SOME EFFECTS OF A LAYERED SYSTEM
ON DILATATIONAL WAVES

Willard James Hannon, Jr., B. S. in Gph. Eg.

Digest

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An important problem in seismology is the effect of the layering in the earth's crust on the surface motion arising from a plane dilatational wave striking the base of the crust. Although several authors have shown that the surface motion does depend on the crustal layering, the frequency, and the angle of incidence, only N.A. Haskell has obtained a quantitative measure of the variation of the surface motion with frequency and angle of incidence. However, even these results were limited to a single model having one layer over a half space.

In this dissertation, the effect of the crustal model on the variation of the surface motion with the angle of incidence and the frequency is examined for several crustal models. The study was carried out by programming the problem for the IBM 1620 and 7072 computer systems using the matrix formulation originally suggested by Thomson and perfected by Haskell and Dorman. From these programs, the ratios of the displacements at the free surface to

the total amplitude at depth were computed for several crustal models in ranges of frequency and angle of incidence of interest in seismology. These ratios are, in effect, transmission coefficients.

Six crustal models having such features as thin low-velocity surface layers, low-velocity layers at depth, and relatively thick and relatively thin total thicknesses were considered. For each model, the transmission coefficients were computed for frequencies ranging from .02 cps to 10.0 cps in steps of .02 cps, and for angles of incidence ranging from 21 degrees to 53 degrees in steps of 4 degrees. Haskell's model was included in these calculations in order to obtain a check on the calculations. A further check was obtained by using the transmission coefficients to synthesize the surface motion due to an incident wave of the form $(1/\pi)(\sin 20\pi t)/t$ and comparing these values with those predicted by ray theory. The agreement was very good.

As a result of these calculations, the importance of the frequency dependent character of the crustal effect has been further emphasized. It has been shown that a thin low-velocity surface layer causes a large variation in the transmission coefficients, while a low-velocity layer at depth has little effect, especially at low frequencies. Further, it has been shown that the total crustal thickness is one of the most significant factors in determining the variation with frequency. The transmission coefficients of relatively thick crustal models have a much more rapid frequency variation than those of the relatively thin crust. At frequencies less than .2 cps, it is very difficult to distinguish between crustal models of very nearly the same thickness by means of the frequency variation of the transmission coefficients unless the internal structure is very different.