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H. Bungum

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VII.2 Modelling of P-wave Amplitude Anomalies in Terms of Heterogeneities in the Lithosphere

The novel block-inversion scheme of Aki, Christoffersson and Husebye (1977) has proved very successful in analysis of relative travel time observations across an array or network of seismic stations. On the other hand, most efforts aimed at explaining P-wave amplitude anomalies have only been moderately successful. At NORSAR due consideration has been given to this kind of problem in view of their importance for seismic discrimination and at the same time reflecting the need for a better understanding of wave propagation effects of lithospheric heterogeneities. The first step in this direction was a comprehensive mapping of all subarray amplitude anomalies for all beam locations (Berteussen and Husebye, 1974; Berteussen, 1975). The next step was aimed at computing theoretical amplitude distributions across the NORSAR array, and then comparing them with the observational data. In this respect we have used a simplified model for the 3-dimensional structure beneath NORSAR the construction of which was based on the following assumptions: (1) The essential 3-D structures responsible for the observed large-scale amplitude and time anomalies are located in a single layer at a mean depth D below the surface; (2) That P-waves entering this layer from below may be treated as plane waves with uniform amplitude in the plane of the wave; (3) The scales of the inhomogeneities are such that ray theory may be applied; (4) P to S conversions and anelastic effects may be ignored. We further assume that so far as the travel time and amplitude anomalies are concerned the postulated inhomogeneous layer may be treated as an equivalent thin lens located at the mean depth D of the inhomogeneities. This thin lens model was subsequently constructed by projecting travel time residuals for all subarrays for about 200 earthquakes at various depths ranging from 50 to 250 km and then averaging. This time residual model was then converted to the equivalent velocity anomaly model and then Claerbout's (1976) approach was used for numerical calculation of the wave field on the free surface.

The results obtained so far are very encouraging, i.e., the differences between observed and calculated P-wave amplitudes are generally very small. Even more startling results have been obtained when reversing the above procedure, that is, we have been able to reproduce in great detail the observed travel time residual field from the amplitude anomaly observations via a modified version of Poisson's differential equation.

A comprehensive documentation of this work will be completed in the near future.

R.A.W. Haddon, Sydney University
E.S. Husebye

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