of 00.00.00 was 13h10m00s, Feb. 7, 1971)

Table 5-2. Time tables of the OBS's operations in this cruise. The magnetic tapes of B and C' ended already before leaving the bottom because the tapes were wound on small reels.

TIME TABLE OF THE OBS OPERATIONS

THE MARIANA EXPLOSION

STATION	OBS	INITIATION OF RECORD	LAUNCHING	REACHING THE BOTTOM	LEAVING THE BOTTOM	STOPPING THE OBS	DEPTH
A	A(V-3)	12h11m, Feb. 4	13h34m, Feb. 4	17h20m, Feb. 4	13h06m, Feb. 7	18h38m, Feb. 7	5860 m
B	B(IV-2)	12h20m, Feb. 3	13h48m, Feb. 3		* (tape ended already)		5900 m
C	C(V-1)	08h32m, Feb. 3	09h17m, Feb. 3		10h51m, Feb. 9	18h29m, Feb. 9	5940 m
C'	C'(IV-1)	08h21m, Feb. 3	08h55m, Feb. 3	10h56m, Feb. 3	** (tape ended already)		5940 m

THE EAURIPIK EXPLOSION

D	D(V-3)	17h15m, Mar. 6	10h34m, Mar. 7	11h28m, Mar. 7	16h59m, Mar. 8	21h47m, Mar. 8	2610 m
E	E'(V-1)	17h55m, Mar. 6	16h58m, Mar. 7	18h03m, Mar. 7	11h47m, Mar. 8	21h27m, Mar. 8	2830 m
E	E(IV-2)	17h44m, Mar. 6	16h48m, Mar. 7	18h29m, Mar. 7	11h24m, Mar. 8	18h57m, Mar. 8	2830 m

*ended at 03h58m, Feb. 7.

**ended at 00h24m, Feb. 7.

Table 5-3. Table of shot time

Date	Shot	Shot Time	Charge Size	Δ Tos	Δ	D	Shot Depth	Correc- tion of Time	Correc- tion of C.O.	Corrected Shot Time	Position	Sound- ing Depth	Ship's Speed	
1971	No.	h m s	kg	sec	m	sec	m	sec	sec	h m s	Lat(N)	Long(E)	m	m/s
2	5	1	1								14° 49.1	150° 15.1	5860	5.35
	2	08:55 24.38	1	21.0	167.9	0.03	23.1	-0.11	+0.23	08:55 24.50	48.25	14.7	5860	5.35
	3	09:00 24.84	1	19.8	161.5	0.03	23.1	-0.10	+0.23	09:00 24.97	47.5	14.3	5860	5.35
	4	09:05 24.20	1	20.4	164.7	0.03	23.1	-0.11	+0.23	09:05 24.32	47.6	14.0	5870	5.35
	5	09:10 39.12	5	36.0	245.0	0.05	38.5	-0.16	+0.23	09:10 39.19	46.0	13.6	5870	5.35
	6	09:15 39.18	5	35.8	154.4	0.06	46.2	-0.10	+0.23	09:15 39.31	45.1	13.3	5870	5.35
	7	09:21 40.83	5	36.8	155.7	0.05	38.5	-0.10	+0.23	09:21 40.96	44.1	12.9	5870	5.35
	8	09:33 01.03	10	58.2	371.9	0.09	69.3	-0.24	+0.23	09:33 01.02	41.6	11.9	5880	5.35
	9	09:59 56.83	10	54.6	354.5	0.10	77.0	-0.23	+0.23	09:59 56.83	37.8	10.4	5870	5.35
	10	10:13 37.30	5	36.0	246.6	0.06	46.2	-0.16	+0.23	10:13 37.37	35.5	09.4	5860	5.35
	11	10:20 36.31	5	36.4	248.7	0.06	46.2	-0.16	+0.23	10:20 36.38	34.5	09.1	5840	5.35
	12	10:24 36.53	5	37.6	213.1	0.05	38.5	-0.14	+0.23	10:24 36.62	33.75	08.7	5840	4.14
	13	10:28 00.49	15	60.6	304.9	0.10	77.0	-0.20	+0.23	10:28 00.52	33.3	08.45	5840	4.14
	14	10:30 11.87	1	22.2	147.7	0.03	23.1	-0.10	+0.23	10:30 12.00	33.0	08.25	5840	4.14
	15	10:34 21.37	1	21.6	145.0	0.03	23.1	-0.09	+0.23	10:34 21.51	32.25	07.95	5840	4.14
	16	10:40 21.45	1	21.0	140.9	0.03	23.1	-0.09	+0.23	10:40 21.59	31.3	07.4	5740	4.14
	17	10:44 20.80	1	21.0	140.9	0.03	23.1	-0.09	+0.23	10:44 20.94	30.7	07.2	5780	4.14
	18	10:50 21.68	1	21.0	161.4	0.03	23.1	-0.10	+0.23	10:50 21.81	29.8	06.6	5800	5.04
	19	10:55 06.93	15	66.0	388.5	0.10	77.0	-0.25	+0.23	10:55 06.91	29.2	06.25	5800	5.04
	20	11:00 21.47	1	21.2	162.5	0.03	23.1	-0.11	+0.23	11:00 21.59	28.4	05.7	5790	5.04
	21	11:04 36.91	5	37.0	240.5	0.06	46.2	-0.16	+0.23	11:04 36.98	27.75	05.3	5800	5.04
	22	11:10 36.18	5	37.0	240.5	0.06	46.2	-0.16	+0.23	11:10 36.25	26.9	04.8	5800	5.04
	23	11:14 37.89	5	37.0	242.4	0.04	30.8	-0.16	+0.23	11:14 37.96	26.3	04.4	5800	5.04
	24	11:25 26.44	50	87.0	500.2	0.13	100.2	-0.32	+0.23	11:25 26.35	25.0	03.6	5820	5.27
	25	12:05 23.04	50	84.8	510.8	0.13	100.2	-0.33	+0.23	12:05 22.94	19.4	14° 59.2	5920	5.27
	26	12:41 54.78	100	113.8	632.5	0.16	123.3	-0.41	+0.23	12:41 54.60	14.8	55.25	5920	4.99
	27	13:16 55.41	100	114.6	629.3	0.15	115.6	-0.42	+0.23	13:16 55.22	09.75	52.5	5940	5.02
	28	16:45 50.19	100	115.4	651.9	0.16	123.3	-0.42	+0.24	16:45 50.01	13° 39.0	35.75	5860	5.08
2	6	1	1								14° 00.5	149° 50.55	5940	4.98
	2	09:17 22.83	1	20.0	155.3	0.03	23.1	-0.10	+0.24	09:17 22.92	01.25	50.55	5940	4.98
	1	09:12 21.42	1	21.1	162.5	0.02	15.4	-0.11	+0.24	09:17 21.55	01.25	50.8	5930	4.98
	3	09:22 23.94	1	21.0	160.2	0.03	23.1	-0.10	+0.24	09:22 23.80	02.0	51.0	5930	4.98
	4	09:27 23.47	1	21.1	161.2	0.02	15.4	-0.10	+0.24	09:27 23.61	02.75	51.25	5930	4.98
	5	09:32 36.40	5	36.0	239.4	0.07	53.9	-0.16	+0.24	09:32 36.48	03.4	51.45	5940	4.98
	6	09:37 37.37	5	36.5	235.8	0.05	38.5	-0.15	+0.24	09:37 37.46	04.2	51.65	5940	4.98
	7	09:42 36.65	5	36.7	241.2	0.06	46.2	-0.16	+0.24	09:42 36.73	04.9	51.9	5940	4.98
	8	09:48 00.21	10	56.5	344.1	0.10	77.0	-0.22	+0.24	09:48 00.23	05.6	52.1	5920	4.98
	9	10:12 56.06	10	56.5	342.4	0.09	69.3	-0.22	+0.24	10:12 56.08	09.7	53.5	5930	4.98
	10	10:22 37.61	5	36.0	236.4	0.05	38.5	-0.15	+0.24	10:22 37.70	11.4	54.0	5920	4.98
	11	10:27 37.75	5	36.5	235.8	0.05	38.5	-0.15	+0.24	10:27 37.84	12.2	54.3	5890	4.98
	*12	10:33 03.20	15	51.5	318.1	0.09	69.3	-0.21	+0.24	10:33 03.23	12.9	54.5	5870	4.98
	13	10:37 22.37	1	20.8	157.6	0.03	23.1	-0.10	+0.24	10:37 22.51	13.75	54.8	5890	4.98
	14	10:42 26.74	1	20.2	154.6	0.02	15.4	-0.10	+0.24	10:42 26.88	14.5	55.1	5900	4.98
	15A	10:47 22.46	1	21.0	160.2	0.03	23.1	-0.10	+0.24	10:47 22.60	15.3	55.3	5900	4.98
	15B	10:52 21.80	1	21.0	160.7	0.02	15.4	-0.10	+0.24	10:52 21.94	16.1	55.6	5900	4.98
	16	10:55 04.92	15	64.3	370.2	0.10	77.0	-0.25	+0.24	10:55 04.91	16.4	55.7	5900	4.98
	17	10:58 23.75	1	21.0	158.6	0.03	23.1	-0.10	+0.24	10:58 23.89	16.75	55.8	5900	4.98
	18	11:00 22.29	1	21.2	161.2	0.03	23.1	-0.10	+0.24	11:00 22.43	17.1	55.15	5900	4.98
	19	11:05 24.43	1	21.8	162.6	0.03	23.1	-0.11	+0.24	11:05 24.30	18.0	56.3	5900	5.53
	20	11:10 21.20	1	21.2	173.2	0.02	15.4	-0.11	+0.24	11:10 21.33	18.7	56.8	5900	5.53
	21	11:15 37.83	5	37.0	258.6	0.05	38.5	-0.17	+0.24	11:15 37.90	19.5	57.3	5900	5.53
	22	11:18 30.10	50	87.0	545.8	0.14	107.9	-0.35	+0.24	11:18 29.99	19.8	57.45	5900	5.53
	23	11:20 39.16	5	37.0	262.6	0.06	46.2	-0.17	+0.24	11:20 39.23	20.2	57.7	5900	5.53
	24	11:25 37.73	5	35.7	255.6	0.06	46.2	-0.17	+0.24	11:25 37.80	21.0	58.2	5900	5.53
	25	12:27 04.14	100	114.7	585.5	0.16	123.3	-0.38	+0.24	12:27 04.00	29.2	150° 04.0	5810	4.52
	26	13:56 56.69	100	113.0	639.5	0.15	115.6	-0.42	+0.24	13:56 56.51	42.0	11.4	5880	5.27
	27	17:41 01.16	100	114.5	668.8	0.16	123.3	-0.43	+0.25	17:41 00.98	15° 10.9	27.8	5790	5.27

14° N
1" = 30.7335m

[14°52'N, 150°09'E]

[14°03.5'N, 149°40.7'E]

Depth	Temp	Salinity
25.6	27.5	34.8
40.8	27.4	34.8
63.7	27.4	34.8
82.7	27.4	34.8
105.5	27.4	34.8
132.2	27.4	34.8
151.2	27.4	34.8
174.1	25.4	35.0

Depth	Temp	Salinity
10.4	27.7	34.7
33.2	27.7	34.7
52.2	27.7	34.7
75.1	27.7	34.7
94.1	27.7	34.8
113.2	27.7	34.8
132.2	27.6	34.8
147.4	26.8	34.8
170.3	25.5	34.8

Sound velocity C m/s

$$C = 1449 + 4.6t - 0.0055t^2 + 0.0003t^3 + (1.39 - 0.02t)(s - 35) + 0.017d$$

t : Temp

s : Salinity

d : Depth

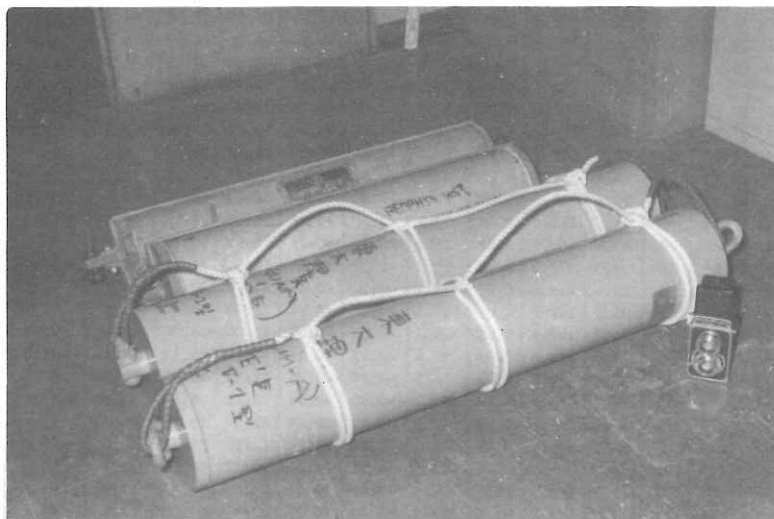


Fig. 5-1. Pressure cases of the ocean bottom seismographs.

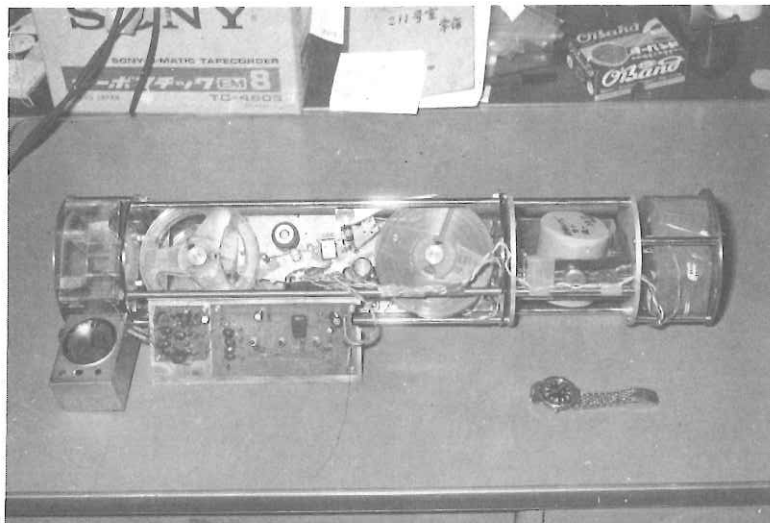


Fig. 5-2. The Ocean Bottom Seismograph (OBS)

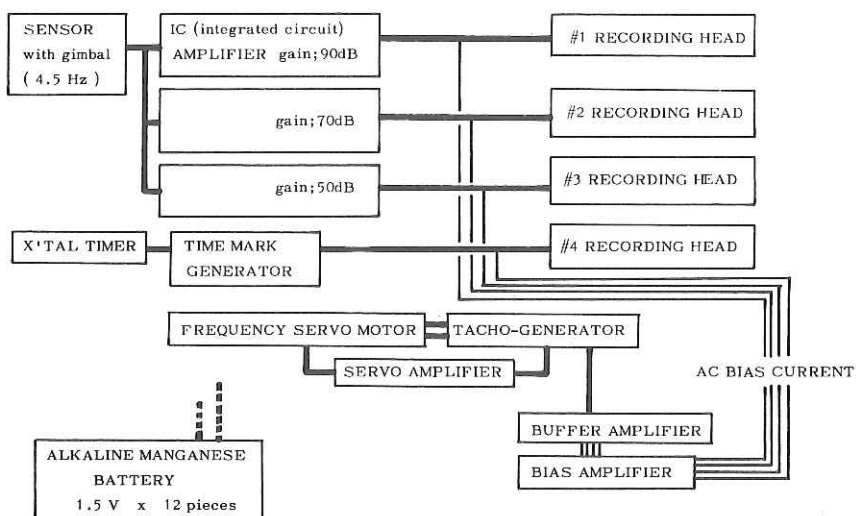
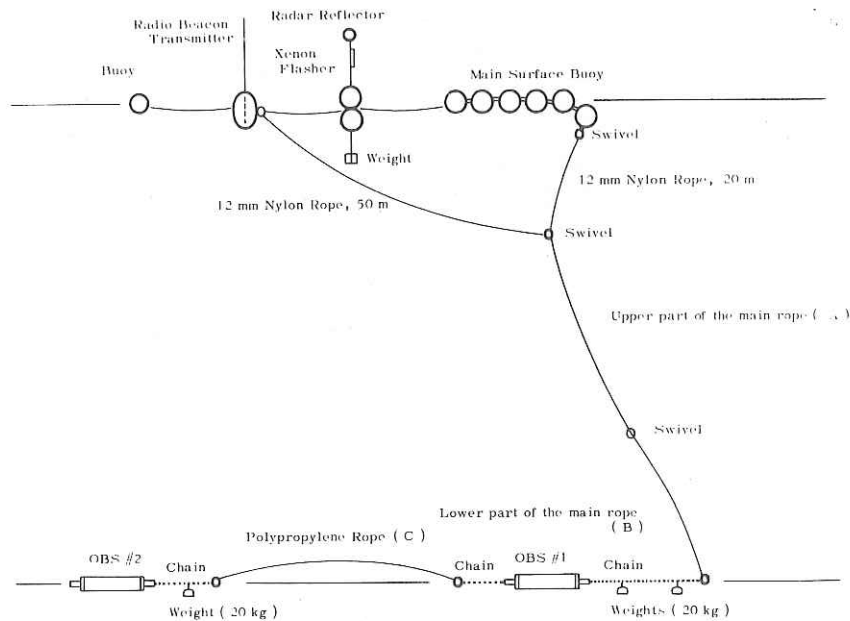


Fig. 5-3. The circuit diagram of the OBS. The total power consumption is 420 mW.



THE MARIANA EXPLOSION

STATION	A	B	C
ROPE (A)	12mm NR 600m 12mm NR 600m 12mm NR 1000m 12mm NR 800m 8mm NR 3400m	12mm NR 500m 12mm NR 1000m 10mm NR 2000m	12mm NR 1000m 10mm NR 4000m
ROPE (B)	12mm PP 500m 16mm PP 400m	13mm PP 1000m 16mm PP 2800m	12mm PP 500m 16mm PP 1200m
OBS No.1	A	B	C
ROPE (C)	*	*	*
OBS No.2	*	*	C'
total length of main rope	7300m	7300m	6700m
the ratio "scope"	1.25	1.24	1.13

(a)

Fig. 5-4. Mooring system of the OBS



PP ; Polypropylene Rope

Fig. 5-4. Mooring system of the OBS

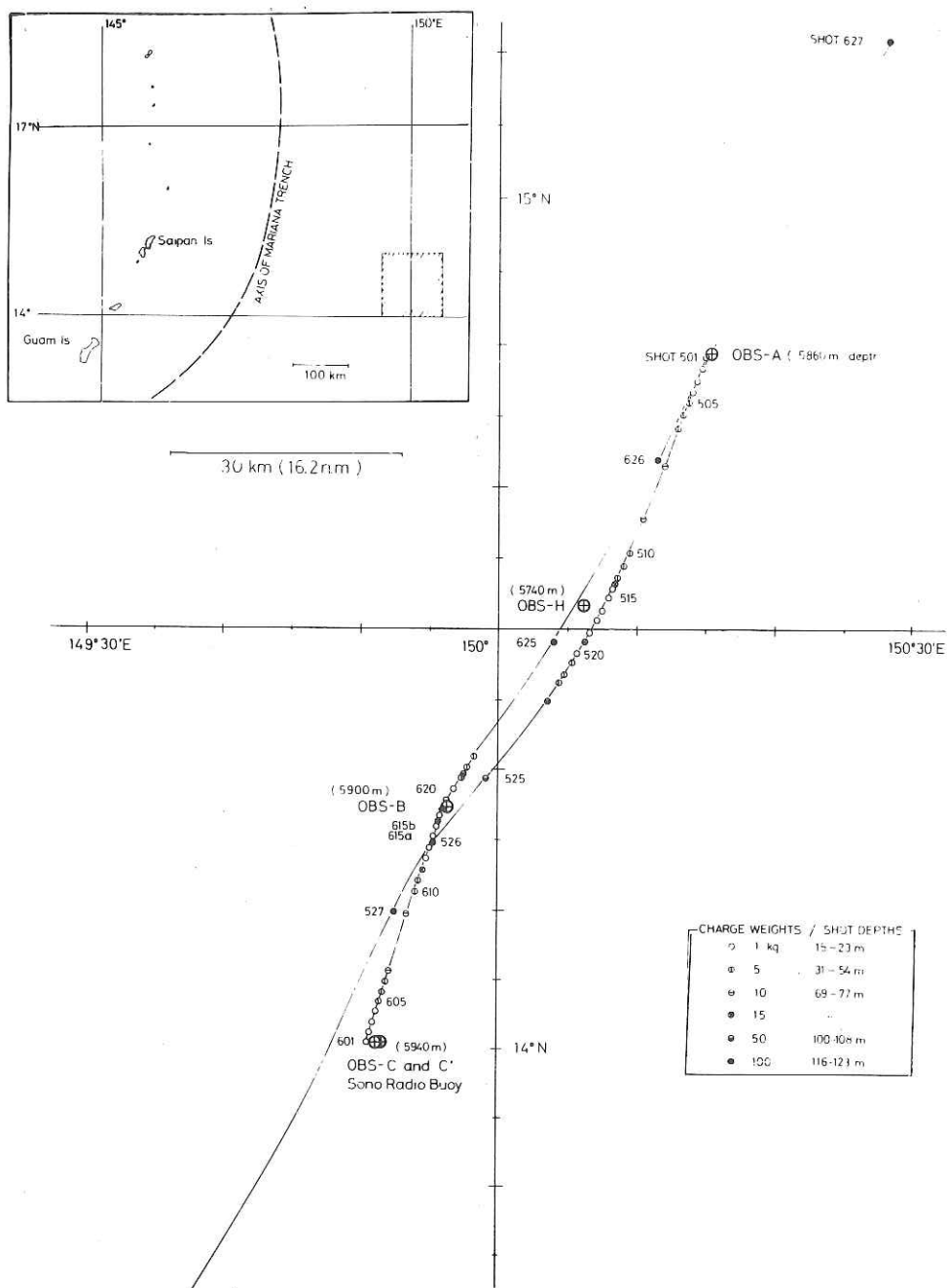


Fig. 5-5. Geometry of the Mariana Explosion experiment, which shows the sites of the OBS's and the explosions in the experiment.

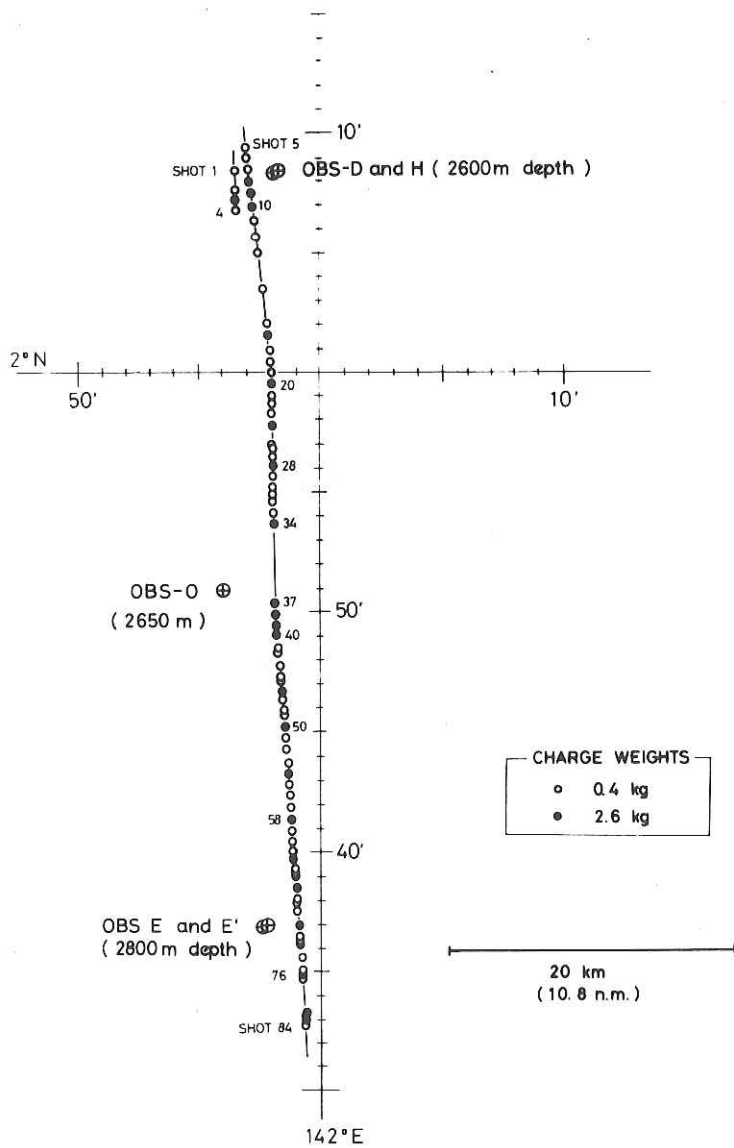
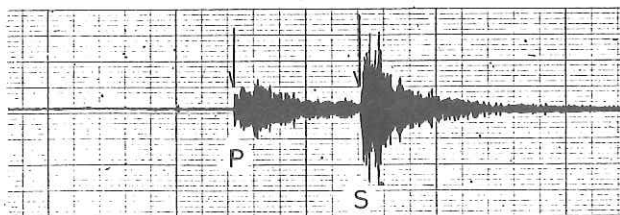


Fig. 5-6. Geometry of the Eauripik Explosion experiment

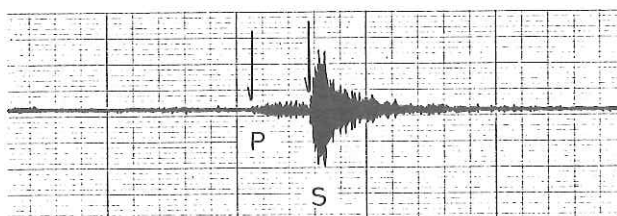
EARTHQUAKE RECORDS

Mariana Basin C'

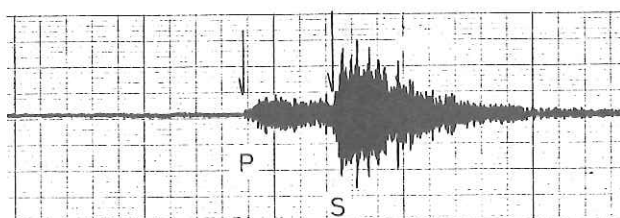
203-1140



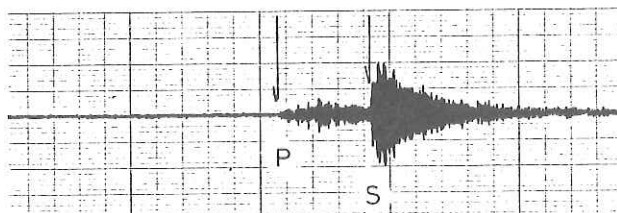
204-0745



204-1116



204-1720



206-0837

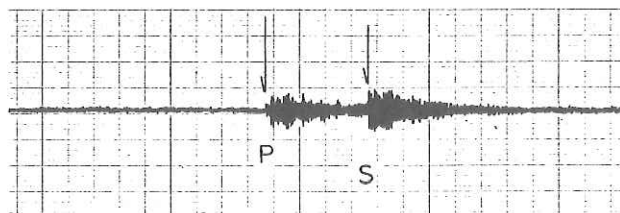


Fig. 5-7. Examples of the natural earthquakes observed on the Mariana basin

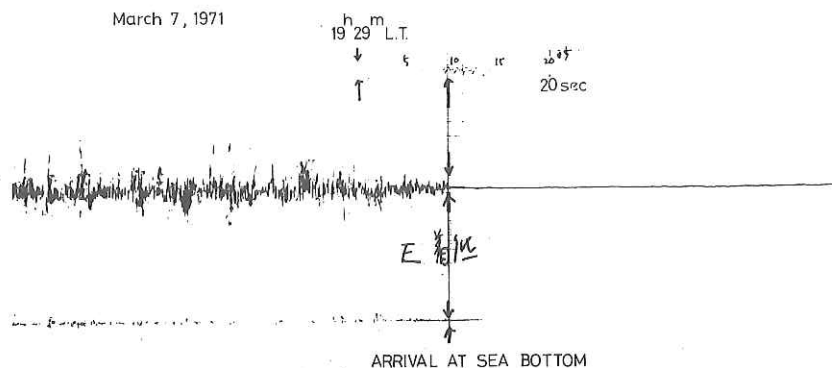


Fig. 5-8. An example of the records of arrival of OBS at the sea bottom recorded by the OBS

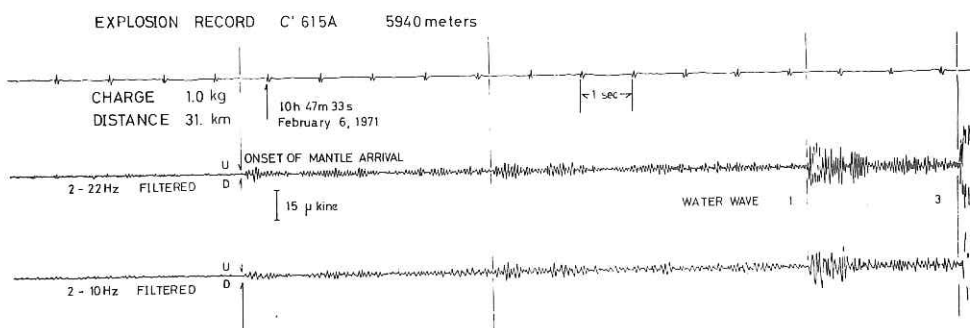


Fig. 5-9(a). An explosion record taken by the OBS
The charge size was 1 kg and the epicentral distance was 31 km.

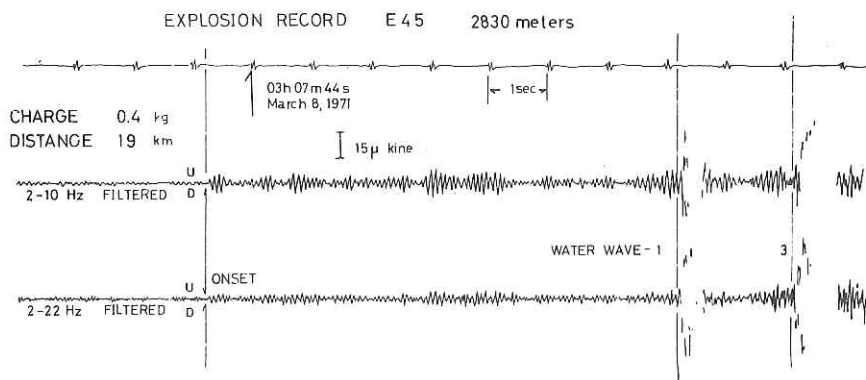


Fig. 5-9(b). A record of a 0.4 kg charge at a distance of 19 km.

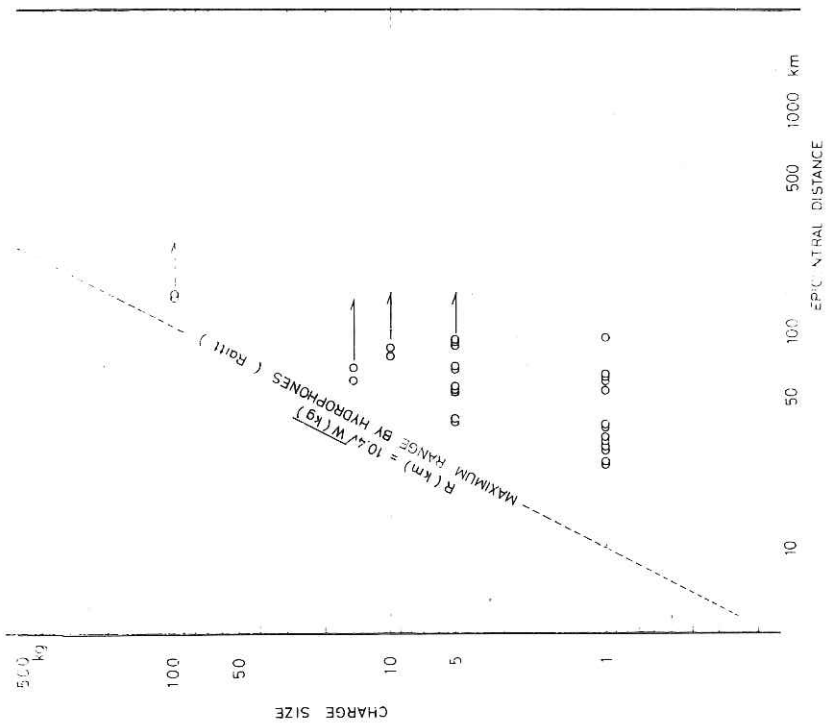
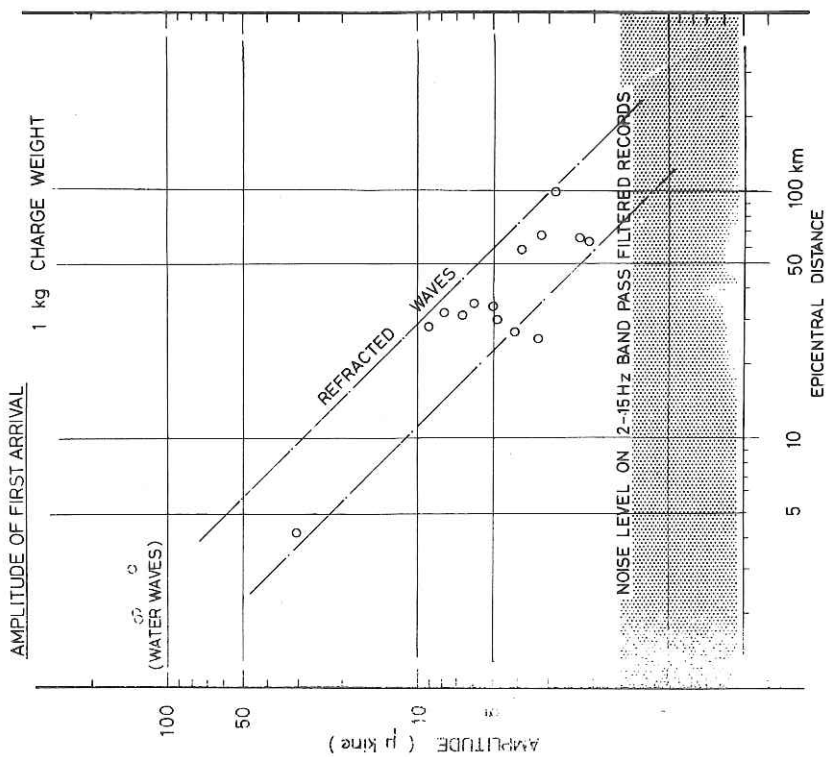


Fig. 5-10. Amplitudes of 1 kg explosions observed by the OBS, relating to the epicentral distances.

Fig. 5-11. Detection capability of the OBS's of explosions as functions of charge weights and epicentral distances.

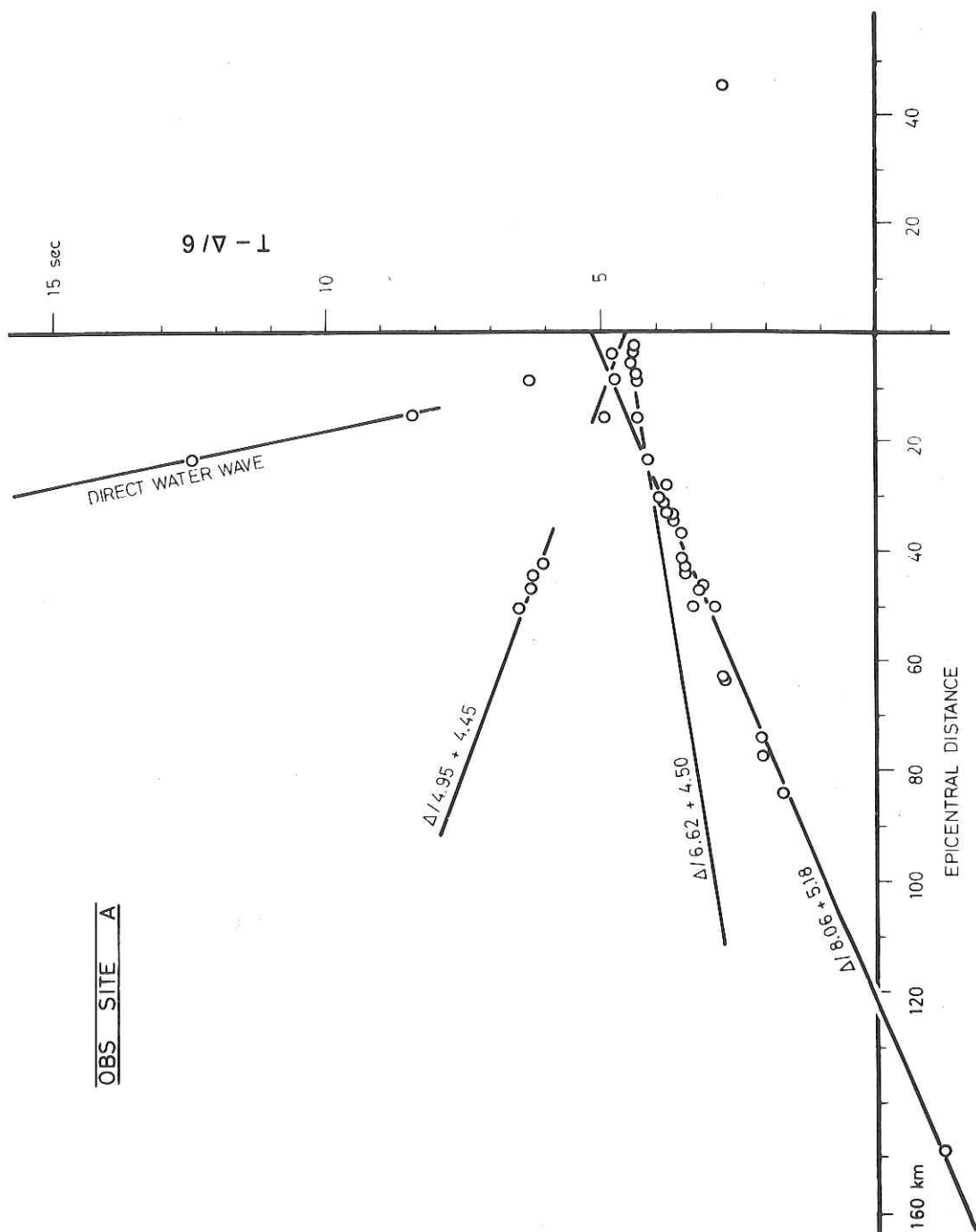


Fig. 5-12. Travel time curves obtained at site A of the Mariana Explosion

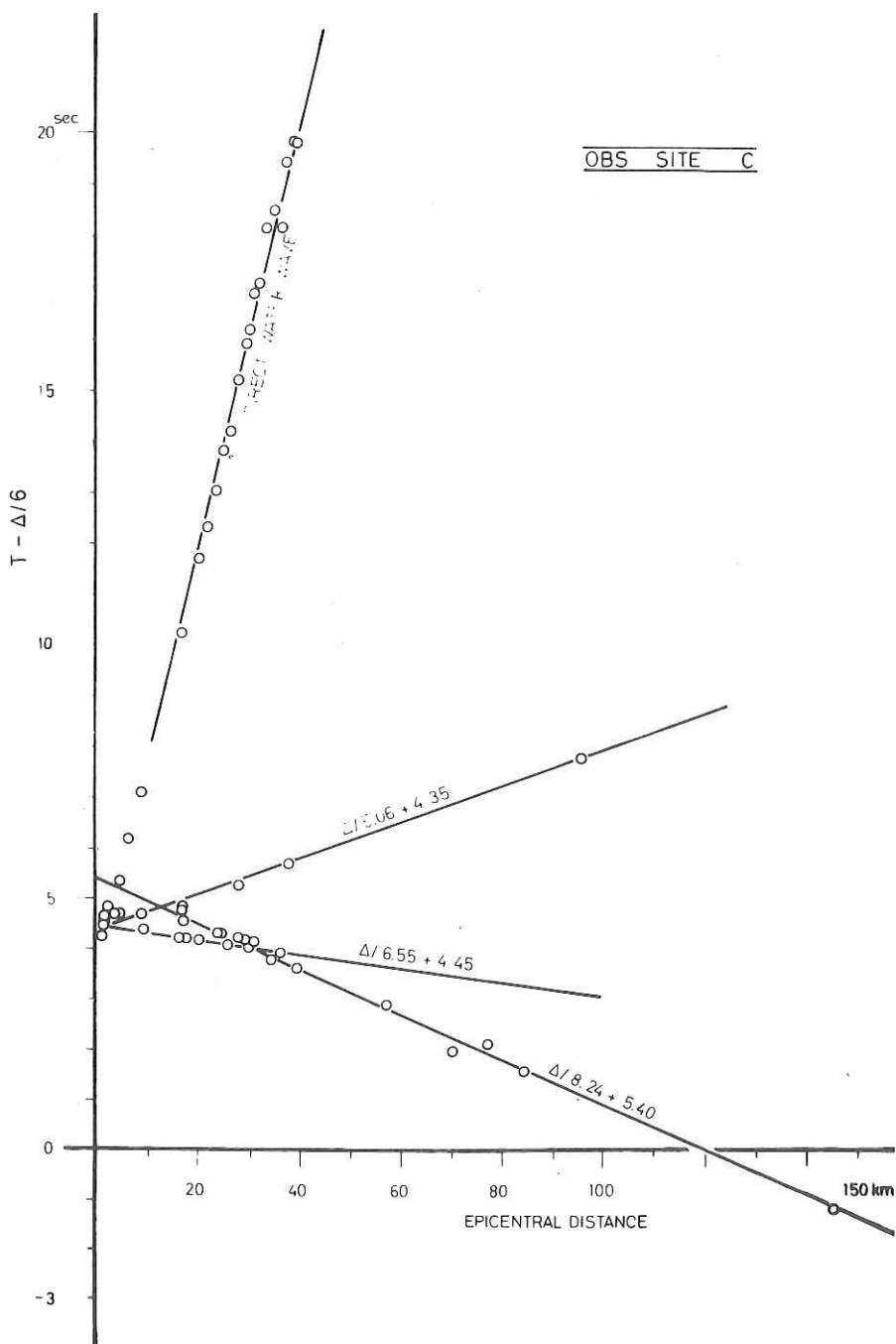


Fig. 5-13. Travel time curves obtained at site C of the Mariana Explosion

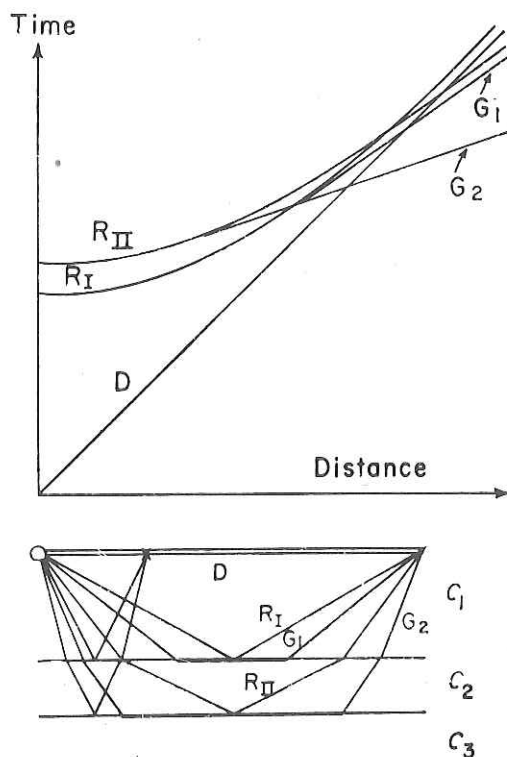


Fig. 5-14. Travel time curves of hydrophone observations, illustrated schematically

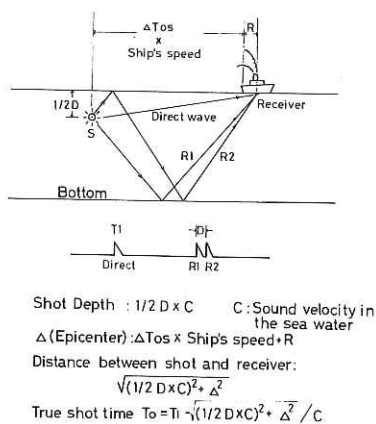


Fig. 5-15. Correction of shot time

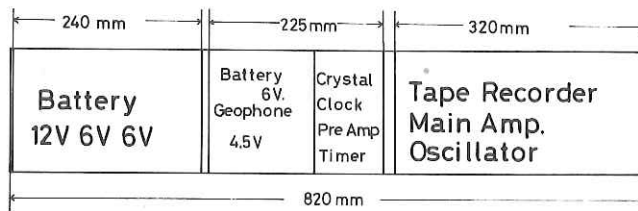
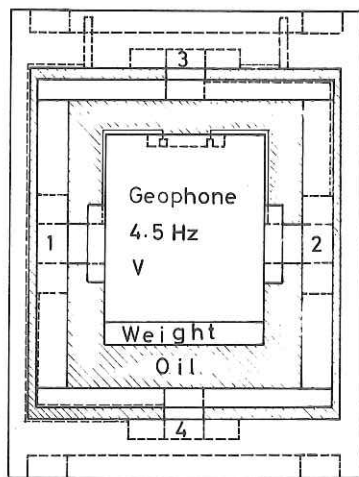
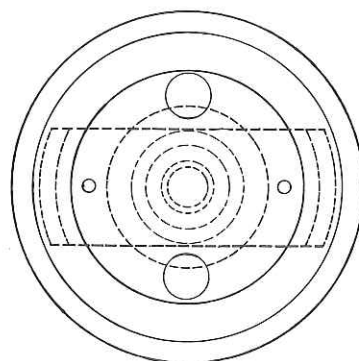


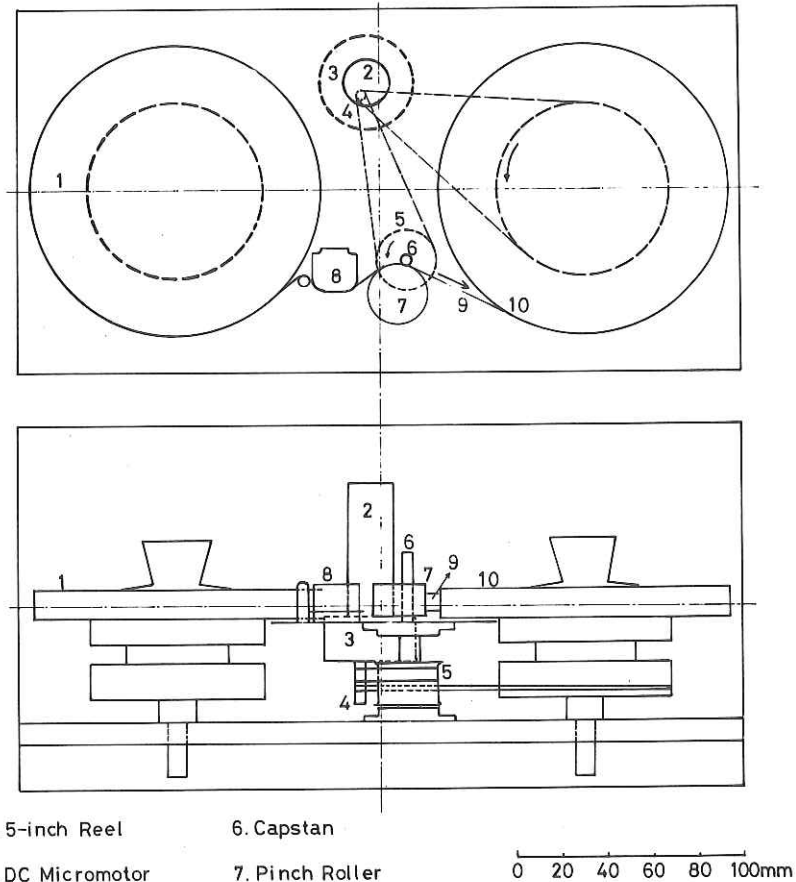
Fig. 5-16. Distributions of observation devices in the pressure vessel



0 10 20 30 40 50mm

12.3.4.: Gimbal

Fig. 5-17. A leveling device for the geophone



- | | |
|-------------------|-------------------|
| 1. 5-inch Reel | 6. Capstan |
| 2. DC Micromotor | 7. Pinch Roller |
| 3. Gear Box | 8. Recording Head |
| 4. Driving Pulley | 9. Magnetic Tape |
| 5. Flywheel | 10. 5-inch Reel |

Motor type	DC Micromotor (CLT-2A-5)
Driving Pulley Dia.	5 ϕ
Flywheel Dia.	26 ϕ
Capstan Dia.	4 ϕ
Capstan rpm	0.96
Tape speed	0.20 mm/s

Fig. 5-18. Mechanisms and specification of Hokkaido OBS and its slow speed driving

6. Continuous Seismic Reflection Profiling with an Air Gun Method

6.1. Continuous seismic reflection (air-gun) surveys at Izu-Ogasawara (Bonin), Mariana and Yap Trenches

by

E. Honza, H. Kagami, C.T. Chung,
K. Konishi, T. Harata and N. Kuroda

The purpose of the survey was to study the structural framework of continental margin, especially of trench and continental terrace. Four areas were planned for the survey, i.e. the Izu-Ogasawara, Mariana and Yap Trenches and the Bashi strait. However, no data were obtained at Bashi strait except bottom reflection.

Continuous seismic reflection (air-gun) surveys were carried out with high pressure of 90 to 120 kg per cm². Fig. 6-1 shows the towing condition of gun and hydrophone array. Table 6-1 shows start and end positions of survey lines with other conditions.

Survey line at Izu-Ogasawara trench was not complete as it had to be stopped immediately before the trench axis. Four profiles were taken across Mariana trench which are distinguished with a hardly discernible thin cover of soft sediment on trench floor. Thin cover of the upper transparent layer is found at the sea side floor of the trench. Structural movement is suggested at the trench slope of the land side by a few ridges and troughs. Thick sediment covers troughs, however they are not filled up yet.

One profile was taken across Yap trench. The soft sediment was thinner on the continental slope than the other trenches surveyed. Detailed discussion will be published later with the result of the studies on the dredged samples.

Table 6-1. Start and end positions and other conditions of the survey

Leg No.	Date	Ship speed (kt)	Lat.	Long.	Pressure (kg/cm ²)
---------	------	-----------------	------	-------	--------------------------------

Izu-Ogasawara trench

1	Jan.23,24	10	27°28.3' 27°06.9'	140°06.4' 141°01.9'	95-100
2	Jan.26	12-14	27°04.4' 27°02.7'	142°00.5' 143°09.0'	90

Mariana trench

5	Feb.10,11	10	13°54.4' 13°52.5'	149°04.9' 146°03.2'	120
6	Feb.12,13	10-12	13°54.5' 13°26.0'	146°44.7' 148°43.6'	120
7	Feb.13,14	10-12	13°34.2' 13°34.3'	148°06.6' 145°02.1'	120
8	Feb.17,18	11-12	13°17.8' 11°55.0'	145°10.0' 147°18.7'	120

Yap trench

15	Mar.9,10	12	07°27.5' 10°01.8'	140°21.5' 137°01.0'	120
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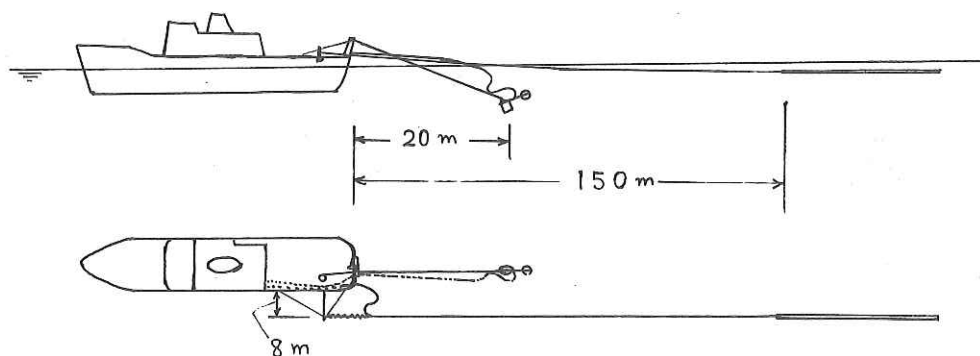


Fig. 6-1. Towing condition of air-gun and hydrophone array

6.2. Other interesting areas

by

S. Murauchi and T. Asanuma

Seismic reflection survey was carried out by an air-gun seismic profiler almost continuously throughout the course of this cruise. Results will be analysed and published elsewhere. Only an example of records is represented in Fig. 6-2 showing a upheaval of sedimentary layers at a small topographic high in a Mariana Basin approximately 100 km north of the refraction sites.

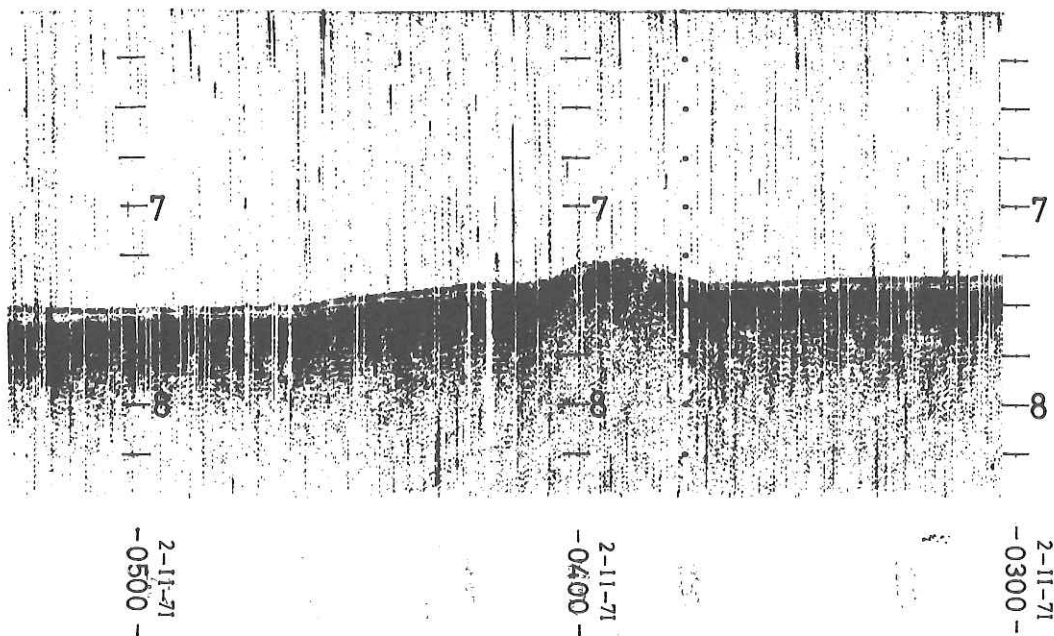


Fig. 6-2. Profiler record, vertical scale in seconds

7. Piston Coring

7.1. Operation Logs

CORE LOG

Date Jan.28,1971 Ship Hakuho-maru Cruise KH71-1 Station 2
Latitude 24°27.0'N Longitude 148°48.0'E
Location north Mariana Basin
Weather clear, partly cloudy Wind breeze
Sea no swell, no waves
Bottom Topography nearly smooth, SE flank of large seamount

Length of Core Pipe 12m No.of Pipe 1 Material Al
I.D. of Pipe 68mm Wall Thickness 6mm
Core Head Wt. 600kg Trigger Wt. 70kg
Length Trigger Line 25m Length Main Line 25m
Length Free Fall 12m

Matthews' correction

Time lowered 14^h54^m ; Uncorrected Water Depth 5700 m 41 m
Time hit 16^h13^m ; Uncorrected Water Depth 5700 m 41 m
Wire Angle at Hit 2° Wire-out at Hit 5773 m Response large
Time surfaced 18^h00^m ; Uncorrected Water Depth 5700 m 41 m

Core Length 0 cm Trigger Core Length 10 cm

Method of Storage _____

Length of Core stored; 1(top) _____cm, 2. _____cm, 3. _____cm
4. _____cm, 5. _____cm, 6. _____cm

No. of Pipe stored _____

No. of Cubic Samples for Paleomagnetism _____ (# -#)

Recovery Condition corer lost due to broken wire

CORE LOG

Date Feb. 13, 1971 Ship Hakuho-maru Cruise KH71-1 Station 8
Latitude 13°25.0'N Longitude 148°41.7'EE
Location SW of the OBS site No.5, East Mariana Basin
Weather cloudy, shower at 14 Wind 9 m/sto 17 m/s
Sea swell
Bottom Topography slightly rugged

Length of Core Pipe 12m No. of Pipe 1 Material Al
I.D. of Pipe 68mm Wall Thickness 6mm
Core Head Wt. 600 kg Trigger Wt. 70 kg
Length Trigger Line 25m Length Main Line 25m
Length Free Fall 12m

Matthews' correction

Time lowered 14^h00^m ; Uncorrected Water Depth 5680 m 39 m
Time hit 15^h20^m ; Uncorrected Water Depth 5680 m 39 m
Wire Angle at Hit 3° Wire-out at Hit 5760 m Response no
Time surfaced 16^h35^m ; Uncorrected Water Depth 5700 m 39 m

Core Length 0 cm Trigger Core Length 45 cm

Method of Storage _____

Length of Core stored; 1 (top) _____ cm, 2. _____ cm, 3. _____ cm
4. _____ cm, 5. _____ cm, 6. _____ cm

No. of Pipe stored _____

No. of Cubic Samples for Paleomagnetism _____ (# -#)

Recovery Condition failed

CORE LOG

Date Feb. 21, 1971 Ship Hakuho-maru Cruise KH71-1 Station 9
Latitude 01°25.8'N Longitude 152°57.5'E
Location NW flank of the Caroline Ridge
Weather clear Wind breeze, 8m/s 80°E
Sea low swell
Bottom Topography flat, near a rift, thick sediment (profiler)

Length of Core Pipe 12 m No. of Pipe 1 Material Al
I.D. of Pipe 68 mm Wall Thickness 6 mm
Core Head Wt. 600 kg Trigger Wt. 70 kg
Length Trigger Line 25 m Length Main Line 25 m
Length Free Fall 12 m

Matthews' correction
Time lowered 10^h05^m ; Uncorrected Water Depth 3820 m - 3 m
Time hit 11^h05^m ; Uncorrected Water Depth 3810 m - 3 m
Wire Angle at Hit 0° Wire-out at Hit 3820 m Response good
Time surfaced 12^h18^m ; Uncorrected Water Depth 3810 m - 3 m
(winch trouble 11:00-11:30)
Core Length 965 cm Trigger Core Length 57 cm

Method of Storage longitudinally cut into a Quater, lapped by vinyl
Length of Core stored; 1 (top) 116 cm, 2. 194 cm, 3. 193 cm
4. 194 cm, 5. 192 cm, 6. 76 cm
No. of Pipe stored 6
No. of Cubic Samples for Paleomagnetism 333 (#8100 - #8833)

Recovery Condition very good

CORE LOG

Date Feb.22,1971 Ship Hakuho-maru Cruise KH71-1 Station 10
Latitude 00°09.8'N Longitude 151°11.5'E
Location north off New Ireland island
Weather changing, cloudy Wind 0 to 8m/s breeze
Sea moderate swell
Bottom Topography trough, flat bottom

Length of Core Pipe 12m No.of Pipe 1 Material Al
I.D. of Pipe 68 mm Wall Thickness 6 mm
Core Head Wt. 600 kg Trigger Wt. 70 kg
Length Trigger Line 25 m Length Main Line 25 m
Length Free Fall 12m

Matthews' correction

Time lowered 09^h00^m ; Uncorrected Water Depth 5685 m 43m
Time hit 10^h30^m ; Uncorrected Water Depth 5685 m 43m
Wire Angle at Hit 1° Wire-out at Hit 5770 m Response no
Time surfaced 12^h00^m ; Uncorrected Water Depth 5685 m 43 m

Core Length 0 cm Trigger Core Length 35 cm

Method of Storage _____

Length of Core stored; 1(top) _____ cm, 2. _____ cm, 3. _____ cm
4. _____ cm, 5. _____ cm, 6. _____ cm

No. of Pipe stored _____

No. of Cubic Samples for Paleomagnetism 2 (# 8832 -# 8833)

Recovery Condition cutting edge OK, pipe bent at 7 m

CORE LOG

Date March 05, 1971 Ship Hakuho-maru Cruise KH71-1 Station 12-1
Latitude 01°52.0'N Longitude 147°02.3'E
Location West Caroline Basin,
Weather clear Wind no breeze, 2m/s
Sea very slight swell
Bottom Topography slightly rugged, slope of a moat

Length of Core Pipe 12m No. of Pipe 1 Material Al
I.D. of Pipe 68 mm Wall Thickness 6 mm
Core Head Wt. 600 kg Trigger Wt. 40 kg
Length Trigger Line 25 m Length Main Line 25 m
Length Free Fall 12m

Matthews' correction

Time lowered 07^h25^m ; Uncorrected Water Depth 4470 m 9 m
Time hit 08^h44^m ; Uncorrected Water Depth 4500 m 9 m
Wire Angle at Hit 11° Wire-out at Hit 4520m Response good
Time surfaced 09^h50^m ; Uncorrected Water Depth 4500 m 9 m

Core Length 1100cm Trigger Core Length cm

Method of Storage normal
Length of Core stored; 1(top) 76 cm, 2. 154 cm, 3. 191 cm
4. 197 cm, 5. 192 cm, 6. 76 cm
No. of Pipe stored 6
No. of Cubic Samples for Paleomagnetism 373 (#8840 -#10020)

Recovery Condition good

CORE LOG

Date March 5, 1971 Ship Hakuho-maru Cruise KH71-1 Station 12-2

Latitude 01°53.0'N Longitude 147°02.0'E

Location West Caroline Basin

Weather clear Wind no breeze

Sea very slight swell

Bottom Topography slightly rugged, slope of a moat

Length of Core Pipe 8 m No. of Pipe 2 Material stainless steel

I.D. of Pipe mm Wall Thickness mm

Core Head Wt. 500 kg Trigger Wt. 70 kg

Length Trigger Line m Length Main Line m

Length Free Fall m

Matthews' correction

Time lowered 10^h14^m ; Uncorrected Water Depth 4520 m 9 m

Time hit ; Uncorrected Water Depth 4520 m 9 m

Wire Angle at Hit Wire-out at Hit m Response good

Time surfaced ; Uncorrected Water Depth m m

Core Length 564 cm Trigger Core Length cm

Method of Storage normal

Length of Core stored; 1(top) 60 cm, 2. 152 cm, 3. 14 cm
4. 154 cm, 5. 145 cm, 6. 39 cm

No. of Pipe stored 6

No. of Cubic Samples for Paleomagnetism 247 (# 9800 -# 11047)

Recovery Condition good

CORE LOG

Date March 06, 1971 Ship Hakuho-maru Cruise KH71-1 Station 13 -1

Latitude 01°53.1'N Longitude 144°56.4'E

Location _____

Weather clear, cloud near hor. Wind 1 m/s E

Sea very calm, very slight swell

Bottom Topography a subbottom high nearby

Length of Core Pipe 12 m No. of Pipe 1 Material Al

I.D. of Pipe 68 mm Wall Thickness 6 mm

Core Head Wt. 600 kg Trigger Wt. 70 kg

Length Trigger Line 25 m Length Main Line 25 m

Length Free Fall 12 m

Matthews' correction

Time lowered 07^h17^m ; Uncorrected Water Depth 4525 m 9 m

Time hit 08^h35^m ; Uncorrected Water Depth 4522 m 9 m

Wire Angle at Hit 0° Wire-out at Hit 4546 m Response good

Time surfaced 09^h45^m ; Uncorrected Water Depth 4500 m 9 m

Core Length 769 cm

Trigger Core Length _____ cm

Method of Storage normal

Length of Core stored; 1 (top) 113 cm, 2. 199 cm, 3. 193 cm
4. 195 cm, 5. 69 cm, 6. _____ cm

No. of Pipe stored 5

No. of Cubic Samples for Paleomagnetism 332 (#10024 - #10356)

Recovery Condition good

CORE LOG

Date March 12, 1971 Ship Hakuho-maru Cruise KH71-1 Station 15
Latitude 12°03.6'N Longitude 130°10.8'E
Location Philippine Basin
Weather clear Wind 6 m/s NEE
Sea low swell
Bottom Topography rugged, near subbottom diapirs

Length of Core Pipe 12m No. of Pipe 1 Material Al
I.D. of Pipe 68 mm Wall Thickness 6 mm
Core Head Wt. 600 kg Trigger Wt. 70 kg
Length Trigger Line 24 m Length Main Line 25 m
Length Free Fall 11m

				Matthews' correction	
Time lowered	<u>09^h10^m</u>	;	Uncorrected Water Depth	<u>5700 m</u>	<u>39 m</u>
Time hit	<u>10^h48^m</u>	;	Uncorrected Water Depth	<u>5700 m</u>	<u>39 m</u>
Wire Angle at Hit	<u>10°</u>	Wire-out at Hit	<u>5329 m</u>	Response	<u>good</u>
Time surfaced	<u>12^h28^m</u>	;	Uncorrected Water Depth	<u>5700 m</u>	<u>39 m</u>

Core Length 697 cm Trigger Core Length _____ cm

Method of Storage normal

Length of Core stored; 1 (top) 20 cm, 2. 117 cm, 3. 177 cm
4. 180 cm, 5. 175 cm, 6. 20 cm, 7. 8 cm

No. of Pipe storaged 4

No. of Cubic Samples for Paleomagnetism 293 (# 10400 - # 0693)

Recovery Condition pipe bent at 7 m,
top and bottom 20 cm are disturbed for extrusion.

7.2. Description of samples

by
K. Konishi

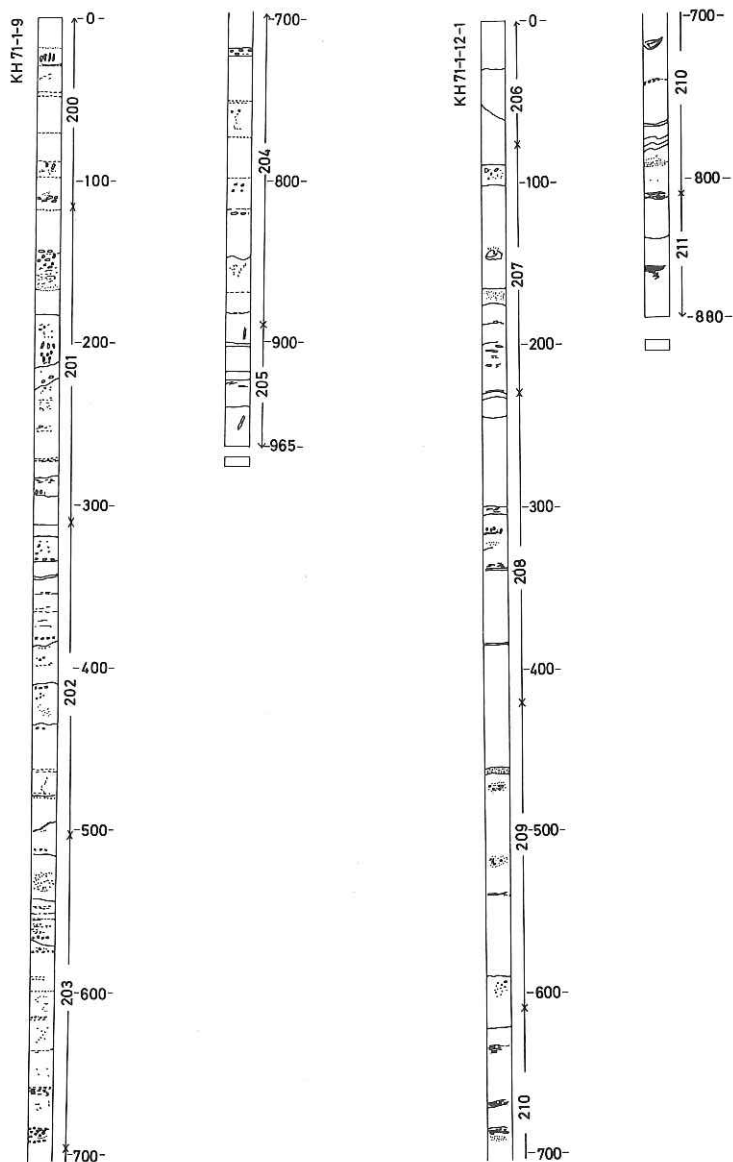
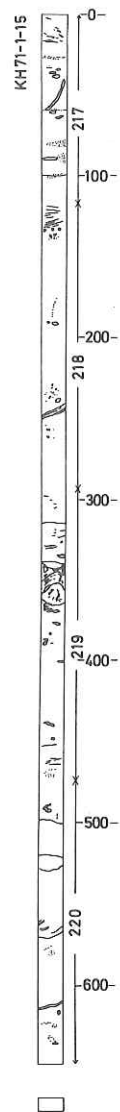
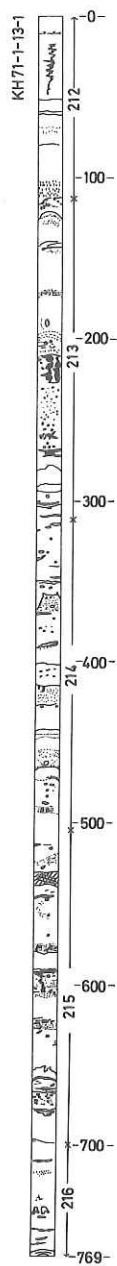
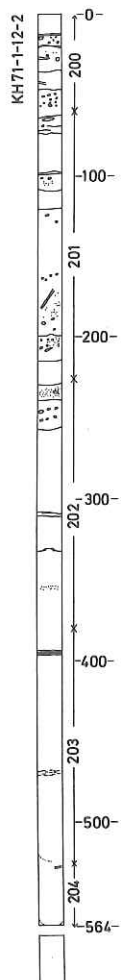


Fig. 7-1.



7.3. Clay mineralogical studies

by
T. Sato

The clay mineralogical studies were carried out on KH-71-1-9, -12, -13 and -15 samples. The upper, middle and lower parts of these cores were studied by X-ray powder method as a preliminary step. The results showed that these core samples included montmorillonite, illite and chlorite or kaolin as the clay minerals, and the other minerals were mainly composed of quartz and calcite. The X-ray powder data are shown in the Table 7-1.

In future, I wish to investigate more detailed researches on the particles smaller than 2 microns.

Table 7-1. X-ray powder data

No. 1

d		St. 9			St. 12		
2θ	Å	upper	middle	lower	upper	middle	lower
6.0	14.7		2	2	10	7	2
8.8	10.2	3	2	2	10	3	2
12.3	7.2	3	3	3	12	5	2
17.6	5.0				7	3	2
18.4					3		
19.6	4.5	2		2	5	6	5
20.8	4.3	2	2	2	5	8	5
23.1	3.9	8	10	7	2	2	5
25.0	3.5		2	2	10	6	2
26.6	3.4	6	7	5	20	28	15
27.8	3.2				7	9	5
29.5	3.0	75	84	70	12	3	40
30.6	2.9			2	2	2	
31.3	2.8	10	7	7	3	2	3
36.0	2.5	10	15	8	3	4	7
36.4	2.4				3	4	2
39.3	2.3	13	18	11	2	2	7
43.2	2.1	11	15	7	3	3	6
45.2	2.0	2			3	3	2
47.5	1.9	22	20	15	3	2	9
48.4	1.9	13	17	9	2		6
50.0	1.8					3	2
56.6	1.6	3	3	1			
57.4	1.6	4	7	4			
58.1	1.5	2					2
60.0	1.5					2	
60.7	1.5		5	2			
61.4	1.5	3	3	1			
64.7	1.4	3	4	3			2
65.6	1.4	9	7	8			3
		upper ; 0- 10 cm middle;480-490 cm lower ;960-970 cm			upper ; 0- 10 cm middle;440-450 cm lower ;870-880 cm		

No. 2

d		St. 13			St. 15		
2θ	Å	upper	middle	lower	upper	middle	lower
6.0	14.7	9	7	6	10	10	10
8.8	10.2	10	6	4	10	11	6
12.3	7.2	13	9	6	11	13	11
17.6	5.0	4	3	2	5	5	4
18.4	4.8	4	2	2	2	4	4
19.6	4.5	3	3	5	3	5	5
20.8	4.3	7	5	7	7	7	6
25.0	3.5	9	5	5	8	9	9
26.6	3.4	31	26	23	30	26	30
27.8	3.2	8	9	7	8	12	12
29.5	3.0	18	20	24	3	3	5
30.6	2.9	3	3	3	2	2	3
31.3	2.8	3	4	3	5	3	2
36.0	2.5	3	5	3		2	3
36.4	2.4	3	3	4	3	2	2
39.3	2.3	4	7	5	3	2	2
43.2	2.1	3	3	5			3
45.2	2.0	3	2	2	7	3	5
47.5	1.9	3	7	5			
48.4	1.9	3	5	5			
50.0	1.8	3	5	3	3		
56.6	1.8		2	2			
57.4	1.6			2			
58.1	1.5			2			
60.0	1.5			2	3		
65.6	1.4	2	2	2			
		upper ; 0- 10 cm middle;380-390 cm lower ;720-730 cm			upper ; 0- 10 cm middle;330-340 cm lower ;650-660 cm		

7.4. Paleomagnetic stratigraphy of cores

by
K. Kobayashi

KH71-1 9

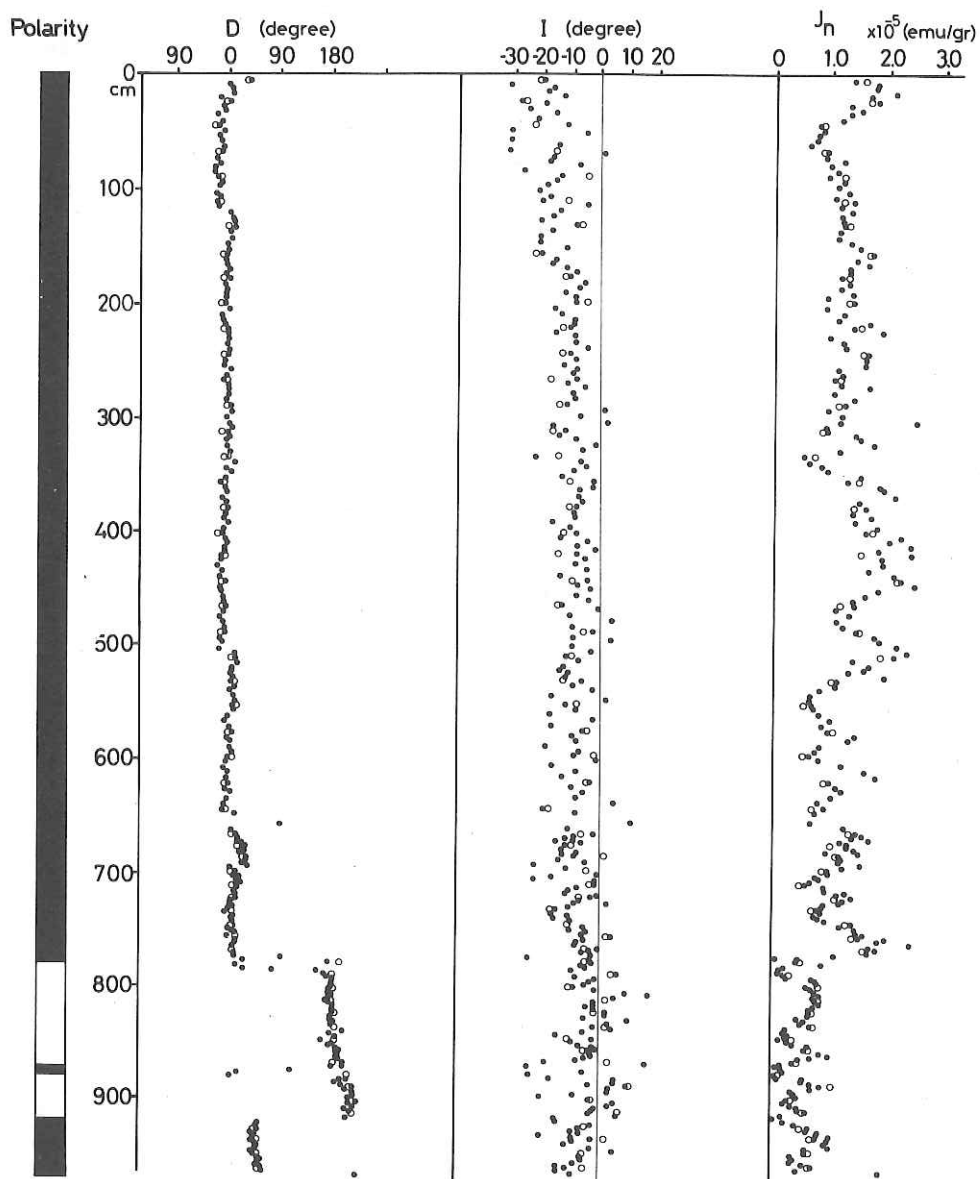
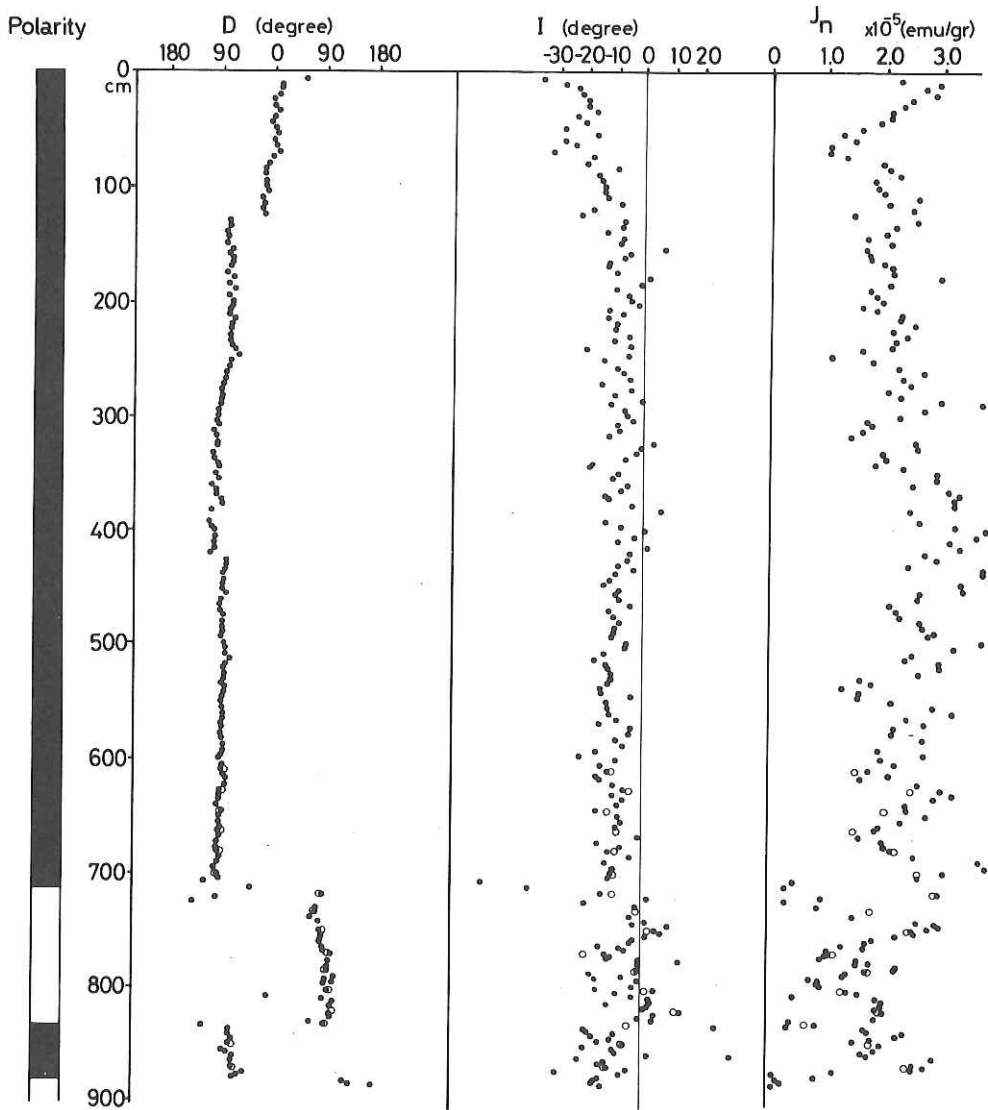
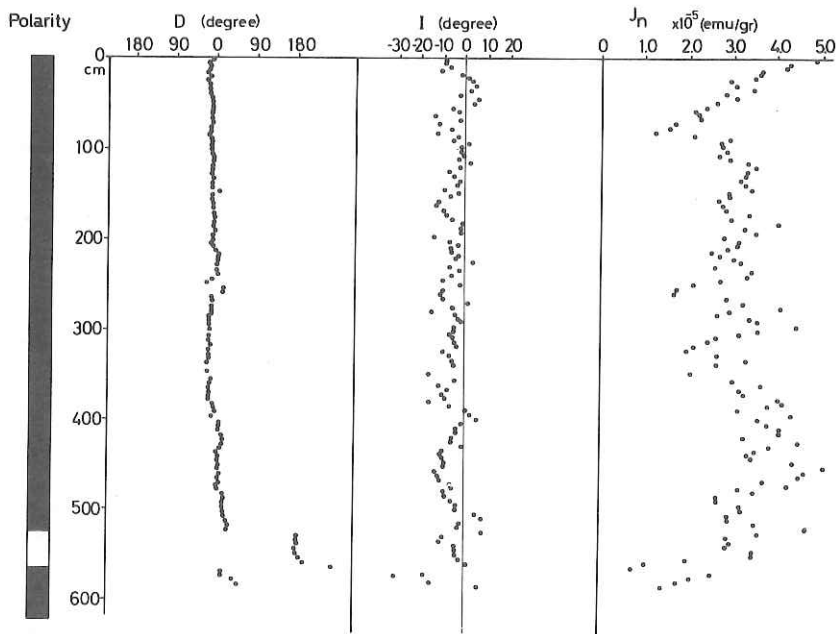


Fig. 7-2. D : declination, I : inclination, J_n : intensity,
Solid circles : natural remanent magnetization,
Hollow circles : after AC demagnetization by 50 oe.

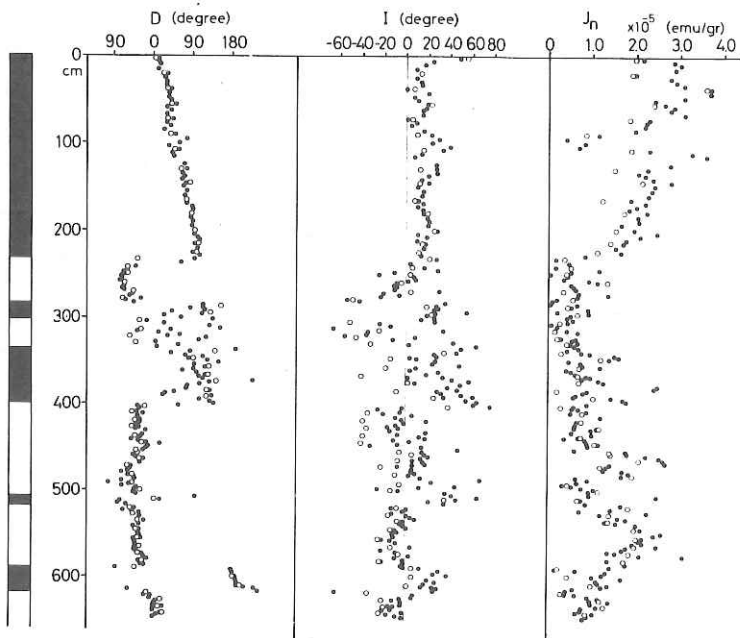
KH71-1 12-1



KH71-1 12-2



KH 71-1 15



8. Dredge Hauls

8.1. Operation Logs

DREDGE LOG

Date Jan.27, 1971 Ship Hakuho-maru Cruise KH 71-1 Station 1
Location flat basin southerast off the Bonin Trench

Weather clear Wind 7 kt

Sea calm, very low swell

Bottom Topography smooth

Type of Dredge Pipe dredge, with holes ^{masked} Add.Wt. 200 kg

Time lowered 14^h 16^m

Uncorr. Water Depth 5500 m

Initial Time on Bottom 15^h 32^m

Uncorr. Water Depth 5500 m Corr. Water Depth 5534 m

Wire Length 5630 m Wire Angle 3

Ship Position: Lat. 27°12.4'N; Long. 146°16.0'E

Direction of haul 137° Ship Speed 1 kt(till 16^h 02^m)

Speed Wire-in 30~50 m/min(from 16^h 02^m) Winch No. 1

Final Time on Bottom 16^h 12^m

Uncorr. Water Depth 5460 m Corr. Water Depth m

Wire Length 5600 m Wire Angle 16°

Ship Position: Lat. ; Long.

Time surfaced 17^h 42^m

Condition of Haul hauled toward SE direction at a speed of
1~0.5 m/sec for about 40 min. Slight but detectable
change in wire tension at the time of bottoming.

Dredged Materials about 100 kgs of surface sediment (yellowish
brown clay with volcanic ash) collected.

Directed by Kazuo KOBAYASHI

DREDGE LOG

Date Jan. 29, 1971 Ship Hakuho-maru Cruise KH 71-1 Station 3-1
Location West-end of the Marcus-Wake Seamounts, NE off the
Mariana Trench.

Weather clear Wind breeze
Sea calm

Bottom Topography steep slope near the top of a seamount, rugged

Type of Dredge Nalwalk chain-bag dredge Add.Wt. 100 kg

Time lowered 09^h 08^m

Uncorr. Water Depth 2800 m

Initial Time on Bottom 10^h 41^m

Uncorr. Water Depth 1220 m Corr. Water Depth m

Wire Length 1997 m Wire Angle 23

Ship Position: Lat. 23° 49.5' N; Long. 148° 42.0' E

Direction of haul 96° Ship Speed 0.5 kt (till 10^h 43^m)

Speed Wire-in 30 m/min (from 11^h 00^m) Winch No. 1

Final Time on Bottom 11^h 13^m

Uncorr. Water Depth 1100 m Corr. Water Depth m

Wire Length 1618 m Wire Angle 30°

Ship Position: Lat. ; Long.

Time surfaced 12^h 00^m

Condition of Haul repeated impulse of wire tension amounting
to 3~4 tons observed soon after the ship hauled dredge
at speed of less than 0.5 kt. The ship stopped immedia-
tely but the dredge was already lost.

Dredged Materials lost

Directed by Kazuo KOBAYASHI

DREDGE LOG

Date Jan.30, 1971 Ship Hakuho-maru Cruise KH 71-1 Station 3-3

Location West-end of the Marcus-Wake Seamounts, NE off the
Mariana Trench

Weather clear Wind 2 m/s W-breeze

Sea low swell

Bottom Topography flat-top of a guyot, smooth

Type of Dredge Nalwalk chain-bag dredge Add.Wt. 100 kg

Time lowered 09^h 39^m

Uncorr. Water Depth 1050 m

Initial Time on Bottom 10^h 21^m

Uncorr. Water Depth 1050 m Corr. Water Depth 1045 m

Wire Length 1501 m Wire Angle 42

Ship Position: Lat. 23°49.0'N; Long. 148°46.5'E

Direction of haul 140° Ship Speed 0~1kt(till 11^h 30^m)

Speed Wire-in 5~10 m/min(from 10^h 26^m) Winch No. 1

Final Time on Bottom 11^h 48^m

Uncorr. Water Depth 1050m Corr. Water Depth m

Wire Length 1070 m Wire Angle 6 °

Ship Position: Lat. 23°49.5'N; Long. 148°46.0'E

Time surfaced 12^h 20^m

Condition of Haul many impulses of wire tension amounting to
2~3 tons observed between 10h20.5m and 10h25m, 10h28m
and 10h50m (softer bottom), 10h55m and 11h48m.

Dredged Materials 89 pieces of Mn-coated limestones (100kgs)
including a fossil of Nerinia.

Directed by Kazuo KOBAYASHI

DREDGE LOG

Date Feb. 11, '71 Cruise no. KH-71-1 Dredge Station 4
Location Land side slope of Marianas trench Station no. 6
Bottom Topography Rough slope
Lat. 13° 53.4' N Long. 146° 17.5' E
Type of Dredge Cylinder type dredge Wt. 350 kg. (lead wt.)
Time Lowered 9^h 07^m ; Uncorr. Water Depth 4500 m
Initial Time on Bottom 10^h 29^m ; Uncorr. Water Depth 4350 m
Wire Length 4432 m Wire Angle 5°
Towing Condition 11^h 29^m the 2nd attack on bottom, 4405 m 3°
12^h 33^m the 3rd attack on bottom, 4448 m
Final Time on Bottom 13^h 10^m ; Uncorr. Water Depth 4120 m
Wire Length 4160 m Wire Angle _____
Time Recovered _____
Other Observation _____

Dredged Materials about 90 fragments of rock, presumably in
Tertiary age

DREDGE LOG

Date Mar.06, 1971 Ship Hakuho-maru Cruise KH 71-1 Station 13-2

Location East Caroline Basin

Weather clear Wind SE weak breeze

Sea calm

Bottom Topography smooth

Type of Dredge Pipe Add.Wt. 130 kg

Time lowered 09^h 53^m

Uncorr. Water Depth 4500 m

Initial Time on Bottom 12^h 25^m

Uncorr. Water Depth 4350 m Corr. Water Depth m

Wire Length 5003 m Wire Angle 11

Ship Position: Lat. 01°54.6'N; Long. 144°53.2'E

Direction of haul 310° Ship Speed 0.5~1kt(till 13^h 07^m)

Speed Wire-in 25 m/min(from 13^h 07^m) Winch No. 1

Final Time on Bottom 13^h 20^m

Uncorr. Water Depth 4320 m Corr. Water Depth m

Wire Length 4700 m Wire Angle 27°

Ship Position: Lat. ; Long.

Time surfaced 14^h 50^m

Condition of Haul no distinct response in wire tension.

Dredged Materials 140 kgs of surface yellowish brown clay

Directed by Kazuo KOBAYASHI

8.2. Dimensions and other features of dredge samples

Sample No.	Size (cm) a x b x c	Roundness*	Weight (kg)	Remarks
3- 1	33 x 19 x 14	0.3	9.8	including Nerimia fossils
3- 2	28 x 25 x 6	0.5	4.2	
3- 3	29 x 20 x 3.5	0.3 tabular	2.4	
3- 4	20 x 16 x 8	0.4	4.2	
3- 5	27 x 11 x 14	0.4	4.3	
3- 6	21 x 17 x 12	0.4	4.0	
3- 7	20 x 17 x 10	0.4	2.8	
3- 8	21 x 12 x 7	0.3 tab.	2.3	
3- 9	18 x 15 x 11	0.35	4.2	
3-10	14 x 12 x 9	0.3	2.1	
3-11	17 x 11 x 10	0.3	2.2	
3-12	22 x 13 x 7	0.3 tab.	2.5	
3-13	24 x 12 x 8	0.2	1.5	
3-14	24 x 14 x 3	0.3 tab.	1.5	
3-15	18 x 15 x 6	0.3	1.0	
3-16	16 x 13 x 11	0.4	2.0	
3-17	17 x 14 x 5	0.3	1.2	
3-18	16 x 12 x 3	0.4	1.5	
3-19	20 x 13 x 7	0.2	1.0	
3-20	17 x 12 x 3.5	0.4 tab.	1.0	
3-21	16 x 12 x 4	0.3 tab.	1.5	
3-22	17 x 9 x 7	0.5	1.0	
3-23	15 x 11 x 6	0.4	0.8	
3-24	11 x 12 x 6	0.6	0.6	
3-25	15 x 9 x 11	0.3	0.8	
3-26	16 x 10 x 9	0.2	} 3.5	
3-27	12 x 11 x 9	0.3		
3-28	14 x 10 x 6	0.7 round	} 3.0	
3-29	14 x 9 x 7	0.7 round		
3-30	16 x 7 x 8	0.4		
3-31	13 x 13 x 5	0.5	} 2.8	
3-32	12 x 9 x 8	0.4		
3-33	13 x 9 x 4	0.4		
3-34	13 x 9 x 7	0.4		

Sample No.	Size (cm) a x b x c	Roundness	Weight (kg)	Remarks
3-35	14 x 13 x 5	0.4	} 2.2	
3-36	13 x 8 x 6	0.3		
3-37	11 x 11 x 3	0.3 tab.		
3-38	12 x 10 x 5	0.2	} 2.5	
3-39	13 x 10 x 6	0.3		
3-40	14 x 11 x 6	0.3		
3-41	14 x 12 x 3	0.2 tab.	} 1.5	
3-42	18 x 6 x 5	0.3		
3-43	14 x 7 x 5	0.3		
3-44	14 x 11 x 5	0.3 tab.	} 2.0	
3-45	12 x 9 x 10	0.6 round		
3-46	8 x 12 x 9	0.2		
3-47	12 x 9 x 6	0.3	} 2.0	
3-48	12 x 8 x 7	0.3		
3-49	10 x 10 x 10	0.2 trian- gular		
3-50	13 x 11 x 9	0.3	} 2.5	
3-51	11 x 10 x 7	0.2		
3-52	13 x 10 x 6	0.4 tab.		
3-53	14 x 5 x 5	0.4	} 2.0	
3-54	15 x 7 x 6	0.3		
3-55	16 x 5 x 5	0.3		
3-56	11 x 7 x 4	0.3	} 1.8	
3-57	11 x 9 x 7	0.4		
3-58	11 x 9 x 8	0.3		
3-59	14 x 10 x 6	0.3	} 2.0	
3-60	10 x 7 x 4	0.3 tab.		
3-61	12 x 11 x 6	0.3		
3-62	11 x 10 x 6	0.4	} 1.8	
3-63	10 x 7 x 6	0.4		
3-64	11 x 8 x 3	0.3		
3-65	10 x 10 x 4	0.4	} 2.0	
3-66	11 x 9 x 6	0.2		
3-67	11 x 8 x 7	0.4		
3-68	11 x 7 x 4	0.3		
3-69	10 x 8 x 5	0.2		
3-70	10 x 8 x 6	0.2		

Sample No.	Size (cm) a x b x c	Roundness	Weight (kg)	Remarks
3-71	11 x 10 x 4	0.2	} 2.0	
3-72	11 x 7 x 5	0.3		
3-73	10 x 8 x 3	0.2		
3-74	10 x 8 x 6	0.3		
3-75	10 x 8 x 5	0.3		
3-76	10 x 7 x 6	0.2	} 3.0	
3-77	9 x 7 x 4	0.3		
3-78	12 x 7 x 5	0.3		
3-79	11 x 7 x 3	0.2		
3-80	10 x 7 x 6	0.3		
3-81	10 x 8 x 6	0.4		
3-82	8 x 7 x 5	0.3		
3-83	7 x 7 x 4	0.5		
3-84	8 x 6 x 4	0.2		
3-85	7 x 7 x 4	0.4		
3-86	7 x 6 x 4	0.3	flake	
3-87	8 x 6 x 3	0.3	flake	
3-88	6 x 5 x 4	0.3		
3-89	3 x 2 x 2	0.1		

* Roundness is indicated by Power's scale (As the number is layer, the shape is more round).

Sample No.	Size (cm) a x b x c	Roundness	Weight (g)	Remarks
6- 1	20 x 6 x 8	0.25	800	
6- 2	19 x 7 x 6	0.2	490	
6- 3	13 x 6 x 4.5	0.2	240	
6- 4	9.5 x 5 x 4.5	0.3	170	
6- 5	9 x 6.5 x 3.5	0.2	110	
6- 6	7.5 x 6 x 5	0.3	125	
6- 7	8 x 5 x 3.5	0.3	90	
6- 8	6.5 x 4 x 2	0.3	45	
6- 9	5.5 x 5.5 x 3.5	0.4	75	
6-10	7 x 4.5 x 2.5	0.2	50	
6-11	6 x 4 x 2	0.3	35	
6-12	7 x 3.5 x 2.5	0.4	40	
6-13	5.5 x 4 x 3	0.4	45	
6-14	4.5 x 3 x 2.5	0.4	25	
6-15	6 x 3.5 x 2.5	0.2	35	
6-16	5 x 5.5 x 3	0.35	50	
6-17	5.5 x 3.5 x 2	0.3	25	
6-18	0.5 x 4.5 x 2	0.2	35	
6-19	5.5 x 4 x 2	0.4	40	
6-20	7 x 3.5 x 2.5	0.4	50	
6-21	6.5 x 5 x 3	0.4	60	
6-22	6 x 5 x 2	0.2	75	
6-23	5.5 x 4.5 x 2	0.4	45	
6-24	6 x 3.5 x 3	0.4	35	
6-25	6.5 x 3 x 3.5	0.3	45	
6-26	5.5 x 4 x 2	0.3	40	
6-27	5 x 3 x 2.5	0.5	32	
6-28	5 x 5 x 1.5	0.2	30	
6-29	4.5 x 4 x 2.5	0.4	30	
6-30	5 x 3.5 x 4	0.3	45	
6-31	4.5 x 4.5 x 2.5	0.2	35	
6-32	5 x 4 x 1.5	0.25	20	

Sample No.	Size (cm) a x b x c	Roundness	Weight (g)	Remarks
6-33	6 x 5.5 x 1.5	0.1	25	Mn plate
6-34	5.5 x 5 x 2	0.35	40	
6-35	5 x 4 x 3	0.4	50	
6-36	4 x 3 x 2.5	0.2	35	
6-37	4.5 x 4.5 x 2	0.5	35	
6-38	4 x 3.5 x 1.5	0.3	25	
6-39	4.5 x 3 x 2.5	0.3	30	
6-40	5 x 3 x 2.5	0.4	30	
6-41	6 x 3.5 x 2.5	0.3	35	
6-42	6.5 x 3 x 1.5	0.2	15	
6-43	5.5 x 4.5 x 2	0.3	30	
6-44	4.5 x 3 x 3	0.4	40	
6-45	5 x 2.5 x 2.5	0.4	30	
6-46	4 x 2 x 2	0.3	20	
6-47	3.5 x 3.5 x 1.5	0.25	10	
6-48	3.5 x 3.5 x 2	0.4	18	
6-49	4 x 3 x 2	0.3	20	
6-50	3.5 x 3 x 2.5	0.5	25	
6-51	5 x 4 x 2.5	0.3	45	
6-52	5 x 3.5 x 2.5	0.3	30	
6-53	5 x 3.5 x 1		20	
6-54	4.5 x 3 x 2.5	0.4	30	
6-55	4.5 x 3 x 2.5	0.3	25	
6-56	4.5 x 2.5 x 2.5	0.3	27	
6-57	4.5 x 3 x 2.5	0.4	27	
6-58	4 x 3.5 x 2	0.4	23	
6-59	4 x 3.5 x 2.5	0.3	20	
6-60	4 x 3 x 2	0.4	20	
6-61	4.5 x 3.5 x 1.5	0.25	13	
6-62	3.5 x 3 x 1.5	0.2	12	
6-63	3.5 x 3 x 2.5	0.5	20	
6-64	4 x 3.5 x 2	0.3	20	

Sample No.	Size (cm) a x b x c	Roundness	Weight (g)	Remarks
6-65	4 x 3.5 x 2	0.25	12	Mn plate
6-66	4 x 3 x 2	0.4	15	
6-67	4.5 x 4 x 1.5		20	
6-68	4 x 3 x 2.5	0.3	20	
6-69	4.5 x 3 x 2	0.4	15	
6-70	4.5 x 3 x 1.5	0.3	20	
6-71	3.5 x 3.5 x 1.5	0.4	15	
6-72	4 x 3 x 2	0.25	20	
6-73	4 x 3.5 x 2.5	0.2	25	
6-74	5 x 3.5 x 1.5	0.4	17	
6-75	1.5 x 3.5 x 3		10	Mn plate
6-76	5 x 3 x 1.5	0.4	15	Mn plate
6-77	5 x 3.5 x 1		15	
6-78	4.5 x 3 x 0.5		10-	Mn plate
6-79	3.5 x 3 x 2	0.3	15	Mn plate
6-80	4 x 3.5 x 3	0.3	25	
6-81	3.5 x 3 x 0.5		10-	
6-82	3.5 x 3 x 1	0.2	10	
6-83	3.5 x 3 x 1	0.3	10-	
6-84	1.5 x 1.5 x 1	0.4	10-	
6-85	2.5 x 1 x 1	0.4	10-	
6-86	1 x 1 x 0.5		10-	
6-87	1 x 1 x 0.5	0.3	10-	
6-88	1 x 1 x 0.5		10-	
6-89	0.5 x 0.5 x 0.5	0.4	10-	chip
6-90	0.5 x 0.5 x 0.5		10-	chip
6-91	0.5 x 0.5 x 0.5		10-	chip

Sample No.	Size (cm) a x b x c	Round- ness	Weight (g)	Remarks
14- 1	33 x 27 x 13.5	0.3		Tuff, calcareous
14- 2	31 x 20 x 7.5	0.25		Tuff, calcareous
14- 3	23 x 18 x 9	0.2		Tuff, calcareous
14- 4	17 x 16.8 x 4.5	0.2	850	Mn crust
14- 5	18 x 15 x 6	0.2	900	Mn crust
14- 6	17 x 14 x 5.5	0.2	800	
14- 7	12 x 9 x 6	0.2	200	Tuff
14- 8	10.5 x 7.5 x 2	0.15	350	
14- 9	10 x 8 x 5	0.2	250	
14-10	9.5 x 7.5 x 3	0.15	150	Coralline lime- stone
14-11	7.5 x 7 x 2.3	0.3	100	
14-12	9 x 6.5 x 3.5	0.25	100	Foram. ooze limestone
14-13	10 x 5.5 x 2.5	0.25	100	
14-14	8.5 x 6.5 x 3.7	0.25	140	
14-15	8.5 x 6 x 4	0.2	110	
14-16	6.5 x 5.5 x 3	0.3	70	
14-17	7 x 4.5 x 1.5	0.1	40	flaky
14-18	6 x 5 x 1.7	0.2	40	flaky
14-19	3.2 x 2.5 x 2.3	0.2	20	
14-20	3 x 2.2 x 2.3	0.3	20	
14-21	4 x 3.7 x 0.7	0.1	10	
14-22	2.5 x 2 x 1.4	0.1	5	flaky
14-23	2.2 x 1.7 x 1.4			
others	more than 12 frag- ments		20	
	7.8 x 7.0 x 4	2	90	Mn coating evenly and rather heavily Foram. ooze lime- stone

8.3. Description of samples

by
K. Konishi

The dredge haul at the site KH-71-1-3-3 (23°48.4'N, 148°45.6'E) on the flat shoulder of the Seamount Syunsetsu recovered 89 gravels ranging in size from small boulder to very coarse pebble, most of which were ferromanganese nodules usually leaving some fossil phosphorite at their cores. Together with one pebble of altered basic tuff probably erupted and derived from the Mariana Arc to the west, two pebbles of shallow-water limestone make the exception, as these three pebbles were escaped from phosphatization and veneered with extremely thin film of ferromanganese oxides.

The shallow-water limestone is either fossil packstone or grainstone and contains abundance of the remains of benthic organisms such as calcareous algae, foraminifers, bivalve shells and echinoidal debris.

The phosphorites which are partially to entirely phosphatized carbonate rocks encrusted and replaced by thick ferromanganese crust range in lithologies from, (1) vuggy, shelly ones preserving molluscan remains as either molds or casts, (2) severely phosphatized (without any trace of calcite left) and irregularly replaced by ferromanganese minerals, resulting in "breccia-like" appearance, to (3) laminated globigerinid biomicrite with occasional inclusion of small thin-shelled molluscs and sponge spicules.

Thin section study on shipboard indicated that the marine phosphorite principally consists of collophane with sometimes appreciable amount of calcite and almost negligible amount of detrital (air-borne?) plagioclase. X-ray diffraction examination revealed that this "collophane" is composed of nearly pure apatite (francolite) with only a small amount of calcium carbonate remaining. Both thin section and X-ray diffraction examinations of the two limestone pebbles indicates

its mineralogy being essentially low magnesium calcite.

A tentative age assignment was paleontologically made to be Late Mesozoic (Cretaceous) for the shelly phosphorites, and to Early Tertiary (Paleocene? or Eocene) for the unphosphatized limestone. Detailed descriptions and their geological implications of the phosphorites and limestones will be published elsewhere separately.

91 gravels were recovered from the site KH-71-1-6 (13°53.4'N, 146°17.5'E) on the midslope basement high, west of the Mariana Trench (Table 2). Detailed lithologies of these gravels, one of which was identified as serpentinite on shipboard, are being extensively examined by E. Honza, and will be reported elsewhere.

The dredge hauls of the sites KH-71-1-14-1 (10°52.0'N, 134°37.6'E), -14-2 (10°52.4'N, 134°43.4'E) and -14-3 (10°52.3'N, 134°38.4'E) recovered 23 gravels of limited lithologies, a small piece of the present-day ahermatypic coral, and a ferromanganese nodule of pebble size with a core of coralline limestone, respectively. Except for those of globigerinid limestone and basic tuff, both of which are practically free from ferromanganese encrustation, almost all the gravels collected from the site KH-71-1-14-1 are coated by ferromanganese crust with irregularly pustular relief, only at their top surface. Majorities of the lithologies are represented by andesitic tuff in which augite phenocrysts occur commonly together with abundance of globigerinid foraminifers, and palagonitized volcanic rocks with sizable vesicular features. This may suggest that the ridge was once, or, at least, very close to, the site of active eruption.

Occurrence of the hermatypic corals at the sites -14-1 and -14-3 as the cores of heavily encrusted ferromanganese nodules may suggest that the sites were once close to sea level and have been considerable subsided down to the

present depth, since the time of coral reefing which may be of Miocene time. Both paleontological and petrographical studies of these gravels are to be reported shortly by K. Konishi.

8.4. Samples from the walls of the Mariana trench

by

E. Honza, H. Kagami and N. Kuroda

Sampling by cylinder type dredge was carried out at the depth of 4500 meters and 8000 meters of the Mariana trench.

Sampling at 8000 meters deep was failed to take sample on account of miss fitting of leads.

Dredge at 4500 meters deep ($13^{\circ}53.4'N$, $146^{\circ}17.5'E$), western landside flank of trench slope was successful to bring up many rock fragments. Most of them are apparently creamy white in color and look like tuffs and tuff breccias. However, all of them are composed of serpentinite which are altered to chlorite.

Serpentinite, occurring as breccias, is composed of serpentinite and a small amount of brown chromite. There is no suggestion on the original rock of the serpentinite, but it may be a kind of ultrabasic rock. The serpentinite has cataclastic texture. Some of the serpentinite breccias are injected with veinlets, which have Mn-coated walls.

Tuff breccia in veinlet contains augite, amphibole, plagioclase, serpentine and foraminifera fossils, and also contains tuffaceous sedimentary grains in matrix.



Fig. 8-1. Rocks from dredge haul KH-71-1-6.



Fig. 8-2. Megafossil in a Mn-coated limestone collected at KH-71-1-3.

9. Deep-sea Photography

by

T. Nakai, H. Ootobe and T. Harata

9.1. Deep-sea camera operations

Photographs of the sea bottom were taken at several sites during this cruise. Locations of the camera sites are shown in Figs. 9-1, 9-2 and 9-3. Camera (EG & G model 200, Underwater Camera) and stroboscopic light source (EG & G model 210, Underwater Light Source) were mounted on a rack with a sonar pinger (EG & G model 220, Sonar Pinger) and a tilt switch (EG & G model 293A, Tilt Switch). Batteries model YB 21 x 4 used here were the same as the Silver-Zinc batteries (Type LR-21 x 4).

A target, vinyl chloride tube, was suspended below the frame for the first operation in order to see dimension of objects (Fig. 9-5), but it was lost at the first station by ship's drifting, so thereafter another target was suspended by a nylon rope. At station KH-71-1-5 two small cores (Fig. 9-4) were mounted on the trigger weight of tilt switch and they successfully collected the bottom sample. The whole system was lowered and raised by No. 1 and No. 5 winches of this ship.

Among 6 operations, 3 were successful and 3 were unsuccessful. Causes of these failures are, however, clear. One is erroneous discharge of the battery, one is trouble of wire going out of a friction drum of the No. 1 winch, and the other is that the whole of camera system was lost due to a hit to rugged solid rocks (Fig. 9-3).

Station No.	3-2	Station No.	3-4
Operation No.	1	Operation No.	2
Date	January 29, 1971	Date	January 30, 1971
Time	12:15-13:50	Time	12:30-13:15
Location	23°48.2'N, 148°43.8'E western end of Marcus Necker ridge SW side slope of the seamount near the peak	Location	23°49.0'N, 148°46.5'E western end of Marcus Necker ridge top of the seamount
Depth	1050 m - 1500 m	Depth	1050 m
Weather	fine	Weather	clear
Wind	NE-6 m/s	Wind	SSE-3 m/s
Sea	NE-3	Sea	SSE-3
Swell	NW-4	Swell	SSW-3
Air temperature	21.0°C	Air temperature	22.6°C
Sea temperature	23.1°C	Sea temperature	23.3°C
Film	Kodak tri X pan	Film	Kodak tri X pan
Film length	17.5 m	Film length	10.8 m
Lens focussed	8 feet	Lens focussed	8 feet
Iris	9.5	Iris	11
Shutter	1/50 automatic triggering with shutter	Shutter	1/25, automatic triggering with shutter
Time delay switch	0	Time delay switch	50 min
Tilt switch	no used	Tilt switch	no used
Target	20 cm square plate with 5 kg weight	Target	20 cm scale weight
Winch	NO. 5 winch	Winch	NO. 5 winch
Remarks	combined with dredging 3-1	Remarks	combined with dredging 3-3
Result		Result	
duration of photography	12:23-13:13	duration of photography	-
number of frame	284	number of frame	-
number of bottom picture	48	number of bottom picture	-
remarks	target was lost	remarks	The signal from the pinger was not caught due to the miss of battery charge, the operation was given up in the midst of wire lowering.

Table 9-1. Operation logs of deep-sea camera

Station No.	3-4'	Station No.	5
Operation No.	2'	Operation No.	3
Date	January 30, 1971	Date	February 9, 1971
Time	17:00-18:45	Time	16:00-23:30
Location	23°49.5'N, 148°46.5'E western end of Marcus Necker ridge top of the seamountain	Location	14°00.6'N, 149°44.9'E Mariana basin
Depth	1060 m - 1070 m	Depth	5960 m
Weather	cloudy	Weather	fine
Wind	SSE-6 m/s	Wind	ENE-7 m/s
Sea	SSE-3	Sea	ENE-3
Swell	SSW-3	Swell	NNW-4
Air temperature	22.2°C	Air temperature	27.2°C
Sea temperature	23.2°C	Sea temperature	28.0°C
Film	Kodak tri X pan	Film	Kodak tri X pan
Film length	10.8 m	Film length	15 m
Lens focussed	8 feet	Lens focussed	8 feet
Iris	11	Iris	13
Shutter	1/25, automatic triggering with shutter	Shutter	open, automatic triggering without shutter
Time delay switch	45 min	Time delay switch	110 min
Tilt switch	no used	Tilt switch	mounted with non return tilt switch and pilot weight
Target	20 cm scale weight	Target	20 cm scale weight
Winch	No. 5 winch	Winch	No. 1 winch
Remarks	combined with dredging 3-3 battery of pinger was recharged	Remarks	Added two heavy iron bars to mounting rack. Hand made two small corer attached to pilot weight

Result		Result	
duration of photography	17:44-18:13	duration of photography	17:54-18:40
number of frame	148	number of frame	226
number of bottom picture	148	number of bottom picture	0
		remarks	
			The non return tilt switch became on by heavy swell while sea surface layer, and triggered with time delay switch, so the picture were all sea water. The No. 1 winch was troubled, the winch wire was run off from friction drum. Core sampling was successful.

Station No.	11	Station No.	14-4
Operation No.	4	Operation No.	5
Date	March 1, 1971	Date	March 11, 1971
Time	18:27-21:05	Time	20:35-21:45
Location	8°44.8'S, 153°01.1'E	Location	10°53.1'N, 134°43.5'E
	Solomon basin		Kyushu-Palau ridge
Depth	2740 m - 2950 m		east side of the steep slope near the
Weather	cloudy		ridge of the sea mountain
Wind	WSW-1 m/s	Depth	1250 m - 880 m
Sea	WSW-2	Weather	overcast
Swell	WSW-2	Wind	ENE-6 m/s
Air temperature	25.7°C	Sea	ENE-4
Sea temperature	30.4°C	Swell	NE-4
Film	Kodak tri X pan	Air temperature	28.3°C
Film length	15 m	Sea temperature	28.7°C
Lens focussed	8 feet	Film	Kodak tri X pan
Iris	13	Film length	15 m
Shutter	open, automatic triggering with shutter	Lens focussed	8 feet
Time delay switch	70 min	Iris	11
Tilt switch	no used	Shutter	open, automatic triggering with shutter
Target	20 cm scale weight	Time delay switch	35 min
Winch	No. 5 winch	Tilt switch	no used
Remarks	Added two heavy iron bars to mounting rack.	Target	20 cm scale weight
		Winch	No. 5 winch
		Remarks	combined with dredging 14-3
Result		Result	equipment was lost
duration of photography	19:41-20:27		
number of frame	231		
number of bottom picture	111		

9.2. Deep-sea photography of the "Syunsetsu" seamount

A total of 432 photographs were taken at two stations (Station 3-2, 3-4') on the "Syunsetsu" seamount. 196 frames were close enough to the bottom to show some evidence of lithology, current activity and organisms. The majority of bottom photographs taken at Station 3-2, 3-4' shows some evidence of current activity. The effect of current on bottom sediments can be seen as ripple marks, scour marks and current lineations and indirect evidence such as bare rock and coarse residual debris.

The form of ripple marks and the orientation of dominant crests were recorded. The individual ripples tend, in general, to be asymmetrical, slightly sinuous to sinuous, and rarely to be catenary or linguoid. They possess sharp crests and somewhat narrow, steeper slipfaces, having the chords of about 10 to 30 cm and the spans of about 100 cm. They are smallscale ripples. The ripple-trains in plan are, in general, transverse sinuous out of phase, rarely transverse catenary out of phase, linguoid and cusped. The junctures of ripple are zig-zag, butted, nearly open.

Pebble and cobble-materials to concentrate in stoss side on the trough of the ripples. Although a veneer of mud covering crests and partially filling troughs, was observed on the some films both at Station 3-2 and 3-4', the majority of ripples observed appear to be sharp and fresh without being covered and filled.

Additional evidence of current activity were obtained on a number of the films from the alignment of gravels in the lee of cobble to boulder-sized materials. Furthermore, the presence of bare outcrops of rock and deposits of coarse gravel, constitutes indirect evidence of current since the fine sediments have been swept away.

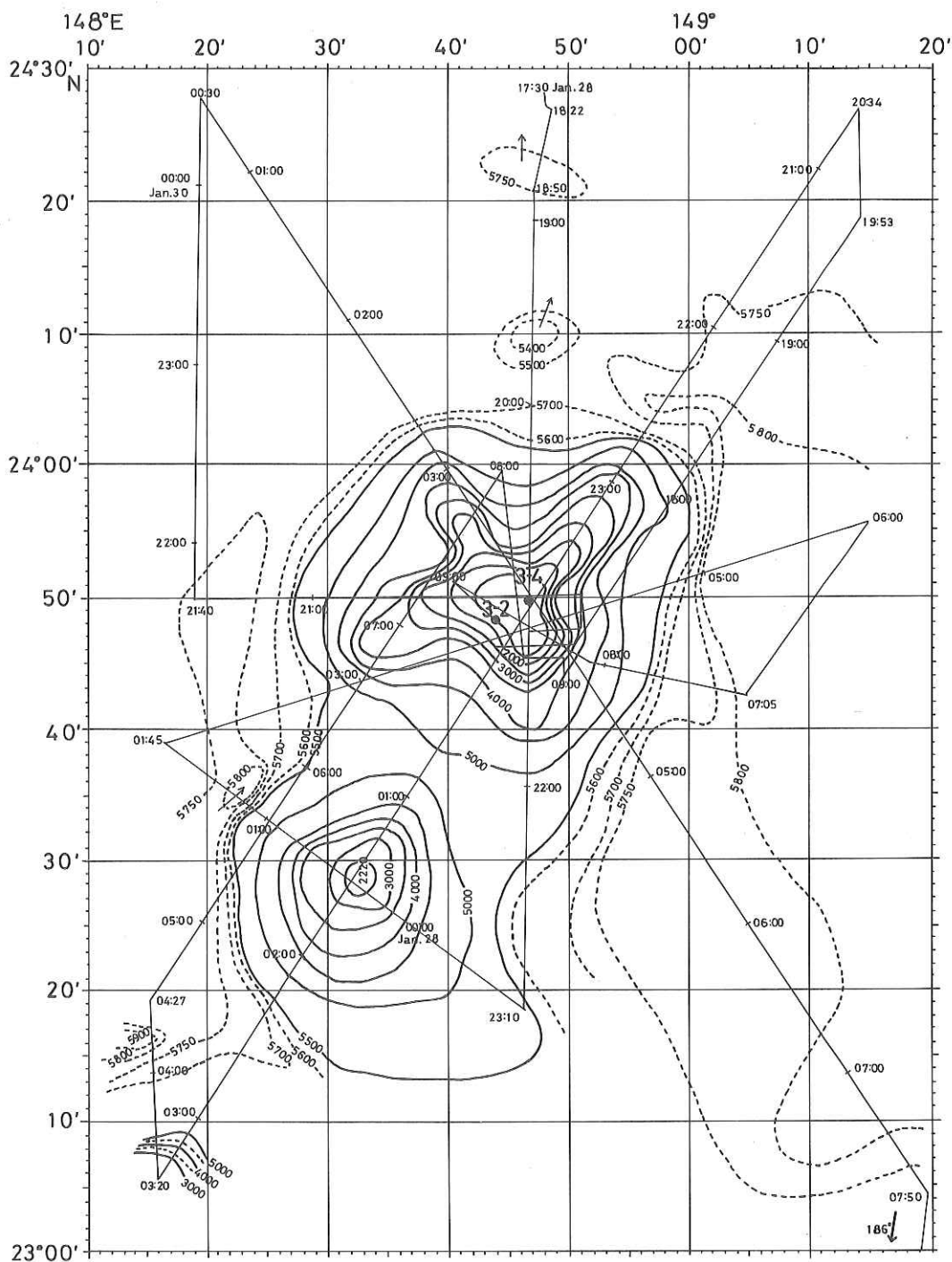


Fig. 9-2. Position of camera stations on the "Syunsetsu" Seamount plotted upon the new topographic map drawn by Tomoda and Koizumi according to the sounding results of this cruise.
(— ship's track with time)

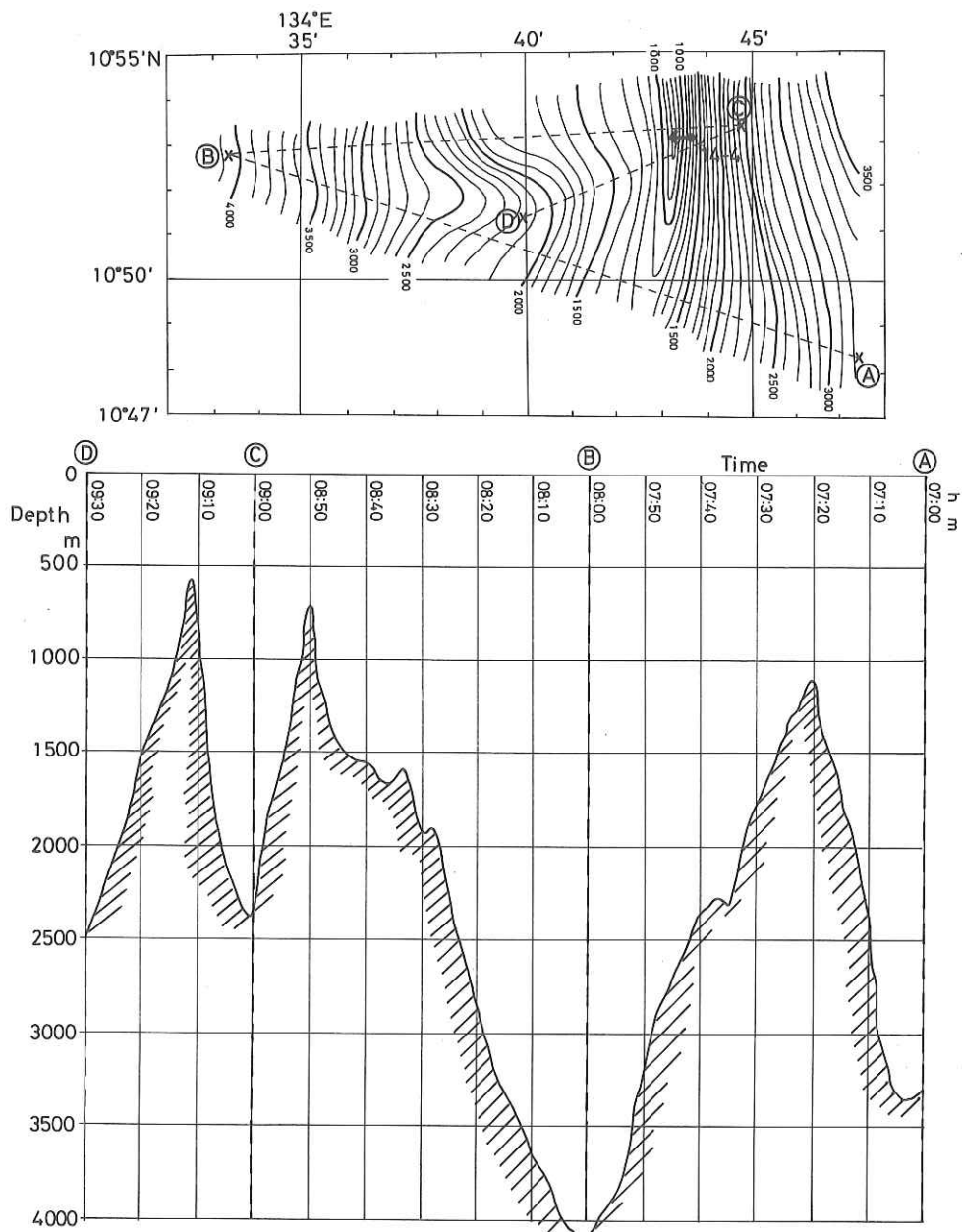


Fig. 9-3. Bathymetric chart of vicinity of KH-71-1-14-4 site, showing location of the camera station and echo sounding profiles.

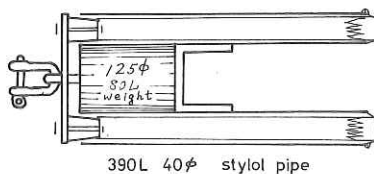


Fig. 9-4.
Small corer
attached to camera

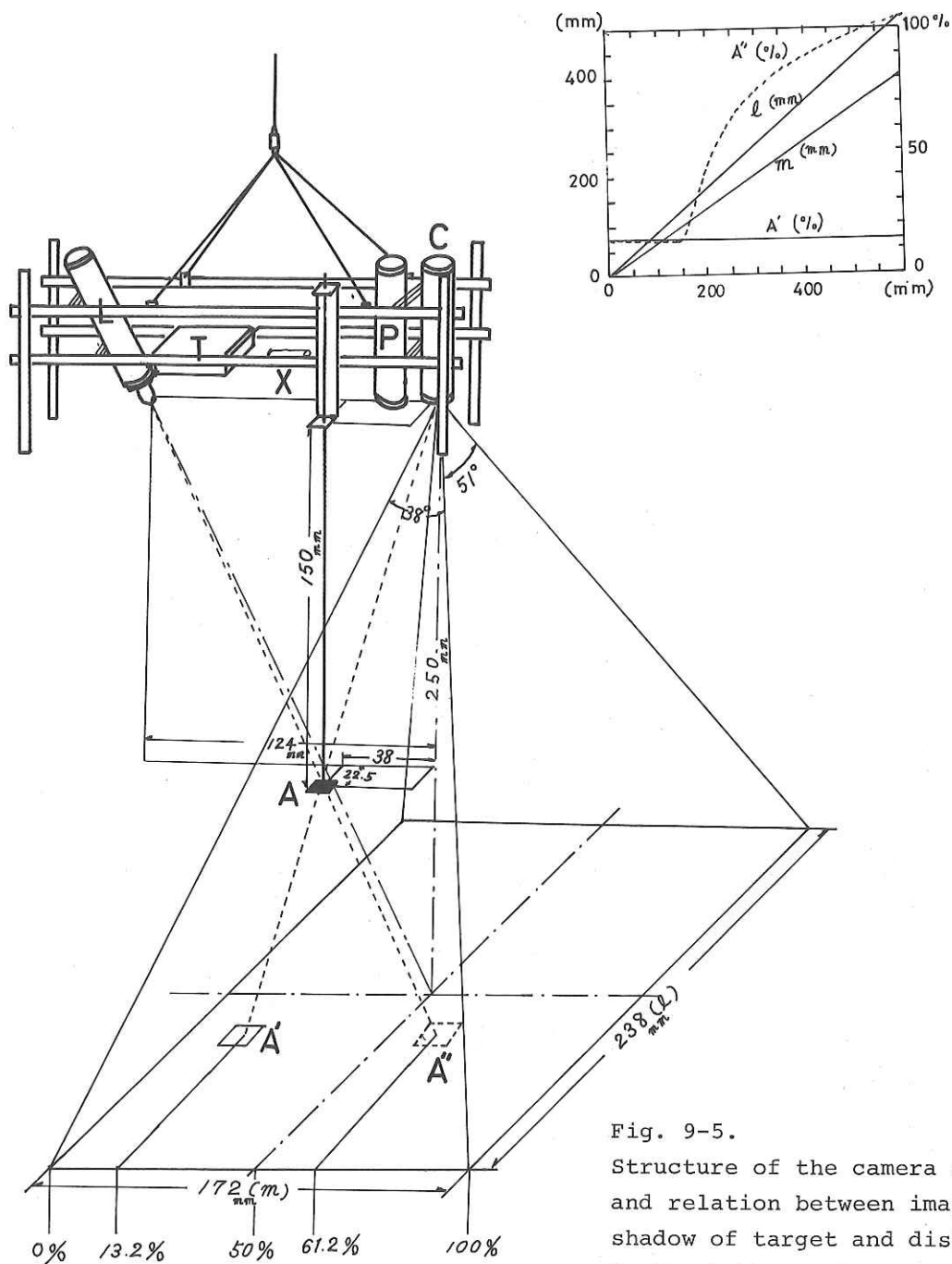


Fig. 9-5.

Structure of the camera system and relation between image and shadow of target and distance to the bottom. C:camera, L:light, P:pinger driver, T:pinger transducer, X:pinger transformer, A:target, A':image of target, A'':shadow of target.

Fig. 9-6. Rock outcrop near the crest of "Syunsetsu" Seamount. KH-71-1, Station KH-71-1-3-2, -1-17, 1050-1500 m, 23°48.2'N, 148°43.8'E, Western end of the Marcus Necker Ridge. Coarse debris and residual sand deposited in the lee of large rock.





Fig. 9-7. Transverse sinuous smallscale ripples, "Syunsetsu" Seamount. KH-71-1, Station KH-71-1-3-4', -2-28, 1060-1070 m, $23^{\circ}49.5'N$, $148^{\circ}46.5'E$, Western end of Marcus Necker ridge.



Fig. 9-8. Tracks, trails and burrows. KH-71-1, Station KH-71-1-11, 2740-2950 m, $8^{\circ}44.8'S$, $153^{\circ}01.1'E$, Solomon Basin.

10. Sampling for the Studies of "extraterrestrial"
Materials

by
Y. Tazawa

Dredged samples are obtained from two stations (KH-71-1-1, KH-71-1-13-2). These are processed for studies of extraterrestrial materials such as "cosmic spherules" and cosmogenic radioisotopes; (Ni-59, Mn-53, Sm-146 etc.) Ni-59, Mn-53 are the cosmic-ray induced radioisotopes and will bring us the knowledges about the history of the solar activity as well as about the dynamics of cosmic dusts in the solar system. Sm-146 is the instnict radioisotopes which may be a proof that "cosmic dusts are suplied partly from the outer space of the galaxy," if they exist in the solar system.

The samples from KH-71-1-1 is contaminated with large amounts of volcanic glasses and skeletal remains of micro-organisms (mainly Radiolarias). On the preliminary survey with stereomicroscope none of "cosmic spherules" are found. Core samples are obtained from the stations; KH-71-1-9, -12-1, -12-2, -13-1 and -15. Parts of these will be used for the determination of sedimentation rates and for the study of fallout rates of extraterrestrial materials. Interstitial water is extracted from a sample at station KH-71-1-12-2 by means of super centrifuge (Marusan 30-CFS; 10,000 R.P.M.; 15,000 G). Interstitial water will be used for chemical and radiochemical analysis. Content of interstitial water in the core KH-71-1-12-2 are shown in Fig. 10-1.

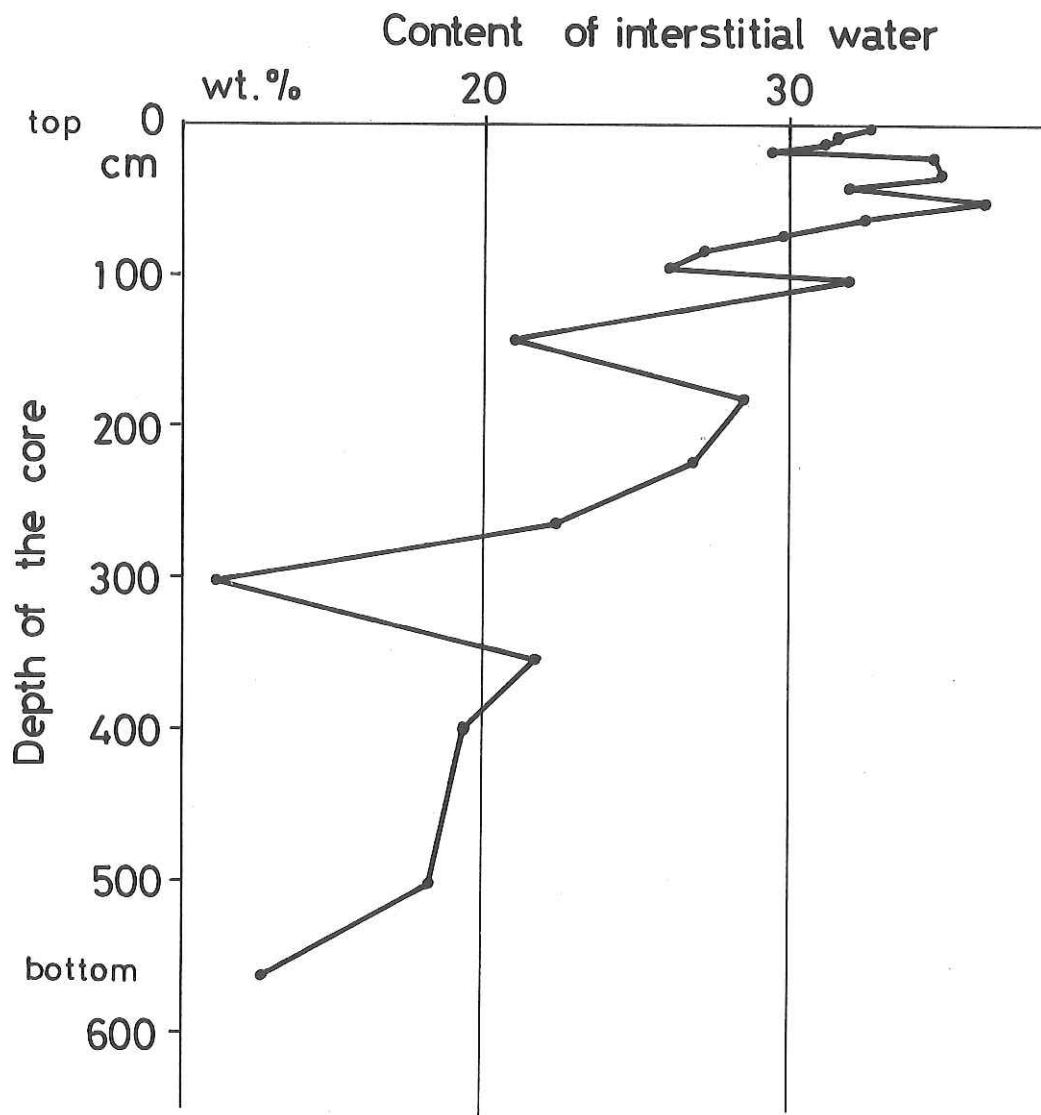


Fig. 10-1. Content of interstitial water
in the core KH-71-1-12-2.

11. Volcanic Rocks from the Islands of Chichi-jima, Guam
and New Britain

11.1. Some petrographical notes

by
N. Kuroda

11.1.1. Tuffs from Syunsetsu seamount
and the station of KH-71-1-14-1

Some fine-grained and loose tuffs were dredged with large amounts of limestone. These rocks are coated with manganese oxides.

Tuff on the flat summit of Syunsetsu seamount consists of volcanic glass and small amounts of microcrystals of hypersthene, augite, plagioclase and quartz. Hypersthene prisms are altered totally or partially to chlorite. Plagioclase laths and augite microcrystals remain unaltered. Quartz shows rounded form. The tuff includes volcanic augite-iron ore-plagioclase fragments. Foraminifera fossils occur in this tuff.

Tuff from the station of KH-71-1-14-1 or the other seamount is largely replaced by calcite. Calcite forms sometimes veinlets. The tuff contains volcanic glass and small amounts of microcrystals of augite and plagioclase. Plagioclase is replaced totally or partially by calcite. This tuff includes glassy dacite fragments. Foraminifera fossils occur also in this tuff.

11.1.2. Volcanic rocks on the islands of
Chichi-jima, Guam and New Britain

The islands of Chichi-jima and Guam are in the Izu-Marianas island arc that extends southward from the Izu Peninsula along the east border of the Philippine Sea.

The island of New Britain is in the other island arc that occupies a part of the Circum-Pacific orogenic belt. These island arcs are parallel to the andesite line which fringes the Pacific basin.

This note is a brief description of 10 volcanics on the three islands.

A. Chichi-jima

Lavas, tuff breccias, and agglomerates on the island are of late Eocene to Oligocene age (1, 2). These volcanics are altered often to green-colored rocks and silicified ones with many quartz- and calcite-veins. Occurrence of the altered volcanics is the same as that of the Yugashima group in Izu.

Three volcanics were collected at Ohmura and at Meshimori-yama on the mouth of Futami Wan (Table 1). These volcanics contain hypersthene in the groundmass. They belong to the calc-alkali rock series.

Augite hypersthene andesite is the most predominant type of rock on the island (1). Boninite appears to be this type of andesite with olivine phenocrysts. Microscopic fragments of fine-grained dolerite are included in a breccia of augite hypersthene andesite in tuff breccia at a road-cutting near harbor. This dolerite consists of augite, hypersthene and plagioclase. Basalt has not yet known on the island, but the dolerite fragments suggest the possible presence of basalt.

A breccia of quartz-bearing augite hypersthene andesite from Ohmura contains a small number of corroded quartz crystals, which have sometimes pale brown glass inclusions and/or embayments. The corroded crystals of quartz are often surrounded by a rim composed of intergrown aggregates of plagioclase and quartz. Judged by texture, these quartz crystals are recognized as xenocrysts. The quartz crystals with the same texture are found also in the Amagi-Sengen-san andesite of Izu.

Augite andesite lavas of Meshimori-yama, containing rare

phenocrysts of augite and plagioclase, are relatively altered, and contain large amounts of chlorite after hypersthene in the silicified groundmass.

B. Guam

Three volcanics were collected at the west coast near Point Facpi, and a volcanic breccia at the south of Mt. Tenjo (Table 2).

Facpi volcanics are involved in the Umatac formation of Miocene age, and consist of olivine basalt pillow lavas, olivine basalt dikes, and hypersthene augite dikes (3). Pillow lavas are slightly silicified. A large number of dikes penetrates into pillow lavas. About 108 dikes are counted from Merizo to Point Facpi (3).

In olivine basalt pillow lavas and dikes, olivine phenocrysts are altered totally to serpentine, and include a small amount of picotite microcubes. These olivine basalts contain hypersthene in the groundmass, and the hypersthene content of the groundmass is higher in pillow lavas than in dikes. They come into the calc-alkali basalt.

A breccia of hypersthene dacite was found from water-laid pyroclastics of the Alutom formation of late Eocene age. Quartz of this rock occurs in corroded crystals up to 0.7 mm in diameter, and some of them are surrounded by a rim of augite microlites. Judged by texture, the quartz crystals of this rock are xenocrysts. This rock includes microscopic fragments of olivine basalt. This dacite is similar to the Saipan dacite (4).

C. Rabaul, New Britain

Some recent volcanoes rise at the vicinity of Rabaul, and an active volcano is at the mouth of Blanche Bay or Port Rabaul, which was a caldera (5).

Two breccias of olivine basalt and hypersthene augite dacite were collected from bedded scoriaceous ejecta at the southwestern foot of Mt. Turangna or Mt. South Daughter, and an olivine basalt, occurring as lavas, at the Nordup

coast at the northwestern foot of Mt. Kombiu or Mt. Mother (Table 3). Obsidian occurs at the Nordup coast.

Olivine basalt of Mt. Turangna does not contain hypersthene in the groundmass, and contains large amounts of honeycombed plagioclase phenocrysts. Olivine phenocrysts of this rock include no picotite microcubes. Olivine basalt at the Nordup coast shows the same fashion as that of this rock.

Hypersthene augite dacite of Mt. Turangna, coexisting with olivine basalt, contains hypersthene in the groundmass. Olivine occurs rarely as microphenocrysts. No quartz phenocrysts occur. This dacite includes andesite fragments.

Coexistence of olivine basalt with dacite in the same ejecta is a material significant for the analysis of magmatic evolution. Simultaneous eruption of olivine basalt and dacite is known in many places, but it is not yet clear how the simultaneous eruption takes place.

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11.2. Paleomagnetic studies

by

K. Kobayashi

Three oriented samples were collected at a road-side cliff in Umatac Village, southwestern Guam, Mariana Islands (Fig. 11-1). Five specimens were cut out of each oriented sample. Direction and intensity of their natural remanent magnetization (NRM) were measured. Directions from specimens of each sample were averaged and shown in a Schmidt's equal-area projection (Fig. 11-2).

The rocks belong to the Facpi volcanic member, Umatac Formation of Guam. Their absolute age has not been dated but it may possibly be of early Miocene.

Directions of natural remanent magnetization of samples no. 1 and 3 are quite agreeable with each other and distinctly different from that of the present field. Direction of sample no. 2 deviates from those of the other two samples. After partial demagnetization by alternating fields up to 250 oersteds, sample no. 2 gradually changes its direction to become concordant with the others, while directions of the others remain almost unchanged after demagnetization. Intensity of natural remanent magnetization is almost invariable against demagnetization by alternating fields up to 75 oersteds and decreases to one-third after demagnetization by 250 oersteds. These results indicate that the rocks have a stable component of natural remanent magnetization useful for paleomagnetic purposes. It may thus be concluded that direction of the geomagnetic field relative to this rock mass at the time of formation of the rock is about 35 degrees upward and that its declination from due north is approximately 70 degrees, greatly apart from the direction of the present field.

There may be three possible explanations of this paleomagnetic results: (1) The geomagnetic field was just in

a transient stage between the normal and reversed polarities at the time of formation of the rock while the rock mass has remained unmoved. (2) The island of Guam has clockwise rotated by about 70 degrees and tilted SSW by 40 degrees or so since formation of the rock while the field was the same as the present. (3) The rock mass has undergone the same block movement by a local minor faulting and folding while both the geomagnetic field and the island as a whole have stayed the same. In the present stage of investigation we can not tell which is the most plausible interpretation of the observation. However, if we recall the geological history of Guam and Mariana island arc system, the second explanation involving the rotation and tilting of Guam Island seems quite attractive.

Table 11-1. Petrography of Chichi-jima,
Bonin Islands

Rocks	Macro- and micro- structures	Phenocrysts	Groundmass
1. Augite hypersthene andesite	Porphyritic Hyalopilitic	Hypersthene Augite Plagioclase	Hypersthene Augite Iron ore: scarce Plagioclase Glass
2. Quartz- bearing augite hypersthene andesite	Porphyritic Hyalopilitic	Hypersthene Augite Plagioclase	Hypersthene Augite Iron ore Plagioclase Glass
3. Augite andesite	(Aphyric) Hyalopilitic	Augite Plagioclase } rare	Hypersthene Augite Iron ore Plagioclase Glass

1 and 2: Breccias in tuff breccia, Ohmura
3: Lava, Meshimori-yama

Table 11-2. Petrography of South Guam,
Marianas

Rocks	Macro- and micro- structures	Phenocrysts	Groundmass
1. Olivine basalt	Porphyritic Subophitic	Olivine: serpentine Hypersthene Augite	Hypersthene Augite Iron ore Plagioclase Quartz (Chalcedony) Glass
2. Olivine basalt	Porphyritic Flow Subophitic	Olivine: serpentine Augite	Olivine: rare Hypersthene: scarce Augite Iron ore Plagioclase Glass
3. Hypersthene augite andesite	Porphyritic Hyalopilitic	Hypersthene Augite Plagioclase	Hypersthene Augite Iron ore Plagioclase Glass
4. Hypersthene dacite	Porphyritic	Hypersthene Plagioclase	Hypersthene Augite Iron ore Glass

- 1: Pillow lava of the Umatac formation, Point Facpi
2 and 3: Dikes, penetrating into the pillow lavas at Point Facpi
4: A breccia in the Alutom formation, the south of Mt. Tenjo

Table 11-3. Petrography of Rabaul, New Britain

Rocks	Macro- and micro-structures	Phenocrysts	Groundmass
1. Hypersthene augite dacite	Porphyritic Hyalopilitic	Hypersthene Augite Plagioclase	Hypersthene Augite Apatite: rare Iron ore Plagioclase Glass
2. Olivine basalt	Porphyritic Subophitic	Olivine Plagioclase: predominant	Olivine Augite: dominant Iron ore: dominant Plagioclase Glass
3. Olivine basalt	Porphyritic Subophitic	Olivine Plagioclase: predominant	Olivine Augite Iron ore Plagioclase Glass

1 and 2: Breccias in bedded scoriaceous ejecta, the southwest
of Mt. Turangna

3: Lava, Nordup

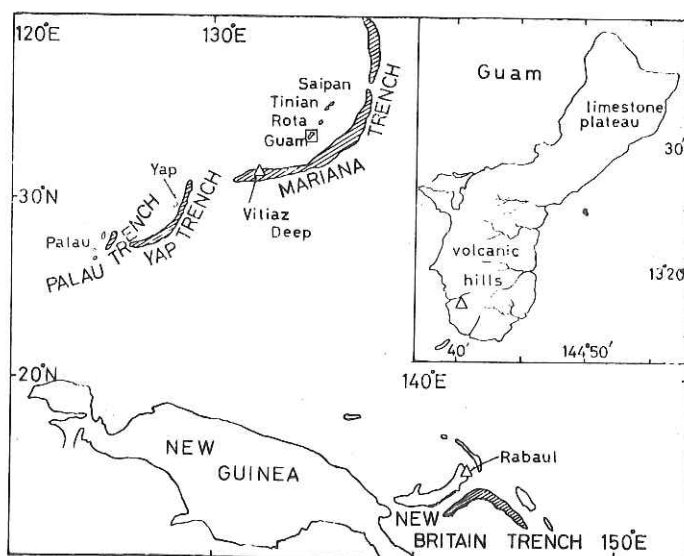


Fig. 11-1. Location map

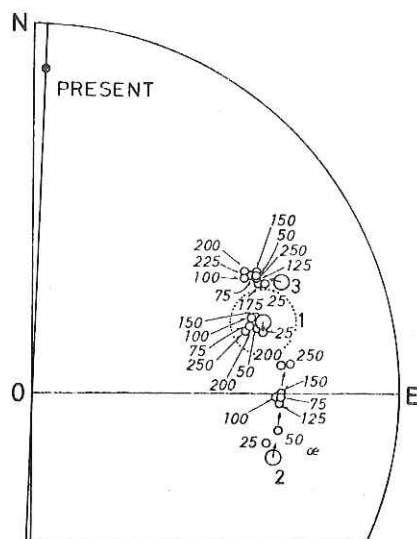


Fig. 11-2. Directions of NRM before and after AC demagnetization

12. STD Real Time Operation

by

T. Nakai, H. Otobe and T. Igarashi

STD (HYTECH Model 9006 Salinity-Temperature-Depth Data Acquisition System) is useful equipment for obtaining accurate and continuous profiles of basic ocean properties: salinity and temperature as functions of depth. Sensed variables are converted into analog frequencies (FM) by oscillators and individual signals are frequency-multiplexed in the "fish" to form a composite FM signal which is transmitted via a signal conductor sea cable to deck equipment.

Until now the signals have been only recorded as continuous graphic plots in our vessel. In this cruise the FM signals were converted to digital and recorded on a punched paper for computer processing (FACOM 270-20 system in Hakuho Maru) and field test was carried out 4 times. Salinity, temperature and depth data read every one second same time. The results are shown in Table 12-1 and Figs. 12-3, 12-4.

For this purpose two supplemental equipments are provided. One is a buffer amplifier, the other is an interface including digital counter (see Figs. 12-1, 12-2).

Real-time operation of STD (see Fig. 12-2 P.101)

- 1 Receives the I.R.T. signal from a digital counter,
- 2 Reads STD data (3 Words) from the counter,
- 3 Judges END data (The data end when the buffer amplifier feeds "All Mark" in case of switch-off.
- 4 Judges if it finishes reading data corresponding to 1 Record (128 Words) of the internal Drum.
- 5 Writes data of 1 Record on the external Drum.
- 6 Prints the first Data written on the external Drum in a form of fixed decimals (after converting the frequency to each unit of S.T.D.)
- 7 Writes the last data smaller than 1 Record on the Drum with END data.
- 8 Reads out all the data written on the Drum in sequence.
- 9 Judges END data.
- 10 Converts data from frequency to each unit (S:0/00, T:°C, D:m).
- 11 Punches data out on a tape in a form of floating decimals, and returns to A.
- 12 Punches END mark on a tape and stops if END data is fed.

Table 12-1. Results of STD operation

Station No.	4-2
Lowering No.	1-3
Date	Feb. 4-5, 1971
Time	22:00-03:40
Lat.	14°51.3'N - 14°52.0'N
Long.	150°12.6'E - 150°09.0'E
Lowering depth	1200 m
Number of obtained STD data	about 16,100
Remarks	include continuous measurement at 150 m layer slight below the thermocline.

Station No.	4-3
Lowering No.	4-8
Date	Feb. 5-6, 1971
Time	20:00-02:50
Lat.	13°59.0'N - 14°03.5'N
Long.	149°50.2'E - 149°40.7'E
Lowering depth	1000 m, 600 m
Number of obtained STD data	about 20,000
Remarks	include continuous measurement at 150 m layer slight below the thermocline.

Station No.	9-3
Lowering No.	9
Date	Feb. 21, 1971
Time	17:05-18:35
Lat.	1°28.0'N
Long.	152°53.5'E
Lowering depth	1200 m
Number of obtained STD data	4,380
Remarks	combined with water sampling (Nansen cast) 9-2.

Station No.	12-4
Lowering No.	10,11
Date	Mar. 5, 1971
Time	17:55-19:40
Lat.	1°52.5'N - 1°52.5'N
Long.	147°03.3'E - 147°01.0'E
Lowering depth	600 m
Number of obtained STD data	3,950
Remarks	measurement on both side of "Shiome".

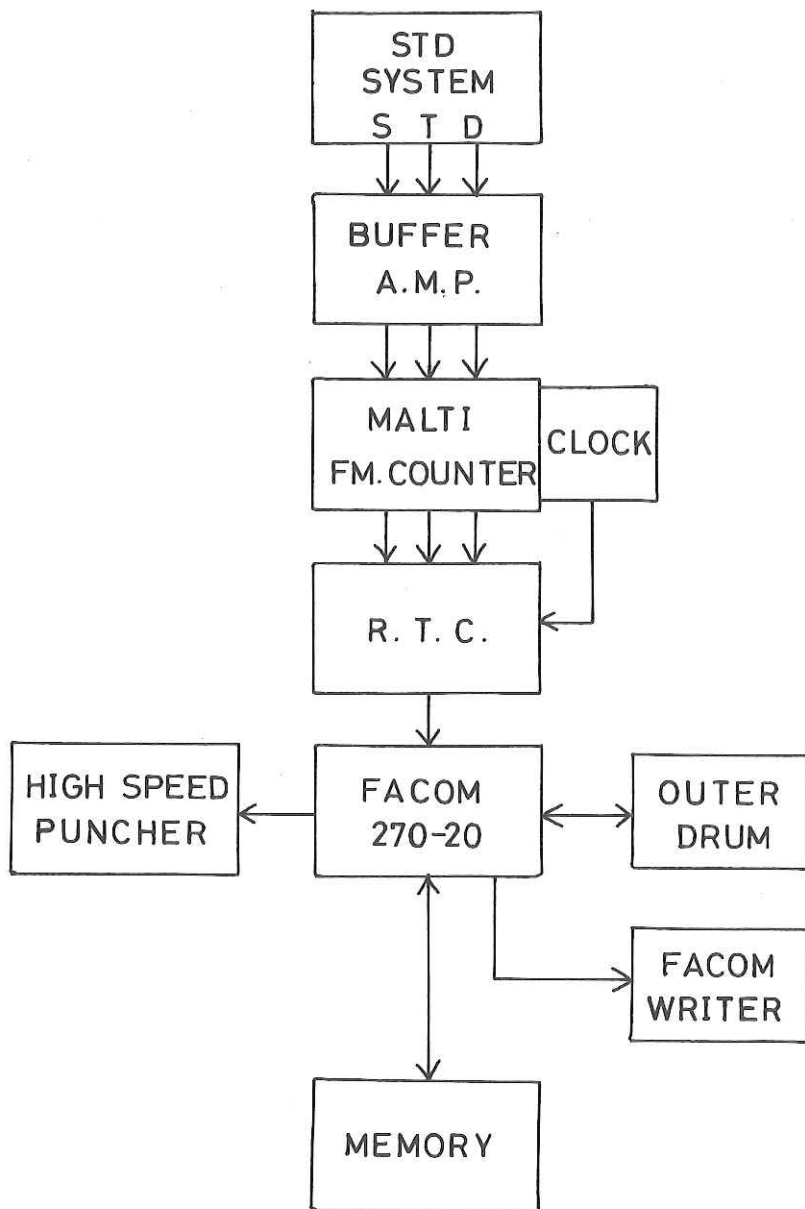


Fig. 12-1. Block diagram of the system

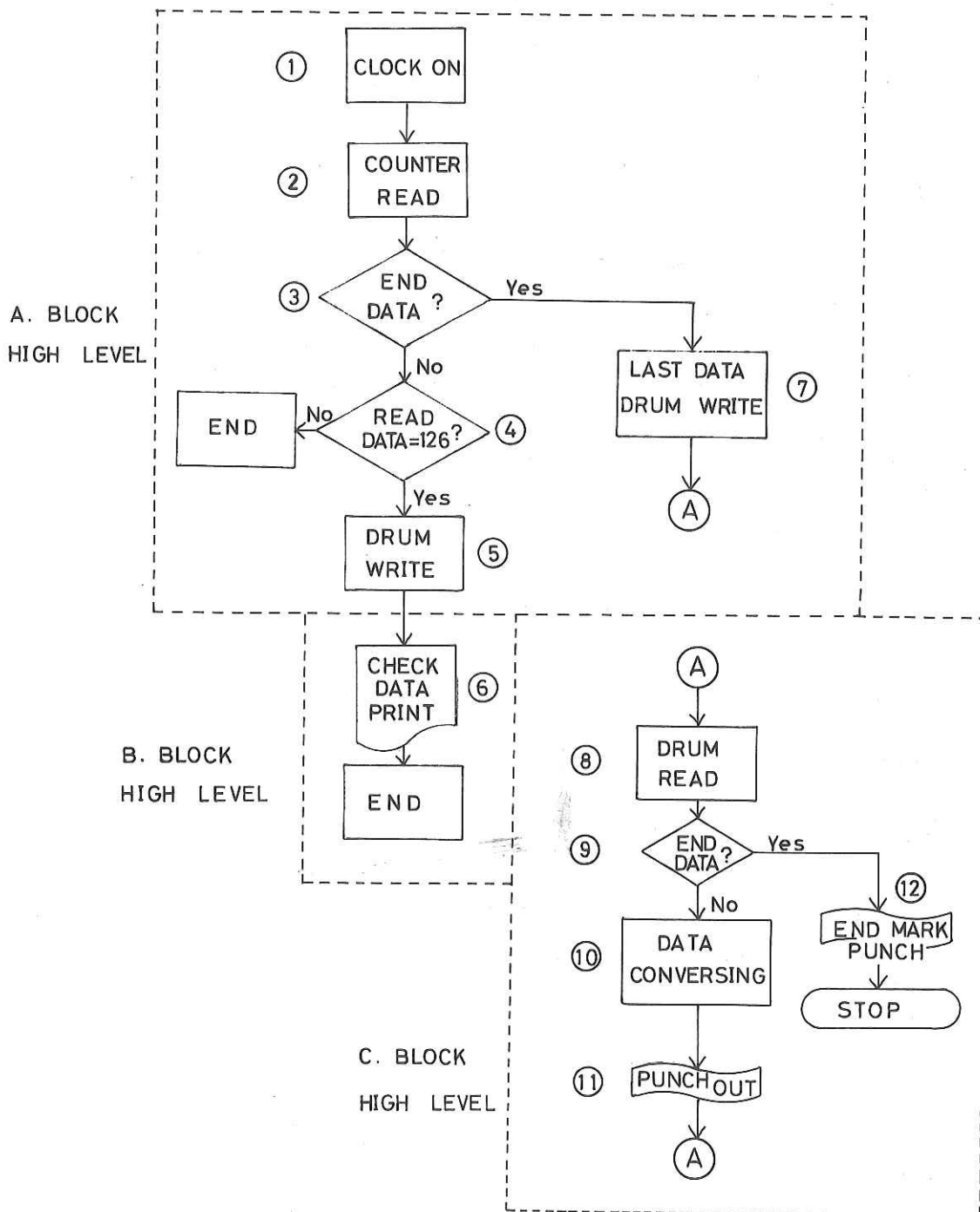


Fig. 12-2. Real-time operation of STD.

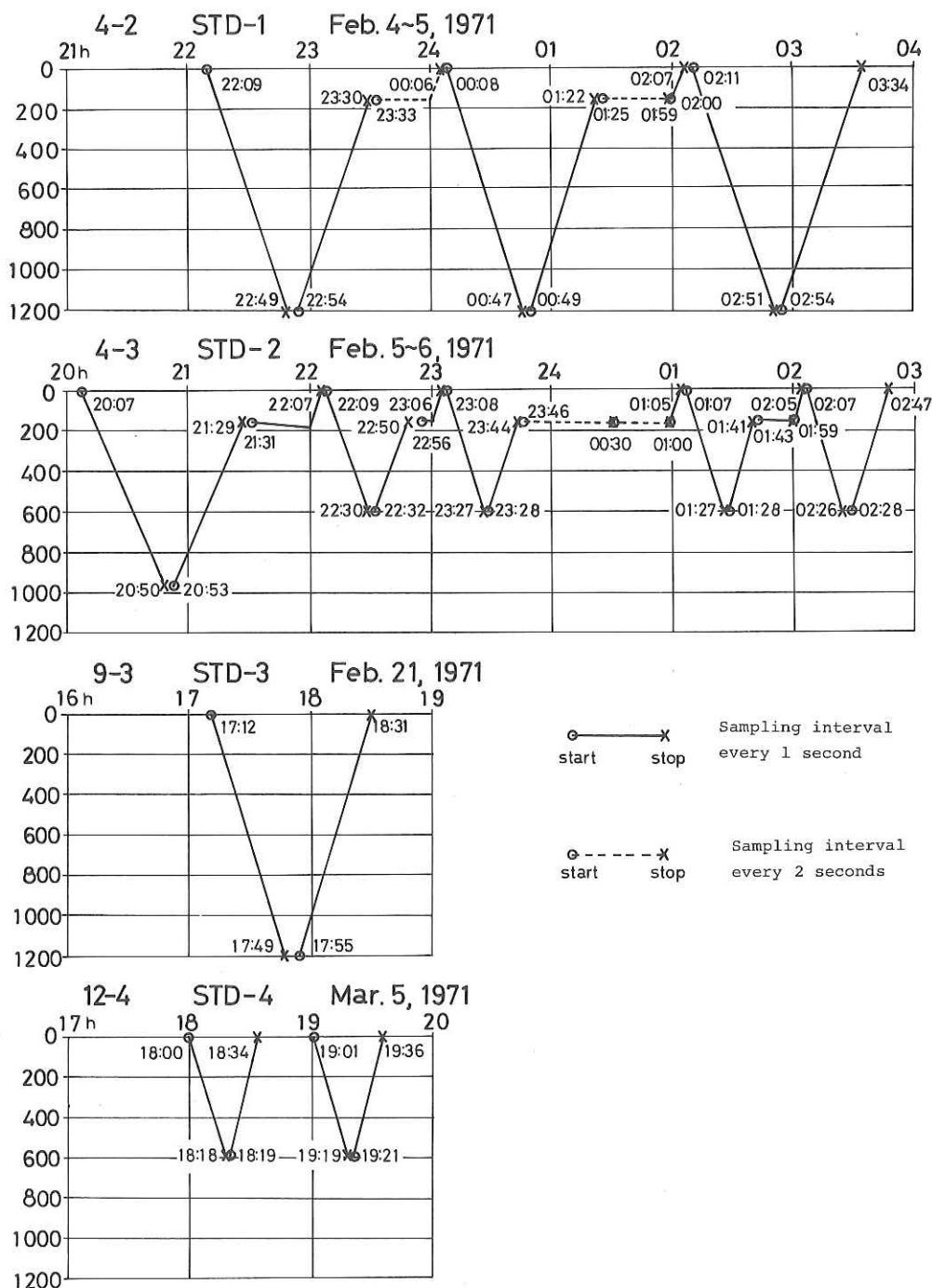


Fig. 12-3. STD operation diagrams

STATION NO. 4-2
 DATE Feb. 4, 1971
 LAT. 14°51.3'N
 LONG. 150°12.6'E
 SAMPLING INTERVAL 2 SEC.

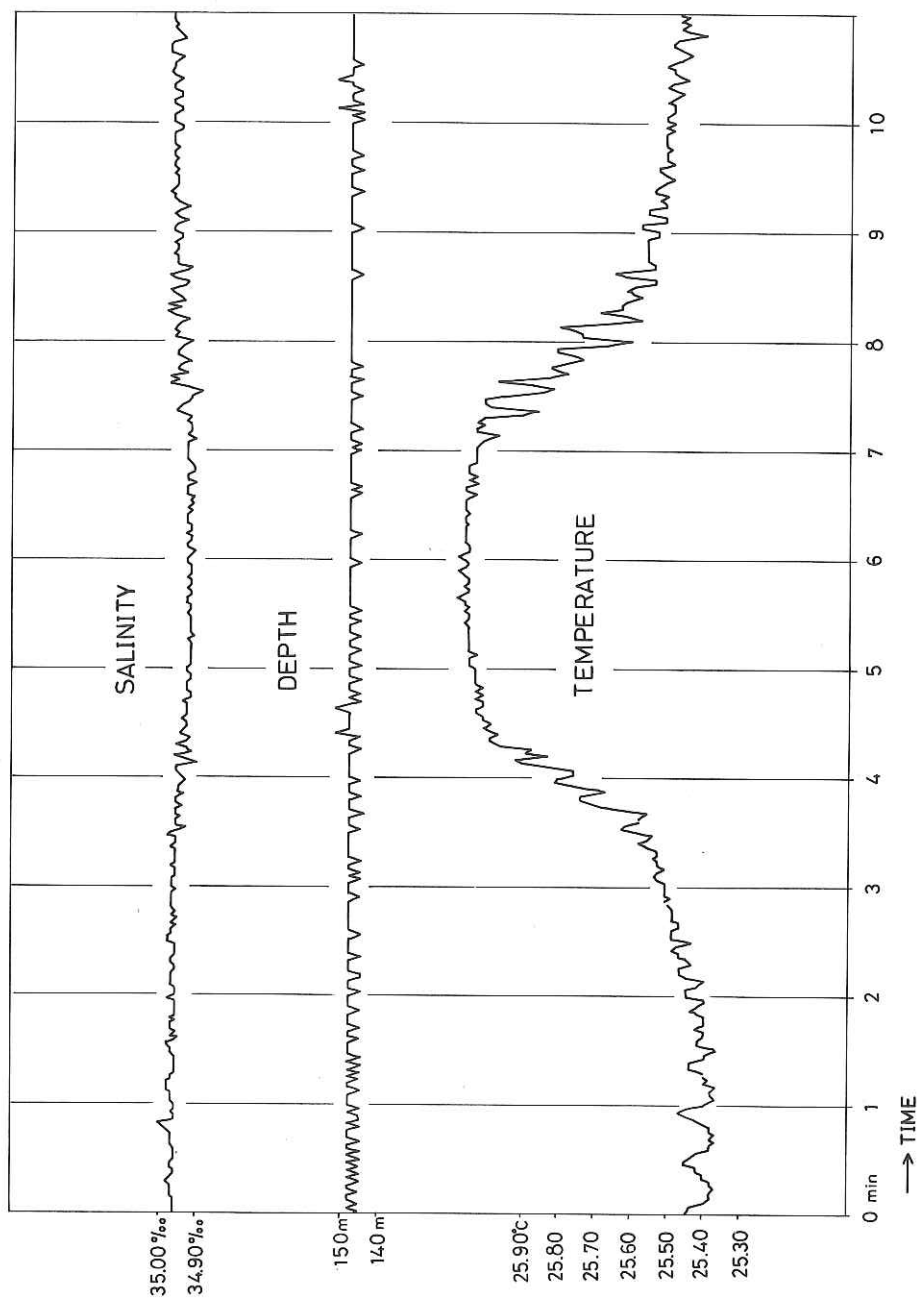


Fig. 12-4. Results of STD measurement

Station 12-4
 Mar. 5, 1971
 Lowering No. 10
 thermocline

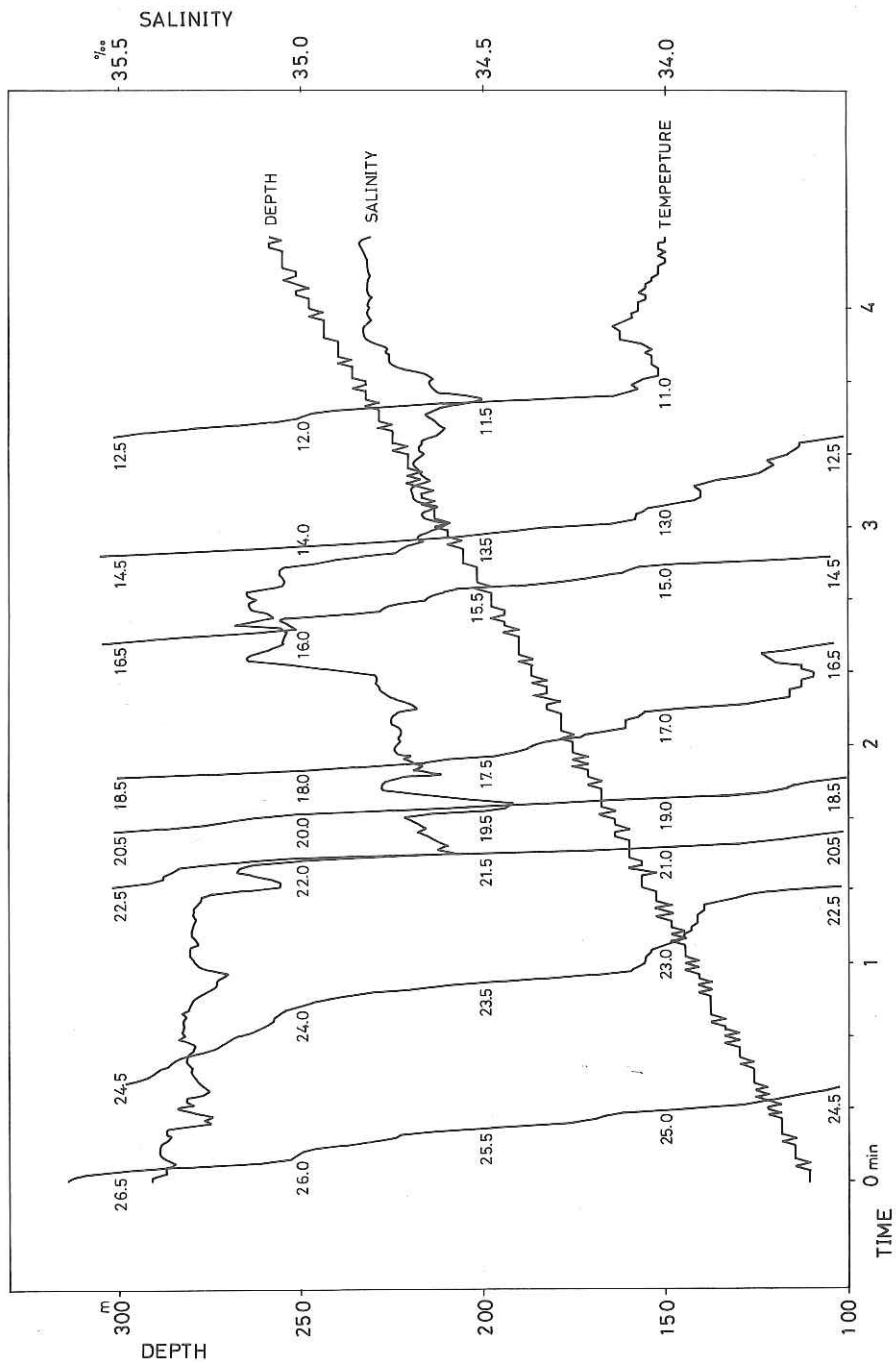


Fig. 12-5. Results of STD measurement

13. Distribution of Nucleic Acids and their Microbial
Degradation in Sea Water and Bottom Sediment

by
M. Maeda

The ability of terrestrial microorganisms to hydrolyze nucleic acids has been already observed by a number of investigators. However, nothing is known about microbial degradation of nucleic acids in marine environment. In this cruise, some ecological observation were made in regard to the occurrence of nucleic acids-hydrolyzing bacteria and the distribution of particulate nucleic acids in the waters of western part of the central Pacific. On the other hand, microbial activity on the hydrolysis of nucleic acids in sea water and bottom sediment was also experimentally measured on board under different conditions of temperature and hydraulic pressure. Observational and experimental procedures on each item of the foregoing investigation were briefly as follows.

1) Determination of particulate nucleic acids

Water samples for this purpose were collected by Van Dorn sampler from various depths between 0 and 892 meters at the station 4-1 (13°55.5'N, 149°43.6'E) and those between 0 and 3645 meters at the station 9-2 (01°27.0'N, 152°54.6'E). Ten liters of each sample were filtered through bolting cloth GG-54 and Millipore filter (HA-type, 47 mm) respectively. Particulate matters collected on these filters were frozen and stored at -20°C until determining the contents of nucleic acids in them.

2) Isolation and viable count of bacteria

Water samples for the purpose of microbiological examinations were collected by the sterilized ORIT-sampler from various depths at the foregoing stations. Mud samples for the same purpose were also obtained by the gravity core sampler at the stations of 2, 8, 9-1, 10, 12-1, 12-2, 13-1, 15 and 16. For the viable counting and isolation of heterotrophic and nucleic acids-hydrolyzing bacteria, sea water samples were filtered

though sterilized Millipore filters (HA-45 mm). The inoculated filters were placed on the agar plates of Medium PRES-II in Petri dishes and incubated at 18°C for two weeks before colonies on filters were counted. While, 0.1 ml portions of mud suspensions diluted successively with sterilized sea water were inoculated on the agar plates by sterilized spreading rods and then the colonies on plates were counted in the same way as above. After isolating colonies from these agar plates, the hydrolyzing property of each bacterial strain on nucleic acids were examined by the modified method of Jeffries et al (1957).

3) Measurement of decomposing activity of nucleic acids by bacteria in sea water and sediment

Each water sample collected from different depths of 0, 30, 60, 110, 350 and 892 meters at the station 4 was divided aseptically into the sterilized four test tubes with cotton stoppers and appropriate concentration of DNA was added to each test tube. After these tubes were incubated separately for 3, 5 and 10 days at 18°C. Each sample in the tubes was filtered through Millipore filter (HA-type, 47 mm) and then the filtrate was stored at -20°C in order to determine later on the residual amount of DNA in each sample. In addition, the decomposing rates of DNA and RNA in crude sea water samples, which were collected from the depths of 0, 48, 96, 384, 959 and 1912 meters at the station 9-2, were examined under different incubating temperatures of 5°, 18° and 32°C by the same procedure as described above. On the other hand, the decomposing activities of DNA and RNA in the crude sediment, which was collected from the depth of 5834 meters at the station 5 (14°00.5'N, 149°43.6'E), were examined under the hydraulic pressures of 0 and 600-atm by using the apparatus described by ZoBell and Oppenheimer (1950) and ZoBell (1959). After these samples were incubated for 9, 15 and 40 days at 8°C, each water-mud samples in the tubes was treated in the same way as described above and stored at -20°C. Further examination and analyses of the collected samples are now in progress after this cruise.

14. Distribution of Sergestid Shrimp in the Western Part
of the Pacific Ocean

by
M. Omori

The utilization of plankton and micronekton organisms for animal and human consumption has been proposed by several scientists to obtain sufficient food to meet the demand of human population in the world. Species of Sergestes (Penaedia, Natantia, Decapoda) are generally meso- or bathypelagic forms, and with the exception of Sergestes lucens in Suruga Bay, Japan, they have never been fished commercially. However, the populations of other species of Sergestes in the oceans are often large, and some of the species have a tendency to form dense swarms. The potential of commercial fisheries of several sergestid shrimp may exist, and someday these shrimp will contribute more to the world's fisheries. The new stocks must be located first and studied.

During the present cruise, geographical distribution and abundance of sergestid shrimp were studied at five localities in the western part of the tropical Pacific Ocean. Collections were made with 10-foot and 6-foot Isaacs Kidd Midwater Trawls (Table 14). The cod-end of both samplers had mesh openings of 2 mm. The sampler was towed obliquely down at the ship's speed of 5 knots as wire paid out, and then towed obliquely back up to the surface at the ship's speed of 2 knots. The length of wire paid out was 250 and 1000 m so that information on the vertical occurrence of the species can be obtained. The maximum depth of trawling was determined from a depth-distance recorder.

Table 14. Collections containing species of Sergestes made from R.V. Hakuho Maru
KH-71-1 cruise with the Isaacs Kidd Midwater Trawl

Station number	Collection number	Type of trawl	Date	Ship's time	Position at start of trawl	Collection depth (m)
P-1	a	10-ft.	Feb. 23, 1971	2203-2240	03°02'S 150°52'E	0-320
	b	10-ft.		2300-2320	03°01'S 150°53'E	0-160
P-2	a	10-ft.	Mar. 1, 1971	2116-2202	08°45'S 153°02'E	0-320
	b	6-ft.		2225-2245	08°42'S 153°02'E	0- 80
P-3	a	10-ft.	Mar. 2, 1971	2104-2151	06°17'S 152°14'E	0-320
	b	10-ft.		2200-2219	06°15'S 152°13'E	0-105
P-4	a	10-ft.	Mar. 10, 1971	2020-2105	10°02'N 137°00'E	0-320
	b	10-ft.		2114-2132	10°03'N 136°57'E	0-115
P-5	a	6-ft.	Mar. 13, 1971	2014-2103	15°29'N 129°17'E	0-300
	b	6-ft.		2110-2134	15°31'N 129°15'E	0- 82

15. Geographical Distribution of Zooplankton Biomass in
the Subsurface Water (Zooplankton Samplings by High
Speed Plankton Catcher V)

by
M. Omori

To obtain useful data for studying the dynamics of plankton production in the open sea, I have been conducting the measurement of standing crop, species composition, and chemical composition of zooplankton which were collected with the High Speed Plankton Catcher V. This is the fourth cruise to study geographical and seasonal variations of each component. The last three cruises by the R.V. Hakuho Maru extended across the Pacific Ocean from 50°N to 65°S between 150°E and 155°W.

The High Speed Plankton Catcher V (described by Motoda, 1959*) was equipped with GG54 net (0.33 mm mesh openings). Night sampling was made at 13 stations between Rabaul and Kaohsiung (Table 15). Like the previous cruises, the sampler was towed for 30 minutes from the stern at the ship's speed of 10 knots. A flowmeter was used to estimate the volume of water filtered. Immediately after sampling, the catches were divided into two parts using a modified Folsom plankton splitter. One part was preserved in 5 % formalin seawater for later examination of the species composition. For the dry weight and chemical composition measurements, the other part was rinsed briefly with distilled water. Then, it was placed on a silk netting XX13 base, and dried in an oven to a constant weight at 60°C. The dry material was then stored in a desiccator. Total carbon, nitrogen, and hydrogen as well as ash content will be determined for each material using a Yanagimoto CHN Corder in the Ocean Research Institute.

* Mem. Fac. Fish., Hokkaido Univ. 7(1-2). (1959)

Table 15. Zooplankton sampling data with high speed palnkton catcher V

Station number	Date	Ship's time	Position at start of sampling	Volume of water filtered (m ³)	Dry weight/m ³ of water (mg)
Hc-1	March 1, 1971	2255-2325	08°42'S 153°02'E	31.7	6.1
Hc-2	March 2	1902-1932	06°42'S 152°21'E	27.0	7.7
Hc-3	March 3	1901-1931	03°20'S 150°35'E	26.6	2.2
Hc-4	March 4	1900-1930	00°43'N 148°04'E	26.9	1.3
Hc-5	March 5	1953-2024	01°53'N 146°59'E	28.7	1.5
Hc-6	March 8	1935-2005	02°10'N 141°58'E	28.8	0.6
Hc-7	March 9	1930-2000	06°59'N 140°36'E	25.7	2.7
Hc-8	March 10	1932-2002	10°00'N 137°05'E	25.7	0.2
Hc-9	March 11	2215-2245	10°54'N 133°42'E	28.1	0.2
Hc-10	March 12	2013-2043	12°58'N 133°06'E	27.5	0.2
Hc-11	March 13	1930-2000	15°25'N 129°22'E	24.5	1.0
Hc-12	March 15	1937-2007	20°00'N 126°05'E	23.5	0.6
Hc-13	March 16	1933-2003	22°03'N 121°20'E	25.3	4.3