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43. Ocean-bottom Seismographic Observation off Sanriku—Aftershock Activity of the 1968 Tokachi-Oki Earthquake and Its Relation to the Ocean-Continent Boundary Fault.

By Shozaburo NAGUMO,
Earthquake Research Institute,
Shuji HASEGAWA,*
The graduate school, the University of Tokyo,
Sadayuki KORESAWA and Heihachiro KOBAYASHI,**
Earthquake Research Institute.

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1. Introduction

An ocean-bottom seismographic observation was perfomed off Sanriku for about forty two days in May~June of 1969 by the M/S "Hakuhō-Maru" of the Ocean Research Institute, the University of Tokyo. The purpose of this observation is to study the aftershock activity of the 1968 Tokachi-Oki earthquake (M=7.9) at the time of one year after the occurrence of the main shock. This paper will report the field operation and some results of the analysis and interpretation of the data.

By analyzing the observation data, very important informations have been obtained about the grade of the aftershock activity on the boundary fault of the geophysical ocean and continent.

2. Field Operation

The localities of the ocean-bottom seismographic observations A, B, and C are shown in Fig. 1 and Table 1. The Mooring periods of the ocean-bottom seismograph are also shown in Table 1. The stations are at almost the same locality which were used one year earlier.[1] These stations are in the west part of the aftershock area of the Tokachi-Oki earthquake (M=7.9) of May 16, 1968. Another ocean-bottom seismo-

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* Present address: Japan Petroleum Exploration Company
** Present address: Tokai University

1) S. NAGUMO *et al.*, *Bull. Earthq. Res. Inst.*, 46, (1968), 1355-1368.

Table 1. Location and mooring period of the ocean-bottom seismographic stations.

Station	Location		Depth	Mooring Period	
	Long.	Lat.			
SAN-A	143° 00′.8E	40° 21′.0N	1525m	1969 May 4	
SAN-B	142 28.7	40 19.3	1000	May 3～June 13	42 days
SAN-C	142 44.7	39 46.9	1050	May 3～June 14	43
ERIMO	145 18.3	40 37.0	5610	May 7～May 9	2

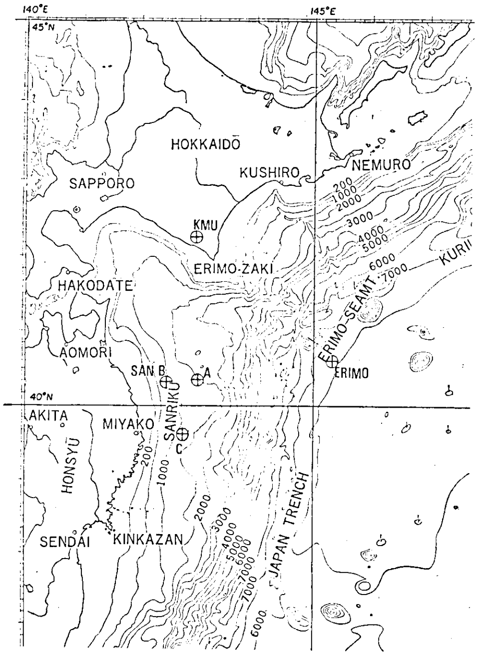


Fig. 1. The ocean-bottom seismographic stations off Sanriku in May～June of 1969 R/V "Hakuhō-Maru".

graphic station ERIMO[2] was placed eastward at the offside of the Japan Trench for a short time during the observation period.

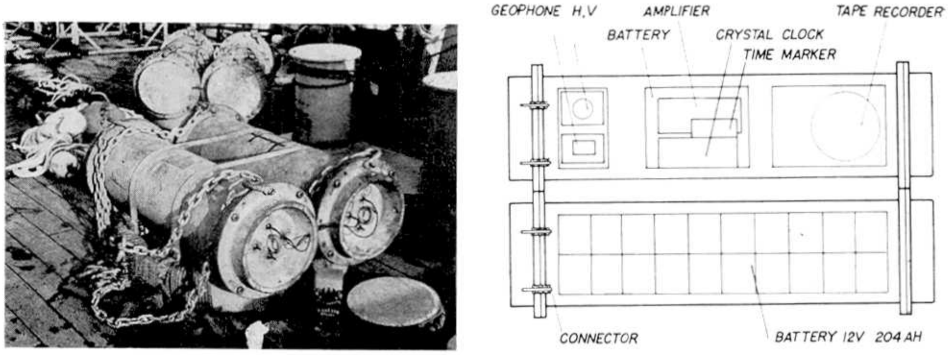
Instrumentation

In order to perform a one month observation at the ocean floor, special long life magnetic tape recorders have been developed.[3] They can record for 1000 hrs on the 1800 ft, 1/4 inch magnetic tape by DR. The geophones, amplifiers and crystal clocks are the same as used before.[4] The capacity of the battery is increased to 208 AH, 12 V for a one month recording. Special pressure vessels were constructed for containing this large battery.[5] As shown in the Fig. 2, the pressure vessels are composed of two identical vessels, one containing the battery and the other containing the recording instruments.

Mooring and Recovering Rope System

The mooring and recovering rope system is shown in Fig. 3. The

2) S. NAGUMO *et al.*, *Bull. Earthq. Res. Inst.*, **48** (1970), 769-792.
3) S. HASEGAWA and S. NAGUMO, *Bull. Earthq. Res. Inst.*, **48** (1970), 967-981.
4) S. NAGUMO *et al.*, *Bull. Earthq. Res. Inst.*, **46** (1968), 861-875.
5) S. NAGUMO *et al.*, *Bull. Earthq. Res. Inst.*, **48** (1970), 955-966.



(a) (b)

Fig. 2. Pressure vessels for monthly recording of the ocean-bottom seismographic observation.

system was designed by Captain Magoshichi Sato of the M/S "Tokai Daigaku Maru II" for us and detailed explanations are given in other papers.[6,7]

The strength of the rope system is taken at about six tones. One of the features is the device which is attached for recovering the system.

Field operation

As reported in the cruise report of the R/V "Hakuhō-Maru" KH-69-2, the operations of deployment and recovery of the ocean-bottom seismograph were very smooth and efficient.

The three ocean-bottom seismographic stations were deployed at the biggining of the cruise and recovered at the end of the cruise. From the three stations, two stations were safely recovered. The last station, unfortunately, was lost, because the polypropylen rope (22ϕ) has been cut at the center part between the anchor and the surface buoy. This was found when the surface buoy with some mooring ropes, drifting far out in the Pacific ocean, were picked up by a fishery boat and returned to us.

3. Seismicity of the Aftershocks

First let us see the grade of the seismic activity. The daily number of earthquakes at the ocean-bottom seismographic station B during the

6) M. SATŌ, *La mer*, **8** (1970), (in press).

7) S. NAGUMO, *La mer*, **8** (1970), (in press).

8) Preliminary Cruise Result of R/V "Hakuhō-Maru," Cruise No. KH-69-2 (May～June, 1969), Japan trench and Japan Sea, Ocean Research Institute, University of Tokyo, 1969.

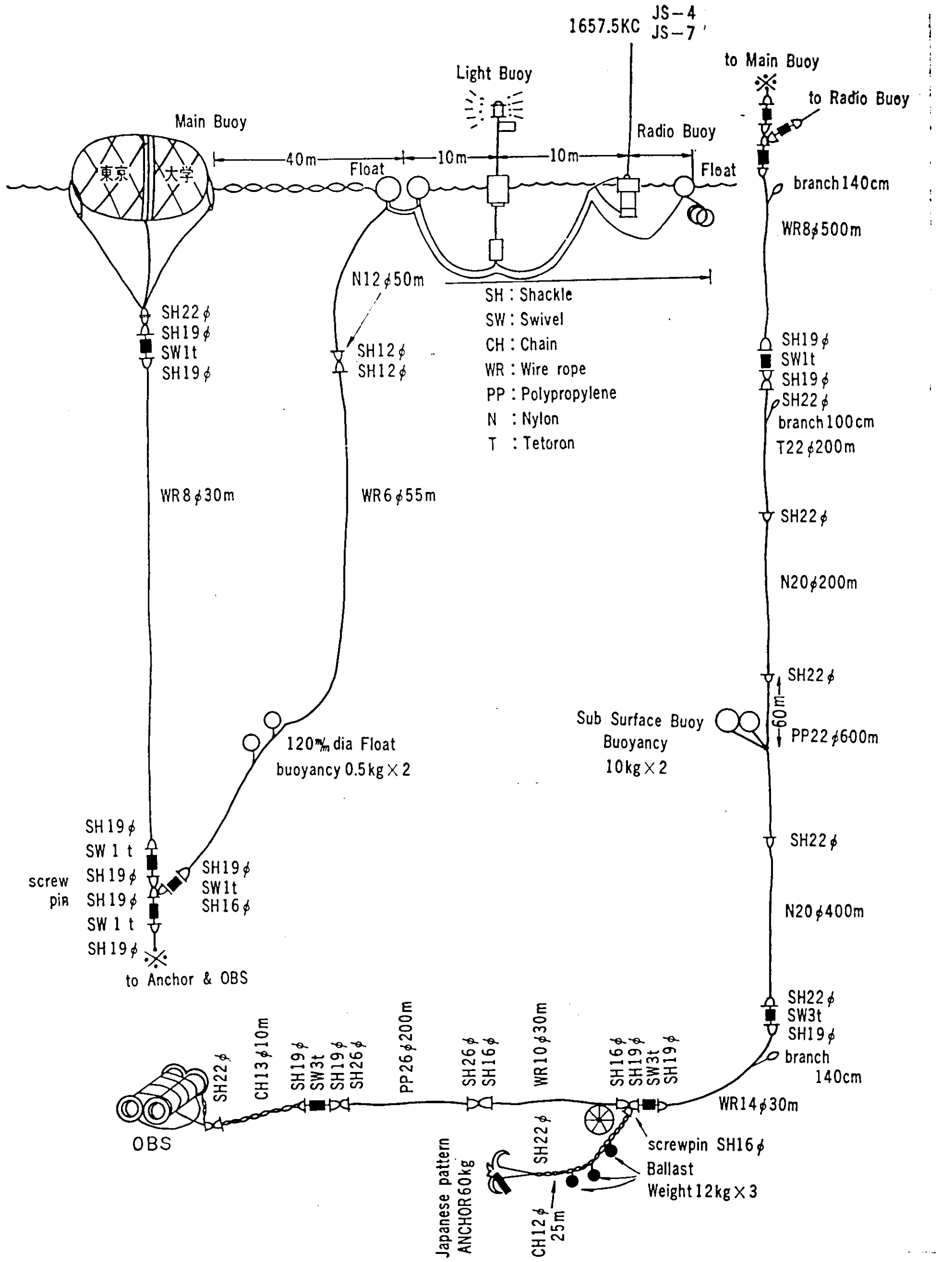


Fig. 3. The mooring-recovering rope system for the ocean-bottom seismographic observation.

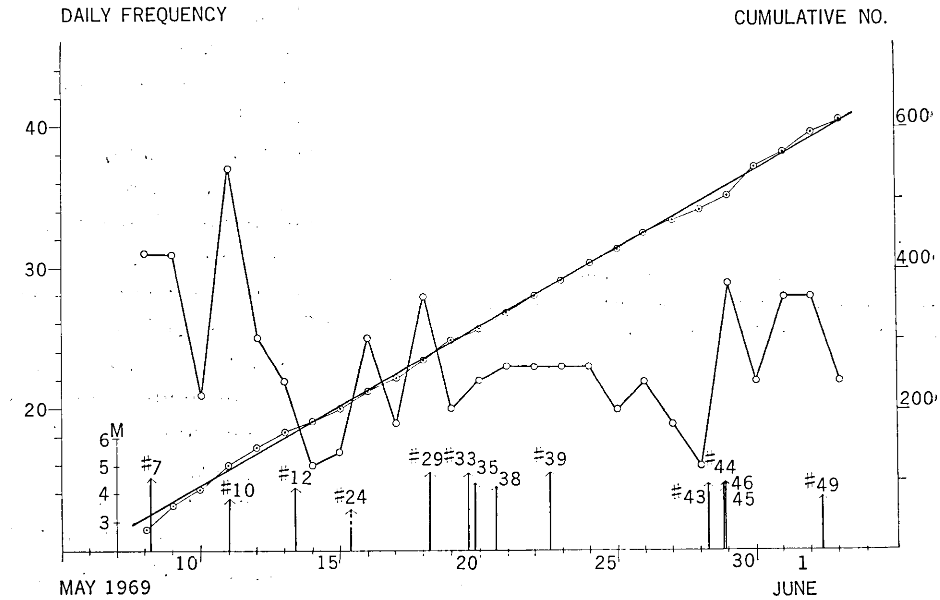


Fig. 4. The daily number of earthquakes and the cumulative number of earthquakes at the ocean-bottom seismographic station B off Sanriku in May~June of 1969.

period from May to June in 1969 is presented in Fig. 4. The velocity amplitude of the earthquakes registered is larger than 100 μkine. The cumulative number of earthquakes is also shown by the solid line in Fig. 4.

The daily number of earthquakes fluctuates very much. However, the curve of the cumulative number of earthquakes is almost linear. The gradient of the cumulative number of earthquakes expresses the grade of the seismicity by giving the average number of earthquake which are observed at a certain station and for which the velocity amplitude is larger than 100 μkine. It amounts to twenty-two earthquakes per day. This shows that the aftershock activity is still very high even though one year has elapsed since the main shock of the 1968 Tokachi-Oki earthquake. Compared with the foreshocks which were observed by the same instrument at almost the same place,[9] the seismicity of 22 earthquakes per day is about three times higher than the seismicity of the foreshocks. It will be interesting to compare this aftershock activity with micro-earthquakes at the offiside of the Japan trench.[10] At the ocean-bottom seismographic station ERIMO, the number of earthquakes which occurred within the true oceanic lithosphere was about 6 earthquakes per day. Since there is a difference in the size of the area where

9) S. NAGUMO, *loc. cit.* 1).
10) S. NAGUMO *et al.*, *loc. cit.* 2).

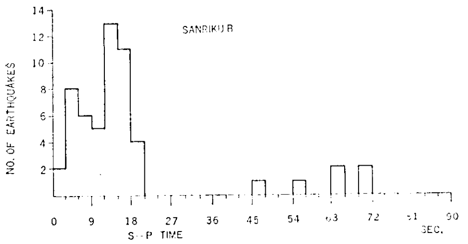


Fig. 5. The S-P time distribution during two days, from May 7 to 9 in 1969 at the ocean-bottom seismographic station B off Sanriku.

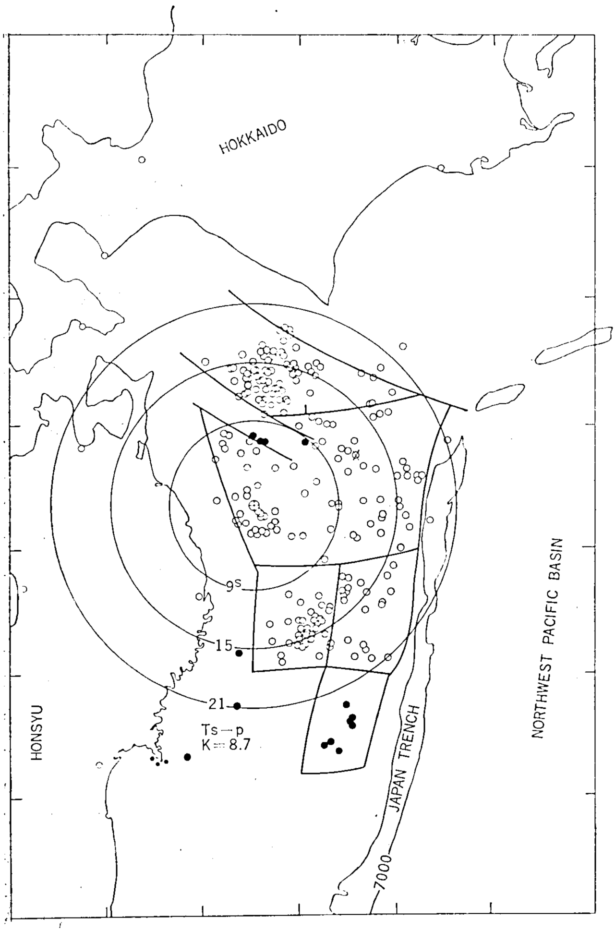


Fig. 6. The relation of the S-P time to the aftershocks and foreshocks of the 1968 Tokachi-Oki earthquake at the ocean-bottom seismographic station B off Sanriku. Ōmori's coefficient is taken as K=8.7 km/sec.

these small earthquakes and micro-earthquakes take place between the oceanic side and the continental side, an exact comparison can not be made. However, it is certain that the grades of the seismic activities are different between the two, and that the seismicity on the oceanic side is smaller.

Next, let us see the area where these earthquakes occur. The distribution of the S-P times during the two days, from May 7 to 9, 1969, is shown in the Fig. 5.

As seen in Fig. 5, there are two groups. One contains earthquakes with S-P times smaller than nine seconds, and the other contains earthquakes with S-P times smaller than twenty-one seconds, with a peak at about fifteen seconds.

In order to have a rough idea about the area where these earthquakes take place, circles are drawn for several S-P times in the map of the foreshock and aftershock distributions of the 1968 Tokachi-Oki earthquake, as shown in Fig. 6. Ōmori's coefficient K, which will be discussed in detail in a later section, is taken as K=8.7 km/sec. The small open circles are the aftershocks, and the solid circles are the foreshocks of the 1968 Tokachi-Oki earthquake. The solid lines represent the boundaries of earthquake blocks of foreshock and aftershock activity of the 1968 Tokachi-Oki earthquake. As seen in Fig. 6, the earthquake with S-P times smaller than nine seconds are those which occur around the observation station B. The earthquakes with S-P times smaller than twenty-one seconds are those which occur in the whole aftershock area.

In order to examine the relation of the earthquake distribution to the bottom topography, S-P time circles are drawn in Fig. 7. It is seen in this figure that the earthquakes for which the S-P times are smaller than twenty-one seconds occur almost upon the continental side of the Japan trench. The peak of the S-P times at about fifteen seconds corresponds to the steep slope along the trench. This will imply that the seismic activity is most violent at the steep slope. This feature will be confirmed in the later section when the hypocenters of the earthquakes will be determined.

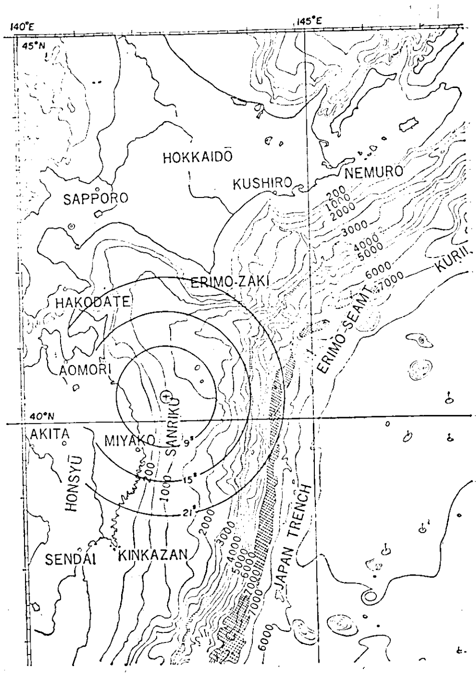


Fig. 7. The relation of S-P times to the ocean-bottom topography at the ocean-bottom seismographic station B off Sanriku. Ōmori's coefficient is taken as K=8.7 km/sec.

4. Distribution of Ōmori's Coefficient K

In order to compute the hypocenter from the data observed at the three stations, Ōmori's coefficient K is determined for each station. As stated in the accompanying paper,[11] the values of K at the ocean-bottom seismographic station ERIMO were determined by using the data of the five earthquakes which were registered by the Japan Meteorogical Agency during the two days mooring period. They vary from 9.4 to 10.7 km/sec according to the direction of the ray path and depth of the hypocentre.

11) S. NAGUMO *et al.*, *loc. cit.* 2).

Table 2. List of the earthquakes which are registered both by the Japan Meteorological Agency and the ocean-bottom seismographic station SAN-B in May～June of 1969.

No.	Data	Origin	Time (JST)	Location	Long.	Lat.	H	M
1	May 4	04h 09m	39s.4	NE OFF CHOSHI	141°06′	35°54′	80 km	
2		11 36	48.3	S OFF BOSO PEN	140 30	34 02	80	
3		15 39	24.0	OFF IWATE PREF	142 40	40 22	30	4.3
4	5	16 32	35.3	MIDDLE OF IWATE PREF	141 48	39 40	100	
5		23 59	37.7	E OFF AOMORI PREF	141 55	40 55	60	4.3
6	8	11 47	58.5	E OF CHIBA PREF	140 29	35 14	40	4.4
7	9	03 36	57.3	OFF SANRIKU	143 19	40 53	40	4.3
10	12	01 04	31.0	OFF IWATE PREF	142 32	40 09	40	3.9
12	13	07 30	55.1	OFF URAKAWA	142 40	41 34	40	4.3
17	15	05 34	10.8	NE OFF NEMURO PEN	146 43	43 20	40	4.9
24	16	11 14	14.7	E OF IWATE PREF	141 51	39 45	80	
29	19	05 56	22.9	E OFF AOMORI PREF	142 30	41 22	40	4.8
33	20	15 35	58.8	OFF MIYAGI PREF	141 50	38 21	60	4.8
35		23 21	49.7	E OFF AOMORI PREF	141 55	40 35	50	4.4
38	21	17 43	36.5	E OFF AOMORI PREF	142 04	41 26	20	4.2
39	22	18 36	34.6	E OFF SANRIKU	143 35	38 14	00	4.9
40		20 40	49.4	E OF IBARAKI PREF	140 34	36 29	50	4.4
41	24	08 04	03.8	SW OF IBARAKI PREF	139 55	36 08	60	4.0
42	29	02 13	13.3	S OF KURIL	147 40	44 56	90	
43		07 25	37.3	OFF IWATE PREF	142 08	40 04	40	4.4
44		22 16	17.5	OFF IWATE PREF	143 19	39 49	10	4.5
45		22 17	50.4	OFF SANRIKU	143 25	39 53	30	4.3
46		22 46	01.4	OFF IWATE PREF	143 28	39 48	30	4.5
49	June 2	10 49	00.2	OFF URAKAWA	142 41	41 26	10	4.0
52	4	01 22	18.0	OFF URAKAWA	142 42	41 36	40	4.2
53		02 11	35.1	E OFF AOMORI PREF	142 39	40 33	00	4.1
54		06 52	57.8	FAR OFF SANRIKU	144 12	40 13	00	5.0
55		23 13	47.8	FAR OFF SANRIKU	143 42	40 20	20	4.4
56	5	18 39	37.3	OFF IWATE PREF	142 09	39 19	50	4.0
57		20 16	26.7	OFF IWATE PREF	142 03	39 59	50	4.0
58	6	03 42	00.9	OFF FUKUSHIMA PREF	141 41	37 36	60	4.3
59		07 18	36.5	OFF FUKUSHIMA PREF	141 44	36 56	40	4.3
60	7	00 48	07.4	OFF IBARAKI PREF	141 15	36 35	50	4.3
62	9	03 25	11.5	OFF AOMORI PREF	142 07	41 24	40	4.1
63	10	08 09	47.8	E OFF HOKKAIDO	148 39	43 29	50	5.0
64	11	01 41	38.2	OFF MIYAGI PREF	141 52	38 35	60	4.5
65		07 51	42.9	FAR OFF SANRIKU	144 26	40 23	00	5.0
67	12	16 41	21.4	FAR OFF SANRIKU	144 02	40 20	40	5.6
68		17 03	23.5	OFF URAKAWA	142 38	41 37	30	4.3
69		19 25	42.6	FAR OFF SANRIKU	144 12	40 04	50	4.6

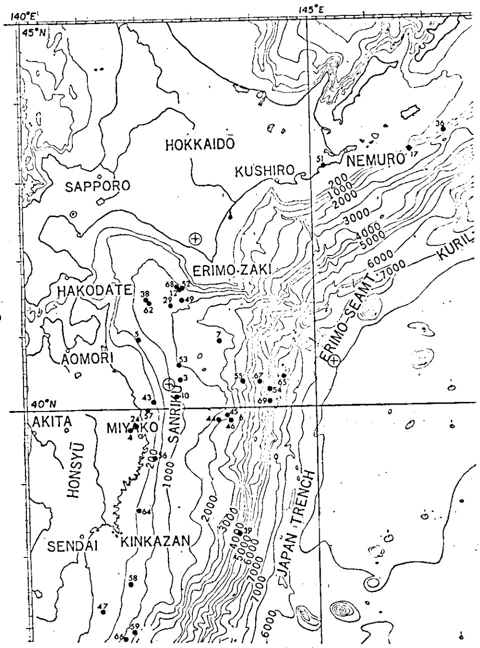


Fig. 8. Epicenter distribution of the earthquakes which are used to compute Ōmori's coefficient K at the ocean-bottom seismographic station B off Sanriku, and at the station URA of the Japan Meteorological Agency. The period is from May to June in 1969.

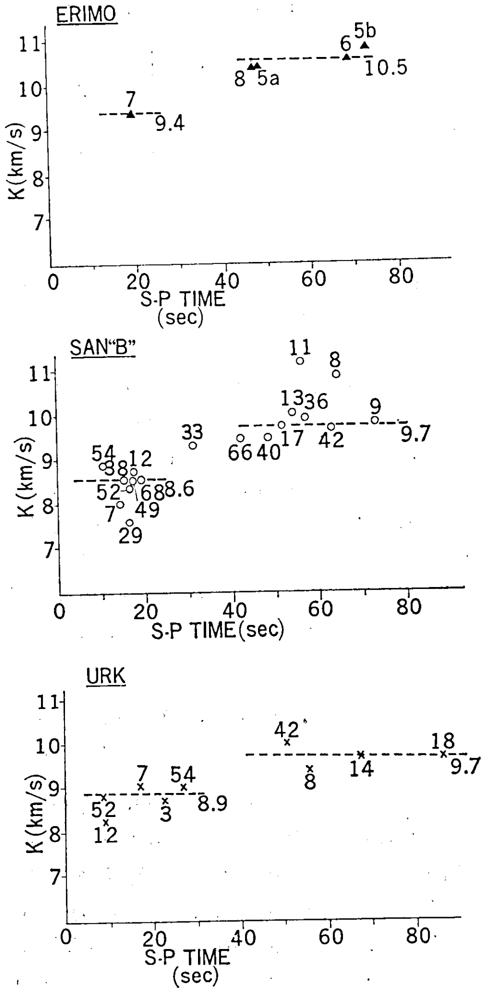


Fig. 9. The distribution of Ōmori's coefficient K for each earthquake, (1) at the ocean-bottom seismographic station ERIMO, and (2) at station B off Sanriku, and (3) at station Urakawa of the Japan Meteorogical Agency.

In Fig. 9–1, the value of K at the station ERIMO is plotted as a function of the S-P time. The values of K at the ocean-bottom seismographic station B and the station URAKAWA of the Japan Meteorological Agency are determined by using the data of many earthquakes which were registered by the Japan Meteorological Agency during the period of about one month (Table 2). The distribution of the epicenters which were

Table 3. Average value of Ōmori's coefficient.

S-P time \ Station	ERIMO	SAN-B	URA
T(s-p) <20 sec	9.4 km/sec	8.6 km/sec	8.9 km/sec
T(s-p) >20 sec	10.4	9.7	9.7

used for this calculation is shown in Fig. 8. The value K is determined for each earthquake from the observed S-P time and the hypocentral distance by assuming straight ray path. The values of K are plotted as a function of the S-P time in Fig. 9-2, 3 for the station URAKAWA and the Sanriku " B ". As seen in Fig. 9, the average value of K seems to be dependent on the S-P time. From these data the average value of K is determined as shown in Table 3.

In this table, earthquakes with S-P times larger than 20 seconds are those which occur in the Kuril region. The existence of a heterogeneity of Ōmori's coefficient K and its large value are due to the velocity heterogeneity around the boundary of the geophysical ocean and continent.

5. Seismic Activity in the Aftershock Area of the 1968 Tokachi-Oki Earthquake

The hypocenters of the earthquakes, which were registered by the three stations (the ocean-bottom seismographic station ERIMO and Sanriku " B ", and the URAKAWA Micro-earthquake Observatory, the University of Hokkaido) are graphically determined by using S-P times and Ōmori's Coefficient K, which is determined in the preceding section. When the observation data are given only at two stations, the hypocenter is determined by assuming that the focus is at the surface and is located at the distant cross point from the third station. The data are presented in Table 4.

The distribution of the epicenters is shown in Fig. 10 and Fig. 11. In Fig. 10, the epicenters are shown corresponding to the earthquake blocks of the aftershocks of the 1968 Tokachi-Oki earthquakes. The solid circles are the epicenters determined by the three stations network during the two days from May 7∼9 in 1969, and the open circles are the epicenters determined by the Japan Meteorological Agency during the mooring period of the ocean-bottom seismographs from May 4 to June 12 in 1969.

As seen in Fig. 10, the earthquakes registered by the ocean-bottom seismographic stations are mainly distributed in the block A and B, and

Table 4. The data of earthquakes which were observed by the three stations (OBS ERIMO, OBS SAN-B and URAKAWA, Hokkaido Univ.) in May 7∼9 of 1969. Amplitude notations, A; saturation, B≧100 μkine, C<100 μkine.

Earthquake No.	Date	Hour	ERIMO				SAN-B				URAKAWA		
			Arrival m	s	S-P sec	Amp	Arrival m	s	S-P sec	Amp	Arrival m	s	S-P sec
1	7	12	55	22.3	12.1	A	55	27.0	17.6	A	55	33.3	
2		13	10	30.3	48.2	A	10	29.0	48.0	A	10	08.3	30.3
3		14					53			C			
4		15	48	39.0	23.6	C	48	31.3	14.0	A	48	17.9	10.7
5		16	14	40.3	3.2	C							
7		17					18			C			
8							27			C			
9		18	05	44	44	C							
10		19	14	32		A					14	32.0	
11			36	37.7	73.0	A	26	27.1	54.2	A	36	46.8	
12		21					26	58.5	7.8	B			
13		23					00	55.6	13.9	A	00	58.4	14.5
14			01	11.4	14.9	B							
15			03	38.8	1.9	C							
16			41	33.0	5.6	A							
17	8	00	07	58.5	3.8	B							
18			10	18.2	4.6	A							
19			20	39.9		A	20	14.2	6.0	A			
20			22	25.0		A	33	21.2			32	36.4	1.4
21			42	09.8	51	A	42	27.8	69.5	A	42	17.3	60.1
22		01	30	14.3		A							
23		02	06	14.4		A							
24							20			B			
25		03									19	43.6	12.7
26							20	00.2	10.7	B			
27							24	12.9	15.8	A			
28			26			A	26	43.3	0.9	B			
29		04					08			C			
30			12	55.5	6.0	A	13						
31							56	40.4	9.0				
32		05					21	00.6	12.5	A			
34							51	20.1	14.7	B			
35		06	58		15	A	58	01.3	16.0	A			
36		07					17			B			
37		08					13	54.0	4.4	A			
38							17			B			
39		09	00	48.4	48.1	A					00	55.8	52.1

(to be continued)

Table 4 (Continued)

Earthquake No.	Date	Hour	ERIMO				SAN-B				URAKAWA		
			Arrival m	Arrival s	S-P sec	Amp	Arrival m	Arrival s	S-P sec	Amp	Arrival m	Arrival s	S-P
40							02	10.3	69.8	A			
41			08	45.6	19.0	A	08	37.6	16.4	A			
42			17	52.2	16.0	A							
43		10	45	30		C	45	08.1	13.5	A			
44			52	16.6	17.0	A	52	12.3	15.0	A	52	32.5	26.5
45		11	04	45.5	28.0	A	04	31.5	16.5	A	04	30.5	14.0
46			14	00	24	A	13	53.0	18.0	A	13	40.0	9.3
47			30	42		C	30			A			
48			49	33.5	68.4	A	49	21.2	64.4	A	49	43.0	
49		13					06			B			
50			11	02	23	A	10	50.3	18.5	A	10	41.9	11.4
51		14	06	50.7	83.3	B	07			C			
52							16			C			
53							48	21.8	14.5	B			
54		15	03	36.9	39.1	A					03	08.9	
55							04	23.6	6.0	B			
56								10		C			
57								37		C			
58		16	14	30.1	3.9	A				B			
59							16			B			
60							40			C			
61							54			C			
62													
63		18					16	53.8	15.6	A			
64													
65		18					27			C			
66		20					11	17.6	17.6	C			
67			33	07.3	23.9	A	32	54.7	20.4	A	32	45.8	10.6
68		21	18	00.6	8.9	A							
69							18	33.0	5.1	B			
70		22	48	38.4	2.7	A							
71		23	20	14.6	1.9	B							
72			58	15.1	24.7	A	58	05.7	17.6	A	57	55.0	9.2
73	9	00					02	41.2	14.5	B			
74							13		7.6	A			
75		01	11	31.4	15.9	A							
76							52		14.9	C	54	25.3	55.9
77			54	35	17	A	54	34.4	15.0	A			
78			59	20.7	15.3	B	59	23.4	17.5	A			

(to be continued)

Table 4 (Continued)

Earthquake No.	Date	Hour	ERIMO Arrival m	ERIMO Arrival s	ERIMO S-P sec	ERIMO Amp	SAN-B Arrival m	SAN-B Arrival s	SAN-B S-P sec	SAN-B Amp	URAKAWA Arrival m	URAKAWA Arrival s	URAKAWA S-P
79		02	08	23.8		A							
80							24	47.5	14.7	A	24	40.5	5.5
81		03	16	20	17	A	16	11.9	16.4	A			
82							26	55.0	11.3	B			
83			37	25.9	19.3	A	37	15.6	15.6	A	37	20.9	17.1
84		04	36			C	35		4	C			
85							40			C			
86							58			B			
87		05					01		4.6	B			
88			07	32.6	14.6	B	07	33.6	15.7	B			
89							13		2.3	C			
90							33		6.9	C			
91			53	10	46.9	A	53	38.9	63.3	A	53	17.2	57.1
92		06	24	53		C	24	21.1	9.0	A			
93							27	56.2	10.6	A			
94							28			B			
95		07	13	02.8	24.6	B	12	53.6	18.8	A			
96							52		4.6	C			
97		09	20				20		6.9	B			
98							27	47.8	10.6	A			
99			35	50.4	4.3	B							
100			38	55.3	1.5	B							
101			39		6	A							
102		10					11	14.0	2.7	A			
103							43	58.5	6.8	A			
104			53	13	27	B					54	04.5	6.1
105		11	09	07.4	11.5	A							
106							19		15.0	A			
107													

some in the block C. This mean that the blocks A and B were active during the observation period. Although the observation period is very short, and amounts to only two days at the offside of the Japan trench, it can be remarked that this seismic activity is higher in the two side blocks and lower in the central block.

The difference of the solid circle and the open circle is due to the size of the earthquakes. The registration by the Japan Meteorological Agency is limited to those with magnitudes larger than 4.0 in this region.

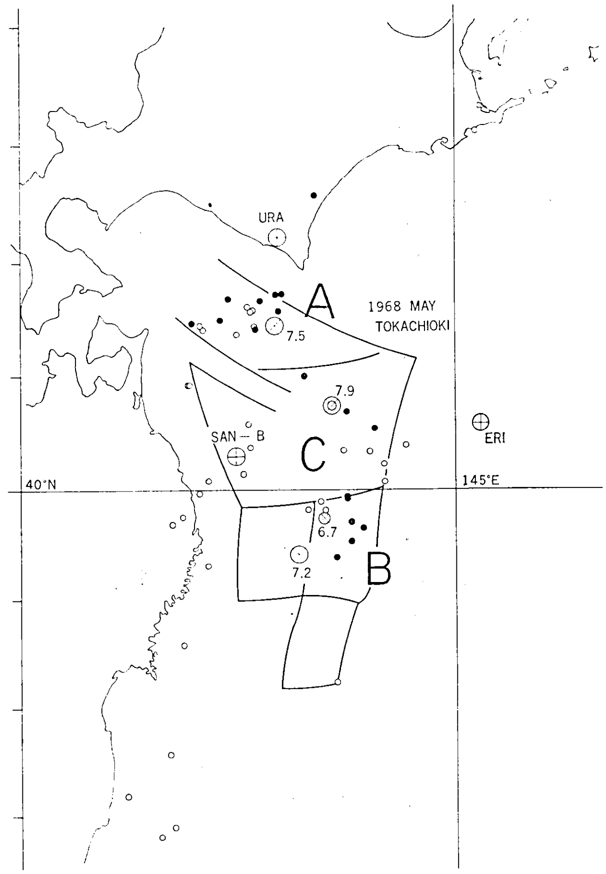


Fig. 10. The epicenter distribution (small solid circles) of small earthquakes and micro-earthquakes which are determined by the two ocean-bottom seismographic stations and one land station. In this figure the relation of the epicenters to the earthquake blocks of the 1968 Tokachi-Oki earthquake is shown.

The registration by the ocean-bottom seismographic stations and the Urakawa Micro-earthquake Observatory is performed for much smaller earthquakes.

6. Seismic Activity of the Ocean-Continent Boundary Fault

The relation between the epicenter distribution and the bottom topography is shown in Fig. 11. The epicenter distribution seems to be composed of two groups. The one is the group off the coast of Urakawa, Hokkaido, and the other is the group distributed along the steep slope of the Japan trench.

It will be seen clearly in this figure that the epicenters of the latter group are alined along the contours of 3 km～4.5 km water depth. This region corresponds to the very steep slope or cliff of the continental slope towards the deepest part of the Japan trench. This characteristics is in accordance with the conclusion deduced by N. Den[12] and H. Hoshino[13] for the larger earthquakes which have been registered by the Japan Meteorological Agency. The observation of this time means that their conclusions are also applicable to the distribution of micro-earthquakes.

Let us examine, next, the relation of this epicenter distribution to the crustal structure. The crustal structure in this region has been investigated by Ludwig *et al.*[14] The lines of a seismic refraction survey and their results are quoted from their paper and are shown in the lower part of the Fig. 11.

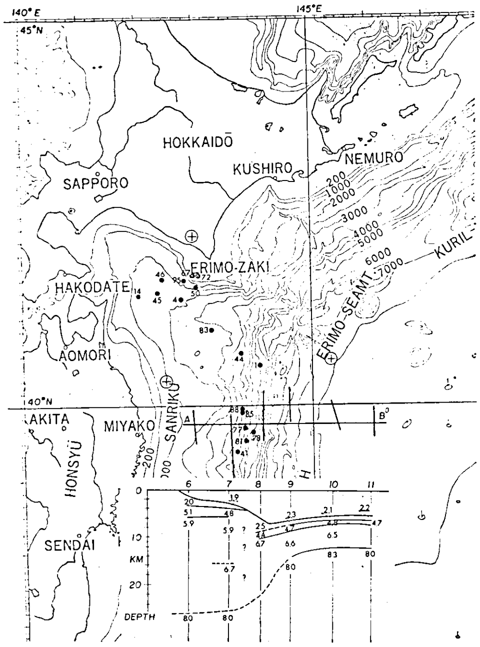


Fig. 11. The epicenter distribution (small solid circles) of small earthquakes and micro-earthquakes which are determined by the two ocean-bottom seismographic stations and one land station. In this figure the relation of the epicenters to the ocean-bottom topography and the crustal structure which was obtained by Ludwig *et al.* is shown.

They have discovered that the discontinuity of the continental crust and oceanic crust lies between the profiles No. 7 and No. 8 at the steepest part of the landward slope of the Japan trench. This discontinuity will be interpreted as the great boundary of the geophysical ocean and the geophysical continent. The steep slope at the water depth contour 3.0 km~4.5 km will be the indication of this boundary fault.

That the epicenters of the micro-earthquakes observed this time lie just at this steep slope means that these earthquakes occur at the boundary fault of the geophysical ocean and continent. This means that the boundary fault of the geophysical ocean and continent is active at present.

From these considerations, it is concluded that the tectonic activity of the ocean-continent boundary fault is the main cause of the aftershock activity of the 1968 Tokachi-Oki earthquake at the period of one

12) N. Den, *Geophys. Bull., Hokkaido University*, **20** (1968), 111-124.

13) M. Hoshino, *Jour. College of Marine Science and Technology, Tokai University*, No. **3** (1969), 1-10.

14) W. J. Ludwig *et al.*, *Jour. Geophys. Res.*, **71** (1966), 2121-2137.

year after the main shock.

7. Summary and Conclusions

In order to investigate the aftershock activity of the 1968 Tokachi-Oki earthquake at the period of one year after the main shock, an ocean-bottom seismographic observation was performed off the coast of Sanriku along the Japan trench in May～June of 1968. The main results obtained are as follows.

(1) The aftershock activity one year after the main shock was still high and the number of earthquakes which are observed at the ocean-bottom seismographic station in the aftershock area with amplitudes larger than 100 μkine was twenty-two earthquakes per day on the average. This activity is about three times higher than the foreshock activity.

(2) Ōmori's coefficient K off the coast of Sanriku is about 8.6 km/sec for the earthquakes with S-P time smaller than 20 seconds.

(3) The epicenter determination was performed by the two ocean-bottom seismographic stations and one land station. The length of the three stations network is about 250 km.

(4) The aftershocks are distributed in two groups: one is off the coast of Urakawa and the other is at the steep slope along the Japan trench.

(5) The distribution of epicenters along the steep slope of the Japan trench corresponds to the boundary fault of the geophysical ocean and continent.

(6) The boundary fault of the geophysical ocean and continent is tectonically active at present. Its activity seems to be one of the main causes of the genesis of the large earthquake activity in the province off the coast of Sanriku.

Acknowledgement

The writers express their hearty thanks to Captain M. Sato of the M/S " Tokai Daigaku Maru II " for designing the mooring and recovering rope system of the ocean-bottom seismographic observation, and to Captain T. Shirasawa and all members of the R/V " Hakuhō-Maru " of the Ocean Research Institute, the University of Tokyo, for performing the field operation of the ocean-bottom seismographic observation. They also extend their sincere thanks to Professor Y. Tomoda, the chief Scientist of the Cruise KH-69-2 of " Hakuhō-Maru " for the nice coordination of our work.

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43. 三陸沖における海底地震観測—1968 年十勝沖地震の余震活動およびその海洋—大陸境界断層との関係

地震研究所　南雲昭三郎
東京大学大学院　長谷川周而*
地震研究所　是沢定之
地震研究所　小林平八郎**

1968 年十勝沖地震本震発生後 1 年経過した時点における余震活動を調べるために，1969 年 5 月～7 月にわたって約 40 日間，三陸沖において海底地震観測を行った．主な結果は次の通りである．

(1) 地震活動度は未だ高く速度振巾 100 μkine 以上の地震の数は平均 22 コ/日であった．この活動度は前震活動の約 3 倍に当る．

(2) 大森係数は，三陸沖において，S-P 時間が 20 秒未満の地震に対して 8.6 km/sec と求められた．

(3) 海底地震計観測点 2 点 (三陸沖 1 点，えりも海山南東方 1 点) と陸上 1 点，(北海道大学浦河微小地震観測所) との 3 点から微小地震の震源決定を行った．三点網の辺長は約 250 km である．

(4) 余震の分布は 2 つの群から構成されている．1 つは浦河沖のもの，他の 1 つは日本海溝の急傾斜面に沿うものである．

(5) 日本海溝の急傾斜面に沿う震央分布は地球物理的海洋と大陸の境界断層に対応する．

(6) 地球物理的海洋—大陸の境界断層は現在構造的に活動している．その活動は三陸沖における大地震活動の発生をもたらす主因の 1 つであると考えられる．

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* 現在，石油資源開発株式会社
** 現在，東海大学海洋学部