Letters to the Editor

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RAYLEIGH WAVE DISPERSION AND CRUSTAL STRUCTURE FROM RUSSIAN NUCLEAR EXPLOSION OF 30 OCTOBER 1961

The use of surface wave dispersion for determination of crustal structure is well known. Oliver (1962) has summarised all such available information in the wide range of spectrum of observed periods. Most of the determination of crustal structure are based on data obtained from natural earthquakes. Recently Pomeroy (1963), Tandon and Chaudhury (1963) have used data obtained from nuclear explosions for the determination of crustal structure by using fundamental and M_2-Rayleigh waves. The Russian nuclear explosion of 30 October 1961 was the biggest of the series and gave rise to very well developed surface waves of fundamental and M_2-mode, which were well recorded by the vertical component of the Press-Ewing long period seismograph ($T_0 = 15$ sec and $T_g = 90$ sec) at New Delhi. A part of the record is shown in Fig. 1. Saha (1964) has used M_2-waves for the determination of crustal structure. The intention of the present author is to present the observations on the fundamental mode Rayleigh waves and to make a study of the average crustal structure between Delhi and Novaya Zemlya.

The co-ordinates of the ground zero for this nuclear explosion and origin time are as follows—

Epicentre	*Origin time*
Lat. 74°N, Long. 52°E	$08^h\ 33^m\ 30^s$ B.C.I.S.
Lat. 73·8°N, Long. 53·5°E	$08^h\ 33^m\ 27{\cdot}8^s$ U.S.C. G.S.

The origin time $08^h\ 33^m\ 33^s$, as determined by Saha, which is nearly equal to the above two values, is used for the determination of phase and group velocities. The observed periods are in the range from 39 to 22 seconds.

The Rayleigh wave dispersion was computed by the graphical method of Press and Ewing (1952). The crests and troughs of wave groups were plotted against arrival times and the slope of the curve was used for the determination of period at successive points. The arrival time at these points were used to compute velocity of the waves. The results are shown in Fig. 2 along with a theoretical dispersion curve of Dorman case 8021 for crustal thickness of 35 and 45 km.

The phase velocity data shown in Table 1 was computed by method suggested by Brune, Nafe and Oliver (1960) by using observations from a single station. For determining the phase velocity, the arrival times were corrected for instrumental phase shift, using the corrections given by Buchbinder (1963) for a similar study. This method was successfully used by Buchbinder (1963) for crustal studies in Canada from explosion generated waves. The superiority of the use of explosion generated waves over the waves generated by natural earthquakes is that the first motion at the origin in the case of explosions could be assumed with certainty. The same computational procedure was followed to determine the phase velocity of waves and the results are plotted in Fig. 2.

The group and phase velocities thus computed for Rayleigh waves are compared with theoretical Dorman case 8021 for a crustal model of total thickness of 45 km and 35 km. The other physical parameters are given in Fig. 2. The following symbols are used in the model—

β = velocity of shear waves, ρ = density,

h = layer thickness in km.

These theoretical curves are plotted for a two layered crust with a sedimentary layer at the top overlying a semi-infinite isotropic half space.

The observed values of group and phase velocities fall in between the theoretical curves for 35 km and 45 km and are closer towards higher thickness of the crust. The similar results from both phase and group velocity demonstrates the soundness of the method adopted and of the assumption that explosions are compression type sources which means that all the spectral components generated by the explosion are in phase as troughs at the origin. The group velocities are also compared with the data obtained by Pomeroy (1963) from nuclear explosion for a path Agra to Novaya Zemlya and a very close agreement can be seen from Fig. 3. These comparisons indicate that the average crustal thickness between Delhi and Novaya Zemlya is of the order of 45 km.

The crustal structure in regions near the present path has been studied by several authors, Pomeroy, Tandon and Chaudhury and Saha using data from nuclear explosions and indicate a crustal thickness of the order of 45 km.

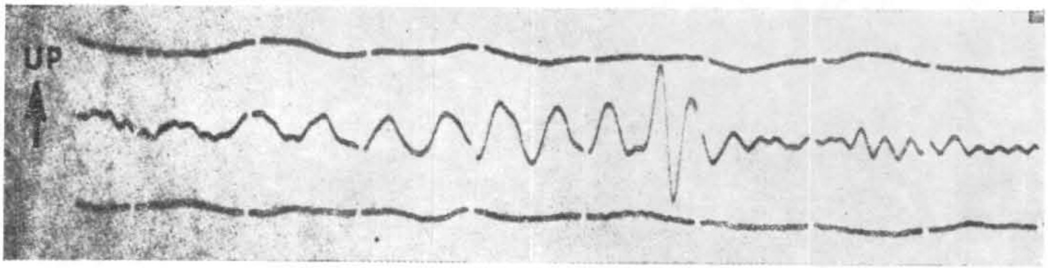

Fig. 1. A section of the Press-Ewing seismogram, 30 October 1961

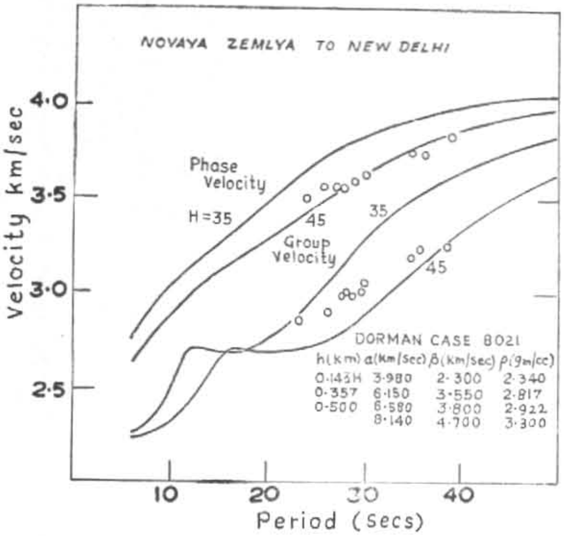

Fig. 2

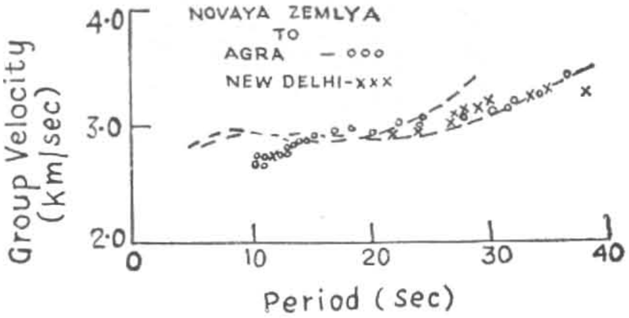

Fig. 3

The dashed lines indicate the theoretical curves for Rayleigh wave, the top line for 35 km and bottom line for 45 km

TABLE 1

S. No.	Period (sec)	Group velocity (km/sec)	Phase velocity (km/sec)
1	34·80	3·28	3·73
2	38·40	3·26	3·92
3	34·10	3·21	3·74
4	30·00	3·17	3·64
5	29·40	3·14	3·60
6	28·00	3·07	3·56
7	27·60	3·05	3·56
8	27·50	3·00	3·56
9	25·80	2·93	3·62
10	22·80	2·92	3·57

Sechkov (1964) has studied the crustal structure in the U.S.S.R. and two deep seismic soundings reported by him, near Kazak region, which lies close to the path under study indicate a thickness of 40-43 km and 40-50 km respectively.

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U. S. DE

Central Seismological Observatory,
Shillong

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