NORSAR

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NORSAR PHASE 3

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H. IMPLICATIONS OF CRUSTAL SCATTERING ON SEISMIC PROFILING

There is evidence from numerous disparate sources for the presence of small-scale random irregularities in the crust and upper mantle. Estimated characteristic sizes of irregularities are typically in the range from 4.5 meters (Jeffreys, 1970) to several tens of kilometers (e.g. Berteussen et al, 1975), but are subject to great uncertainties (Berteussen et al, 1975; King et al, 1975). Notwithstanding the uncertainties which prevail as to the characteristic size of the irregularities, their presence would be expected to scatter relatively strongly the short wavelength P (and S) waves commonly recorded in seismic profiling surveys. It is a simple matter to estimate the range of sizes of irregularities within which the fundamental assumptions underlying profiling methods are so seriously violated that a statistical (diffraction) theory is strictly necessary in any interpretation. For instance, for a typical signal wavelength of 2 km and a path length of 300 km, it can be shown from the acoustic wave scattering theory of Chernov (1960) that only inhomogeneities smaller than 0.1 km or greater than 18 kms would permit the application of standard ray theory.

A number of previous studies have indicated that a significant part of the irregularities in the vicinity of NORSAR have characteristic sizes less than about 20 km. It is to be expected then that recordings of local ($\Delta \lesssim 5^{\circ}$) events should exhibit features not readily interpretable in terms of ray theory. A number of local explosions and earthquakes recorded at NORSAR have been plotted as distance sections and the durability of various arrivals scrutinized. Almost all arrivals exhibit a great variability over small surface areas. As an example, data from an earthquake approx. 320 km away

from two subarrays separated laterally by only 40 kms are plotted on a common section in Fig. H.1. Interpretations of crustal layering based on subsets of this data would undoubtedly have grossly different features. This example is by no means atypical -- records from within 7 km-aperture subarrays commonly exhibit a comparable variability, particularly with regard to secondary arrivals. It is planned to re-examine the uncertainties in crustal interpretations using the NORSAR recordings from local earthquakes and explosions distributed widely in azimuth.

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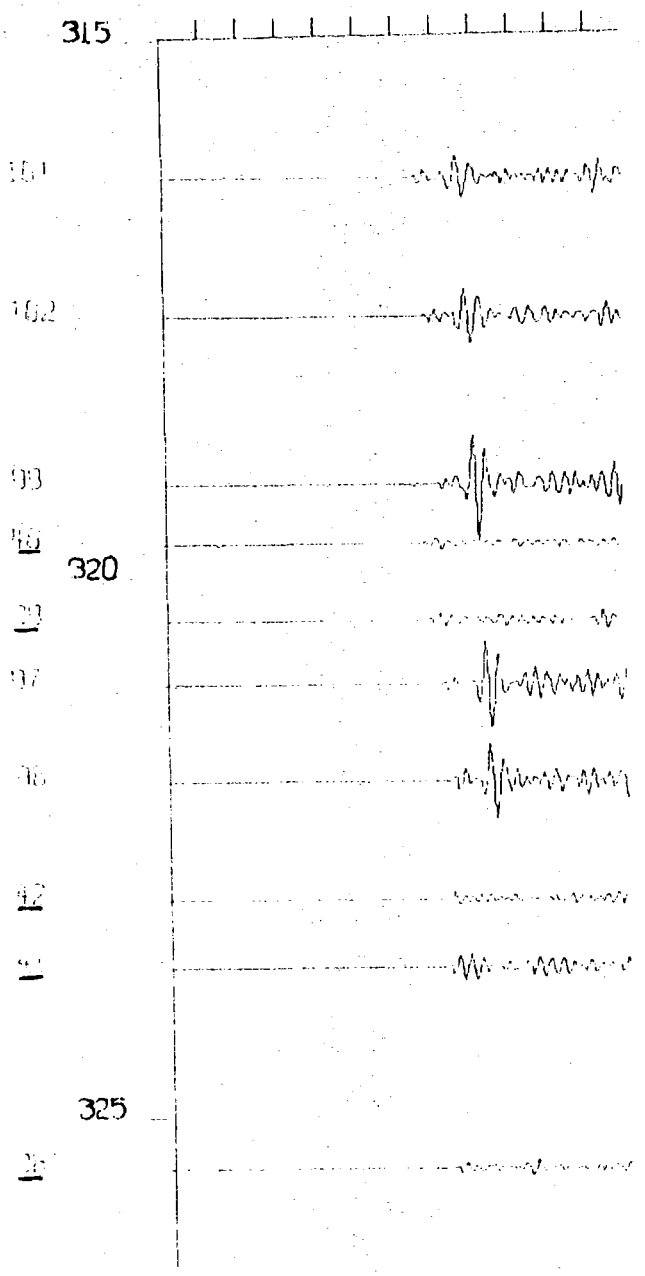

Fig. H.1 NORSAR recorded P-signals for event close to Haugesund, Norway, 03 April 1975. The leftmost numbers give instrument number (those underlined are from subarray 06B while the others are from subarray 09C). The numbers close to the vertical axis give kilometer from the source. The distance between the marks on the horizontal axis is one second. The data has been filtered with a 1.6-4.4 Hz bandpass filter.