2. *Periods and Amplitudes of Oscillations in L- and M-phases.*

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1. It is a well known fact that in L-phase of seismic waves oscillations of longer periods and of relatively smaller amplitudes are predominant, while in M-phase the periods become rather smaller and the amplitudes are frequently very large. It appears recognized that L- and M-phases are equivalent in the majority of cases to those of oscillations due to Love- and Rayleigh-waves respectively. For this purpose we have calculated the displacement distribution of Love-waves in the media, through which they are transmitted, and compared the result with the similar data obtained in our preceding paper[1] concerning Rayleigh-waves, and also with the known nature of bodily waves.

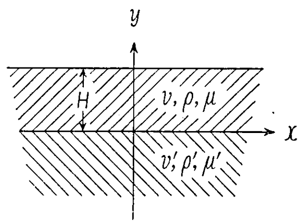

Fig. 1.

2. The method of finding solutions of Love-waves is too well established to explain here. In the case of a one-stratified body the characteristic equation[2] to determine the velocity of transmisson is expressed by

$$\tan\sqrt{k^2-f^2}\,H=\frac{\mu'\sqrt{f^2-k'^2}}{\mu\sqrt{k^2-f^2}}, \tag{1}$$

where $k^2=\rho p^2/\mu$, $k'^2=\rho' p^2/\mu'$, $2\pi/f=L=$wave length, $2\pi/p=T=$period, $H=$thickness of the stratum, $\rho, \rho', \mu, \mu'=$densities and rigidities of the stratum and the subjacent medium. The equations of displacement are expressed by

$$\left.\begin{aligned} v&=\frac{A\cos\{\sqrt{k^2-f^2}(H-y)\}\cos(pt-fx)}{\cos\sqrt{k^2-f^2}\,H},\\ v'&=Ae^{\sqrt{f^2-k'^2}\,y}\cos(pt-fx), \end{aligned}\right\} \tag{2}$$

where v, v' are displacements in the stratum and in the subjacent medium respectively. The relation between L/H and the velocity p/f for

1) K. SEZAWA and K. KANAI, "Amplitudes of Dispersive Rayleigh-waves at Different Depths of a Body," *Bull. Earthq. Res. Inst.*, 12 (1934), 641.

2) A. E. H. LOVE, *Some Problems of Geodynamics*, (Cambridge, 1911), 162.

$\mu'/\mu=\infty$, 5, 3, 2, 1·1 are indicated in Fig. 2. The ratios of displacements at depths $\frac{1}{4}H$, $\frac{1}{2}H$, $\frac{3}{4}H$, H from the surface to the one at that surface for $\mu'/\mu=\infty$, 5, 3, 2, 1·1 are plotted in Figs. 3, 4, 5, 6, 7.

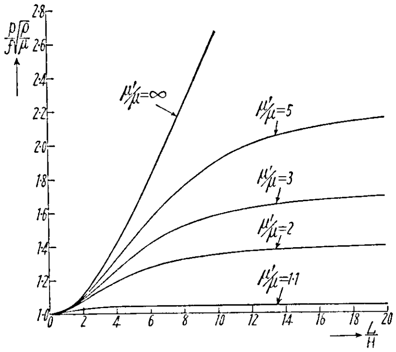

Fig. 2

3. The case, where there are two superficial layers, was studied independently by Matuzawa[3] and Stoneley[4] and their solutions are not difficult to deduce here. But, in the present case we consider a simplest problem in which the lowest medium is infinitely rigid, so that the boundary conditions are simply denoted by $y=0$, $v'=0$; $y=H'$, $v'=v$, $\mu'\partial v'/\partial y=\mu\partial v/\partial y$; $y=H+H'$, $\partial v/\partial y=0$. We, thus, find the characteristic equation to determine the velocity of transmission as follows :

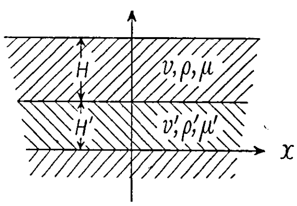

Fig. 8.

$$\tanh\sqrt{f^2-k'^2}H'\tan\sqrt{k^2-f^2}H=\frac{\mu'\sqrt{f^2-k'^2}}{\mu\sqrt{k^2-f^2}}, \qquad (3)$$

where H, H' are thicknesses of the upper and the second strata respectively. The displacements v, v' are expressed by

$$\left.\begin{aligned} v&=\frac{A\cos\{\sqrt{k^2-f^2}(H+H'-y)\}}{\cos\sqrt{k^2-f^2}(H+H')}\cos(pt-fx),\\ v'&=\frac{A\cos\sqrt{k^2-f^2}H\sinh\sqrt{f^2-k'^2}y}{\cos\sqrt{k^2-f^2}(H+H')\sinh\sqrt{f^2-k'^2}H'}\cos(pt-fx). \end{aligned}\right\} \qquad (4)$$

The dispersion curves for $H/H'=\infty$, 10, 1, 1/10, when $\mu'/\mu=5$, are plotted in Fig. 9 and similar curves, when $\mu'/\mu=2$, in Fig. 10. The ratios of displacements at various depths to the one at the surface for different H/H' of the case $\mu'/\mu=5$ are plotted in Figs. 12, 13, 14; the similar ratios of the case $\mu'/\mu=2$ in Figs. 15, 16, 17.

4. The ratios of displacements for various depths in the case of Rayleigh-waves were obtained in our preceding paper[5], so that it is not necessary now to show the result. Nevertheless, we shall reproduce one of the results, namely the case $\mu'/\mu=2$. The ratios of horizontal

3) T. MATUZAWA, "Propagation of Love Waves along Trebly Stratified Body," *Proc. Phys.-Math. Soc., Japan*, [iii], 10 (1928), 25~33.

4) R. STONELEY and E. TILLOTSON, "The Effect of a Double Surface Layer on Love Waves," *M. N. R. A. S., Geophys. Suppl.*, 1 (1928), 521~527.

5) K. SEZAWA and K. KANAI, *loc. cit.*

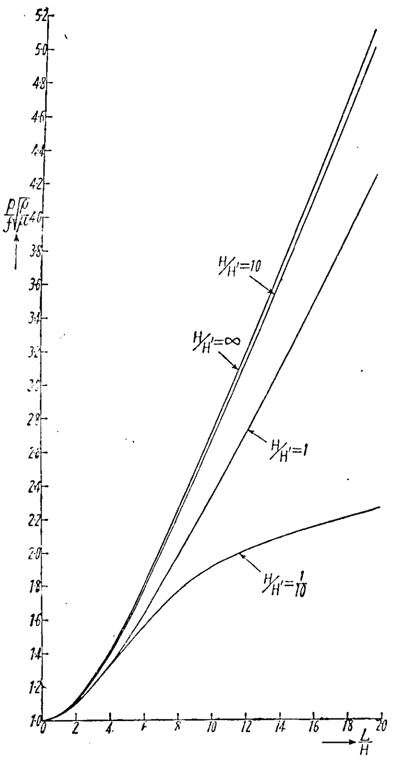

Fig. 9. $\mu'/\mu=5$.

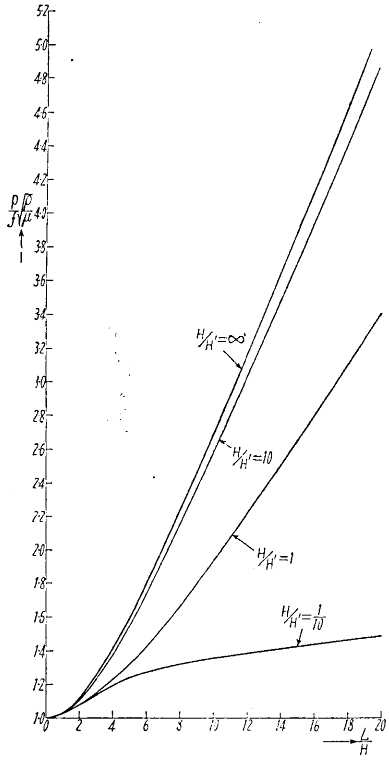

Fig. 10. $\mu'/\mu=2$.

components, $u_{H/2}/u_0$, u_H/u_0, and those of vertical ones, $v_{H/2}/v_0$, v_H/v_0, are plotted in Fig. 19.

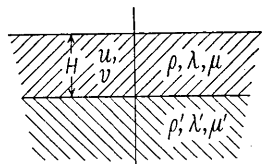

Fig. 18.

5. It is impossible to find features in dispersion curves of Love-waves that are special to that kind of waves as there are nearly similar characters in relation to the connection between the velocity of transmission and the ratio of L/H for Love-waves as well as for Rayleigh-waves. It is a common fact that, if the rigidity of the lowest medium in a singly or doubly stratified body is infinitely large, the velocity of transmission tends to infinite as L/H becomes very large. It seems, however, that the curves indicating the distribution of dispalcements at different depths reveal some significant qualities.

It is certain that, if the rigidities of the strata and the lowest medium are not much different, displacements are approximately constant at any depth for relatively longer wave length in both cases of Love-waves and Rayleigh-waves, tending to take the types of bodily waves having velocities of distortional- and Rayleigh-waves peculiar to the lowest medium in respective cases. In the same condition of rigidities of both media the displacements take different distributions when the wave length is not large. For smaller wave length, the displacements of Rayleigh-waves are concentrated more intensely on the surface, while the accumulation of displacements of Love-waves in the superficial part of the body is not so intense as that of Rayleigh-waves. In the limiting case, where the wave length is exceedingly small, the displacements of Rayleigh-waves are found practically only at the surface, while those of Love-waves are not accumulated at the surface but distributed in a sinusoidal type in the uppermost stratum. In this case the displacements of all lower strata are exactly zero. This is a special feature of short Love-waves, which plays an important part on the fundamental nature of L-phase and is extremely differing from that of M-phase. The difference between short Love-waves and short Rayleigh-waves is also directly connected with two kinds of high-frequency vibrations of an elastic plate.[6]

If the rigidity of the lower medium of a one-stratified body is very large compared with that of the superficial layer, the distribution of displacements of Love-waves in the layer takes always the same type for any wave length. This type is precisely equivalent to that of displacements of the critical case of Love-waves for any ratio of μ'/μ when the wave length is exceedingly small. The distribution of displacements of Rayleigh-waves in such condition of rigidities takes different types according to wave lengths. If there are two or more superficial strata on a very rigid medium, the distribution of displacements of Love-waves in the strata depends upon the wave lengths over a range, but beyond a certain wave length the distribution tends to take the same type, the type conforming with the ratio of thicknesses as well as that of rigidities of respective media. If there are two superficial strata and the upper stratum is much thicker than the second one, the distribution tends to the asymptotic type at a smaller ratio of L/H, while, if the upper stratum is much thinner than the second one, the approach to the asymptotic type takes place at a larger ratio of L/H. The effect of rigidities of both media is remarkable when the upper medium is much thinner than the second one, and in this case the waves tend to take asymptotic type at a smaller ratio of L/H when the difference of the rigidities is not large.

Generally speaking, the distribution of displacements of Love-waves in a one-stratified body tends to take asymptotic type, namely the type

6) K. SEZAWA, "On the Accumulation of Energy of High-frequency Vibrations of an Elastic Plate on Its Surfaces," *Proc. 3-int. Congr. f. Appl. Mech., Stockholm, 1930*, **3**, 167~172.

of waves of an infinite length, at smaller wave length if the difference of rigidities of the layer and the subjacent medium becomes smaller and smaller. Thus, when the rigidities of both media differ very little, the displacements of extremely short waves in the stratum are distributed in a sinusoidal form of $\frac{1}{4}$ period and those in the subjacent medium are zero, while the displacements of waves, which are longer than the above, are distributed approximately uniformly in the stratum as well as in the subjacent medium. But, if the medium is uniform at all depths, the displacements are distributed uniformly for any wave length.

6. The explanation, which we wish to suggest here as to the reason why periods of oscillations of L-phase are relatively longer than those of M-phase in spite of the smaller amplitudes of the former phase, comes directly from the above result with respect to the distribution of displacements. It is, however, necessary to assume that the law of equipartition of energy holds: in other words, that the transmitted disturbance consists of an aggregate of trains of harmonic waves of different periods and the energy involved in each train of waves is constant when there is no any damping force. This criterion may be in contradiction with the recent conception of energy partition. Such conception will, of course, modify our result to a certain extent, yet the character due our result will still remain as a certain element of the problem. Let the surface values of displacements of Rayleigh-waves, Love-waves and bodily distortional waves be

$$v_1 = A_1 e^{-b_1 l/H} \cos\frac{2\pi V_1 t}{l}, \quad v_2 = A_2 e^{-b_2 l/H} \cos\frac{2\pi V_2 t}{l}, \quad v_3 = A_3 \cos\frac{2\pi v_3 t}{l} \tag{5}$$

respectively, where H is effective thickness of the layer, l wave length, V_1, V_2, V_3 velocities of transmission of Rayleigh-waves, Love-waves, and bodily waves, A_1, A_2, A_3, b_1, b_2 constants depending upon the distribution of displacements of respective kinds of waves under the preceding assumption of energy partition.

In the first place, we take the case in which there is little damping due to solid viscosities, etc.. It is certain that, the more the energy of waves is accumulated in the vicinity of the surface, the larger becomes the surface values of the displacements. Similarly, the variation of the distribution of displacements in accordance with the length of waves determines the law of variation of surface displacements. This criterion and the results of the preceding section show that

$$A_1 \gg A_2 \gg A_3, \quad b_1 \gg b_2, \tag{6}$$

from which it follows:

$$v_1 > v_2 > v_3 \tag{7}$$

for small wave lengths. Thus, the amplitudes of M-phase are greater than those of L-phase, and the amplitudes of L-phase are greater than those of S-phase at least for smaller wave lengths. For longer waves we have merely

$$v_1 > v_3, \quad v_2 > v_3 \tag{8}$$

in virtue of (6). Let us suppose that the wave length, at which the amplitude becomes a certain fraction of that at zero wave length, is used as a criterion of comparison of effective wave length. Then, if l_1, l_2 are respective criterion wave lengths of Rayleigh-waves and Love-waves, we find

$$b_1 l_1 = b_2 l_2,$$

so that, from $b_1 \gg b_2$, we get

$$l_1 \ll l_2. \tag{9}$$

It appears therefore that the effective period of L-phase is less than that of M-phase.

Secondly, we consider the case that the damping due to the visco-elastic nature of the media is influential on the transmission of waves. We know that the damping factor[7] of waves is of the type $exp.(-ct/l^2)$, where t is time and c a constant depending on the type of waves. Thus, we write

$$\left.\begin{aligned} v_1 &= A_1 e^{-\left(\frac{c_1 r}{V_2 l^2} + b_1 \frac{l}{H}\right)} \cos \frac{2\pi V_1 t}{l}, \\ v_2 &= A_2 e^{-\left(\frac{c_2 r}{V_2 l^2} + b_2 \frac{l}{H}\right)} \cos \frac{2\pi V_2 t}{l}, \\ v_3 &= A_3 e^{-\frac{c_3 r}{V_3 l^2}} \cos \frac{2\pi V_3 t}{l}, \end{aligned}\right\} \tag{10}$$

where r is epicentral distance. Maxima of v_1, v_2 take place at

$$l_1 = \left(\frac{2c_1 r}{V_1} H\right)^{\frac{1}{3}} \Big/ b_1^{\frac{1}{3}}, \quad l_2 = \left(\frac{2c_2 r}{V_2} H\right)^{\frac{1}{3}} \Big/ b_2^{\frac{1}{3}} \tag{11}$$

respectively. As it may be assumed that $c_1 \approx c_2$, $V_1 \approx V_2$ in comparison with the inequality $b_1 \gg b_2$, it follows that

$$l_1 < l_2. \tag{12}$$

Thus, it is probable that the periods of maximum amplitudes of M-phase are less than those of L-phase. Substituting (11) in (10) we find the respective maxima of the forms:

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7) K. SEZAWA, "On the Decay of Waves in Visco-elastic Solid Bodies," *Bull Earthq. Res. Inst.*, 3 (1927), 43; "On the Diffusion of Tremors on the Surface of a Semi-infinite Body," *ditto*, 5 (1928), 85.

$$\left.\begin{aligned} v_1 &= A_1 e^{-\frac{3}{2} b_1 l_1/H}, \\ v_2 &= A_2 e^{-\frac{3}{2} b_2 l_2/H}. \end{aligned}\right\} \tag{13}$$

Rewriting these we get the maxima:

$$\left.\begin{aligned} v_1 &= A_1 e^{-\frac{3}{2} C_1 b_1{}^{2/3}/H}, \\ v_2 &= A_2 e^{-\frac{3}{2} C_2 b_2{}^{2/3}/H}, \end{aligned}\right\} \tag{13'}$$

provided $C_1=\left(\dfrac{2c_1r}{V_1}H\right)^{\frac{1}{3}}$, $C_2=\left(\dfrac{2c_2r}{V_2}H\right)^{\frac{1}{3}}$. Although $b_1 \gg b_2$ exists, c_1 and c_2 are actually very small, and therefore the exponential factors do not take an important part in comparison with A_1 and A_2 in (13′) within a range of a certain epicentral distance d. Thus, we have

$$v_1 > v_2, \quad l_1 < l_2. \quad (r < d) \tag{14}$$

Beyond the epicentral distance, d, the exponential factors become important and

$$v_1 < v_2, \quad l_1 < l_2 \quad (r > d) \tag{14'}$$

exist. In these both cases $l_1 < l_2$ holds with the condition that the absolute values of l_1 and l_2 increase as $r^{3/2}$.

7. In order to confirm the validity of our present conclusion we have analysed the records of earthquakes of various epicentral distances which were principally observed at Tôkyô (two special ones were observed at Osaka) and determined the approximate ratio of v_1/v_2 as well as that of T_1/T_2 together with the value of T_1, where v_1, v_2, T_1, T_2 are the effective values of the amplitudes and the periods of oscillations in M- and L-phases, the result being tabulated in Table I and the seismic records used being shown in Figs. 20∼44. In this table EW-component of two cases, III and XV, are the results of observation in Osaka. The values of v_1/v_2 and T_1 are plotted in Figs. 45 and 46.

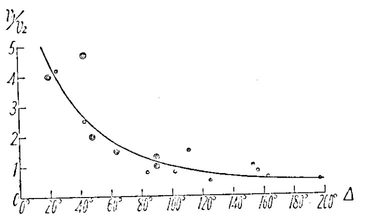

Fig. 45. {⊙ Trans-Pacific, ◎ Trans-continental.

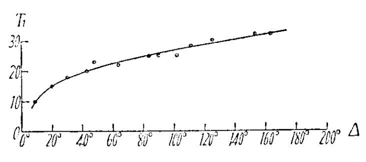

Fig. 46.

Even though there are special features of wave forms according to the paths of transmission of waves as already mentioned by Matuzawa[8],

8) T. MATUZAWA, *Bull. Earthq. Res. Inst.*, **6** (1929), 211.

Table I.[9][10]

	Δ	Epicentre	Date	T_1/T_2	v_1/v_2	T_1 (sec.)
I	8°38′	Sakurazima	1914 I 12	1·0	15	10
II	20°	Taiwan	1919 XII 20	0·6	4·0	15
III	25°	Aleutian	1906 VIII 17	0·7	4·2	18
IV	43°	Mandate	1913 X 11	0·7	2·5	20
V	43°	Tibet	1924 VII 3	0·7	4·7	20
VI	48°	India	1934 I 15	0·8	2·0	23
VII	64°	Baluchistan	1931 VIII 27	0·7	1·5	22
VIII	84°	New Zealand	1931 II 2	0·7	0·8	25
IX	90°	Calabria	1905 IX 8	0·7	1·0	25
X	90°	Messina	1908 XII 28	0·7	1·3	25
XI	102°	Mexico	1932 VI 3	0·7	0·8	25
XII	111°	Mexico	1931 I 15	0·7	1·5	25
XIII	125°	South Pacific	1920 III 20	0·6	0·5	28
XIV	153°	Atacama	1922 IX 11	0·6	1·0	30
XV	156°	Valparaiso	1906 VIII 17	0·6	0·8	32
XVI	163°	South Atlantic	1929 VI 27	0·7	0·6	32
XVII	197°	......(Major arc)	....	0·7	0·5	?

yet the existence of the characteristics due to our conclusion in (12), (14), (14′) can be recognized with certainty as far as for the seismic records we have taken up. It seems that the distance d, at which v_1 becomes v_2, is roughly $\Delta=100°$.

Now, from Table I it is possible to put $T_1/T_2=0{\cdot}7$. If we assume that $V_1=3{\cdot}6$ km./sec. and $V_2=4{\cdot}2$ km./sec., it follows:

$$\frac{l_1}{l_2}=\frac{T_1V_1}{T_2V_2}=0{\cdot}6. \tag{15}$$

From (11) and (15) we get $b_2c_1/b_1c_2=0{\cdot}185$. Again, we may take for simplicity that $c_1=c_2=c$, then we obtain $b_2=0{\cdot}185\,b_1$. From the first equation of (11) and the curve in Fig. 46 we have

$$\frac{cH}{b_1}=144\ \text{km}^3\text{./sec..} \tag{16}$$

9) Records of I, III, IX, X, XV are copied from Omori's papers, *Bull. Earthq. Inv. Comm.*, 1, 8; those of XVI, XVII from Imamura's paper, *Proc. Imp. Acad.*, 8 (1932), 354; XIII and XIV from the original records cited in Matuzawa's paper, *Bull. Earthq. Res. Inst.*, 6 (1929), 215; and VI and VIII from *Seism. Rep. Earthq. Res. Inst.*, 1931 and 1934.

10) In determining initial phases of L- and M-waves we used Oxford Summary, Macelwane's table and etc.. But, some corrections were necessary to get times of arrival of waves through Pacific Ocean and through East China Sea.

From (13), (15), and (16) we find

$$\frac{v_1}{v_2}=\frac{A_1}{A_2}e^{-4\cdot31\frac{b_1}{H}r^{\frac{1}{3}}}. \tag{17}$$

Comparing this equation with the curve in Fig. 45 it follows:

$$\frac{A_1}{A_2}=6\cdot82, \quad \frac{b_1}{H}=0\cdot041\,\text{km}^{-1}., \tag{18}$$

and accordingly $c=5\cdot90\,\text{km.}^2/\text{sec.}$. Hence we find the following expression in place of (13):

$$\left.\begin{aligned} v_1&=Ae^{-\left(\frac{5\cdot90\,r}{3\cdot6\,l^2}+0\cdot041\,l\right)}\cos\frac{7\cdot2\pi t}{l}, \\ v_2&=\frac{A}{6\cdot82}e^{-\left(\frac{5\cdot90\,r}{4\cdot2\,l^2}+0\cdot00759\,l\right)}\cos\frac{8\cdot4\,\pi t}{l}, \end{aligned}\right\} \tag{19}$$

where r is epicentral distance (km.), and l wave length (km.). With view to get damping coefficients of the earth crust the following equation is assumed to exist:

$$\frac{\mu'}{2\rho}=\frac{c}{4\pi^2}, \tag{20}$$

from which we find

$$\frac{\mu'}{\rho}=0\cdot3 \quad \text{in C. G. S. units.}$$

This value is exceedingly small in comparison with those observed experimentally by means of small test pieces. This tells the fact that the effect of the material damping on long seismic waves, especially when the length of waves is so large as 100 km., is negligibly small.

In conclusion our sincerest thanks are due to Professor Imamura and Dr. Nasu who gave us many important knowledges on seismic analysis, to Drs. Kishinouye, Suzuki, and Yasuda who supplied us a good deal of seismic records, and also to Mr. Hirano who assisted us in copying some records.

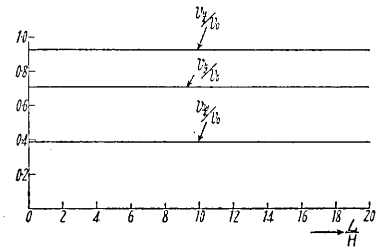

Fig. 3. $\mu'/\mu=\infty$.

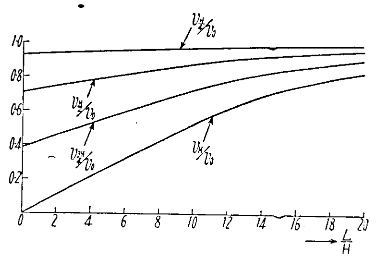

Fig. 4. $\mu'/\mu=5$.

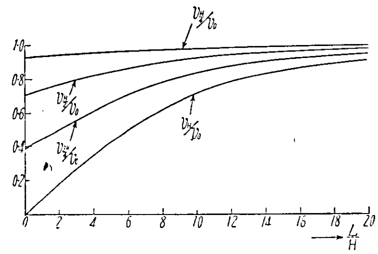

Fig. 5. $\mu'/\mu=3$.

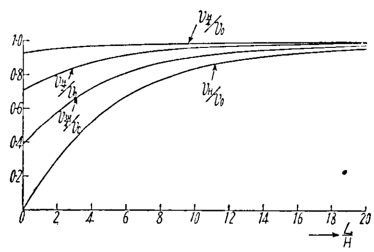

Fig. 6. $\mu'/\mu=2$.

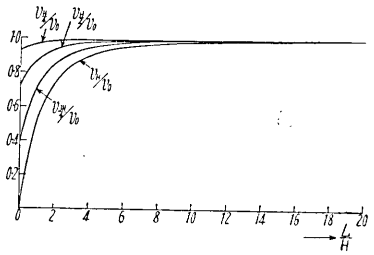

Fig. 7. $\mu'/\mu=1.1$.

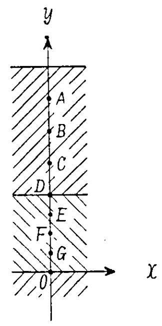

Fig. 11.

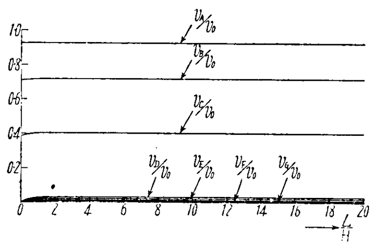

Fig. 12. $\mu'/\mu=5$, $H/H'=10$.

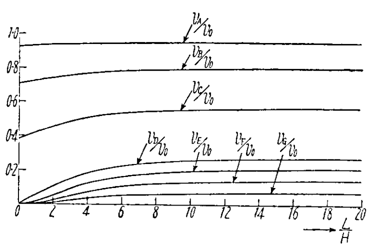

Fig. 13. $\mu'/\mu=5$, $H/H'=1$.

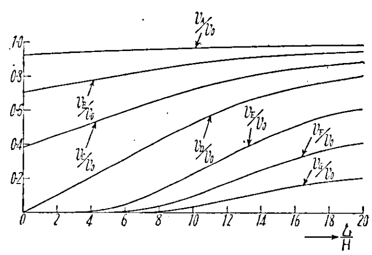

Fig. 14. $\mu'/\mu=5$, $H/H'=1/10$.

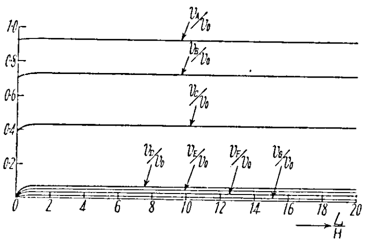

Fig. 15. $\mu'/\mu=2$, $H/H'=10$.

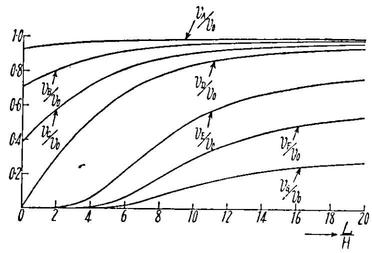

Fig. 17. $\mu'/\mu=2$, $H/H'=1/10$.

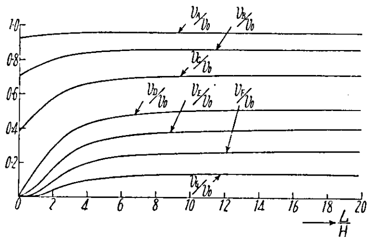

Fig. 16. $\mu'/\mu=2$, $H/H'=1$.

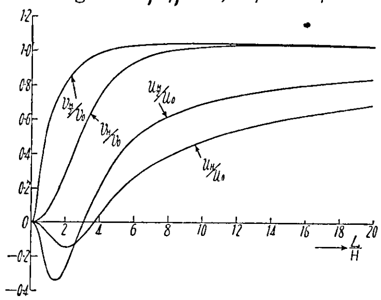

Fig. 19. $\mu'/\mu=2$. (Rayleigh-waves)

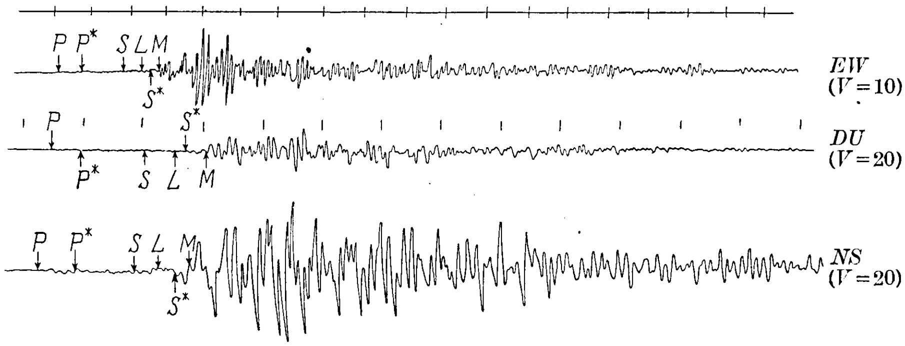

Fig. 20. $\Delta=8°38'$; Sakurazima, 1914 I 12. Original×1/3.

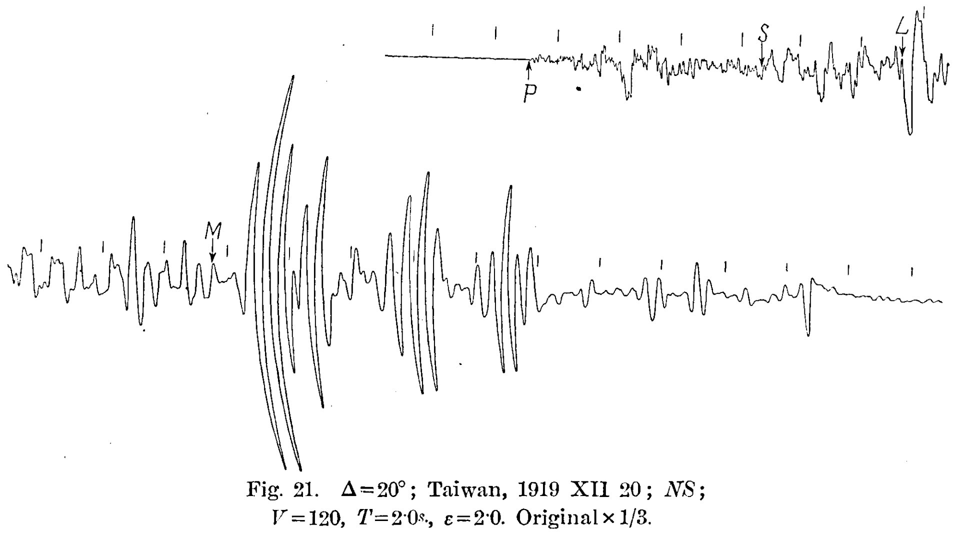

Fig. 21. $\Delta=20°$; Taiwan, 1919 XII 20; *NS*;
$V=120$, $T=2{\cdot}0^s$, $\varepsilon=2{\cdot}0$. Original×1/3.

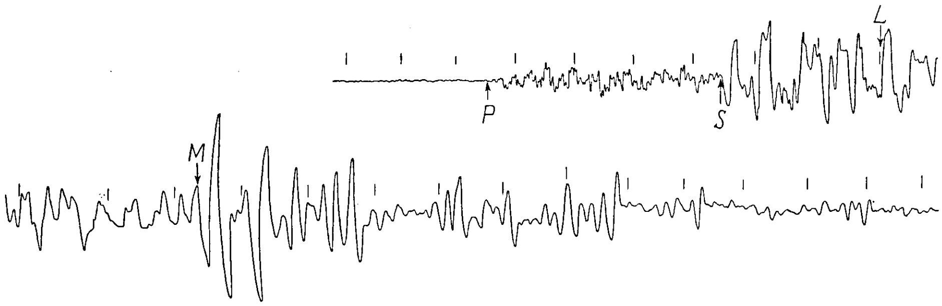

Fig. 22. $\Delta=20°$; Taiwan, 1919 XII 20; EW;
$V=120$, $T=20^{s}$, $\varepsilon=2{\cdot}0$. Original × 1/3.

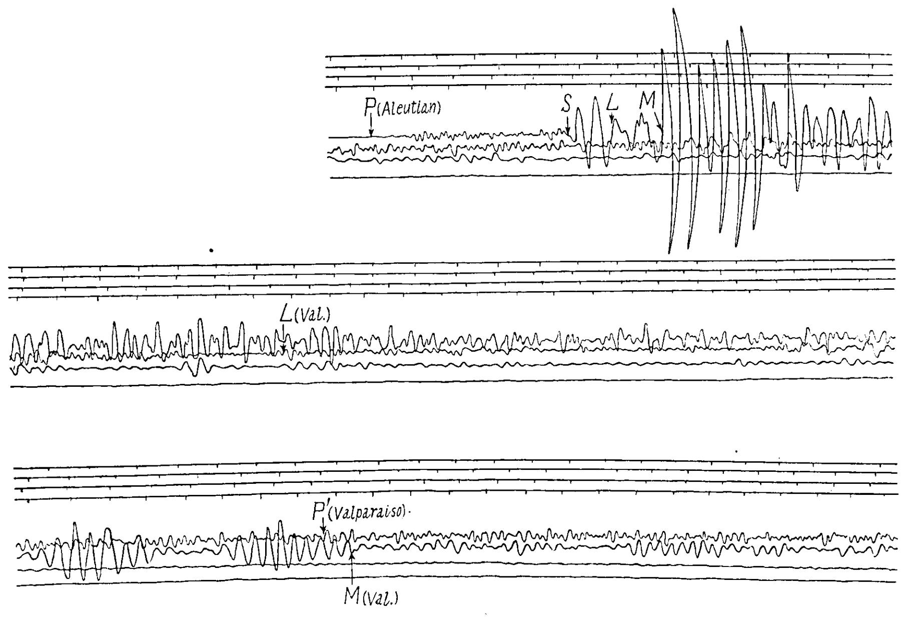

Fig. 23. $\Delta=25°$; Aleutian, 1906 VIII 17; NS; $V=10$, $T=28^{s}$. / $\Delta=156°$; Valparaiso, 1906 VIII 17; NS; $V=10$, $T=28^{s}$. Original × 1/3.

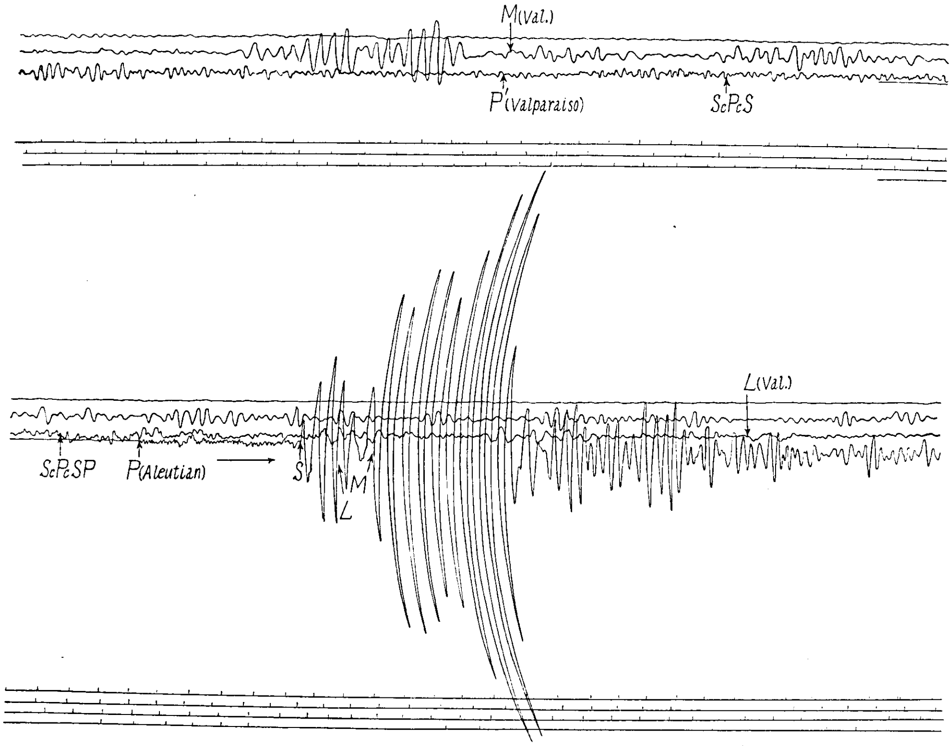

Fig. 24. {Δ=25°; Aleutian, 1906 VIII 17; *EW*; *V*=20, *T*=27^s. / Δ=156°; Valparaiso, 1906 VIII 17; *EW*; *V*=20, *T*=27^s.} Original×1/3. (Osaka obs.)

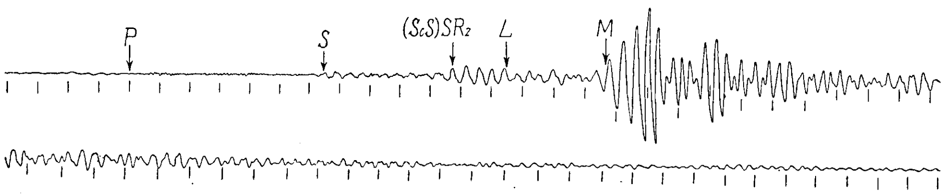

Fig. 25. Δ=43°; Tibet, 1924 VII 3; *N'S'*(*N'*=*N* 13° *W*); *V*=10, *T*=30^s., ε=2·0. Original×1/3.

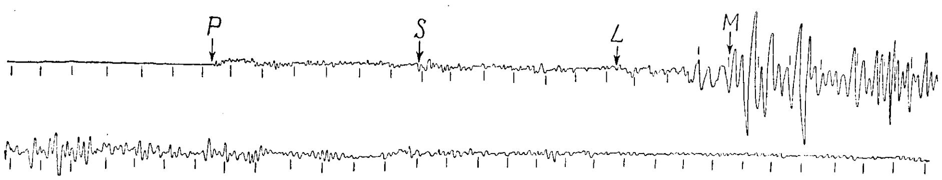

Fig. 26. Δ=43°; Tibet, 1924 VII 3; *E'W'* (*E'*=*N*77° *E*); *V*=30, T=40^s., ε=2·0. Original×1/3.

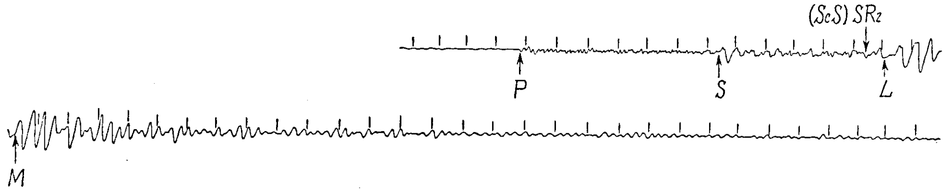

Fig. 27. Δ=43°; Mandate, 1913 X 11; *NS*;
V=20, *T*=59ˢ. Original×1/3.

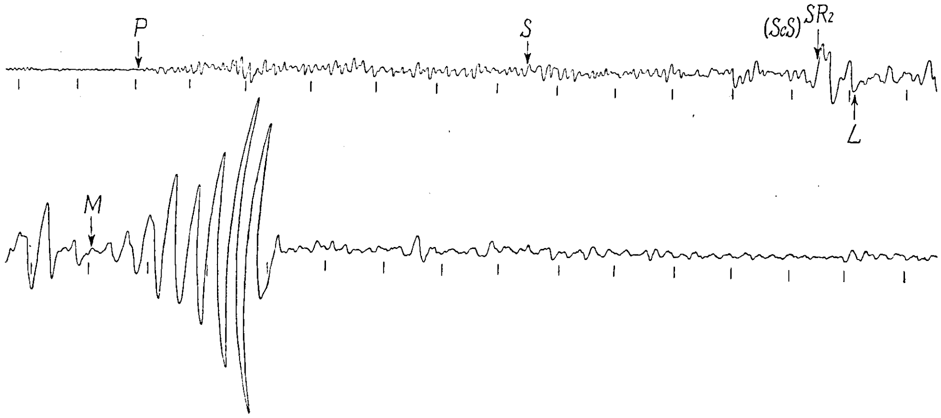

Fig. 28. Δ=43°; Mandate, 1913 X 11; *EW*;
V=120, T=20ˢ. Original×1/3.

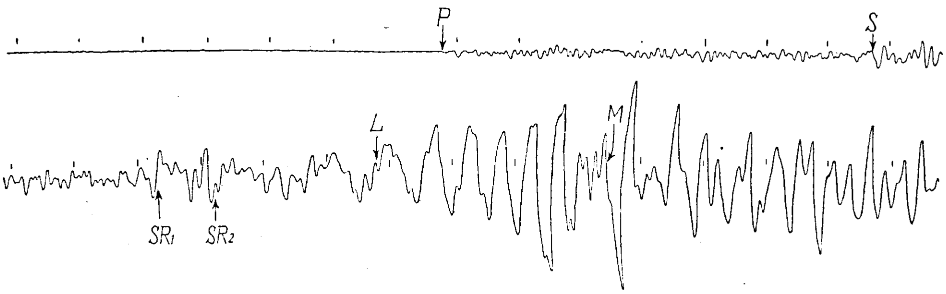

Fig. 29. Δ=48°; India, 1934 I 15; *N'S'* (*N'*=*N* 13° *W*);
V=10, *T*=33·2ˢ, ε=2·2. Original×1/3.

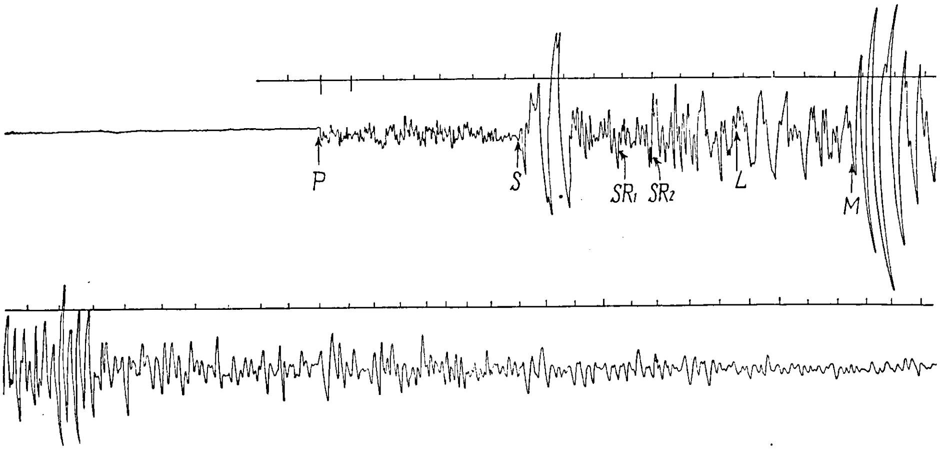

Fig. 30. $\Delta=48°$; India, 1934 I 15; $E'W'$ (E' $N 77° E$); $V=15$, $T=40{\cdot}9^{s.}$, $\varepsilon=2{\cdot}7$. Original × 1/3.

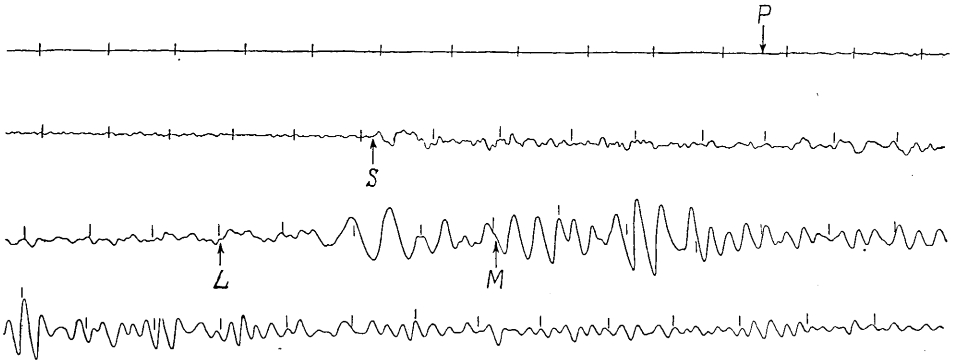

Fig. 31. $\Delta=64°$; Baluchistan, 1931 VIII 27; NS; $V=20$, $T=55^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

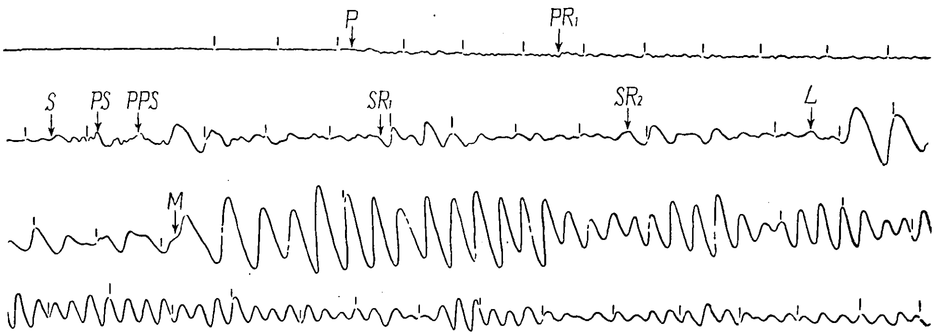

Fig. 32. $\Delta=84°$; New Zealand, 1931 II 2; NS; $V=20$, $T=59^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

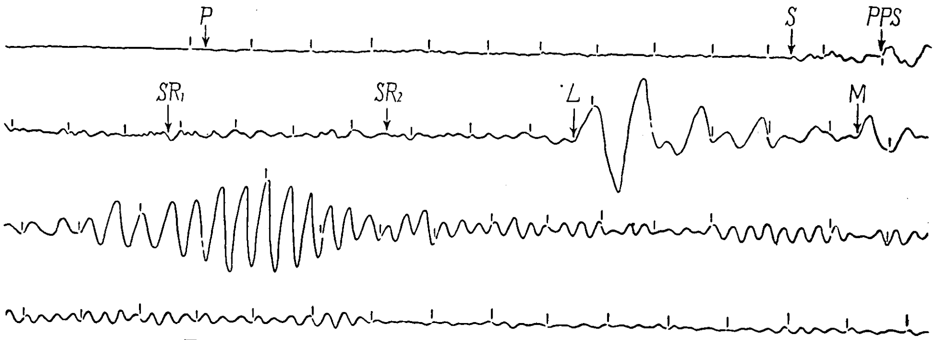

Fig. 33. $\Delta=84°$; New Zealand, 1931 II 2; *EW*;
$V=15$, $T=71^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

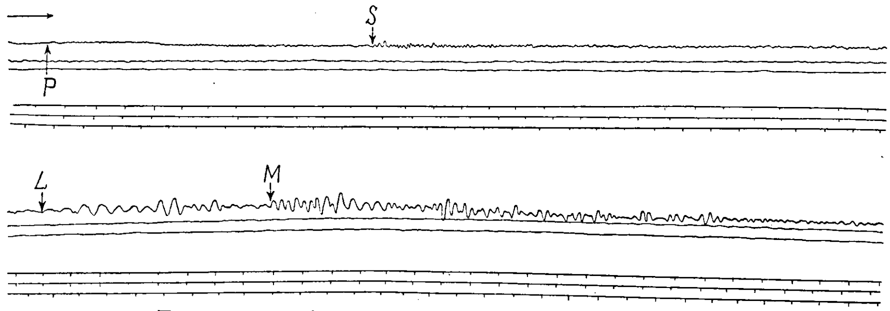

Fig. 34. $\Delta=90°$; Calabria, 1905 IX 8; *NS*;
$V=20$, $T=48{\cdot}5^{s.}$. Original × 1/3.

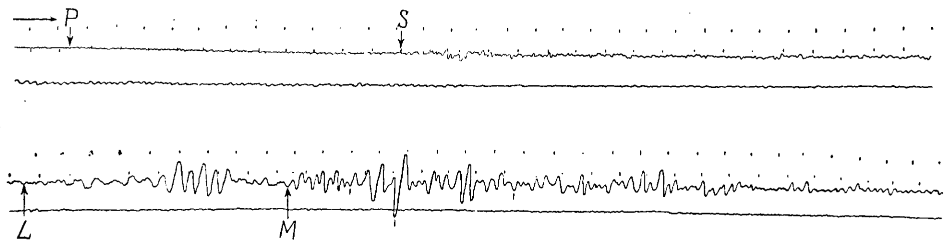

Fig. 35. $\Delta=90°$; Messina, 1908 XII 28; *NS*;
$V=20$, $T=48{\cdot}5^{s.}$. Original × 1/3.

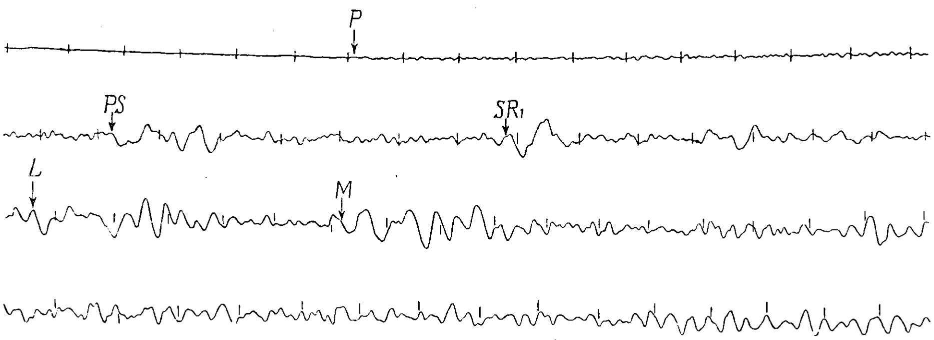

Fig. 36. $\Delta=102°$; Mexico, 1932 VI 3; *NS*;
$V=20$, $T=59^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

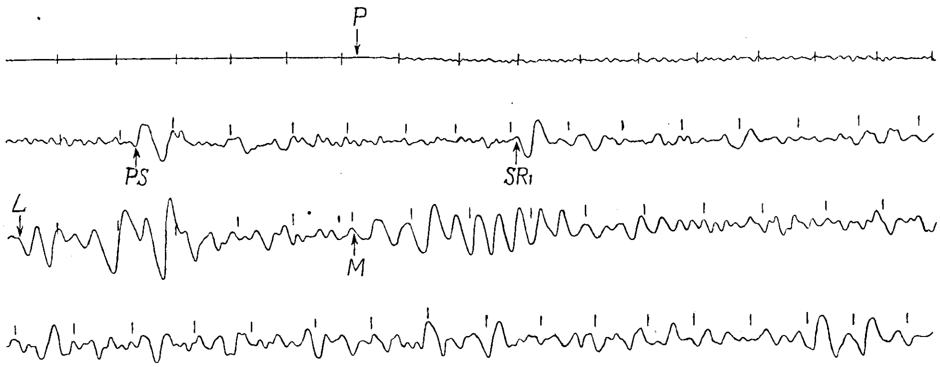

Fig. 37. $\Delta=102°$; Mexico, 1932 VI 3; *EW*;
$V=15$, $T=71^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

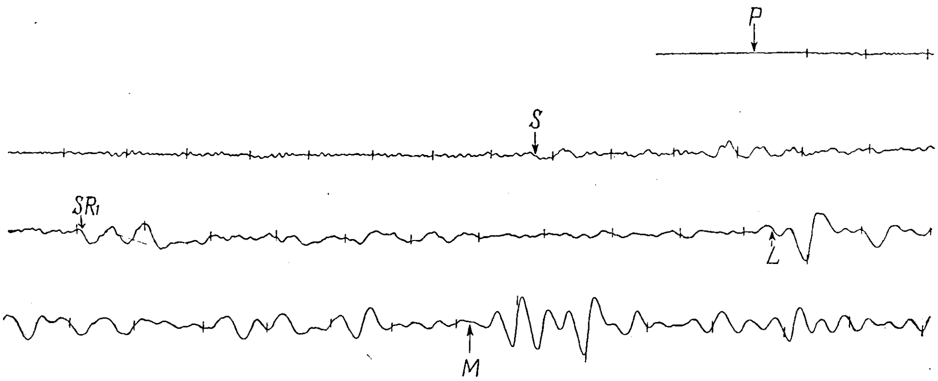

Fig. 38. $\Delta=111°$; Mexico, 1931 I 15; *NS*;
$V=20$, $T=59^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

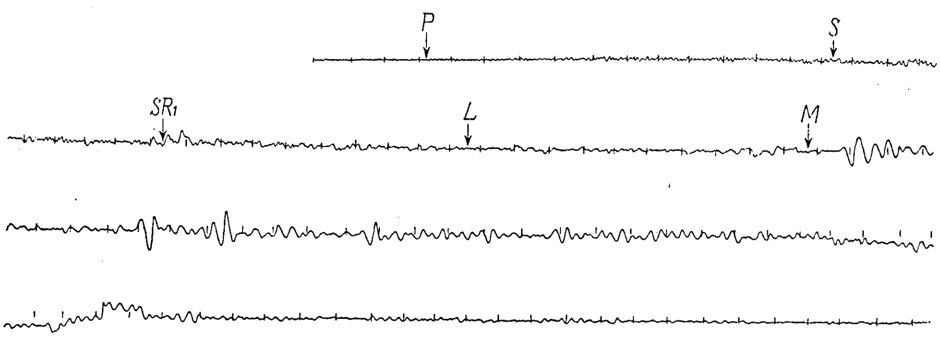

Fig. 39. $\Delta=111°$; Mexico, 1931 I 15; *EW*;
$V=15$, $T=71^{s.}$, $\varepsilon=1{\cdot}9$. Original × 1/3.

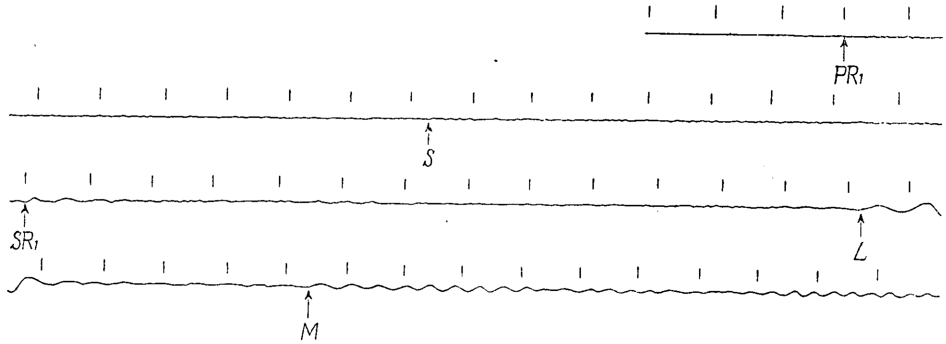

Fig. 40. $\Delta=125°$; South Pacific, 1920 III 20; *NS*; $V=20$, $T=50^{s}$, $\varepsilon=2{\cdot}0$. Original × 1/3.

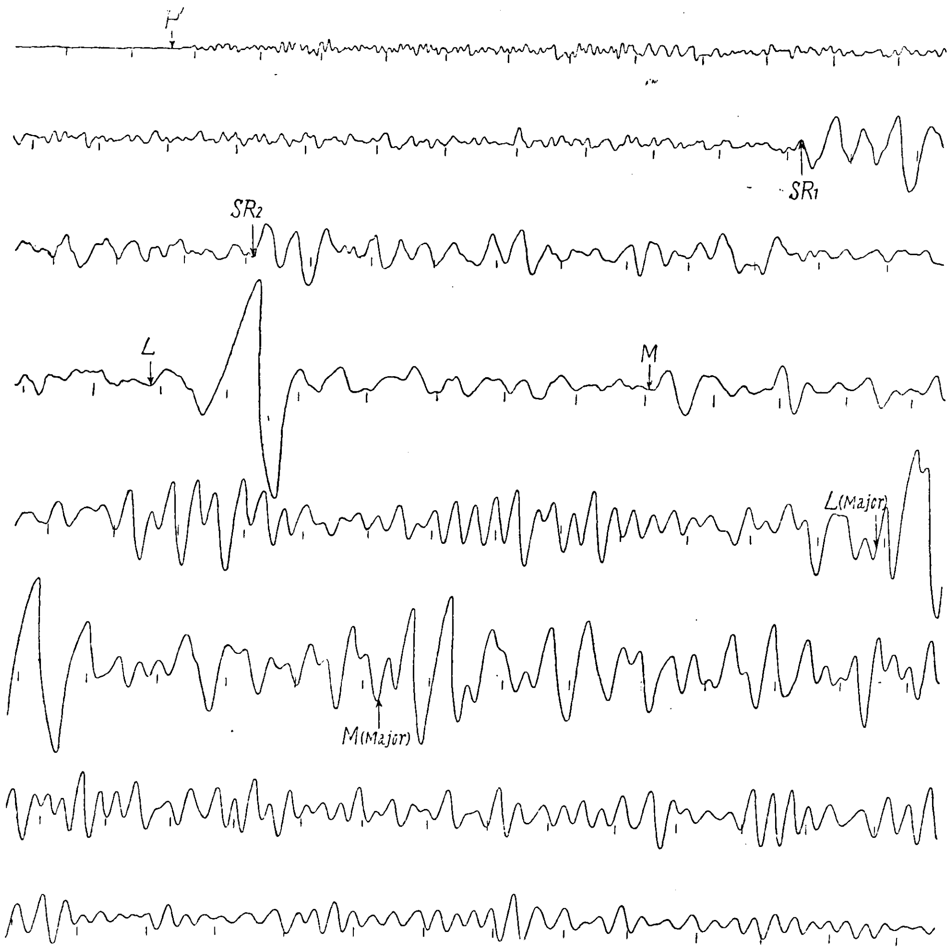

Fig. 41. $\Delta=153°$; Atacama, 1922 XI 11; *NS*; $V=20$, $T=50^{s}$, $\varepsilon=2{\cdot}0$. Original × 1/3.

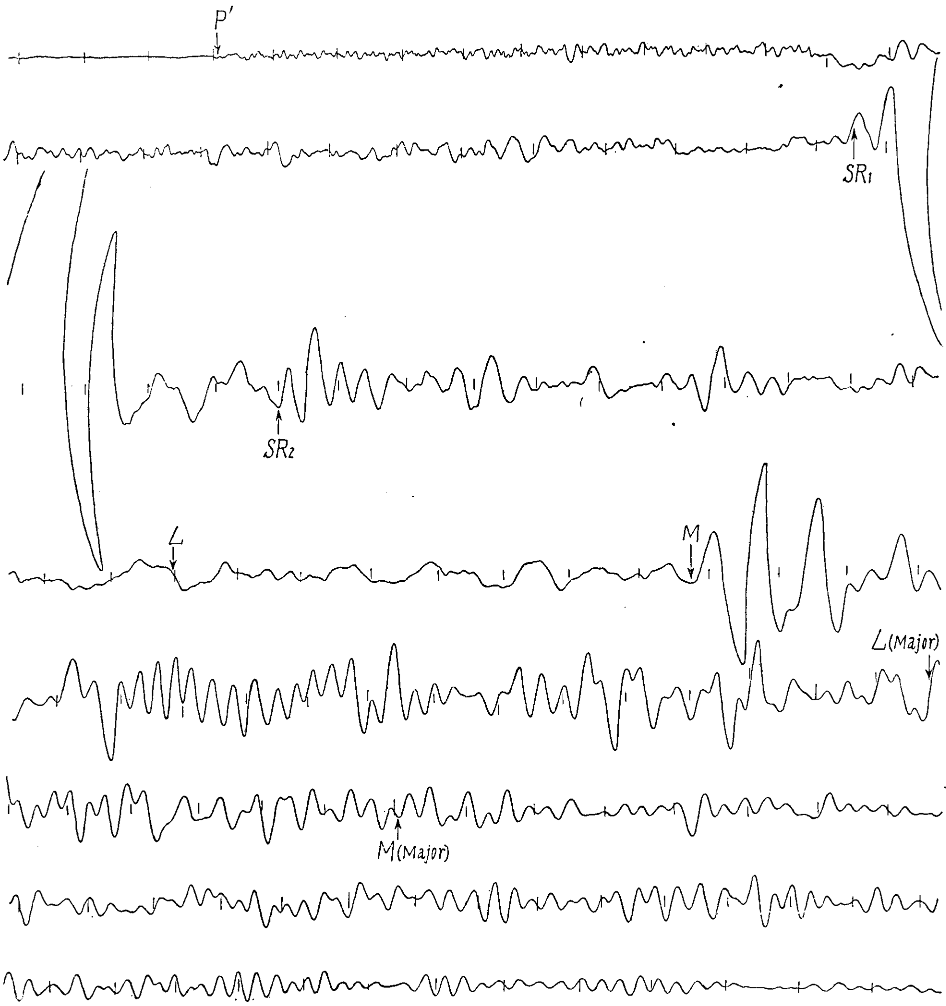

Fig. 42. $\Delta=153°$; Atacama, 1922 XI 11; EW;
$V=15$, $T=60^{s}$., $\varepsilon=3{\cdot}2$. Original $\times 1/3$.

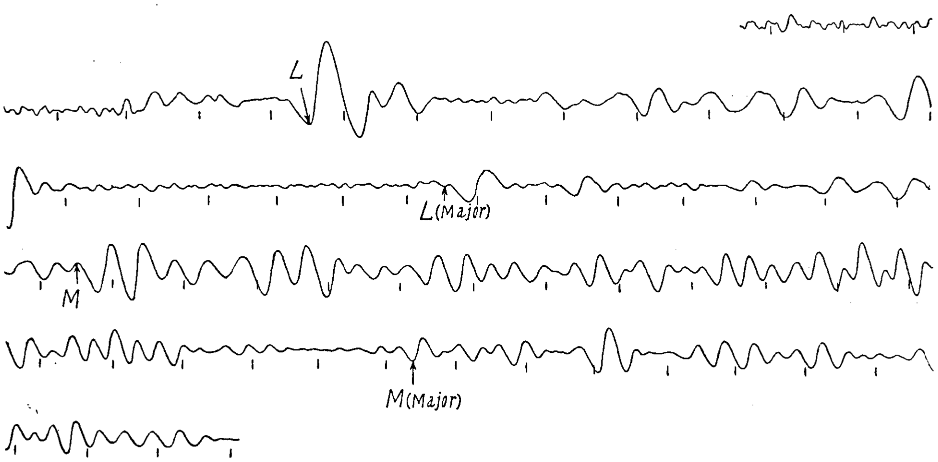

Fig. 43. $\Delta=163°$; South Atlantic, 1929 VI 27; *NS*;
$V=20$, $T=49^{s.}$, $\varepsilon=1{\cdot}56$. Original × 1/3.

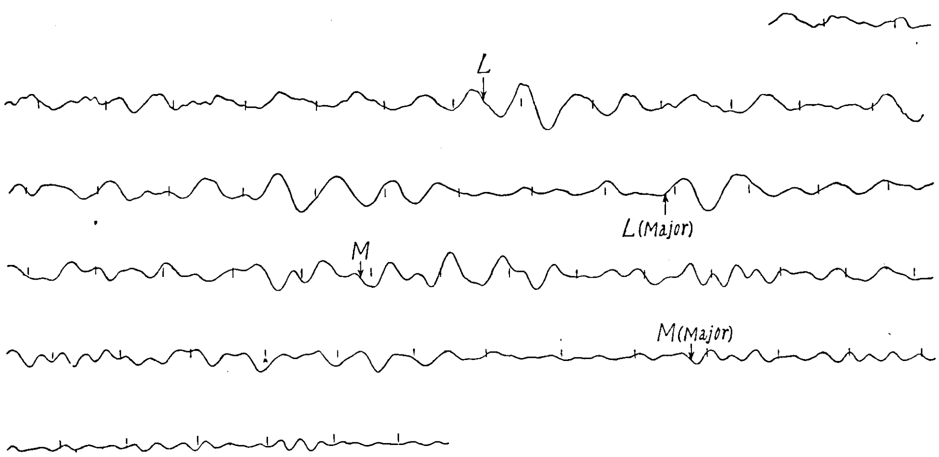

Fig. 44. $\Delta=163°$; South Atlantic, 1929 VI 27; *EW*;
$V=15$, $T=53^{s.}$, $\varepsilon=1{\cdot}96$. Originial × 1/3.

2. L位相M位相の振動週期及振幅

地震研究所 {妹澤克惟
金井清

地震記象のL位相は振幅は小さいけれども振動週期が長く，M位相は逆に週期は稍短いけれども振幅が大きいことが普通認められてゐるところである．これを委しくしらべる爲にラブ波とレーレー波を更に考へ直して見た．一體ラブ波は波長が如何に短くなつても其振動部分は表面層全體に行きわたつてゐるものであつて，これをレーレー波のやうに波長の極く短いものゝ振動部分が固體の表面にのみ蓄積するのと大いに違ふものである．さて問題を簡單にする爲に震動の勢力が各波長の調和波に各等しく分配されると假定して計算を試みると，L位相の波はM位相の波よりも常に振動週期が長いことがわかる．然るに振幅については近い震央距離ではL波の方がM波の方よりも小振幅であるけれども，遠距離になると寧ろL波の方がM波の方よりも大振幅になることが知られるのである．之等の結果が實際にあてはまるかどうかを見る爲に，種々の震央距離の遠距離地震の記象を比較して見たところが週期についても振幅についても上述の議論が略々成立することが確められたのである．