THE CRUSTAL STRUCTURE OF THE ST. LOUIS AREA DETERMINED FROM THE PHASE VELOCITY OF RAYLEIGH WAVES

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This study is concerned primarily with the determination of the crustal structure of the St. Louis area from the phase velocity of Rayleigh waves.

In the past several seismologists have investigated the crustal structure of the St. Louis area using refracted earthquake body waves. However, the disparity of the results of these studies indicates that the problem has not been conclusively solved.

The data for this study were provided by two large magnitude, shallow focus earthquakes. They were the Assam earthquake of Aug. 15, 1950 and the Kamchatka earthquake of Nov. 4, 1952. The Rayleigh waves generated by both of these earthquakes were well recorded by short period, horizontal component Wood-Anderson seismographs operating at both stations in the immediate St. Louis area (Florissant and St. Louis).

The proximity of the two recording stations (21.78 km.) had several important consequences. Since phase propagation times between the recording stations were relatively small, the correlation of the phases on the records of both recording stations was greatly facilitated. Also, the distance between the recording stations was less than the wave lengths of even the shortest period phases, thereby minimizing the dispersive effects on the propagating phases. (The phases propagated between the recording stations with nearly constant phase velocities.) However, because certain errors in reading the phase arrival times were unavoidable, the relatively small times required for the phases to propagate between the recording stations proved to be the main limitation on the accuracy of the determined phase velocities. Another limitation was the fact that it was not possible to directly determine the azimuths of the arriving waves, since only two stations were available.

The crustal model used in this study was the same as that employed by Press, Ewing, and Oliver in their study of the crustal structure and surface wave dispersion in Africa. It was a single superficial layer overlying a semi-infinite medium.

The observed Rayleigh wave phase velocity versus period relationships for both the Assam and the Kamchatka earthquakes were considered in light of this theoretical Rayleigh wave phase velocity versus period curves introduced by Press, Ewing, and Oliver in their African study. Many of the phases considered possessed apparently anomalous phase velocities. But, as Evernden pointed out, this phenomenon could readily be explained as being the result of phases passing the recording stations at azimuths quite different from that of the great circle arc joining the earthquake epicenter and the recording stations. As a logical cause for the different phase azimuths Evernden cited the refraction of the Rayleigh waves encountering the boundaries between oceanic and continental type crusts during their propagation. In this study, Rayleigh wave group velocity information from the Assam earthquake was employed to support this explanation.

Finally, from the combined data of both the Assam earthquake and the Kamchatka earthquake, the "actual" phase velocities (the phase velocities of those phases thought to have followed the great circle arc from epicenter to station) were plotted against period. The theoretical Rayleigh wave phase velocity versus period curve that gave the best least squares fit to these data was the 35 kilometer curve, indicating that the actual layered crust in the St. Louis area may be approximated by a single layer 35 kilometers thick with $V_{s1} = 3.51$ km./sec., $V_{s2} = 4.68$ km./sec., $\rho_2 = 1.25\rho_1$, and $\sigma_2 = \sigma_1 = .25$.