NORSAR

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SEMIANNUAL TECHNICAL SUMMARY

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Linda B. Loughran (Ed.)

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VII.7.1 NORESS Regional Array developments

Evaluation of the performance of the newly established NORESS array in Norway has been initiated. In particular, real time processing algorithms aimed at detection and location of events at regional distances have been developed and tested.

The design criteria and associated specifications on the performance of the new array were originally formulated as follows:

- Detection: The array should provide optimum SNR gain by beamforming.
- Location: The array should have a narrow main lobe and small side lobes.
- Performance as a function of signal frequency: The array performance should be good or at least reasonable for a wide range of frequencies, typical of regional wave propagation.
- Research aspects: The array should have an optimum coarray pattern. Add as many horizontal component seismometers as can be afforded (within the geometry of the vertical array).

The array geometry of Fig.VII.7.1 was worked out in close cooperation between Sandia, LLNL and NORSAR. It represents the best compromise we found between the partly conflicting demands made above on array performance. In the design work, we were able to draw heavily on the experience gained from several provisional array installations in Norway. For example, actually observed correlations for signals and noise were used to optimize the SNR gain. For evaluation of the location capability of the new array, beam patterns were computed for realistic signal correlations. The geometry of Fig. VII.7.1 contains useful subgeometries, which are close to optimum for different frequencies within the range 2-10 Hz.

In order to have an experimental check on the proposed geometry, a provisional 21-element array was installed during the summer of 1983. Analysis of data from this installation has confirmed the correlation

curves for signals and noise on which the design work was based. Testing of the RONAPP processing package (Mykkeltveit & Bungum, 1984) for regional events recorded on this array, shows that the arrival azimuths can be estimated to within a few degrees of the true value.

Results from the 1983 provisional installation basically confirmed the projected capabilities of the new array, and it was finally decided to deploy an array with the geometry given in Fig. VII.7.1.

The final array installed during the summer of 1984 comprises 25 short period elements, 4 out of which are 3-axis deployments with the remaining 21 elements consisting of vertical-motion seismometers only. In addition, there is a broad-band 3-axis system. Sampling rates are 40 Hz for the short period channels and 10 Hz (intermediate period) and 1 Hz (long period) for the broadband system. Data from the new array are transmitted to Kjeller via a leased land line and via satellite to the U.S. Preliminary analysis of the new data has given promising results. Fig. VII.7.2 gives an example of the automatic output from the on-line event processing of data from the new array.

Several improvements to the on-line processing package are under way. For instance, the success of the location part of the RONAPP processing package depends on a proper identification of the secondary phase associated with the P arrival. This secondary phase is either Lg or Sn and a priori knowledge on the occurrence of these phases on the NORESS records as a function of source region will be incorporated in RONAPP. For this end, regional data recorded at NORSAR over the past 13 years have been examined. The general picture is that Lg is the dominant secondary arrival, but notable exceptions have been identified, corresponding to source regions for which Sn is the more prominent or even sole secondary phase. Fig. VII.7.3 gives an example of

a tectonic feature in the North Sea that is an effective barrier to Lg wave propagation (Kennett & Mykkeltveit, 1984).

S. Mykkeltveit

References

Kennett, B.L.N. & S. Mykkeltveit (1984). Guided wave propagation in laterally varying media - II. Lg waves in north-western Europe.

Mykkeltveit, S. & H. Bungum (1984). Processing of regional seismic events using data from small-aperture arrays. Bull. Seism. Soc. Am., December 1984.

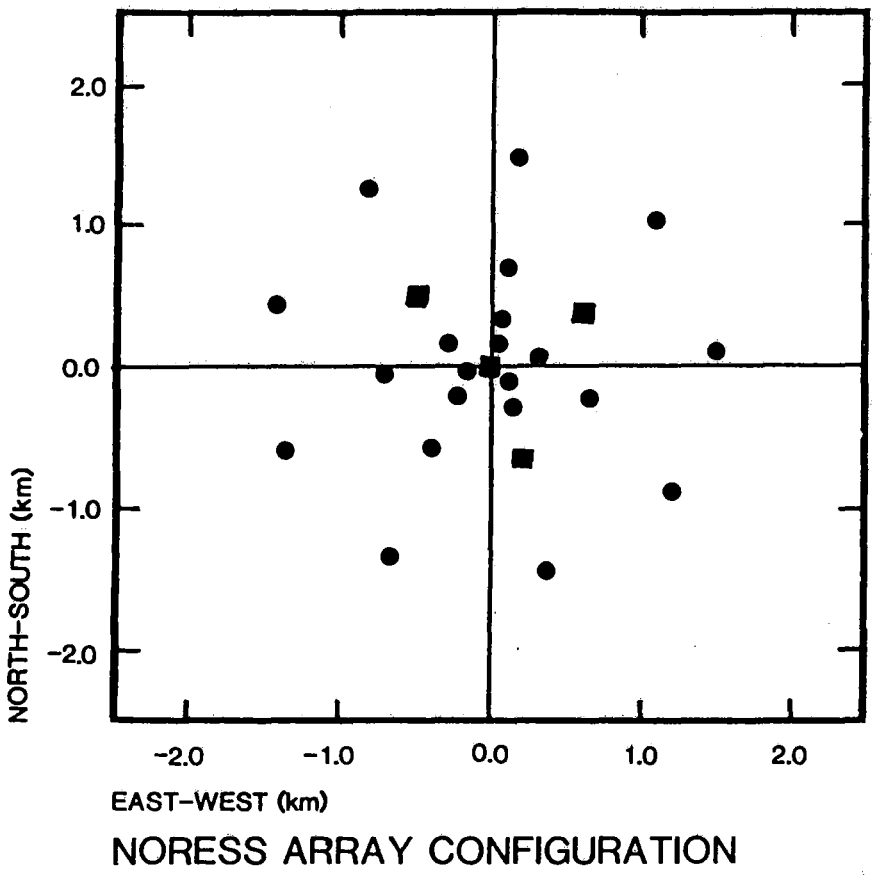

Fig. VII.7.1 Geometry of the new NORESS array, which has been installed during the summer of 1984. The four three-axis instruments are indicated by squares. All instruments are in shallow vaults, except the three-axis seismometer at the center of the array, which is installed in a 60 m deep borhole.

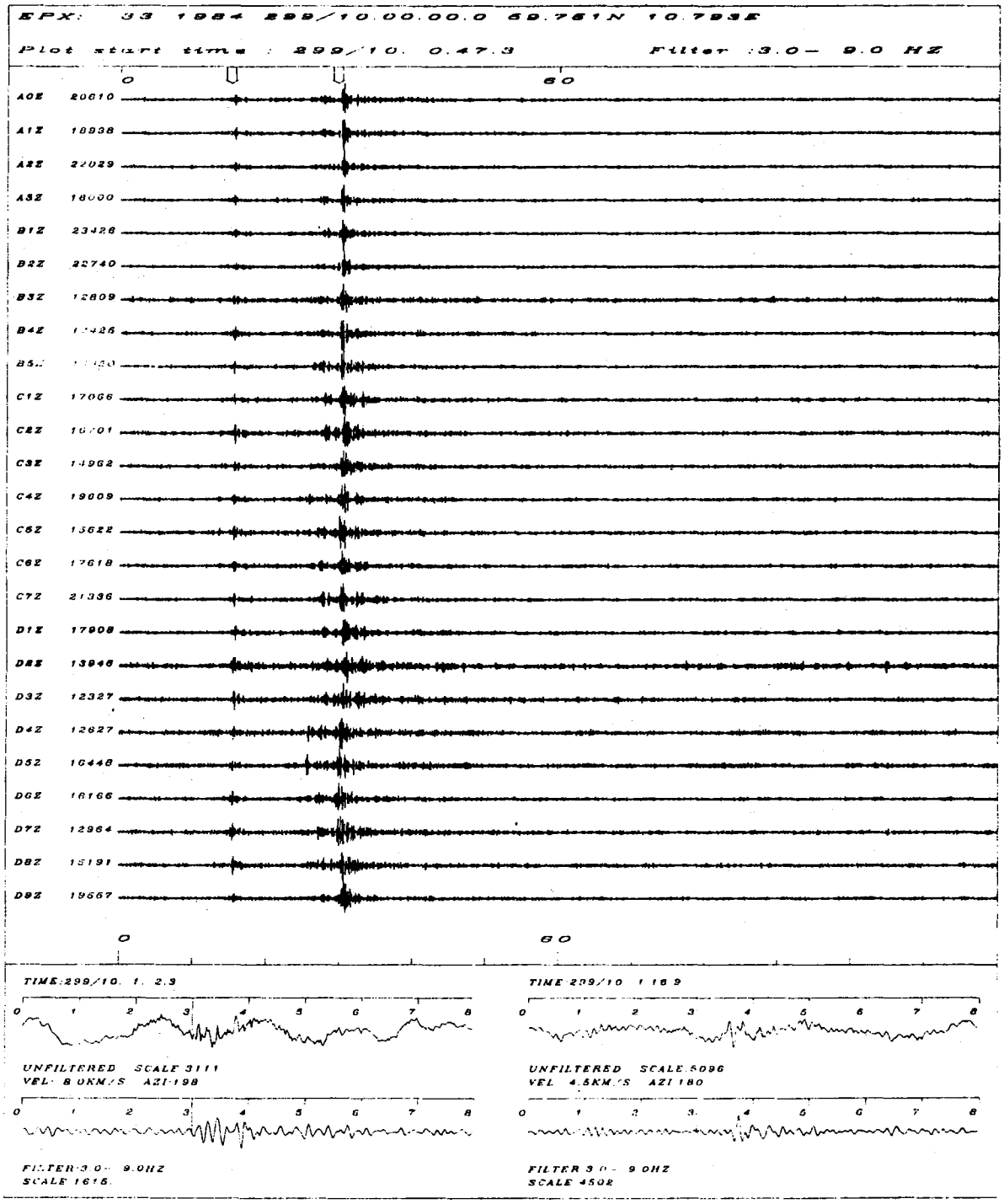

Fig. VII.7.2a Vertical component records from the new NORESS array for a local event detected and located by RONAPP. The two arrivals detected and associated are marked by arrows. Bottom: Unfiltered and filtered beams for the two detections.

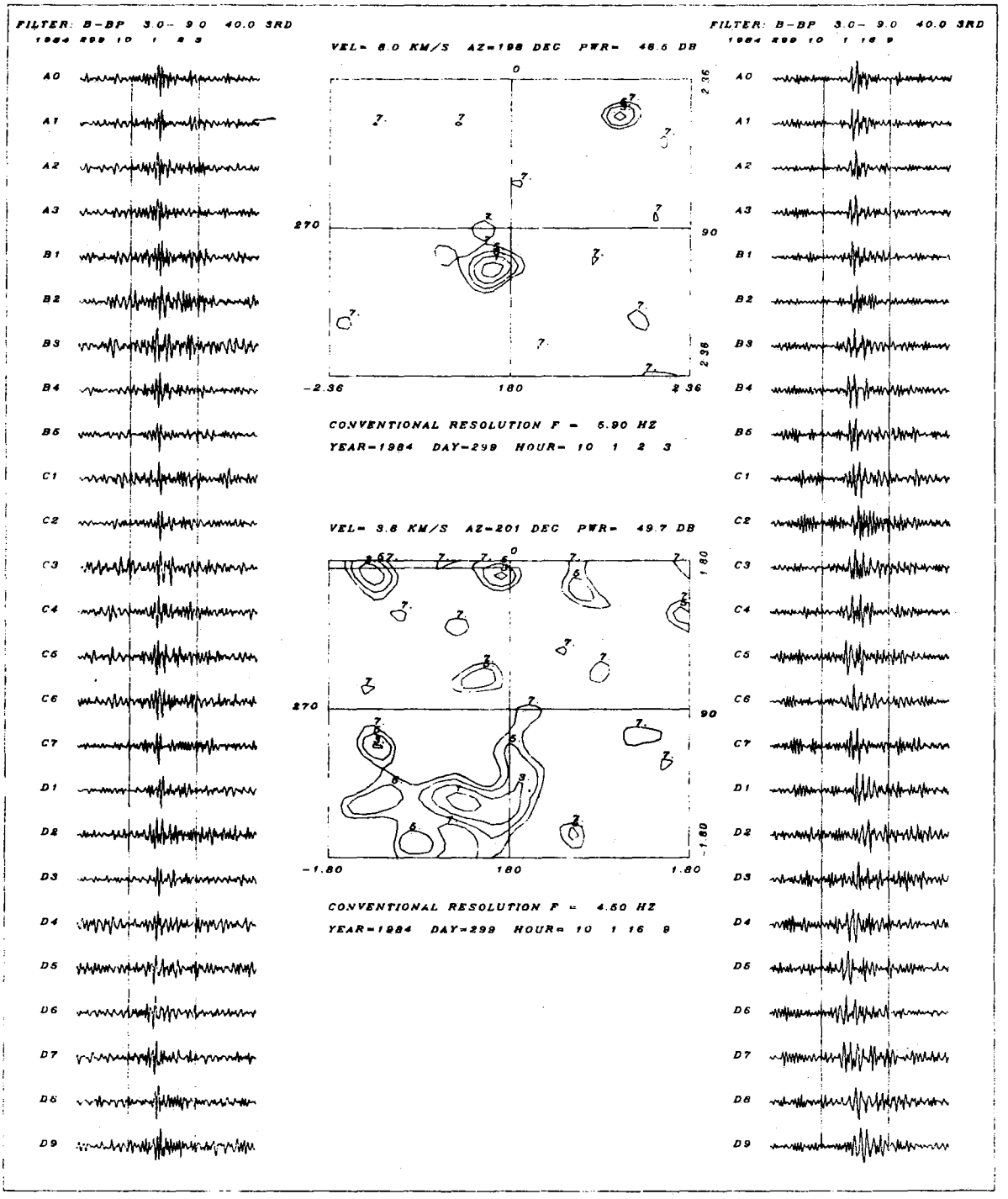

Fig. VII.7.2b Results of frequency-wavenumber analysis of the indicated time windows around the two detections in Fig. VII.7.2a.

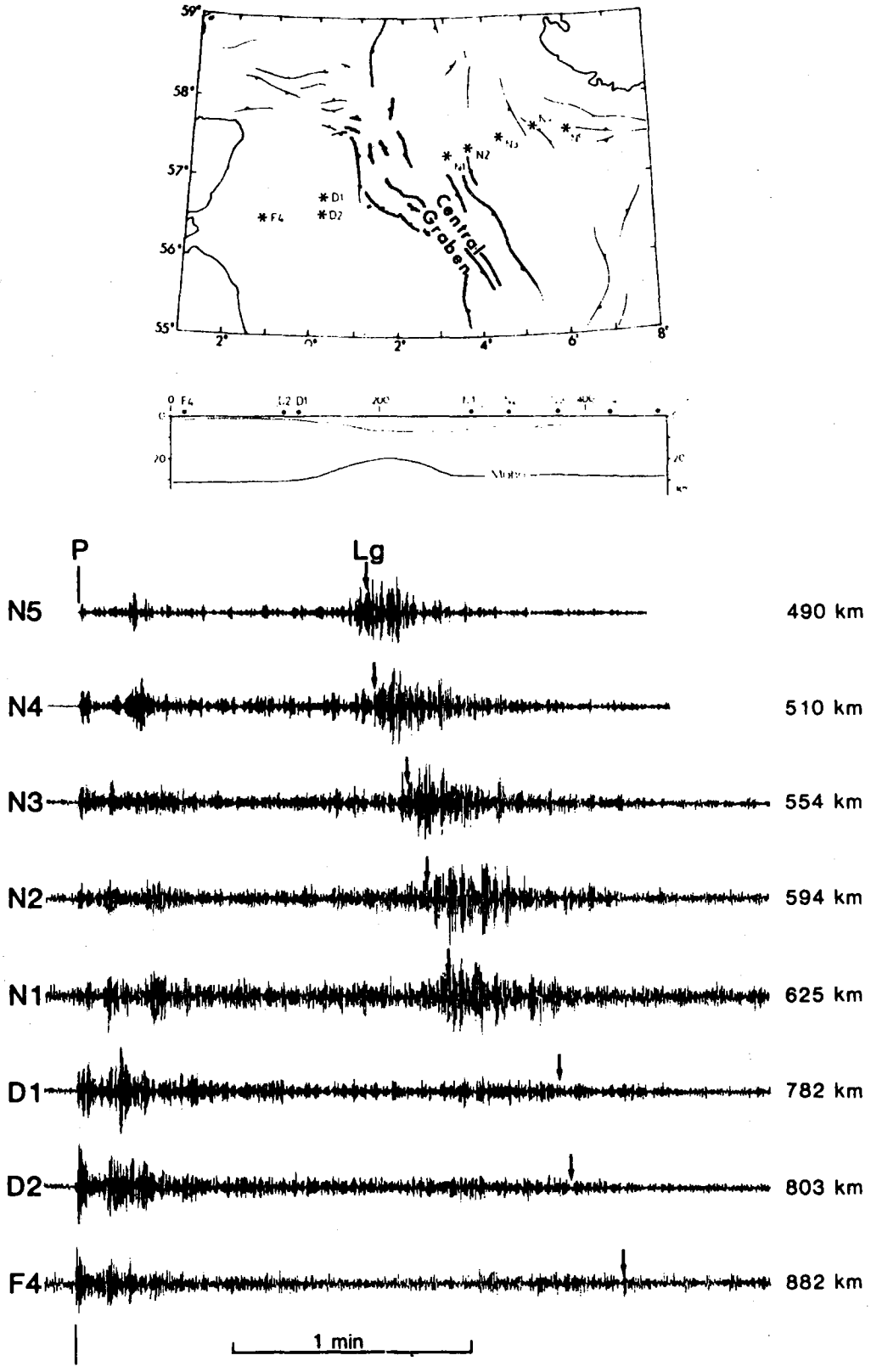

Fig. VII.7.3 Map of the central North Sea Basin (top) and main structural features (middle). NORSAR records from shots located at positions indicated in the map. Arrows indicate a group velocity of 3.5 kms^{-1} corresponding to Lg wave arrivals.