Observations of Lg and Rg waves and remarks about the nature of Lg,

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The result of the seismic sounding in the Black Sea (1) showed that to the South of the Crimean peninsula the granitic layer is interrupted in the deep part of the sea.

The preliminary data about the weakening of the Lg and Rg waves when they propagate through the central part of the Black Sea was exposed in our previous work (**) and by M. Bath (*). The further investigation consists in finding the clear waves Lg on the continental paths. We succeeded in this comparing the records of waves at stations Tiksi from the earthquakes of two groups. The first group of earthquakes: Mongolia, Pamir, Southern China. The second group: Aleutian Islands, Kamchatka, Kuril Islands, Japan.

For the Mongolian earthquakes very sharp beginnings of waves, especially Lg, having great amplitudes with the period of 2 to 4 sec are observed. On the records of the station Tiksi clear waves Lg and Rg are noticed (fig. 1). For the earthquakes of Southern China these waves are clear, however the amplitudes are smaller and the periods of the waves are greater than previous. On the whole the first group of the paths corresponds to the continental structure of the earth’s crust. The mean values of the velocities of these waves are: $Lg_1 = 3.53 \text{ km/sec}; \ Lg_2 = 3.31 \text{ km/sec}; \ Rg = 3.05 \text{ km/sec}$.

For the epicentres of the Aleutian Islands no clear beginnings of the waves Lg and Rg are distinguished. The period of 18 to 24 sec with the superposition of rather weak waves of short period is predominant on the records of surface waves (fig. 2). The direction of the paths in

this case passes through the deep part of the Bering Sea ($H \approx 3.5$ km) where the granitic layer seems to be interrupted or absent. For this region seismograms of 12 earthquakes are interpreted.

The group of the epicentres of Kamchatka, the Kuril Islands and Japan does not present a clear pattern of the interruption of the granitic

layer or the continental structure of the earth's crust. In this case seismograms with the $Lg$ and $Rg$ waves and without them are available. This can be explained by the presence of a deep part in the Okhotsk Sea ($H = 3$ km) on the path of the propagation as well as the Kuril trench which has some effect creating the breakings of the granitic
Fig. 2. — Copy of a seismogram of the seismic station. The waves are shown...
layer. This is the cause of the doubtful cases and the disappearance of Lg and Rg on records. 26 earthquakes of this group are investigated. For some of them the mean values of the velocities are the following: 

\[ Lg_1 = 3.50 \text{ km/sec}; \quad Lg_2 = 3.29 \text{ km/sec}; \quad Rg = 3.06 \text{ km/sec}. \]

Fig. 3 shows the results of the calculations of the dispersion curves of the group velocities for Love waves in the two layered crust \((^t)\). The ordinate axis represents the ratio of the group velocity to the velocity of transverse waves \(v_s\) in the upper layer. The abscissa axis represents the value inversely proportional to \(kH\) \((H = h_1 + h_2)\) expressed in terms of the period \(T\) velocity and the thickness of the crust \(H\), namely \(kT/H\).

The parameter of the family of curves is the ratio of the upper layer’s thickness \(h_1\) to the total thickness of the earth’s crust \(H\). The group of the curves in fig. 3 corresponds to the first mode.

The family of curves for the first mode shows the presence of the points of maximum. For them the amplitude in the conditions of dispersion is great and the appearance of such waves on a seismogram will form as if onsets of waves. The maximum will be seen on the background of the preceding waves.

We suppose that such is the nature of waves \(Lg_1\). This wave corresponds to the maxima on the dispersion curves of the first as well as higher modes of the Love wave.

For the final solution of the problem about the correctness of our explanation of nature of the \(Lg_1\) wave the observed data of the velocities and periods of \(Lg_1\) wave must be compared with the theoretical curves in fig. 4. The comparison of empirical results with the curves was made on different assumptions about the thickness of the earth’s crust.
Families of curves are plotted in fig. 4. The abscissa axis represents the period in sec., the ordinate axis — the value of the velocities based on the assumption that $b = 3.3$ km/sec. Each straight line corresponds to the points of the maximum for the dispersion curves of the first mode of the Love wave at different values of the total thickness of the earth's crust from 20 to 60 km. The horizontal straight lines on this chart correspond to different values of the ratios of the thickness of the upper granitic layer $h$ to the total thickness of the crust $H$. Points designate the values of velocities and the periods of their onsets obtained from observations by different authors: for the propagation of waves from the Black Sea earthquakes to Swedish stations by Bath (1), for the waves from the Black Sea earthquakes to the Moscow and Simferopol stations by the authors, for the waves propagating through the USA...
continent by Press (1). The data of the Lg wave from various earthquakes obtained at the Toledo seismic station by Payo Subiza (2) and finally the data obtained by Oliver, Ewing and Press for the Arctic (4).

On the whole the points corresponding to the observation data on the chart for the thickness of the crust from 20 to 60 km. However their scattering considerably exceeds the 60 km thickness of the crust. The relative thickness of the upper layer of the crust ranges from 0.25 to 0.45. Thus to a first approximation the agreement with our assumption that Lg is as a rule the first mode of the Love wave can be considered satisfactory.

Fig. 5. - Plot of lines of maximum group velocity (2\textsuperscript{nd} mode) and the velocities and periods of the Lg\textsubscript{w} wave of the Mongolian earthquakes.

More detailed comparisons show that the Lg\textsubscript{w} wave can correspond also to the second mode of the Love wave. This is suggested by the fact that on the path of the propagation of waves from Mongolia to the station Tiksi the thickness of the earth's crust is sufficiently great. If to use the formula permitting to estimate the crustal thickness on the basis of relief (7) (or the map given in the same paper) the crustal thickness on this path must be of the order of 45 km approximately, the same thickness would be obtained by means of the method of A. A. Treskov (7). If to extrapolate the data obtained in the process of the deep seismic sounding of the Northern Tien Shan (9) to the path from Mongolia to North then the crustal thickness must also be estimated equal to 40-45
km and the relative thickness of the granitic layer can be considered equal to 0.3-0.5. Fig. 5 is a chart of the straight lines for the points of the maximum on the group velocity curves of the second mode of the Love wave with different crustal thickness. The points representing the velocities and the periods of the Lg, at the station Tiksi from Mongolian and Chinese earthquakes when the beginnings of Lg, were the most clear are also plotted on this chart. These points agree with the presented data about the crustal thickness expected on the investigated path.

**SUMMARY**

This investigation consists in finding the waves Lg and Rg on the paths in the far east. On the bases of theory and observations some conclusions are made concerning the nature of Lg wave as a mode of Love waves in two layered crust.

**REFERENCES**

(5) PAYO SUBICIA, Report During V European Seismological Comission, Spain, 1959.

