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D. ON THE ORIGIN OF SLOWNESS AND AZIMUTH ANOMALIES OF TELESEISMIC SIGNALS

Using slowness and azimuth anomalies observed from P and PKP phases at NORSAR, it has been demonstrated (Berteussen, 1975) that as much as 90% of the corresponding anomalies for PP and PcP phases can be predicted. It is thus concluded that anomalies caused by inhomogeneities at the source side or at the deepest part of the ray path cannot be observed at NORSAR, i.e., for PP phases inhomogeneities on the source side of the surface reflection point and for PcP phases inhomogeneities on the source side or at the mantle-core reflection point are not strong enough to produce anomalies which can be identified in this type of data. Even after having corrected for the first order effect of the local structure (a dipping plane interface), there is no significant part of the anomalies left that can be ascribed to inhomogeneities at the source side. It has further been demonstrated that locating a significant part of the anomalies deep in the mantle would require unreasonable velocity contrasts; one thus has to conclude that most of these anomalies are caused by structures in the very upper part of the mantle or in the crust.

An additional piece of information (Berteussen, 1975) has been time residual and wave front slowness and azimuth measurements of long period P-waves inside three different frequency bands, 0.1 Hz highpass, all pass, and 0.05-0.1 Hz bandpass. It is found that the location error vectors gradually diminish as the frequency decreases. For the 0.1 Hz highpass data the vectors are essentially the same as for short period data, and then they change to about half the size but keep their direction for the longest wavelengths. Assuming that the linear extent of structures causing measurable anomalies have to be, say at least half a wavelength, it is thus found that since the longest wavelengths used (160-80 km) have 58%

of the (dT/dΔ, Φ) anomalies of the short period data, 58% of these have to be caused by inhomogeneities with a linear extent of at least say 1/2 $(\frac{160+80}{2})$ = 60 km. Then there are 42% of the anomalies which these long waves do not 'see', thus indicating that the inhomogeneities causing these anomalies must have a linear extent too small for these waves, i.e., 42% of the slowness and azimuth anomalies are caused by inhomogeneities of linear extent less than 60 km. From the 0.1 Hz highpass filtered data (wavelength ~ 80 km) it is further concluded that 17% (75-58) of the anomalies are caused by inhomogeneities of linear extent between 60 and 40 km. The remaining 25% of the slowness and azimuth anomalies and virtually 100% of the plane wave front deviations then have to be caused by inhomogeneities which have characteristic sizes of less than 40 km. It has been shown (Berteussen, 1975) that at NORSAR the best plane wave front reduces the variance of the time anomalies relative to the wave front predicted from the PDE event location by approximately 50% and that thus the time deviation around this best plane wave front accounts for the remaining 50%. If one therefore instead of thinking in terms of (dT/dΔ, Φ) anomalies and plane wave front deviations thinks of time deviations relative to the wave front predicted from the PDE event location the following picture emerges. 29% (58/2) of these are caused by inhomogeneities larger than 60 km, 9% are caused by inhomogeneities between 60 km and 40 km, and the remaining 62% $(\frac{100+25}{2})$ are caused by inhomogeneities of size less than 40 km. From the previous section we know that virtually all the anomalies are caused by inhomogeneities in the very upper mantle under the receiver, say above 600 km. We are now in a position to also set an upper limit to these inhomogeneities. Assuming that the anomalies are caused by structures as close to the receiver as possible, we find that a maximum of 71% (62+9) of these are produced within the last 40 km, and in order to include the remaining 29% we then have to go down to a depth of at least 60 km.

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REFERENCES

Berteussen, K.A. (1975): The origin of slowness and azimuth anomalies at large arrays, submitted for publication.