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24. *Dispersion of Love Waves along Various Paths to Japan (Part 1).*

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Abstract

The dispersion characters of Love waves along various paths to Japan were investigated by using the seismograms recorded by Columbia-type ultra-long period seismographs at Tsukuba Station, Japan. For the oceanic paths, the dispersion characters were classified into five groups, from I to V. In the central and northern Pacific region, Love waves show the purely and nearly oceanic dispersion character of I and II respectively (Fig. 1, 2). When travelling path comes into the Micronesia region, however, they show a remarkable shift to a continental one with the shift of the path to the west (Fig. 3, 4). This phenomenon is quite similar to that observed in Rayleigh wave dispersion.

Two unexpected results were obtained. That is, 1) clearly dispersive Love wave trains hardly transmitted along the paths which cross the Mariana Sea (Fig. 6), and 2) the shocks which took place in the continent west of Japan did not transmit long-period dispersive trains of Rayleigh waves (Fig. 8).

The dispersion character of Love waves along the oceanic path from Sumatra Island region to Japan was as continental as those along the path from Outer Mongolia or the Sinkiang region to Japan (Fig. 9).

The dispersive characters along the continental paths were classified into five groups (from VII to XI). An interesting result was that the maximum group velocity of Love waves decreases remarkably when Love waves pass in or around the Tibet region (Fig. 12). Such a dispersive character may be explained by the special conditions not only in the earth's crust but also in the upper mantle along this high mountain region.

1. Introduction

In the previous papers[1),2),3)] the author dealt with the dispersion of Rayleigh waves along the various oceanic paths to Japan. Now the dispersion of Love waves will be investigated in the present paper. The seismograms used were, as those used in the previous papers, all obtained at Tsukuba Station by Columbia-type ultra-long period seismographs. In the present paper, only a general description will be given.

2. Conditions for observing the dispersive trains of Love wave

Rayleigh waves should appear on a vertical component record independent both of the azimuth of an epicenter to an observation station and of the crustal structure along the path. Therefore, in the case of Rayleigh waves, if the vertical component seismograph has a suitable period response character for the arriving energy of the surface waves, dispersion data can always be obtained for a considerable period range from the record. In the case of Love waves, however, there are some disadvantageous conditions for observing the dispersive wave train long enough to obtain dispersion data over a period of sufficiently wide range.

These disadvantageous conditions are: (1) When the crustal structure along the travelling path is a purely oceanic one. In this case, Love waves are almost non dispersive for the periods approximately longer than 25 seconds. Therefore, Love waves of these periods reach the observation station approximately at the same time. As a result, the wave form of the Love waves becomes like a pulse.—(2) When the direction of the epicenter from the observation station makes an angle around 45° with the direction of motion of the two perpendicularly installed horizontal seismographs, and further, when the epicentral distance is small. In this case, if the first condition is fulfilled, Rayleigh waves appear not only in the record of the vertical component but in the records of the two horizontal ones. Therefore, if the epicentral distance is

1) T. A. SANTÔ, "Observation of Surface Waves by a Columbia-type Seismograph Installed at Tsukuba Station, Japan (Part 1)—Rayleigh wave dispersions across the Oceanic Basin—," *Bull. Earthq. Res. Inst.*, **38** (1960), 219.

2) T. A. SANTÔ, "Rayleigh Wave Dispersions across the Oceanic Basin around Japan (Part II)," *Bull. Earthq. Res. Inst.*, **38** (1960), 385.

3) T. A. SANTÔ, "Rayleigh Wave Dispersions across the Oceanic Basin around Japan (Part III)—On the Crust of the South-Western Pacific Ocean—," *Bull. Earthq. Res. Inst.*, **39** (1961), 1.

small, the wave train of Love waves will be disturbed by the arrival of Rayleigh waves. For this reason, we cannot measure the group velocities of Love waves for such periods which reach the station later than the arrival of Rayleigh waves.

3. Dispersive features of Love waves along oceanic paths around Japan

On account of the restrictions given in the previous section and of some undiscovered reasons which will be mentioned in a later section, the amounts of the observed dispersion data of Love waves along oceanic paths around Japan were much less than those of Rayleigh waves. The data of the earthquakes for which Love waves dispersion data could be obtained for a sufficiently wide period range are given in Tables 1 (southern oceanic paths), 2 (northern oceanic paths), 3 (continental paths), and 4 (mixed paths).

At first, on account of the condition (1) given in the previous section, the wave form of Love waves along purely oceanic paths, for instance,

Table 1.

No.	District	Epicenter	Origin Time (G. M. T.)	Date	h (in km)	△ (in km)
			h m s			
13	Tonga Is.	24 S 176.5W	13 15 49	Sept. 14, 59	113	8100
263	〃	28.4 S 176.0W	23 21 42.5	Mar. 12, 61	28	8500
227	〃	24.2 S 176.1W	14 12 21.1	Nov. 23, 60		8130
14	〃	17 S 173 W	21 09 09	Aug. 06, 58		7670
147	Solomon Is.	10 S 161.5E	07 56 15	Apr. 04, 60		5600
44	〃	10.5 S 162.5E	09 46 30	Nov. 17, 58		5770
269	〃	10.7 S 161.6E	01 26 26.1	Mar. 05, 61	99	5660
221	〃	10.3 S 161.2E	08 22 00.9	Oct. 22, 60	90	5570
50	New Hebrides Is.	13 S 167 E	00 06 00	May 19, 58		6230
60	〃	16 S 172.5E	17 55 29	July 03, 59		6650
61	〃	18.5 S 169 E	04 51 30	〃 11, 59		6720
9	Kermadec Is.	29 S 177 W	22 23 53	Sept. 14, 59		8500
10	〃	29 S 176.5W	15 31 57	〃 29, 59		8510
239	Loyality Is.	21.3 S 169.5E	19 43 01.4	Jan. 28, 61		7070
119	Fiji Is.	20 S 174.5E	16 14 47	Nov. 23, 59		7180
112	South Pacific Oc.	54 S 136 W	16 20 34	〃 22, 59		12780
138	Norfolk Is.	28 S 167.5E	11 12 31	May 20, 60		6600
218	Nicobar Is.	7.9N 92.9E	20 40 06.6	Oct. 08, 60		5710
28	Sumatra Is.	2 N 98.5E	03 21 52	〃 12, 59		8850

Table 2.

No.	District	Epicenter	Origin Time (G. M. T.) h m s	Date	h (in km)	Δ (in km)
265	Off west coast of Mexico	19.2N 107.3W	08 03 43.9	Mar. 13, 61	49	10630
59	Northern Calif.	41 N 125.5W	01 23 09	July 24, 59		7770
141	Off coast of Calif.	41 N 125 W	07 17 48	June 06, 60		7820
240	Central Alaska	65.2N 149.9W	12 12 39.7	Jan. 30, 61	34	5480
241	Kodiak I. Alaska	55.8N 153.9W	00 48 36.5	〃 31, 61	26	5310
149	Alaska Peninsula	52 N 161.5W	16 07 12	May 13, 60		4830
229	Fox Is., Aleutian	52.7N 168.0W	22 10 06.4	Nov. 06, 60	42	4390
46	〃 〃	52.5N 170 W	13 08 05	July 24, 58		4275
88	And. Is., 〃	51.5N 176.5W	09 08 35	Aug. 17, 58		3830

Table 3.

No.	District	Epicenter	Origin Time (G. M. T.) h m s	Date	h (in km)	Δ (in km)
36	Western Sinkiang	51 N 99 E	10 55 31	Apr. 10, 58		3620
39	〃	30.5N 78.5E	04 48 15	June 24, 58		5380
37	Outer Mongolia	46 N 98 E	04 08 56	Apr. 13, 58		3620
38	〃	45 N 98 E	12 27 06	Feb. 24, 58		3550
55	Lake Baikal	52 N 106.5E	17 03 10	Aug. 29, 59		3060
70	Western Sinkiang	44.5N 81 E	05 46 26	Dec. 21, 58		4980
135	Albania—Greece	40 N 20 E	05 10 05	May 26, 60		9560
1	Northern Tibet	36 N 89 E	20 56 12	Nov. 10, 59		4550
26	Burma—Pakistan	23.5N 94.5E	10 11 27	Mar. 22, 58		4500
191	India	26.9N 90.3E	10 42 44.6	July 29, 66	11	4800
202	Western China	32.4N 95.8E	05 29 32.7	Sept. 28, 60	25	4060
222	Western Pakistan	25.5N 67.6E	01 25 35.5	Oct. 29, 60	23	6860
156	Ethiopia	9.8N 40.0E	04 51 10.4	June 02, 61	41	10250
157	〃	10.8N 40.1E	20 32 24.0	〃 14, 61	56	10160
283	Southern Iran	27.8N 56.7E	18 13 40.7	Feb. 13, 61	109	7650
286	Outer Mongolia	41.8N 104.5E	10 45 39.1	Apr. 29, 61	25	3120
287	Sinkiang-China	40.1N 77.8E	16 34 39.1	〃 13, 61	19	5330
279	Sinkiang Province	39.6N 77.7E	15 18 22.8	Feb. 03, 61	21	5370
277	Northern Burma	24.7N 95.3E	08 51 48.9	〃 04, 61	162	4460
161	Ethiopia	9.8N 39.8E	15 23 11.6	June 03, 61	60	10280
164	Iran	28.3N 54.9E	00 24 30.8	〃 13, 61	62	7800
151	Gulf of Aden	11.5N 44.5E	03 21 26.5	〃 20, 61	30	9710
176	Burma-China	24.3N 39.3E	23 29 21.1	〃 11, 61	38	4170

Table 4.

No.	District	Epicenter	Origin Time (G. M. T.)	Date	h (in km)	△ (in km)
			h m s			
92	Costa Rica	8 N 85 W	09 11 18	June 06, 58		13110
199	Columbia-Panama	6.9N 77.5W	19 01 25.3	Sept. 19, 60		13820
212	Indian Ocean	13.4S 65.8E	06 58 56.4	Aug. 15, 60	15	9510
213	〃	13.5S 67.0E	14 33 38.4	〃	25	9410
87	South Indian Oc.	40 S 45.5E	06 13 50	July 25, 58		12650
33	Antarctic Ocean	57 S 147 E	09 29 43	Oct. 01, 58		10360
62	Indian Ocean	36 S 78 E	12 01 36	July 11, 59		10256
76	Atlantic Ocean	9 N 39.5W	07 20 02	Sept. 25, 58		15000

those originating from shocks in the Easter Is. region (220) or Samoa Is. (270) showed only one or two undulations. (See the upper three examples in Fig. 1).

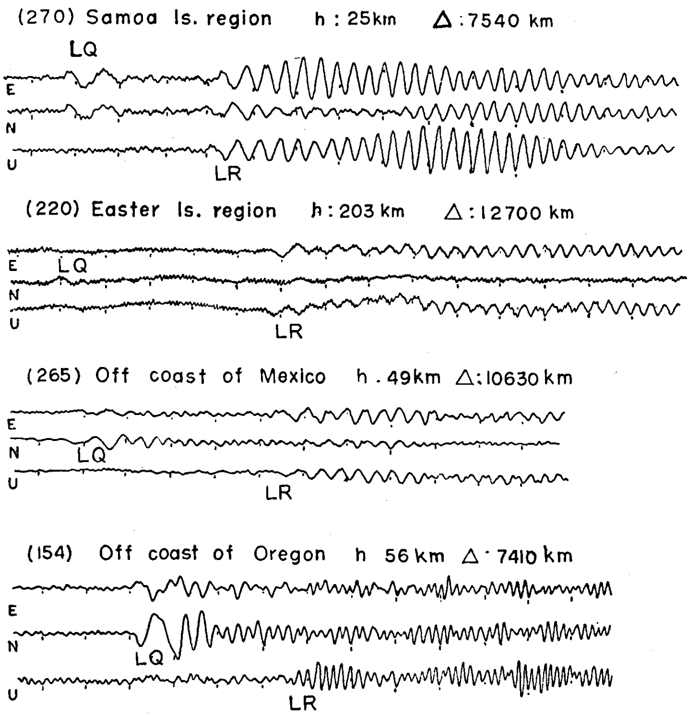

Fig. 1. Examples of seismograms which show a clear dispersive wave train of Rayleigh waves (LR) and a non or poorly dispersive wave train of Love Waves (LQ). The dots on every component represent minute marks.

It means, on the contrary, that the crustal structure along the paths of these shocks is purely oceanic. This result identifies well with the result obtained from the previous investigation into Rayleigh waves dispersions.

The wave form of Love waves caused by the shock which took place off the west coast of Mexico (265) or Oregon (154) showed a short duration (lower two examples in Fig. 1), and the dispersion data for these paths showed little deviation from the purely oceanic one (Fig. 2). The writer named this kind of dispersion character as number (II) in order to classify the dispersion characters of Love waves along the oceanic paths just as was done previously in the case of Rayleigh waves.

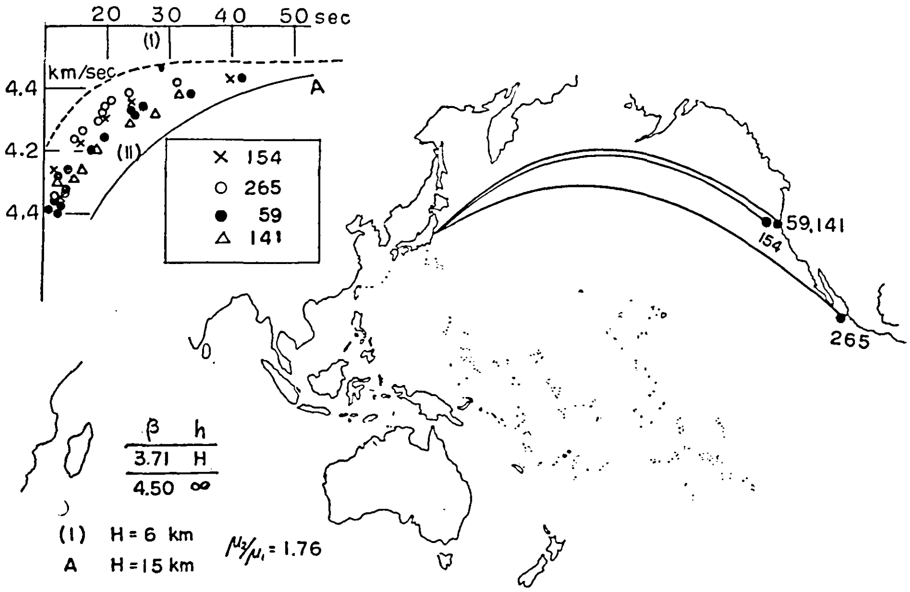

Fig. 2. Dispersion data of Love waves with the characteristic number II, and the corresponding travelling paths. The dispersion data belong to the characteristic number II lie between the two theoretical curves I and A which had been obtained by J. Oliver et. al.[4] by such crustal models as are represented in the figure.

Among the dispersion data in Fig. 2, those originating from two shocks (59) and (141) show a little more continental feature than the remaining two resulting from the shocks (265) and (154). This may have resulted from the fact that the paths due to the former two shocks

4) J. OLIVER, F. PRESS and M. EWING, "Crustal Structure and Surface Wave Dispersion IV: Atlantic and Pacific Ocean Basin," *Bull. Geol. Soc. Amer.*, **66** (1955), 913.

cover the parts much more continental near Aleutian Islands than in the latter two shocks.

For the paths across the Central Pacific Ocean, the writer could not observe any clear dispersive wave train of Love waves. This may be due to the purely oceanic crustal structure of the region. When the path enters into the western side of the "Andesite-line", however,

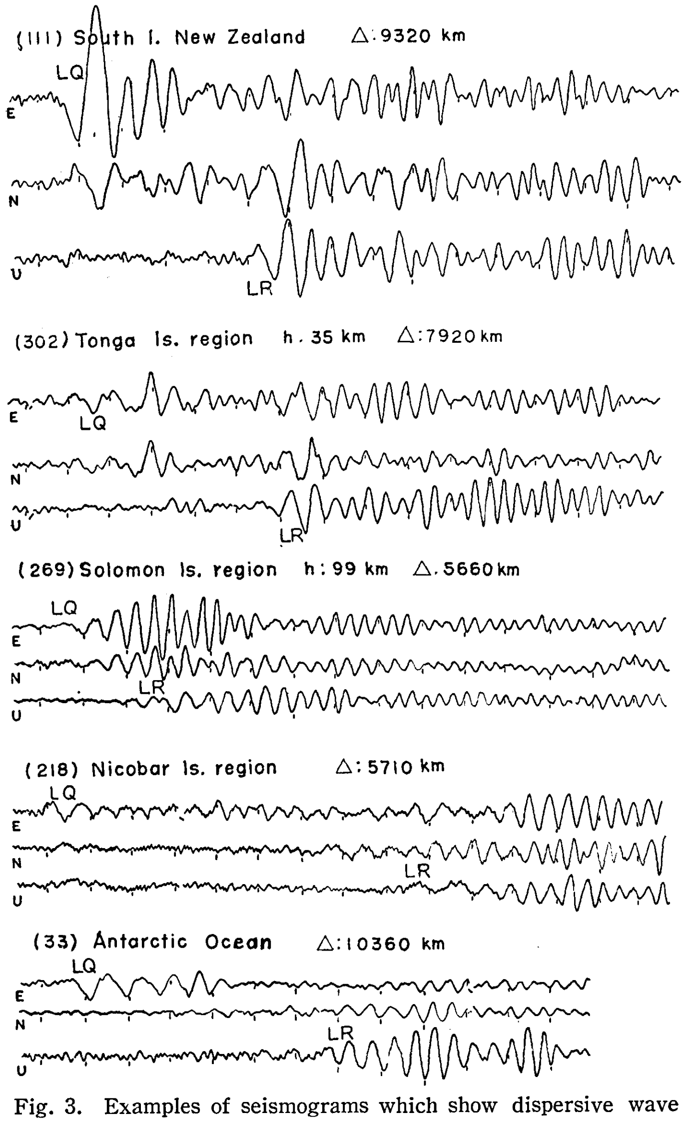

Fig. 3. Examples of seismograms which show dispersive wave trains of both Love and Rayleigh waves.

clear dispersive wave trains of Love waves begin to appear in the seismograms. The examples of the wave forms are shown in Fig. 3 by those caused by the shocks in New Zealand (111), the Tongas (302) and the Solomons (269).

The dispersive characteristic for these paths are represented in Fig. 4. These dispersion characteristics can be classified into three

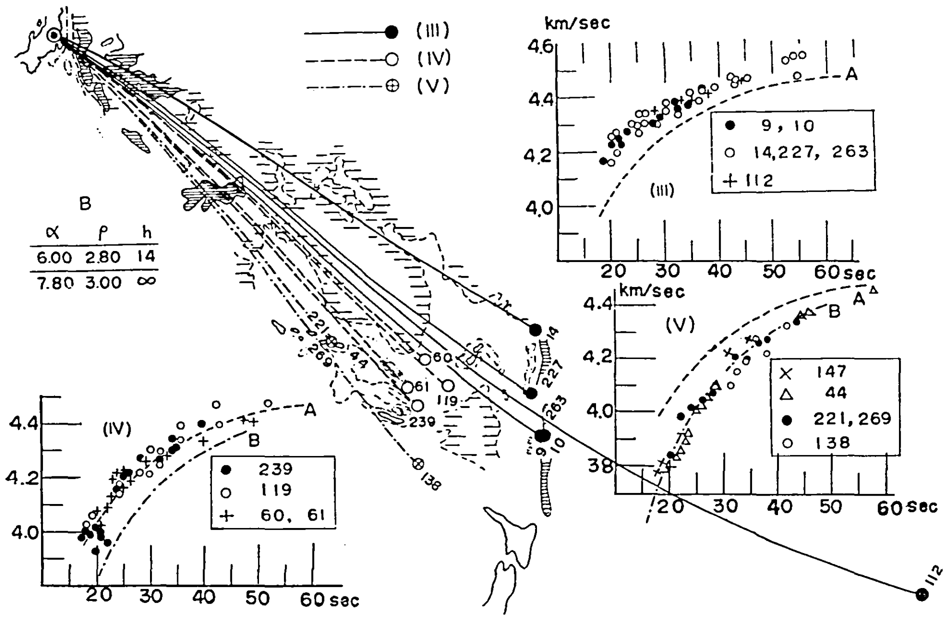

Fig. 4. Dispersion data of both Love waves with the characteristic numbers III, IV and V, and the corresponding travelling paths. The dispersion data belonging to the characteristic number III, lie a little above the theoretical curve A, while those belonging to the characteristic number IV and V lie just on the curves A and B respectively. The theoretical curve B was obtained by R. Yamaguchi basing upon such model as is shown in this figure.

groups (III), (IV) and (V), and the paths through which these dispersive characters were obtained, are represented by solid, broken and half broken curves respectively. An interesting fact can be noticed from this figure, that is, the shift in the dispersive character to rather a continental one with the shift of the travelling path westward. This tendency coincides well with the previous results which were obtained from the investigations into Rayleigh waves dispersions.

Except along the paths from the Sumatra Island region to Tsukuba (the copies of the wave form of Love waves through these paths are given in the lower two examples in Fig. 3), the oceanic paths shown in

Fig. 4 were the special one for which we could obtain dispersion data of Love waves for a sufficiently large period range. Therefore, we can investigate into two kinds of dispersion character of both Love and Rayleigh waves. Some examples are shown in Fig. 5, in which the same marks are used in the dispersion data of Love (LQ) and Rayleigh waves (LR) for each shock. Comparing each mark in every diagrams, we can notice a good correlations between them.

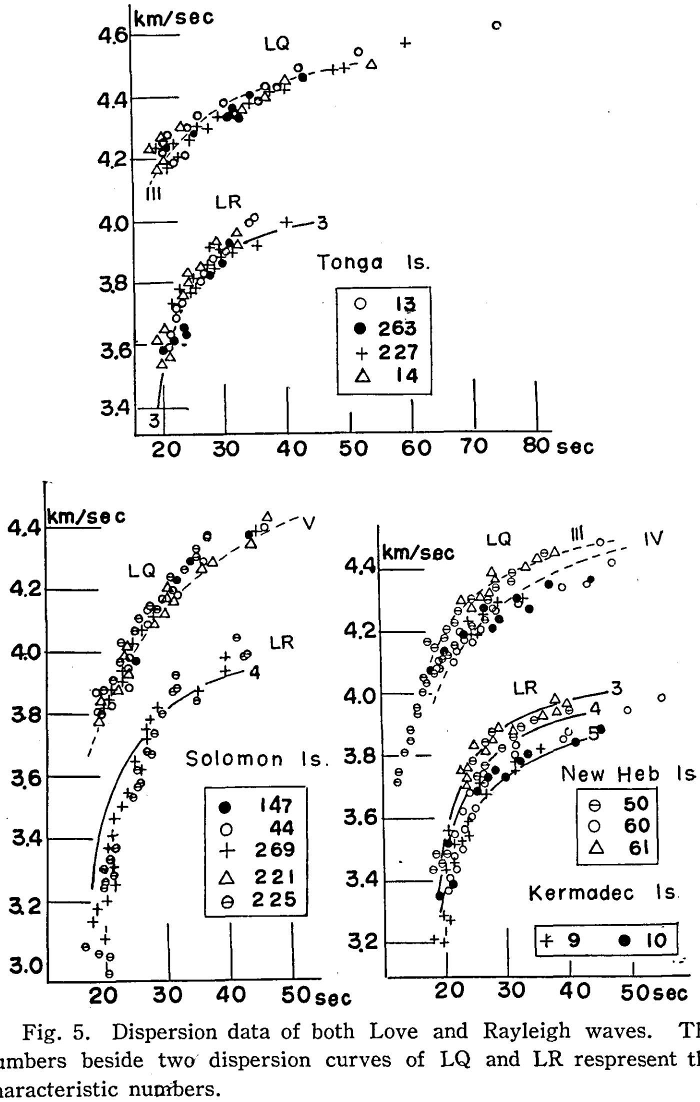

Fig. 5. Dispersion data of both Love and Rayleigh waves. The numbers beside two dispersion curves of LQ and LR respresent the characteristic numbers.

By using these two kinds of dispersion data, we can make, if we want, a more reliable estimation of the average crustal structure along each path between the epicenter and the observation station than by using any of the single type dispersion data. But, the writer did not take this labour, because such estimation for such an intricated structured region has little significance.

Concerning the paths which cover the Mariana Sea, a strange fact was obtained. That is, the wave form of Love waves becomes too irregular or too obscure from the beginning to obtain the dispersion

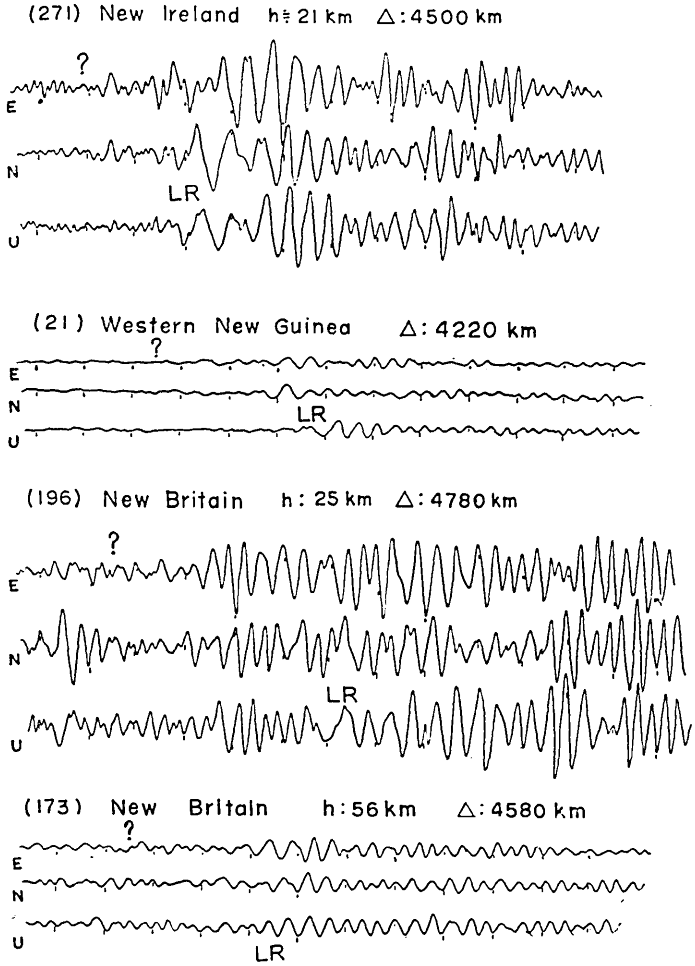

Fig. 6. Examples of seismograms on which Love waves are not apparent.

data. The examples are shown in Fig. 6 from the seismogram data obtained from shocks around New Ireland (271), New Guinea (21) and New Britain (196, 173). As the azimuths of these epicenters are all nearly due south from Tsukuba Station, Love waves should appear clearly in the EW component records. But, as is obvious in all of these examples, they are quite obscure. This unexpected fact cannot be explained at the present stage.

The wave forms and the dispersion characters of Love waves along northern oceanic paths such as from Aleutian Islands or Alaska Peninsula to Tsukuba are shown in Fig. 7.

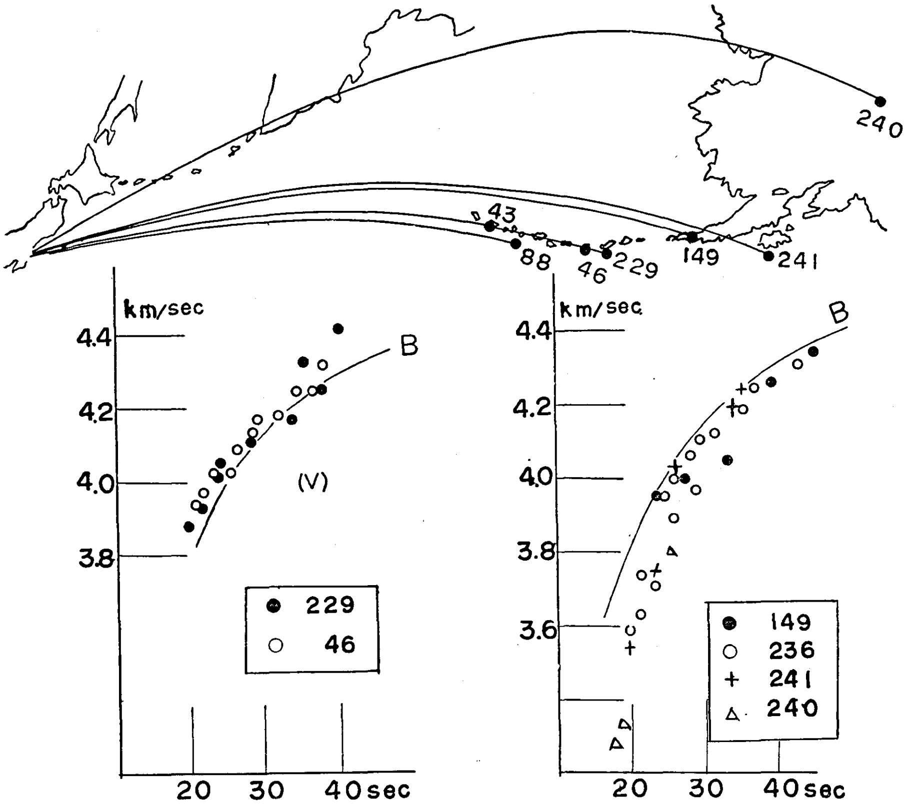

Fig. 7. Dispersion data of Love waves in the northern oceanic region and the corresponding travelling paths.

The dispersion characters of Love waves result from them show rather continental character (V) according to our characteristic number. Together with the result obtained in previous investigations into the

Rayleigh waves dispersions, the crust along these paths is considered to be much thicker than in the central Pacific Ocean.

4. Dispersions along continental paths

On account of the geographical condition, we cannot observe the dispersion of surface waves along purely continental paths in a geographical sense in Japan. "Continental paths" as used here mean, therefore, those due to the shocks which took place in the continent west of the Japanese Islands.

An interesting fact must again be reported here concerning the

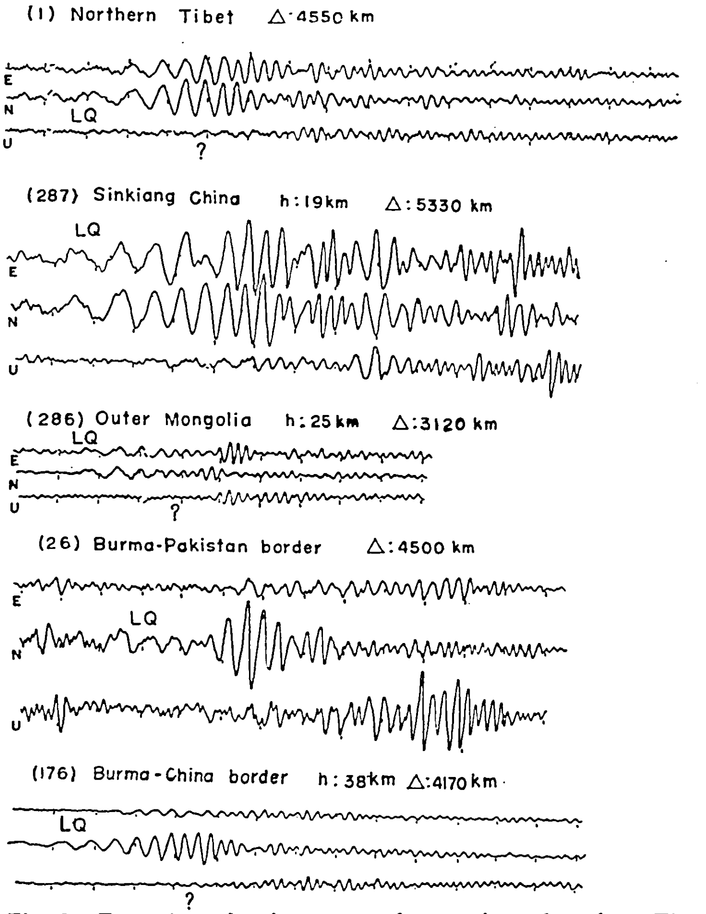

Fig. 8. Examples of seismograms for continental paths. They show clear Love wave trains but poor or else disturbed Rayleigh waves.

propagation of surface waves along the continental paths. That is, quite the oposite to the case of surface wave propagations in the Mariana Sea, the longer period Rayleigh waves were absent or quite obscure in this case in almost all the seismograms. Some examples are given in Fig. 8. For this reason, the writer could not make a complete investigation into the dispersion of Rayleigh waves along the continental paths to Japan.

5. Classification of the dispersive character of Love waves along continental paths

In Fig. 9, the dispersion feature of Love waves due to the shocks in western Sinkiang, China (36, 39) and Outer Mongolia (37, 38 and 286) are shown. It must be noticed that these dispersion data coincide well

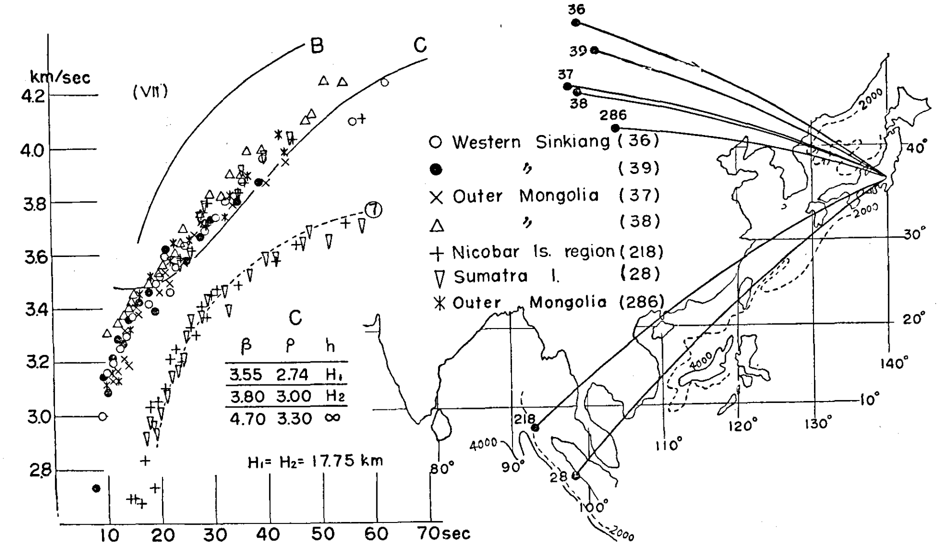

Fig. 9. Dispersion data of Love waves and corresponding paths. The dispersion data of Rayleigh waves for the shocks (218) and (28) are added.

with those caused by the Nicobar Islands shock (218) and the Sumatra Island shock (28). In the previous paper, the writer showed that the crustal structure along the oceanic path from the epicenter (28) to Tsukuba Station is purely continental. Besides, it was found in the present study that the averaged crustal structure along the oceanic path given above is, from the view point of Love wave dispersion at least, quite similar to that along the continental paths from Sinkiang or the Mongolian region to Tsukuba. These dispersion data approximately lie on a theoretical dispersion curve C (Dorman's case 208).

The discrepancy in the data from the theoretical curve in the short period range may be due to the influence of a sedimentary layer near the observation station. The characteristic number VII was given for this dispersion character.

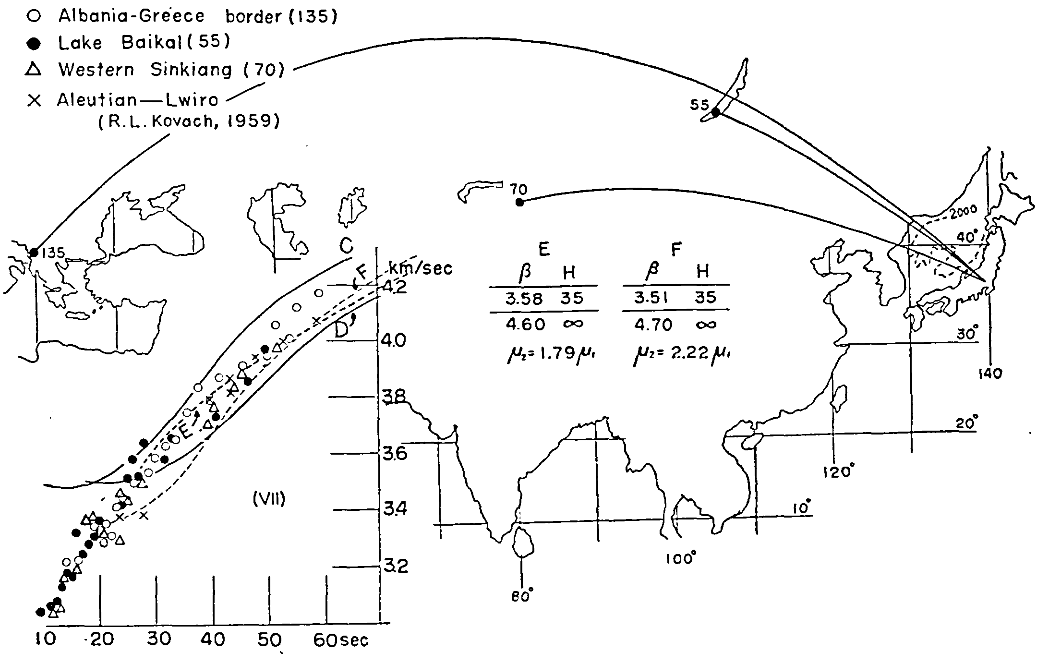

Fig. 10. Dispersion data of Love waves with the characteristic number VIII. Two theoretical curves E and F are those obtained by J. T. Wilson[5] by such models as are represented in the figure.

The dispersion data along the paths represented in Fig. 10 show another group, which lie between the two curves C and D. The curve C is the same as the previous one, and D is the curve when the thickness of the crust is thickened to 45.5 km in Dorman's case 208. The number VIII, was given for these dispersion data.

When the path shifts southward, the group velocities of Love waves gradually decrease, and for such paths as are shown in Fig. 11, the

5) J. T. WILSON, "The Love Waves of the South Atlantic Earthquake of August 28, 1933," *Bull. Seism. Soc. Amer.*, **38** (1940), 273.

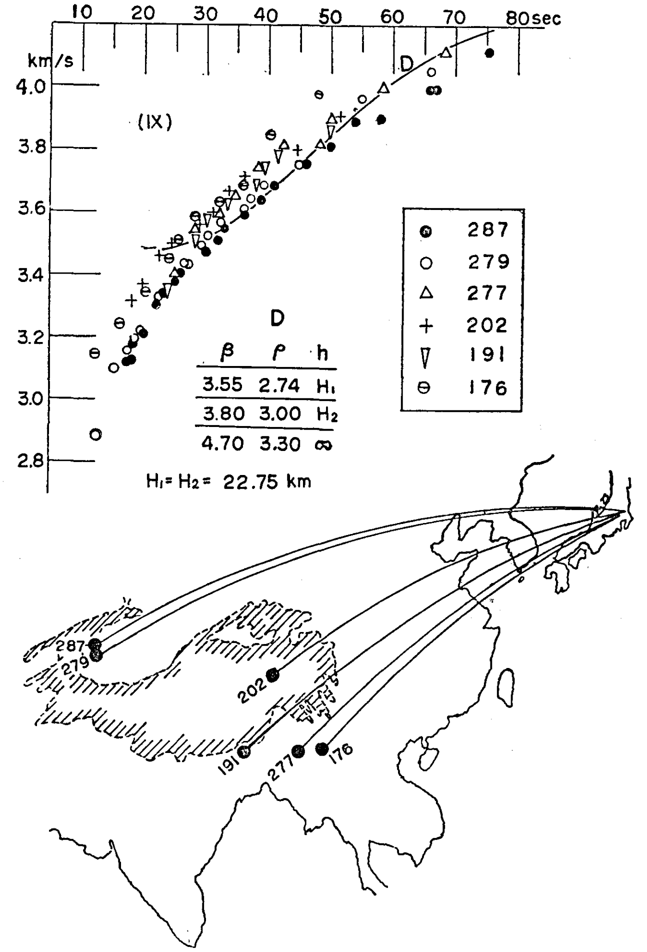

Fig. 11. Dispersion data of Love waves with the characteristic number IX and the corresponding paths.

dispersion data come to lie well on the theoretical curve D, and further, for such paths as are shown in Fig. 12 which include the Tibet Plateau, the dispersion data come beneath the curve D.

In Fig. 13, some other dispersion data of Love waves for the continental paths obtained by other authors[6),7),8)] are shown for comparison.

6) R. S. KOVACH, "Surface Wave Dispersion for an Asio-african and a Eurasian Path," *Journ. Geophys. Res.*, **64** (1959), 805.

7) T. AKIMA,* "On Dispersion Curves of Surface Waves from the Great Assam Earthquake of August 15, 1950," *Bull. Earthq. Res., Inst.*, **30** (1952), 237. (*The same as the present author)

8) J. N. BRUNE, J. E. NAFE and J. E. OLIVER, "A Simplified Method for the Analysis and Synthesis of Dispersed Wave Trains," *Jour. Geophys. Res.*, **65** (1960), 287.

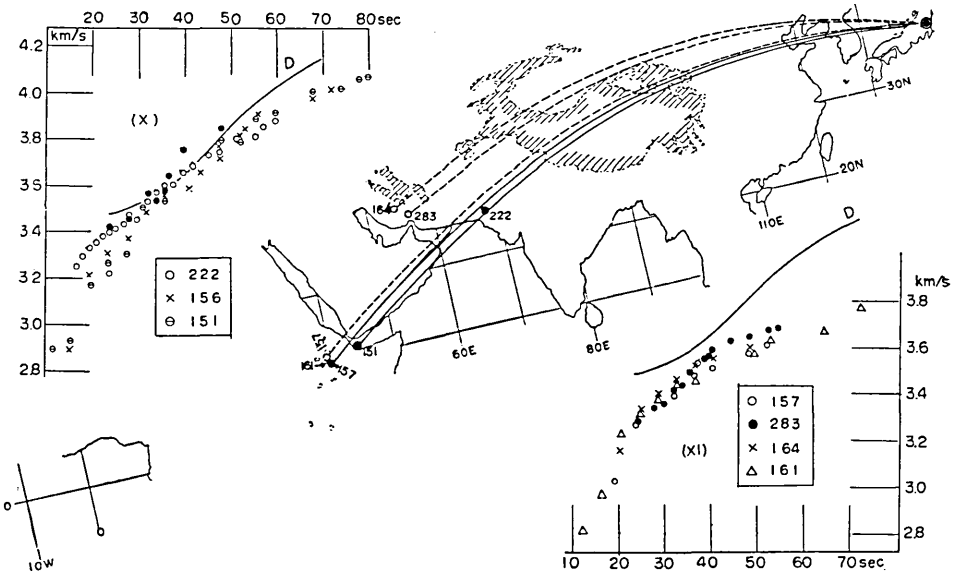

Fig. 12. Dispersion data of Love waves with the characteristic number X and XI. The effect of the high mountain region is remarkably apparent. The corresponding paths are distinguished by solid (belongs to X) and broken (belongs to XI) curves respectively.

Estimating these dispersion characters by our characteristic numbers, they lie approximately between VII and VIII.

Figs. 10, 11 and 12 tell us an interesting fact concerning the shift of the dispersion character from IX to XI. That is, the group velocity of Love waves seems to be remarkably decreased at its maximum value by the effect of the high mountain region in and around the Tibet Plateau. This phenomenon may be explained by the effect of some special conditions not only in the crust but in the upper mantle in these regions.

6. Dispersion data for the mixed paths

The dispersion data for the paths which partly cover the continental region in a geographical sense are shown in Fig. 14, in which, the most continental dispersion character for the oceanic path, hitherto obtained in the present investigations (V) and the most general one for the continental path (VII) are indicated by dotted curves. The list of the shocks used is given in Table IV.

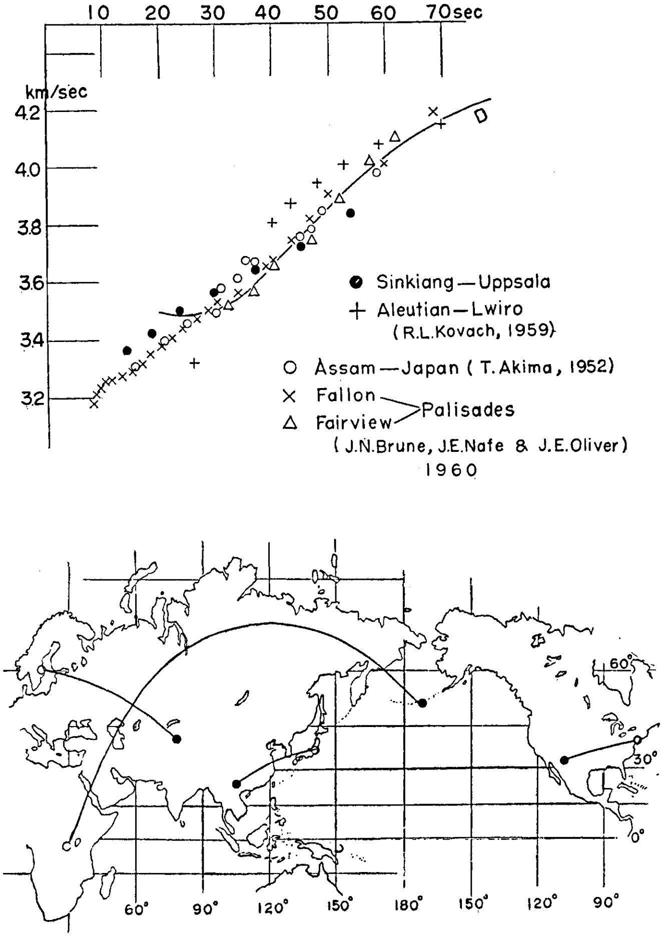

Fig. 13. Dispersion data of Love waves by other authors and the corresponding paths.

It is quite reasonable that these dispersion characters (the writer will give them the characteristic number VI) for the mixed paths lie between V and VII, and that the group velocity for the path, caused by the shock (163) which contains the largest continental portion is slower than the others. A noticeable fact is that most of the dispersion data lie in the same single curve.

In order to explain this, the percentages of the path lengths of a geographically continental region (D_0), a sea region shallower than 2 km (D_2) and one deeper than 4 km (D_4) were measured on every path. The results are given in Table 5. It can be read in this Table, that

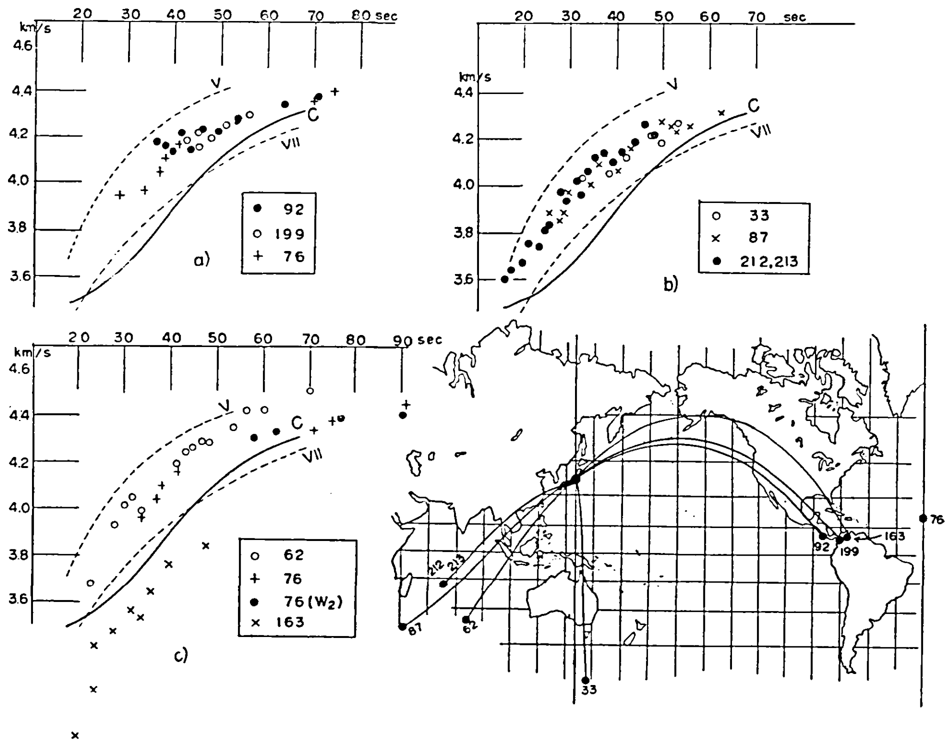

Fig. 14. Dispersion of Love waves with mixed travelling paths.

Table 5.

No.	D_0	D_0+D_2	D_4
76	35	49	33
76 (W_2)	30	40	26
199	31	49	27
92	29	42	51*
212, 213	33	59	32
87	10*	48	39
33	39	51	16*

the values of D_0, D_0+D_2 and D_4 are approximately around 33%, 42% and 30% respectively along most of these paths. Therefore, the similarity in the dispersion character along most of these paths can be explained by the similarity in the percentages of D_0, D_0+D_2 and D_4.

A few exceptional cases, however, can be noticed in Table 5. That is: 1) The value of D_0 along the path from the shock (87) is remarkably small (10%) while two other values D_0+D_2 and D_4 are both approximately the same as the others. This exceptional result can be explained if we assume that the crustal structure along an oceanic part from Sumatra Island to central Japan is as continental as the continental region (D_0) in other paths. The same conclusion has been obtained in the previous investigations into the dispersion of Rayleigh waves. 2) The dispersion data of Love waves for the path resulting from shock (33) is rather oceanic in spite of its small percentage of path length over a sea region deeper than 4 km (16%). This can be explained if we assume that the large portion of the region from the epicenter to somewhere southward off Tasmania Island may have a crustal structure like that in deep sea regions deeper than 4 km, though bathymetrically the depth is shallower than 4 km. The same suggestion has also been made from an investigation of the Rayleigh wave dispersions[9]. 3) The group velocity of Love waves along the path from the epicenter (92) to Tsukuba is rather slow in spite of having a larger ratio for the deep sea region path (51%). The same tendency has also been given in the study of Rayleigh waves dispersion by the same shock[10]. One explanation of this fact may be that the surface waves do not travel along the great circle but some other longer path due to refraction when they cross obliquely through the Sierra Madre mountain region in Mexico.

In the dispersion diagram c) in Fig. 14, the dispersion data of Love waves due to shock (62) are added, though the path can not be said to be a mixed one but an oceanic one. The reason for adding this data here is to show that inspite of its purely oceanic path, the dispersion along this path is a nearly mixed one with a continental portion of nearly 30%. This fact emphasized the conclusion previously made concerning the dispersion character of Rayleigh waves that the crustal structure between Sumatra Island to Tsukuba along the same path is a nearly continental one with the characteristic number "6".

7. Conclusions

The dispersion of Love waves along various paths to Japan was investigated. Some interesting facts were discovered. Though a detailed analysis of the abundant data is not yet completed, the general conclusions concerning the dispersive character of Love waves around Japan

9) *loc. cit.* 1) p. 229
10) *loc. cit.* 2) p. 395

can be summarized as follows.

a) Love wave propagation is much disturbed along the path which covers the Mariana Sea. On the other hand, the shocks which take place in the Micronesia region, for instance, at the Tongas, Kermadecs, Solomons and New Hebrides can transmit clear dispersive, long trains of Love waves. Further, the Love wave dispersion character along these paths changes gradually with the shift of the paths westward. This tendency is quite the same as with Rayleigh waves.

b) The shocks which take place in the continent west of Japan such as in Mongolia, Sinkiang, India etc. transmit very clear Love waves but not Rayleigh waves.

c) The dispersive characters of Love waves along the continental paths were classfied into four groups. The effect of the special conditions both in the crust and in the upper mantle for the path which covers the Tibet Plateau remarkably appears in the decreasing of the maximum group velocity of Love waves in the long period range.

d) The dispersion character of Love waves from the Sumatra Island region to Japan is as continental as that from Mongolia to Japan.

e) The classified dispersion characteristics of Love waves around Japan are summarized in Fig. 15, in which the broken, dotted and solid curves mean those which were obtained through oceanic, mixed and continental paths respectively.

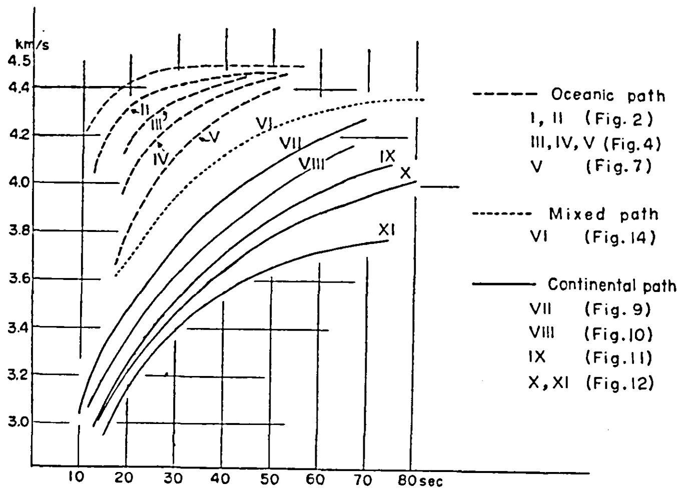

Fig. 15. Summarized figure for the eleven kinds of dispersion curves of Love waves.

24. 日本周辺を伝わるラブ波の分散について

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前にレーリー波について調べたのと同様に，地震研究所の筑波支所におかれているコロンビア型地震計の記象を用いて，日本の周辺を伝わるラブ波の分散を調べた．

海洋径路のラブ波の分散は6種に分けられる．このうち，波の伝播径路が，太平洋西部を走るいわゆる「安山岩線」にかからない範囲の広い海域を通るものは，純海洋性（特性 I）か，それに近いもの（特性 II）の何れかに包含されるが，径路がメラネシヤ海域に入ると，レーリー波の場合に見られたと全く同様に，径路が西に移動するにつれて，ラブ波の場合にも分散特性が次第に陸的なものに移つていく傾向がはつきり見られた（第 3，4 図）．

ただ，意外だつたのは，径路がマリアナ海に入ると，ラブ波の波形が急にひどく乱れたり，またはつきり出なかつたりして（第6図），これらの径路に沿つては分散曲線が全く得られなかつたことである．このことは，アジア大陸方面からやつてくる大陸径路の表面波の場合には，今度は逆に，ラブ波は極めてきれいに現われるのに，レーリー波の方が短周期のものに限られてしまつて（第8図），この場合にはレーリー波に対する分散曲線が十分な周期範囲では得られなくなることと合せて，今後調べて見たい問題である．

スマトラ島附近から日本への径路に沿うレーリー波の分散が大陸的であることは前の論文で示した通りであるが，ラブ波の方でも全くその通りで，その分散性は，外蒙古附近から日本に向う径路に沿つてのそれと全く同一である（第9図）．

大陸径路のラブ波の分散特性は5つに分けた．このうちで特に注目される点は，径路がチベット高原を横切る様になると，ラブ波の群速度の極大値が著しく小さくなる様な傾向を示すことである（第15図）．この特殊な分散傾向が果して地殻内部だけの問題として片づけられるかどうかは残された問題である．