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9. *Regional Study on the Characteristic Seismicity of the World. Part IV. New Britain Island Region.*

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Summary

Character of seismicity in New Britain Island region was investigated by using the data of U.S. Coast and Geodetic Survey during the period from January 1963 to July 1969.

There were three parallel seismic zones running in an E-W direction. Earthquakes along the northernmost and southernmost zones were limited to shallow ones. Foci distributions in the central seismic zone along the profiles perpendicular to the trench showed a trench-island arc system. They were expressed by the same curve excepting one along a profile crossing the Bougainville Island. In the latter profile, foci were dispersed to such an extent that no focal zone could be recognized, and there occurred upper mantle events even just beneath the axis of the trench.

In the central zone, swarms and aftershocks were quite active. Large earthquakes have historically been active along this zone only. These features are common with the seismicity along an arc from New Hebrides to New Guinea. Their foci in New Britain Island region, however, were found to penetrate deeper. A special concern was given upon the existence of a northernmost shallow seismic zone running through the Bismarck Sea.

1. Introduction

In the part III,[1] characteristics of the seismicity in the New Hebrides Island region was studied with relation to those of the eastern seismic belts running through Fiji to the Tonga region.

In the present study, focus of the study will be shifted to the westward seismic region in and around New Britain Island (0°S~12°S, 140°E~160°E), where the topography itself has characteristic feature, that is the New Britain Island connects New Ireland and New Guinea

1) T. SANTÔ, "Regional Study on the Characteristic Seismicity of the World. Part III. New Hebrides Islands Region," *Bull. Earthq. Res. Inst.*, **48** (1970) 1.

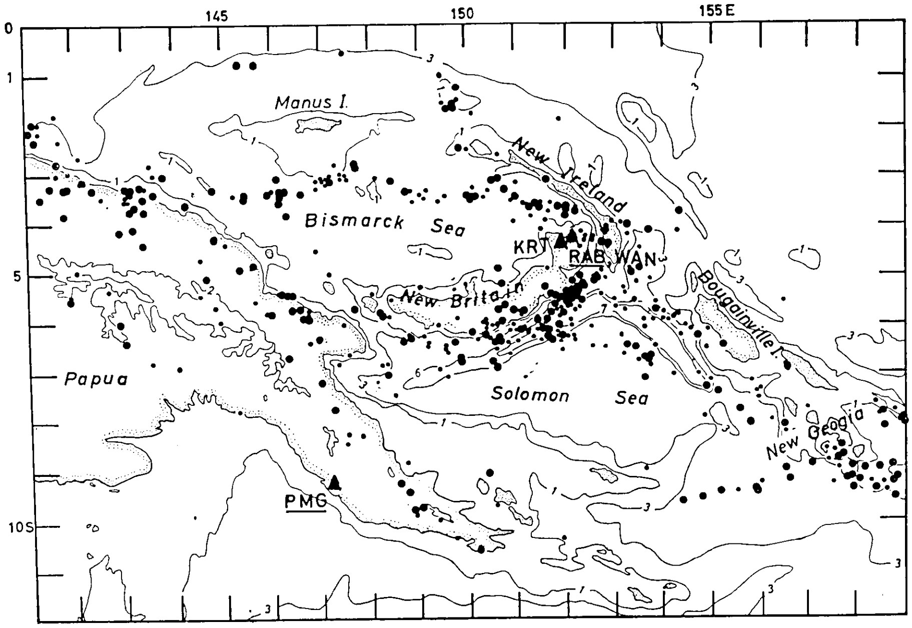
over the Sea as a bridge, and well developed trench in the Solomon Sea is sharply bent by this bridge. (See Fig. 1 for instance). Above situation suggests that some sort of special tectonic activity might have been or is still acting in the region in question, which may reflect more or less on the characteristics of the seismicity in this region. Quite recently, the seismicity in this region has been studied by D. Denham.[2] The ways of approach to discover the characteristics of the seismicity presented in the present paper, however, will be a little different from those in D. Denham's paper.

Seismological data were taken from the Preliminary Determination of Epicenter and/or Earthquake Data Report by U.S. Geodetic Survey (USCGS) during the period from January 1963 to July 1969. Distributions of the seismological stations, the data of which were always or sometimes (more than 50%) used by USCGS to determining the epicenters and depths of smaller events ($m \leqq 4.5$), were examined for an earlier

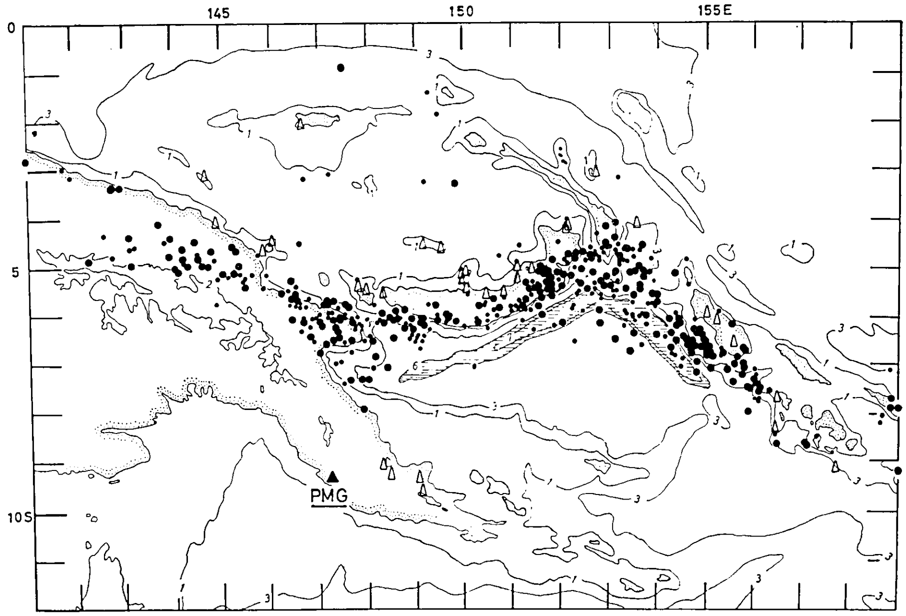
Table 1. List of the seismological stations the data of which were used by USCGS to determine the foci of small events ($m \leqq 4.5$). Underlined: WWSSN. A group: stations always used. B group: stations sometimes used.

Group	Station	Dist. (km)	Az. (deg.)
Earlier period (1964)			
A.	PMG (Port Moresby, New Guinea)	near	
A.	BRS (Brisbane, Astralia)	2,700	170
B.	RAB (Rabaul, New Britain)	near	
B.	CTA (Charters Tower, Australia)	1,900	210
B.	CAN (Cambera, Australia)	3,500	180
B.	COL (College, Alaska)	9,200	20
B.	BMO (Blue Mountains, Oregon)	10,500	45
Later period (1968)			
A.	PMG (Port Moresby, New Guinea)	near	
A.	KRT (Keravat, New Britain)	near	
A.	HNR (Honiara, Solomon I.)	near	
A.	RAB (Rabaul, New Britain)	near	
B.	WAN (Wanliss Street, New Britain)	near	
B.	WRA (Warramunda Array, Australia)	2,300	230
B.	SPA (South Pole, Antarctica)	8,300	180
B.	COL (College, Alaska)	9,200	20

2) D. DENHAM, "Distribution of Earthquakes in the New Guinea-Solomon Islands Region," *Jour. Geophys. Res.*, **74** (1969), 4290-4299.



(a)



(b)

Fig. 1-a). Epicentral distribution of the shallow earthquake ($d<50$ km). Epicenters of swarms and aftershocks are excluded. Numerals on the contour line mean the depth of the sea and/or heights of the land in km. Large circles: $m \geqq 5.0$. Filled triangles: locations of nearby stations. 1-b). Epicentral distribution of the upper mantle earthquakes with the depth range from 50 km to 100 km. Distribution of active volcanoes is also shown by open triangles.

period (1964) and a later one (1968) respectively. They are given in Table 1. Four nearby stations are plotted in Fig. 1-a). The total number of the stations always available for determining the foci of such small events were, on average, 5～7 in the earlier period and 8～12 in the later one respectively.

2. Epicenter distributions

Epicenters of shallow earthquakes (shallower than 50 km) and upper mantle earthquakes shallower than 100 km determined by USCGS distribute as are plotted in a) and b) of Fig. 1 respectively. As will be clarified later, there are many swarms and aftershocks in various small areas in the depth shallower than 100 km. Epicenters of the events which belong to these swarms and aftershocks are excluded in these figures.

The shallow seismic zone running north-westward from New Hebrides Islands through the Solomon Islands region is divided into three parallel branches around New Britain Island. The southernmost one branches off eastward near New Geogia. Though this branch is interrupted halfway, it looks likely to be connected to the continental zone along the east coast of New Guinea. The northernmost branch is crossing the Bismarck Sea parallel to the trend of New Ireland and Manus Island and reaches to New Guinea. This zone is named "The Bismarck Sea seismic lineation" by D. Denham[3] to which he paid special attention. The central branch, the most active one, runs between the New Britain Island and the southern trench with the most active area near its eastern end.

Epicenters for the deeper earthquakes with the depth range from 50 km to 100 km, on the other hand, distribute along one route only corresponding to the central branch for the shallower zones. As is shown later, this zone has many swarms and aftershocks. Great earthquakes ($M \geqq 7.0$) have also taken place along this zone only. From these points, the central branch is specially characterized from the other two. In Fig. 1-(b), locations of active volcanoes are also presented from the catalogue compiled by N. H. Fisher.[4] The seismic zone in this figure runs mainly between this volcanic belt and trench.

Epicentral distribution of the earthquakes deeper than 100 km are plotted in Fig. 2. Epicenters for the earthquakes deeper than 300 km are mostly found in the area A, B and C containing a trench. This fact is agreeable with the suggestion which was made before by the

3) *ibid.*, 2)

4) N. H. FISHER, *Catalogue of the Active Volcanoes of the World Including Solfatara Fields, Part V. Melanesia*, (Intern. Volc. Assoc., 1957.)

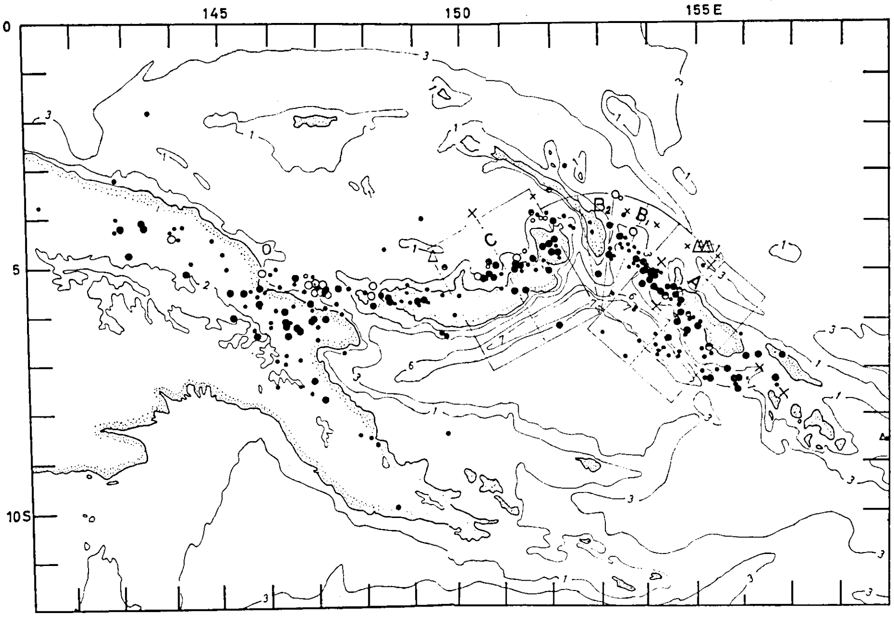


Fig. 2. Epicentral distribution of the upper mantle earthquakes of deeper than 100 km. Filled circles: $d<200$ km. Open circles: $200\text{ km}\leqq d<300$ km. Half filled circles: $300\text{ km}\leqq d<400$ km. Crosses: $400\text{ km}\leqq d<500$ km. Triangles: $d\geqq 500$ km. Four areas A, B_1, B_2 and C are those in which foci distributions along the profiles perpendicular to the trench are examined.

Table 2. List of deep earthquakes ($d\geqq 500$ km)

Date	Origin Time (G.M.T.)	Epicenter λ	Epicenter φ	Depth (km)	Mag. (m)
July 06, 1965	18 36 47.3	4.5S	155.1E	510	6.5
Dec. 11, 〃	00 01 28.3	4.4S	155.0E	510	5.1
Aug. 28, 1966	10 03 03.0	4.6S	155.2E	509	5.6
Feb. 16, 1967	08 22 44	4.7S	155.4E	489	4.5
Feb. 15, 1968	18 53 00.3	4.4S	155.1E	516	4.7
Apr. 25, 〃	17 42 08.3	4.5S	155.1E	476	4.7
Aug. 18, 1968	18 38 30.6	10.1S	159.9E	538	6.2
July 13, 1969	13 59 44.3	8.5S	158.9E	533	4.7

present author[5,6] that the formation of the trench has a close relation to the deep underthrusting of the lithosphere slab.

The number of earthquakes deeper than 500 km are comparatively scarce. They have a speciality in their distribution. As is also shown

5) T. SANTÔ, "Regional Study on the Characteristic Seismicity of the World. Part II. From Burma Down to Java", *Bull. Earthq. Res. Inst.*, **47** (1969), 1049-1061.

6) *ibid.*, 1)

in table 2, including two deep events with nearly 500 km depth, six events out of eight took place almost at the same spot at around 4.5°S, 155.1°E of epicenter and 510 km in depth. Similar phenomenon has been observed in Java.[7]

3. Foci distributions

Basing upon the location and shape of the trench, foci distributions

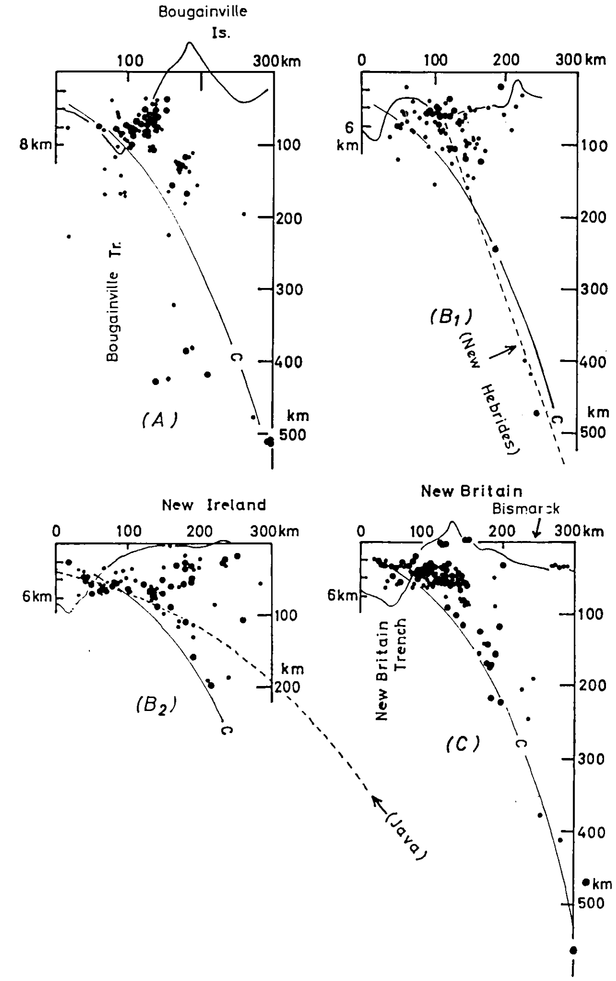


Fig. 3. Foci distributions along four profiles A, B_1, B_2 and C which are presented in Fig. 2. Topography along the center line (dashed line in Fig. 2) of each profile is also shown for comparison with the foci distribution. Dashed straight line in (B_1): dip of the foci plane near New Hebrides Island. Dashed curve in (B_2): a curve which was fit for the foci distribution along the arc from Burma to Java.

7) *ibid.*, 5)

along the profiles perpendicular to the trench are examined in four areas A, B_1, B_2 and C as were shown in Fig. 2. The results are presented in Fig. 3. As before,[8] a trial was made to find a curve which fits each foci distribution. The curve c presented in Fig. 3 was successfully found for the central and western areas B_1, B_2 and C, but was not applicable for the easternmost one A, in which foci dispersed so much that it was difficult to recognize any focal zone. In this area, upper mantle earthquakes occur even just beneath the axis of the trench, which is a characteristic of seismicity in this area. In the previous study on the seismicity of the New Hebrides region,[9] a steep dip of foci distribution was observed. This dip is drawn again on the foci distribution (B_1) in Fig. 3 for comparison. It is seen that the curve c approaches the same dip beyond the depth of about 200 km. The curve c is, however, quite different from the curve which was suitable to represent the foci distribution along the arc from Burma to Java[10] (see the map (B_2) in Fig. 3). There are no earthquakes deeper than 200 km along the profile B_2 in which New Ireland penetrates deeply from the north. This is another noticeable fact.

4. Swarms and aftershocks

As was the previous case in the New Hebrides Island region,[11] the seismic activity in the New Britain region is characterized by the high activity of swarms and/or aftershocks. They are presented in Figs. 4 and 5 being classified by the depth range in which they took place. Numberings of swarms (S) and aftershocks (A) were denoted chronologically. Activity of swarms and aftershocks in the New Britain Island region, however, reveals some characteristics different from those in the New Hebrides Islands region. That is, the scales (area, duration and total number of events) are smaller, and some of them take place even in the upper mantle (see Table 3). As for the areas, all of those in the New Britain Island region are less than 300 km^2 excepting one group A1 associated with the largest shock of $m=6.7$. A1 also has the largest duration of 17 days. In the New Hebrides Islands region, on the other hand, many swarms and aftershocks have a much longer duration. Regarding the total numbers of events in each S and A in the New Britain Island region, the greatest number is 23 for S3. Such a number is rather common in the New Hebrides Islands region.

Seismicity in the Solomon Islands region has not been dealt with in

8) *ibid.*, 5)
9) *ibid.*, 1)
10) *ibid.*, 5)
11) *ibid.*, 1)

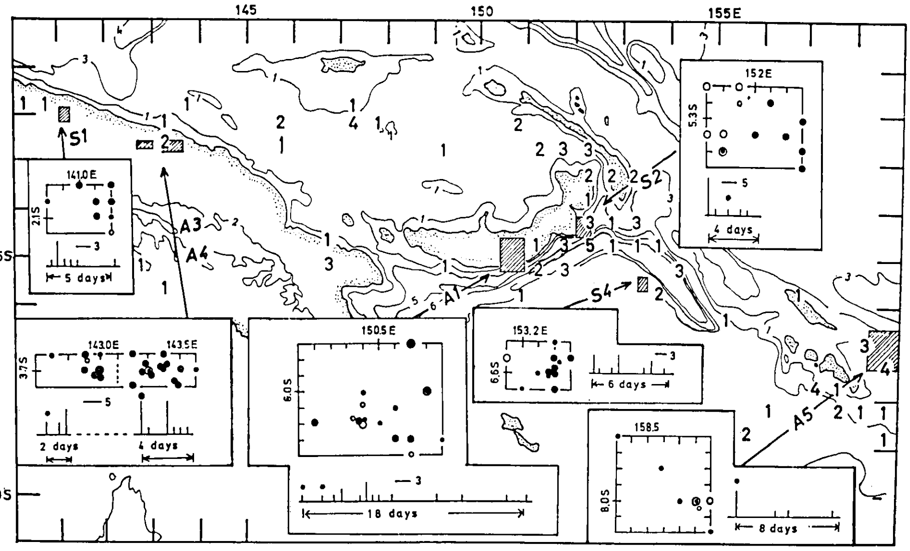


Fig. 4. Locations, epicentral distributions and activity in each 12 hours of swarms (S) and aftershocks (S) with the foci shallower than 50 km (filled circles). Double circles in the epicenter map mean the epicenters of the large shocks of $m \geqq 6.0$, and the times of their occurrences are given by small circles in frequency diagrams. Frequency distribution of shallow ($d<50$ km) inductive events in each $0.5° \times 0.5°$ mesh is also presented.

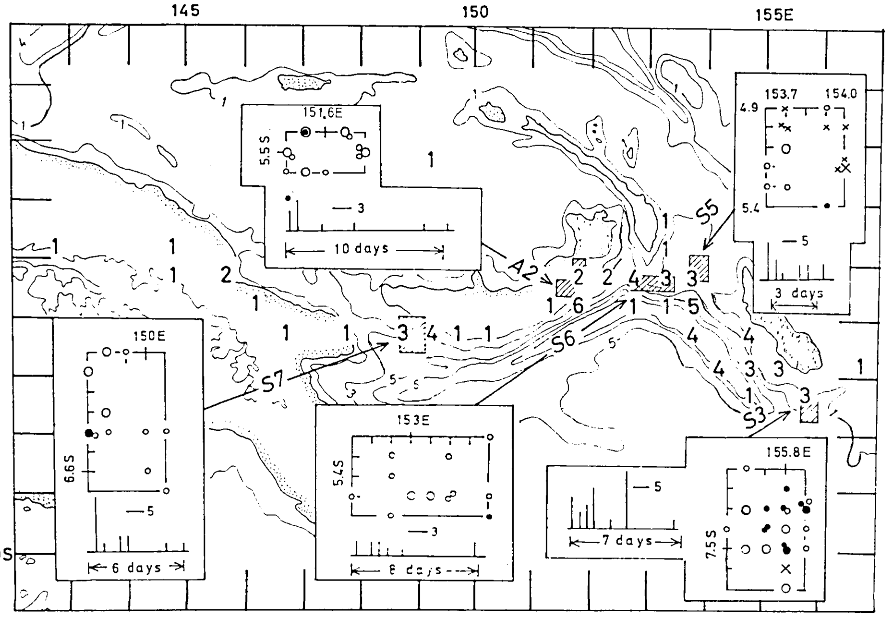


Fig. 5. The same figure as Fig. 4 for the swarms and aftershocke as well as frequency distribution of inductive events deeper than 50 km. Open circles: $50\,\text{km} \leqq d < 100\,\text{km}$. Crosses: $d \geqq 100\,\text{km}$.

the present series of study. Swarms and aftershocks in this region, therefore, will be additionally studied on this occasion. Two groups of swarms and aftershocks were found to take place from Jan. 63' to July '69 in this region. Their locations, epicentral distributions and activities are presented in Fig. 6 together with the distribution of their areas in New Hebrides Islands and the New Britain Island regions. In this map, we can see that the predominant activity of swarms and aftershocks are uniformly distributed along the total Island arc from New Hebrides to New Guinea. Correlation between the distributions of volcanoes and such groups of successive events are doubtful because there are some volcanic areas in which no groups of successive events have taken place,

Table 3. List of swarms (S) and aftershocks (A). (Jan. 1963—July 1969)

a) New Britain Island region (Length of arc: 2000 km)

No.	Date	Area	Duration	Freq.	Depth range	m (max)
		$\times 10^3 km^2$				
S1	June 11-16, 1964	0.4°×0.3° (0.12)	5 Days	9	33	5.0
S2	Mar. 1-Apr. 4, 1965	0.6 ×0.5 (0.30)	3	10	33- 63	6.0
S3	Apr. 9-14, 1967	0.4 ×0.6 (0.24)	7	23	40- 80	5.0
S4	Sept. 28-Oct. 3, 1967	0.4 ×0.3 (0.12)	5	12	33- 40	5.9
S5	Dec. 25-28, 1967	0.4 ×0.5 (0.20)	3	14	60-140	5.2
S6	Feb. 12-22, 1968	0.7 ×0.4 (0.28)	7	12	50- 80	5.0
S7	Sept. 16-22, 1968	0.4 ×0.7 (0.28)	6	14	55- 60	5.8
A1	Nov. 17-Dec. 4, 1964	0.9 ×0.7 (0.63)	17	16	40- 50	6.7
A2	Feb. 22-Mar. 4, 1966	0.4 ×0.2 (0.08)	10	11	55- 60	6.2
A3	Sept. 8-10, 1968	0.4 ×0.2 (0.08)	2	8	40- 50	6.0
A4	Sept. 27-Oct. 1, 1968	0.4 ×0.2 (0.08)	14	14	30- 45	6.2
A5	Jan. 5-13, 1969	0.1 ×0.5 (0.05)	8	7	30- 50	6.8

b) New Hebrides Islands region (Length of arc: 1400 km)

S1	Aug. 8-Oct. 10, 1966	0.9 ×2.5 (2.25)	32	102	33	6.4
S2	Aug. 13-Sept. 12, 1966	0.5 ×1.0 (0.50)	30	22	33	5.6
S3	Sept. 12-25, 1966	0.3 ×0.2 (0.06)	13	12	33	5.1
S4	Oct. 17-19, 1966	0.5 ×0.2 (0.10)	3	9	33, 55	5.5
S5	Jan. 1-Feb. 8, 1967	1.2 ×2.0 (2.40)	38	113	33	5.5
S6	Mar. 6-16, 1967	0.5 ×0.3 (0.15)	10	26	33	6.4
S7	Aug. 3-11, 1967	0.1 ×0.5 (0.05)	8	6	33, 50	4.7
S8	Nov. 19-Dec. 18, 1967	0.8 ×0.4 (0.32)	29	16	33	5.2
S9	Sept. 2-17, 1968	0.7 ×0.4 (0.28)	16	28	20- 35	5.3
A1	Jan. 10-16, 1965	0.5 ×0.2 (0.10)	6	6	50, 80	6.5
A2	May 20-24, 1965	0.5 ×0.8 (0.40)	4	9	20- 30	5.6
A3	Jan. 6-25, 1969	0.8 ×0.2 (0.16)	19	20	N	6.5

c) Solomon Islands region (Length of arc: 600 km)

No.	Date	Area	Duration	Freq.	Depth range	m (max)
S1	Sept. 24-26, 1963	0.2 ×0.9 (0.18)	2	12	33	5.1
S2	Nov. 14-15, 1965	0.3 ×0.3 (0.09)	1	8	20- 33	5.2
A1	May 21-29, 1963	0.4 ×0.5 (0.20)	8	12	33, 60	6.0
A2	June 15-20, 1966	0.6 ×1.3 (0.78)	5	51	33	6.2

d) South America (Length of arc: 6600 km)

A1	Oct. 17-29, 1966	0.5 ×1.2 (0.60)	12	23	33	7.5(M)
A2	Dec. 28, '66-Jan. 15 '67	0.4 ×0.5 (0.20)	18	22	33	6.9
A3	Feb. 9-12, 1967	0.25 ×0.8 (0.20)	3	10	60,100	6.3
A4	June 19-July 16, 1967	0.3 ×0.6 (0.18)	26	45	33	6.4

e) Sunda—Java (Length of arc: 4000 km)

A1	Apr. 12-22, 1967	0.4 ×0.5 (0.20)	10	7	30- 70	6.1

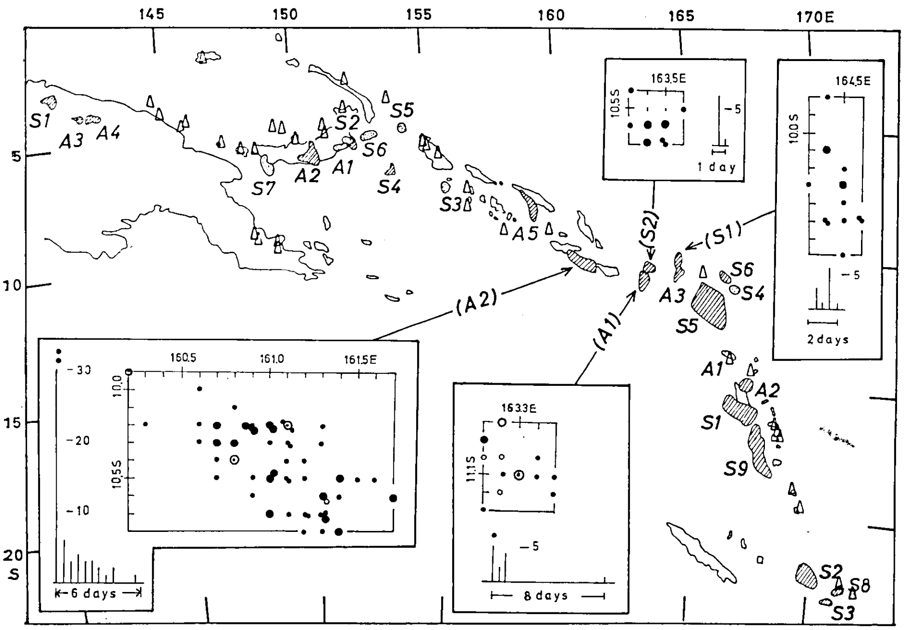


Fig. 6. Locations of swarms (S) and aftershocks (A) along a seismic zone from New Hebrides Islands to New Guinea. Epicentral distribution and activity of each swarm and aftershock in Solomon Islands region are added. Distribution of active volcanoes is also presented by open triangles.

Table 4. Examples of inductive shocks which are followed by one, two or sometimes three shocks being related with previous ones closely both in space (less than 50 km) and time (less than one day).

Date	Origin T. (G.M.T.)	Epicenter λ	φ	Depth (km)	Mag. (*m*)	Time difference ΔT	Focal difference Δλ Δφ Δd
1967 Jan. 20^d	00^h 19^m 16.0^s	3.7°S	151.9°E	33	5.2	00^h 03^m 37.2^s	0.2° 0.1° 10^{km}
	22 53.2	3.9S	152.0E	23	5.0		
Feb. 26	17 19 15.9	6.6S	154.9E	78	4.8	22 31 42.1	0.3 0.1 01
27	15 50 58	6.3S	154.8E	77	4.9		
Apr. 02	03 21 41	9.5S	155.9E	33	5.1	01 14 59	0.0 0.0 00
	04 36 40	9.5S	155.9E	33	5.0	03 55 04	0.2 0.1 00
	08 31 44	9.3S	156.0E	33	4.5		
23	01 11 19.5	5.4S	152.4E	37	4.8	17 09 37.5	0.1 0.5 12
	18 20 57	5.5S	151.9E	49	4.6		
May 04	13 32 42.3	6.0S	146.7E	39	5.1	02 49 18.6	0.0 0.0 10
	16 22 00.9	6.0S	146.7E	49	5.2	00 26 58.1	0.1 0.0 14
	16 48 59	6.1S	146.7E	63	4.9	21 13 38.2	0.3 0.2 45
05	14 02 37.2	5.8S	146.5E	18	5.0		
15	12 57 30	6.0S	146.7E	48	4.9	17 20 54.4	0.3 0.3 05
16	06 18 24.4	5.7S	146.4E	53	5.4		
June 15	15 12 08.9	6.4S	146.0E	126	4.4	14 15 47.1	0.1 0.4 02
16	05 27 56	6.3S	146.4E	128			
18	12 24 45	3.5S	149.0E	26		01 27 36	0.2 0.2 35
	13 52 21	3.3S	149.2E	61			
21	15 00 42	7.0S	154.8E	75		00 28 53	0.2 0.2 42
	29 35	7.2S	155.0E	33			
24	21 35 56	2.8S	147.3E	32	4.9	13 50 03	0.4 0.1 17
25	11 25 59	3.2S	147.2E	49	5.0		
Aug. 05	10 31 27.4	5.6S	152.0E	39	4.6	00 49 03.6	0.1 0.1 08
	11 20 31	5.7S	152.1E	27	4.6		
13	16 54 45.7	4.3S	152.5E	25	4.5	03 56 08.4	0.1 0.2 09
	20 50 54.1	4.2S	152.3E	34	4.7	01 20 18.7	0.2 0.1 04
	22 11 12.8	4.4S	152.4E	30	5.3	00 03 56.8	0.0 0.1 01
	22 15 09.6	4.4S	152.5E	29	4.4	01 37 29.4	0.2 0.2 26
	23 52 39	4.6S	152.3E	3	5.4		
Apr. 18	18 12 59	6.9S	156.6E	55	4.7	02 18 33.7	0.0 0.0 14
	20 31 32.7	6.9S	156.6E	39	5.3		

(to be continued)

Table 4. (continued)

Date	Origin T. (G.M.T.)	Epicenter λ	φ	Depth (km)	Mag. (m)	Time difference ΔT	Focal difference Δλ Δφ Δd
May 13^d	01^h 16^m 10.5^s	3.9°S	151.6°E	33	4.8	19^h 53^m 33.^{s}5	0.3° 0.1° 00^{km}
	21 09 44	3.6S	151.5E	33			
June. 02	08 18 36.2	8.1S	158.5E	35	5.4	03 03 42.8	0.3 0.0 02
	11 22 19	7.8S	158.5E	33	4.5		
July 04	10 01 45	6.8S	154.3E	98	4.8	00 14 06	0.1 0.1 11
	15 51	6.7S	154.2E	109	4.7		
10	19 57 58	5.6S	151.9E	55	5.2	11 47 01	0.3 0.4 00
11	07 44 59	5.3S	151.5E	55		23 16 51.0	0.3 0.4 05
12	07 01 50.0	5.6S	151.9E	50			
21	05 52 10.4	3.2S	150.7E	5	5.3	00 17 31.4	0.0 0.2 28
	06 09 41.8	3.2S	150.5E	33	5.4		
Aug. 03	21 15 53.7	6.2S	147.1E	114	5.1	21 08 22.9	0.1 0.5 33
04	18 24 16.6	6.1S	147.6E	81	4.9		
28	15 28 05.1	5.3S	145.5E	80	4.5	22 58 17.8	0.1 0.0 06
29	14 26 22.9	5.4S	145.5E	86	5.8		
Sept. 02	07 30 55.6	5.2S	152.8E	39	4.8	04 24 26.8	0.1 0.3 24
	11 55 22.4	5.1S	152.5E	63			
Oct. 10	15 05 37.1	6.0S	148.6E	72	5.0	00 00 14.6	0.0 0.0 02
	15 05 51.7	6.0S	148.6E	70G	5.1	01 08 46.5	0.2 0.0 04
	16 14 38.2	6.2S	148.6E	74	5.0		
23	21 04 41.3	3.3S	143.3E	12	6.4	02 42 03.1	0.4 0.2 32
	23 46 44.4	2.9S	143.5E	44	4.9		
Nov. 04	12 30 39.7	5.0S	153.3E	79	4.9	14 40 32.8	0.2 0.1 40
05	03 11 12.5	5.2S	153.4E	39	4.9		
Dec. 09	09 45 26.2	5.5S	151.6E	54	5.1	02 12 24.0	0.3 0.0 35
	11 57 50.2	5.2S	151.6E	89		14 09 27.5	0.3 0.2 18
10	02 07 17.7	5.5S	151.8E	71			
Sept. 12	21 49 47.6	5.5S	151.7E	50	5.2	00 40 51.4	0.0 0.4 23
	22 30 39	5.5S	152.1E	27		03 59 56.7	0.2 0.1 07
13	02 30 35.7	5.7S	152.2E	34	4.6		
Oct. 04	17 21 20.7	5.7S	153.9E	52		05 53 12.3	0.1 0.1 16
	23 14 33	5.8S	153.8E	76		04 53 07.1	0.0 0.2 01
05	04 07 41.9	5.8S	154.0E	75	4.6		

(to be continued)

Table 4. (continued)

Date	Origin T. (G.M.T.)	Epicenter λ φ	Depth (km)	Mag. (m)	Time difference ΔT	Focal difference Δλ Δφ Δd
07[d] 08	19[h] 11[m] 02[s] 13 13 46	6.0°S 154.1°E 5.8S 153.9E	33 54		18[h] 02[m] 44[s]	0.2° 0.2° 21[km]
31	13 04 00.6 36 03	6.0S 154.0E 6.0S 154.2E	33 39		00 32 02.4	0.0 0.2 06
Nov. 13 14	08 55 05 05 28 36.9	5.4S 146.8E 5.4S 147.1E	186 201	 5.8	20 33 31.9	0.0 0.3 15
17	09 19 21.0 24.2	6.3S 154.9E 6.3S 154.8E	60 91	5.1 5.0	00 00 03.2	0.0 0.1 31
Dec. 11 12	16 18 20.3 04 24 42.3 35 28 11 08 11.5	5.2S 152.9E 5.2S 152.8E 5.1S 152.4E 5.2S 152.9E	54 54 58 52	5.1 4.9 4.8 4.4	12 06 22.0 00 10 45.7 06 32 43.5	0.0 0.1 00 0.1 0.4 04 0.1 0.5 06
18 19	12 27 38.4 02 58 27	6.1S 153.5E 6.0S 153.5E	61 53		14 30 48.6	0.1 0.0 08
25 26	19 49 52.3 05 24 33	5.0S 153.7E 5.0S 153.9E	103 111	4.5 4.9	09 34 40.7	0.0 0.2 08
1968 Jan. 09	14 25 15.6 49 01	6.7S 153.7E 6.8S 153.7E	38 21	5.0 5.4	00 23 45.4	0.1 0.0 17
19	06 04 38.2 08 37 14 09 00 00.5	9.4S 158.4E 9.3S 158.6E 9.7S 158.9E	33 33 23	6.0 4.9 5.1	02 32 37.8 00 32 46.5	0.1 0.2 00 0.4 0.3 10
21	00 28 12.5 11 25 05.7	5.2S 154.0E 5.2S 154.3E	113 95	5.1 5.2	10 56 53.2	0.0 0.3 18
29	10 16 16.5 16 25 05.7	5.6S 153.9E 5.2S 154.2E	70 111	5.3 5.0	06 08 49.2	0.4 0.3 41
Feb. 01	03 48 28.3 10 12 32.4	5.2S 154.0E 5.2S 154.1E	121 112		06 24 04.1	0.0 0.1 09
Mar. 07	13 22 16.6 14.41 02.5	5.9S 151.1E 5.9S 151.1E	39 63	 4.8	01 18 45.9	0.0 0.0 24
Apr. 01	00 16 30.0 03 20 42.0	6.2S 151.1E 6.2S 151.2E	27 17	4.9 4.9	03 04 12.0	0.0 0.0 10

and vice versa. The data of S and A in the Solomon Islands region are given in Table 3 together with those for other seismic regions which have already been studied by the present author. High activity of swarm and aftershocks in the regions (a), (b) and (c) which are now of interest is recognized by comparison with length of arc.

Excepting these groups of successive events, there are many inductive shocks which are followed by one, two or sometimes more than three shocks which are closely related to the previous one both in time and space. In Table 4, data of such inductive shocks in 1967 and 1968 are given as examples. Frequency distribution of these inductive shocks in each $0.5° \times 0.5°$ mesh are shown in Fig. 4 ($d<50$ km) and Fig. 5 ($d \geqq 50$ km) respectively. Diagram (a) in Fig. 7 is the presentation of the activity of these inductive shocks as a function of depth including the same events in swarms and aftershocks (hatched column). Here in the New Britain Island region, around 20% of the shocks shallower than 125 km are occupied by the inductive events. In the New Hebrides Islands region ((b) of the figure), on the other hand, the inductive events are predominant in depths shallower than 50 km, in which the probability of their occurrence is about 0.3.

S. J. Duda[12] compiled the data of large earthquakes ($M \geqq 7.0$) which had taken place in the Circum-Pacific belt from 1897 to 1964, from which the epicenters in the regions from New Hebrides Islands to New Guinea can be plotted, the result of which is presented in Fig. 8. One of the facts to be noticed is that the large events deeper than 100 km ((B) in Fig. 8) are limited in New Guinea, New Hebrides Island, and between the region of New Ireland and Bougainville. Another thing is that no great earthquakes have taken place since 1897 along the northern-

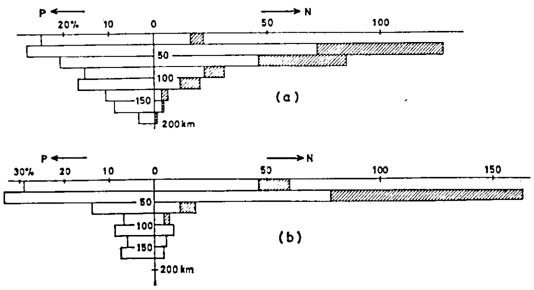


Fig. 7. Activities of inductive events in various depth ranges in New Britain Islands region (a) and New Hebrides Island region (b). N: frequency. *P*: percentage of N for total number of earthquakes. Hatched column means the frequency of inductive events in swarms and in aftershocks.

12) S. J. DUDA, "Secular Seismic Energy Released in the Circum-Pacific Belt", *Tectonophysics*, **2** (1965), 409–452.

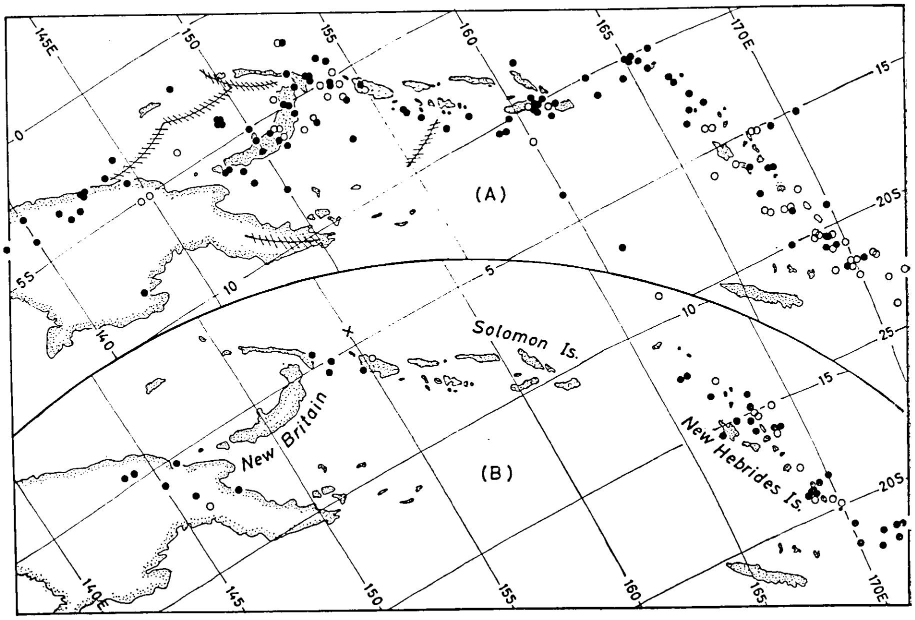


Fig. 8. Distribution of large ($M \geqq 7.0$) earthquakes in the region from New Hebrides Islands to New Guinea. Epicenters are plotted based on the data compiled by S. J. Duda. (A) Filled circles: $d < 50$ km. Open circles: 50 km $\leqq d < 100$ km. (B). Filled circles: 100 km $\leqq d < 200$ km. Open circles: 200 km $\leqq d < 300$ km. Crosses: $d \geqq 300$ km. In (A), two shallow seismic zones in New Britain region are schematically shown by hatches.

most or southernmost zones which are hatched in (A). As was mentioned before, the central zone crossing the New Britain Island is without doubt the continuation of a long seismic belt comming from New Hebrides Islands by way of Solomon Islands from many evidences. Seismicities along the other two zones, on the other hand, have quite different characters, having neither swarms nor aftershocks. Large earthquakes have never taken place along these zones. As for the southernmost shallow zone, it looks like an oceanic ridge system though this suggestion is made only from a topographical viewpoint. The northernmost shallow zone running parallel to the central one, is quite peculiar one. It is common that shallow epicenters are dispersed deeply into the "land side" around the seismic zone of trench-island arc system, but in the present case, they form an distinct zone being so clearly apart from the main system. Why does the stress so clearly concentrate in the crust along an arc? What makes the capacity of storing the energy so small along this line? Hitherto, two types of mid-oceanic seismic zones are suggested along which shallow earthquakes are sharply concentrated. One is an oceanic ridge type and the other the transform fault type.[13] Among these two types, the first one is difficult to be accepted for our shallow zone in question from the topographical viewpoint. On the other hand, D. Denham[14] observed that the foci dipped gently to the south under western New Guinea. This is a profitable evidence for accepting the second type. Because, if the Pacific 'plate' is moving eastward in Bismarck Sea with a boundary just along the shallow zone in question and gradually turning southward in the northern part off the coast of New Guinea, and underthrusting beneath New Guinea, Denham's result becomes quite a reasonable one. There still remains a difficulty, however, in accepting this second type. That is, if it belongs to the second type, that is if the shallow earthquakes along this zone are generating by the shear force acting along the zone due to the relative movement of the 'plates' in opposite directions, epicenters must be aligned in a much smoother curve having a gentle convex to the north in our case. This is not the case. Our zone looks like being composed from three short arcs with convexes to the south. D. Denham[15] suggested it to be either an embryo mid-ocean ridge, an embryo trench, or a simple fault. Anyhow, study on the mechanism of earthquakes along this zone is necessary for giving any reliable suggestion.

5. Conclusions

Characteristics of the seismicity in the New Britain Island region which were revealed in the present paper may be summarized as follows.

1) Three parallel seismic zones are running with E-W direction. Deeper shocks are limited only along the central one which passes through New Britain Island. (Fig. 1).

2) In the area in and near the New Britain Island, foci distributions along the profiles perpendicular to the trench are expressed by the same curve. Trend of this curve, in its portion deeper than 200 km, significantly fit the dip of focal zone which was observed in the New Hebrides Islands region. This trend has, however, a much steeper dip than that which represents the foci distribution along the Islands arc from Burma to Java. (Fig. 3).

3) Systematic distribution of foci distribution of trench-island arc system is utterly destroyed along a profile containing Bougainville. (Fig. 3).

4) Small-scaled swarms and aftershocks along the central seismic zone are quite active (Fig. 4, 5). This feature is a general one along

13) E. BULLARD, "The Origin of the Ocean," *Scientific American*, **221** (1959), 66-75.
14) *ibid.*, 2)
15) *ibid.*, 2)

the whole Island arc from New Hebrides Islands to New Guinea (Fig. 6). Those in the New Britain Island region, however, have a special character that the activity penetrates into as deep as around 200 km. Including other inductive events, about 20% of the shocks shallower than 125 km, for instance, are occupied by the inductive events (Fig. 7).

5) No swarms and aftershocks have been reported along the northernmost and southernmost shallow seismic zone. Since 1897, large earthquakes ($M \geqq 7.0$) have taken place along the central zone only. (Fig. 8).

6) Six deep earthquakes out of eight have taken place at almost the same spot centering at 4.5°S, 155.1°E as epicenter and 500 km in depth (Table 2).

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9. 世界の特殊な地震活動地区について
(その四) ニューブリテン諸島周辺

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1963 年 1 月から 1969 年 7 月までの 7 年 7 ヶ月の期間中にニューブリテン諸島周辺で起こつた地震について，今まで同様，USCGS の資料をそのまま用いて，その活動の特徴を調べた．

第 1 に注目されたことは，するどく急に曲がつた海溝ぞいにニューブリテン島を通つてニューギニアに向う島弧系の地震帯をはさんで，1 本は北のビスマルク海底を西に，他の 1 本はニュージアジー島からやはり西に分れてニューギニアの南端に向う 2 本の平行な浅発地震帯があることである (第 1 図 a)．これらの海底地震帯が，トランスフォーム型断層による地震帯か，海嶺性のものかは，今のところきめ手に欠けているが，この辺の意味あり気な地形と考え合わせると，たいへん興味深い．これら 2 本の浅発地震帯の中では，過去においても大きな地震もなければ (第 8 図)，誘発性の地震も余りない (第 4 図)．

ニューブリテン海溝に直角な切口での震源分布は，ブーゲンビル島をよぎる切口でのそれを除いては，いずれも同一の曲線で示されるおち込み方をしている (第 3 図)．この曲線は，深さ 200 km 以上の部分では，(その三) で調べたニューヘブリデス諸島近辺のそれと殆んど同じ約 70 度の深い傾斜をしていることからみて，ニューブリテンからニューヘブリデスにかけての震源面のおちこみ方は，総じて他の島弧のそれよりも例外的に傾斜が急だとみてよい．

小規模な群震や余震がほうぼうで起こる傾向を持つのも，ここに限らず，ニューヘブリデス諸島に至る長い島弧全体に亘つていえる特徴の 1 つと言つてよい (第 6 図)．特にニューブリテン諸島周辺のそれは，200 km の深さにまでこのような誘発性地震の活動がしみこんでいるのが目につく (第 7 図)．全体として，これらの誘発性地震の起こり易い地域は，火山帯とは関係がなさそうである (第 6 図)．

深発地震については，8 つの地震のうち 6 のつまでが，4.5°S, 155.1°E 深さ 500 km という，殆んど同じ震源で起こつていることが注目される (第 2 表)．