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L.B. Loughran (ed.)

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VII.8 3-D ray tracing and structural heterogeneities in Fennoscandia

It is well known that array estimates of the P-wave slowness vectors deviate significantly from that expected on the basis of homogeneous earth structures and the corresponding velocity distribution as implied by the J.B. travel time tables. The reason for this is obviously that the "homogeneous" earth assumption is not strictly valid, but still there is some controversy as regards which part of the wave path contributes most significantly to the observed slowness anomalies. In this respect we have undertaken a 3-D imaging of the upper mantle velocity structure beneath the southern part of Fennoscandia on the basis of P-wave travel time residuals as observed across local seismograph networks (Fig. VII.8.1) in the mentioned area. The results here are displayed in Fig. VII.8.2, and the necessary details on this experiment are given by Husebye et al (1986). Using a 3-D ray tracing approach, we have calculated the range of slowness (azimuth and apparent velocity) anomalies for the NORESS/NORSAR siting area on the basis of the velocity anomaly structure in Fig. VII.8.1. In extreme cases, that is, with the largest lateral velocity gradients, the corresponding azimuth anomaly was only 3 deg, while apparent velocity anomalies amount to about $\pm$ 0.5 km s^{-1}. Note that in the latter case the choice of top or average crustal velocities would introduce a bias. The above "synthetic" findings have been confirmed from analysis of NORESS broadband records in which cases azimuth anomalies were found to be less than 2 deg and apparent velocities less than $\pm$ 1 km s^{-1}. Further details here are given in Section VII.7.

Past analysis of short period P-wave NORSAR recordings gave that the observed slowness vector anomalies could be attributed to structural heterogeneities in the lithosphere just beneath NORSAR (e.g., see Aki

et al, 1977; Christoffersson and Husebye, 1979). Interestingly, analysis of 3-component short period NORESS records provide very good azimuth estimates, while apparent velocity estimates fluctuate considerably (for details, see Section VII.7). The latter seems predominantly to reflect interference phenomena rather than direct structural effects.

E.S. Husebye
J. Hovland, Univ. of Oslo
A. Christoffersson, Univ. of Uppsala
K. Åström, Univ. of Uppsala
R. Slunga, National Def. Res. Establishment, Sweden
C.-E. Lund, Univ. of Uppsala

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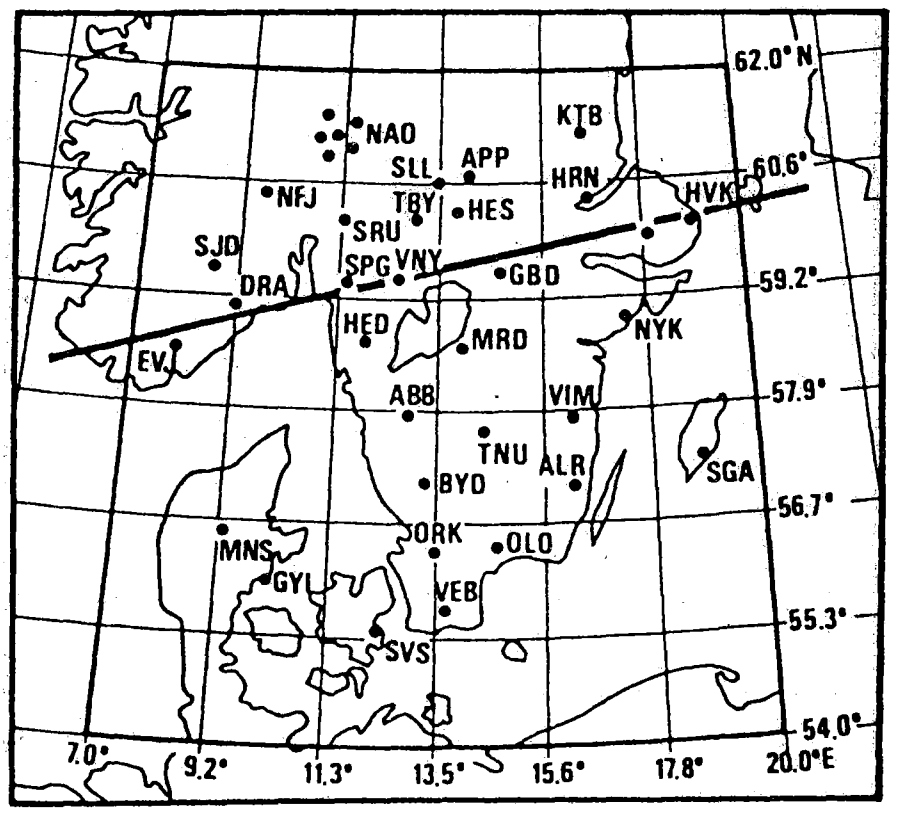

Fig. VII.8.1 The short-period seismograph network of southern Scandinavia from which the P-wave recordings have been used in analysis. This network consists of the south Swedish and the southern Norwegian (suspended from operation in May 1983) networks, plus the NORSAR array and a few Danish stations (part of the S. Swedish network). Regarding Sweden, stations HED, MRD, BYD, TNU and ABB are now suspended from operation.

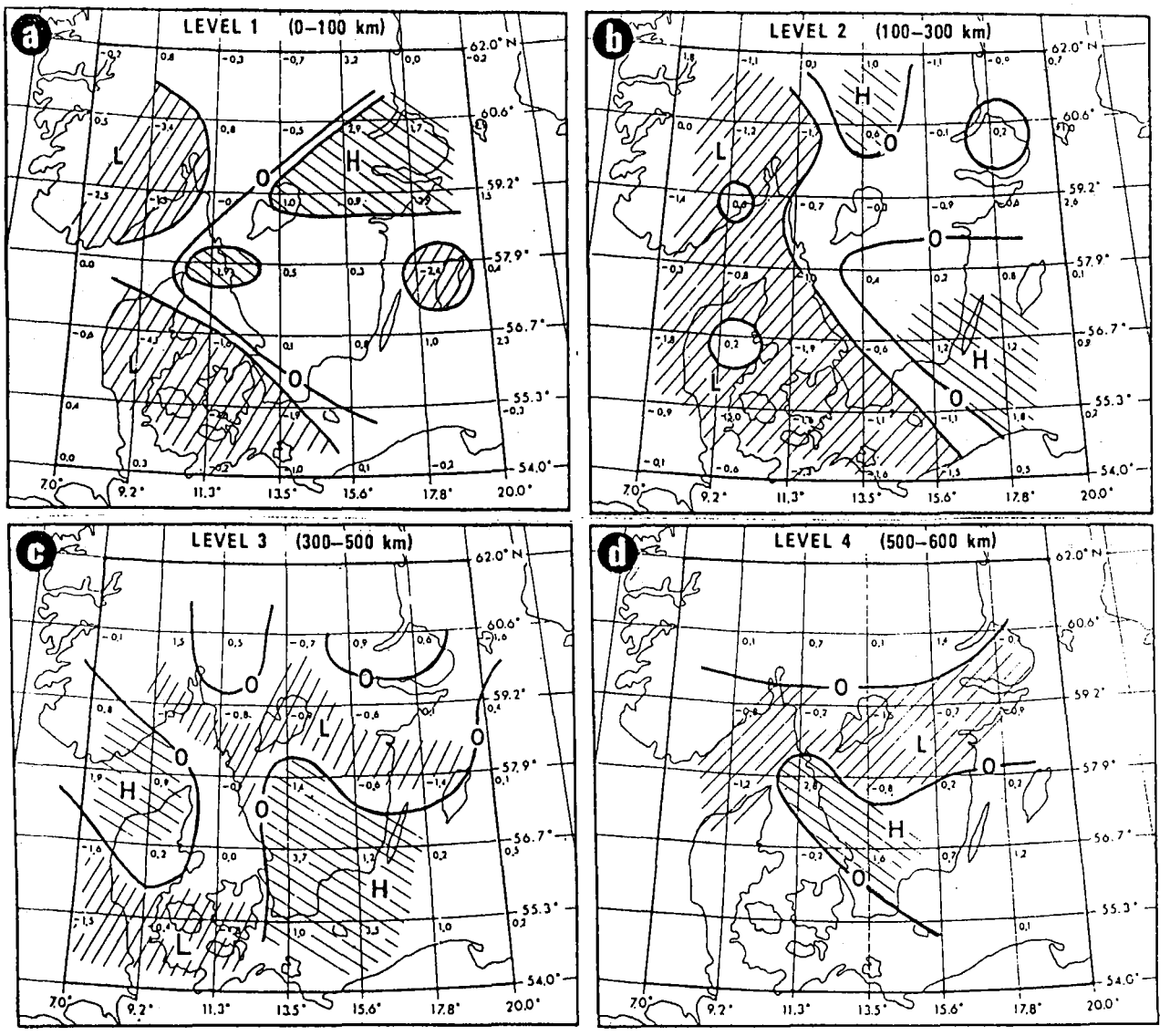

Fig. VII.8.2 3-D seismological images of the S. Scandinavian lithosphere/ asthenosphere. Here is used a 7 x 7 knot layout on four levels (cubic spline velocity interpolation). The given seismic velocity perturbations are in per cent; the letters L and H denote areas with respectively low and high velocities. Knots with resolution less than 0.5 were not used in contouring the velocity anomalies.