Topography and Sediment in the Southern Part of Japan Trench*

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Abstract: In the twice surveyings of July and September of 1959, Takuyo a surveying vessel of Hydrographic Office found out the Second Kashima Seamount from the Japan Trench. Several transverse profiles from the east coast of Japan to the Japan Trench, show three terraces on the continental slope off the east coast of Japan. In these terraces, the flat plains at 1,000 to 2,000 meters in depth are very wide and continuous on the sea bottom off the east coast of Japan. Transverse profiles of the Japan Trench are commonly asymmetrical and bottoms of the trench are flat. By the operation in latter cruise, short core was obtained, which was so-called radiolarian ooze of deep sea type.

1. Introduction

The soundings of the Japan Trench had been carried out by the Japanese Hydrographic Office since 1918. Arranging the data from these soundings, TAYAMA (1952) and DIETZ (1954) reported on the submarine topography of the deep sea floor of the adjacent sea of Japan. Since 1957, the Japan Trench has been attractive as the dumping ground of the radioactive residues and Japanese oceanographers have engaged the deep sea researches.

For the reasons above mentioned, Takuyo surveying vessel of Hydrographic Office and Ryofu-maru that of Japan Meteorological Agency have initiated the survey of Japan Trench since the middle of 1957. During the survey of 1957, Meiyo the vessel of Hydrographic Office discovered Kashima Seamount from the Japan Trench off the Kashima-nada Sea and collected the bottom sediment from the top of the seamount (KOMUKAI and NAKAYAMA, 1958). In twice surveys of July and September of 1959, Takuyo carried out the soundings of the Japan Trench from Lat. 37° to 38.5° N and discovered the seamount at 55 miles northeastward of Kashima Seamount and collected bottom sediment from 7,065 meters deep in the Japan Trench.

In present paper, the authors reported the submarine topography and bottom sediment of

the Japan Trench and its vicinity compiling the soundings of Takuyo in 1959 and the past ones reserved by the Hydrographic Office. The hydrographers on board of these cruises are as follows:

July of 1959; N. KINOSHITA, A. MOGI, S. AO and others.

September of 1959; B. IMAYOSHI, B. KAWAMURA, K. SATO and others.

Captain S. MATSUBARA and crew members of Takuyo.

2. Submarine topography

The depths were recorded continuously by a deep sea type echosounder. The soundings were positioned by Loran and the astronomical method in each hour. The depths directly read from the echograms are corrected by the physical and chemical conditions of sea water. These corrections are -24 meters in 3,000 meters, $+7$ meters in 5,000 meters and $+86$ meters in 7,000 meters respectively. The difference of depth at the intersecting point of the sounding lines of July and September soundings are 10 to 50 meters.

1) Continental slope

The authors selected representative four sounding lines from the east coast of Japan to the Japan Trench and the tracks are shown in Fig. 1 and these profiles are shown in Fig. 2. These courses are fairly straight as shown in Fig. 1.

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Fig. 1. Topographic chart and the situations of profiles.

Fig. 2. Profiles of the continental slope off Japan.

Course D-D' runs off Kinkazan Island to the Japan Trench. As seen in the illustrations, there are very flat areas in the depth of 700 to 1,600 meters and the shallower than 400 meters. Especially, the flat area between 700 to 1,600 meters deep is very wide and the width of which is approximately 50 miles. While the slope between 1,600 to 7,000 meters is steeper and has step-like relieves.

Course E-E' runs off Cape Shioya to the Japan Trench. As seen in Fig. 2, the flat bottom exists only in the area shallower than 600 meters. The bottom profile becomes steeper

from 800 meters, but this slope is interrupted by the elevation of 2,300 meters depth.

Course B-B' runs off Cape Isozaki to the Japan Trench. As seen in Fig. 2, there are very flat areas in the depths of 1,000 to 2,100 meters and the shallower than 800 meters. Especially, the width of the flat bottom between 1,000 to 2,100 meters in depth is very wide and is of about 40 miles. The slope between 2,200 to 4,000 meters is steeper than the surroundings. From 4,000 meters deep, the bottom profile becomes gentler again.

Course C-C' runs to NEE trend off Cape Isozaki to the Japan Trench. As seen in Fig. 2, there are very flat areas in the shallower than 200 meters that is the continental shelf. From 200 meters deep, the bottom profile becomes steep slope. Between 2,400 to 2,700 meters, there is the gentle elevation and the slope between 2,800 to 3,600 meters becomes very steeper again. The bottom profile of 3,600 to 4,500 meters is the gentle slope with irregular relieves.

Course A-A' takes the trend of NEE from the south of Cape Inubo to the Japan Trench. As seen in Fig. 2, the marginal depth of the continental shelf is 140 meters deep. From 200 to 900 meters, the bottom profile shows very steep slope and it becomes very flat from 900 to 2,200 meters. The slope between 2,200 to 3,000 meters becomes much steeper again, but there is a flat area of 3,000 meters deep. The slope from 3,100 meters deep to the Japan Trench is very steep slope.

Every profiles show the very wide flat plains at 1,000 to 2,000 meters in depth. These terraces were initially discovered by TAYAMA (1950) from the sea bottom off Shikoku, and then in the middle of 1959, NASU and others noticed these terraces on the continental slope of the eastward of Japan on the occasion of Ryofumaru Expeditions.

And the profiles along the courses of D-D', E-E', and B-B' show the flat bottom at the depth of 300 to 800 meters. These terraces are widely distributed on the sea bottom from Kashima-nada Sea to Kinkazan Island, and are lacked on the sea bottom off Boso Peninsula

Table 1. Terraces on the profiles.

Profile	Continental shelf	First terrace	Second terrace	Other flat plain
D-D'		250?-400 m	700-1,600 m	
E-E'		250?-600 m	2,300 m (elevation)	
B-B'		400?-800 m	1,000-2,100 m	deeper than 4,000 m
C-C'	0-200 m	—	2,400 m (elevation)	3,600-4,500 m
A-A'	0-140 m	—	900-2,200 m	3,000 m

(Table 1).

There is another narrow terrace at the depth 3,000 to 4,000 meters, which is developed partly on the continental slope in Kashima-nada Sea. According to the bathymetric chart of the continental slope in Kashima-nada Sea which is constructed from fairly abundant soundings (Fig. 3), the flat plain at the depth of 1,000 to

Fig. 3. Bathymetric chart in southern part of the Japan Trench.

2,000 meters is very wide. The wide flat plain is interrupted by the depression off Cape Inubo and it appears again in the southern side of the depression. The south of the depression forms submarine ridge extending to eastward. This ridge continues to the Kashima and Second Kashima Seamounts, and the depression may be related to the ancient Musashino Bay.

2) Trench topography

Four transverse profiles of Japan Trench off Kinkazan Island to Cape Shioya are shown in Fig. 4. On the eastern slope of the trench, these profiles resemble each other and the average gradient of these slopes is about 1° . On the western slope of the trench, two pro-

Fig. 4. Transverse profiles of the Japan Trench off Kinkazan Island to Cape Shioya.

files of the northern part of this area have steeper slopes of which the average gradient is about 4° . Otherwise, two profiles of the southern part of this area have gentle slopes with the average gradient of about 1° . Accordingly, two profiles of the northern part of trench are asymmetrical and two profiles of the southern part are symmetrical.

The maximum depths of the trench on the four profiles are 7,400, 7,580, 7,800 and 7,780 meters; the trench becomes deeper from north to south.

3) Seamount

In July Cruise, Takuyo discovered the seamount at 55 miles northeastward of Kashima Seamount. In September Cruise, she carried out again the sounding of this area and confirmed the existence of this seamount. Authors named this seamount as the Second Kashima Seamount.

The Second Kashima Seamount has a peaked top and the shallowest sounding is 2,662 meters in depth at Lat. $36^\circ 04.8' N$ and Long. $143^\circ 28.0' E$. The basal plain of this seamount is the ocean floor of 5,800 to 6,000 meters in depth, so that the seamount rises at 3,100 to 3,300 meters in height above ocean floor. The horizontal form of this seamount is oval and has diameter of 28 and 23 kilometers. Vertical profile of this seamount shows cone, the slope

of which is about 30° at the top of mount and 12° at the foot of it. In this manner, the slope of this seamount becomes gentle from top to foot, which suggests that the Second Kashima Seamount is submarine volcano (Fig. 5).

Fig. 5 Transverse profile of continental slope, Japan Trench, Kashima Seamount and Second Kashima Seamount.

3. Sediment

In the cruise of Takuyo in September, core-sampling operation was carried out with the long piston core-sampler. Unfortunately, the release mechanism of the device did not permit free-falling of main body and long core was not obtained. But the short core-sampler attached as the pilot weight, caught some sediment. The pilot sampler is 15kg of weight and 3cm of inner diameter. Coring tube is divisible into three parts. The sediment fulfilled in these three parts was divided into three horizon such as upper part (several cm long),

middle part (7cm long) and lower part (11cm long). Because the inner wall of pilot sampler had become somewhat rusty, the rust was mingled in the sediment, especially in the upper part.

1) Remarks of sediment

Situation: $37^\circ 29'N$ and $143^\circ 53'E$. Oceanward slope of the Japan Trench.

Date: 4, July, 1959.

Depth: 7,065m uncorrected.

The sediment is a dark grayish lutite almost of which is clay and a small quantity of siliceous organic remains such as radiolaria and diatom.

2) Grain size distribution

Grain size analysis was carried out according to the hydrometer method and the sedimentograph which was automatic grain size analyzer. Results are listed in Table 2.

The sediment is clay size and contains small quantity of sandy fraction. The residues of analyzed sample are used for following analyses as clay part for clay mineral determination and coarse part for mineral composition analysis.

3) General constituents

The coarse fraction than 300 mesh is observed under microscope, and measured the ratio of

Table 2. Results of grain size analysis.

	$\phi 16$	$\phi 25$	$\phi 50$	$\phi 75$	$\phi 84$	So	Weight % of coarse fraction*
Upper part	4.55	5.55	7.05	8.50	8.95	1.50	16%
Middle part	5.85	6.45	8.05	11.15	—	2.35	7%
Lower part	5.60	6.30	7.70	10.60	—	2.15	9%

* Coarse fraction means the coarser than 300 mesh (approximate to 4.5ϕ).

Table 3. Ratio of component materials in coarse fraction.

	Organic remains	Inorganic grains		
		Feldspar	Quartz	Others*
Upper part	93.4%	2.1%	1.8%	2.7%
Middle part	86.7%	6.4%	3.6%	3.3%
Lower part	87.4%	3.0%	5.0%	4.7%

* Glass of uncertain origin whether organic or inorganic, and heavy minerals.

component materials by number (Table 3).

Almost of coarse fraction is organic remains such as radiolaria and diatom. Residues are light minerals such as feldspar and quartz. Mineral grains are generally very angular except a little quantity of very weathered feldspar.

4) Heavy residues

As the coarse fraction had contained fairly much of rust, the large part of rust was taken away by electromagnet. Then, the heavy minerals are separated by bromoform (specific gravity 2.89), and the frequency of mineral assemblage is counted under the microscope (Tables 4 and 5). Dominant heavy minerals are augite, hypersthene and common hornblende in descending order. Mineral grains are generally very angular but a few large grains of hypersthene. The augite is pale green to green augite or nearly opaque one stained by weathering or coating materials. Hornblende is largely brownish green hornblende. The lower sample contains large angular fragments (about 0.5mm) of green hornblende and a few of reddish brown hornblende. The latter is nearly oxyhornblende.

Generally, the all minerals in the sample are common in Japanese Islands. The angularity of grains does not due to the volcanic origin but to the fineness of grains, because the non-volcanic minerals such as andalusite, tremolite and zircon are also very angular. Very fine

grains are not apt to be round. The large parts of these minerals are terrigenous detritus.

5) Pumice grain

The sample of middle part contains one grain of pumice which is 3×5mm in size and subround. Under microscope it consists of glass and fragments of vitroclastic texture, immense stream-bubbles and one fragment of green hornblende.

6) Summary

The results of analyses indicate following characteristics; (1) The sediment is lutite. (2) About 90% of whole sample is clay or silt. (3) About 90% of coarse residues is siliceous organic remains. (4) Almost of mineral grains are feldspar and quartz, and only 1-2% of coarse residues is heavy minerals of terrigenous origin. (5) A very small quantity of coarse residues is perhaps volcanic clastics.

Then the sediment is so-called radiolarian ooze of deep sea type.

Table 4. Weight percentages of heavy minerals.

	Heavy mineral
Upper part	1.7%
Middle part	1.4
Lower part	1.5

Table 5. Composition of heavy minerals.

	Augite	Hypersthene	Hornblende	Biotite	Magnetite	Others
Upper part	55.0%	15.4%	13.2%	5.5%	7.7%	3.3%*
Middle part	39.8	21.7	15.7	3.6	9.6	9.6 **
Lower part	39.0	32.6	11.6	2.1	6.3	8.4 ***

* Chromite, decomposed materials, etc.

** Andalusite, chlorite, decomposed materials, etc.

*** Titan augite, tremolite, zircon, apatite, chlorite, etc.

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