NORSAR

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SEMIANNUAL TECHNICAL SUMMARY

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VI. SUMMARY OF TECHNICAL REPORTS/PAPERS PREPARED

VI.1 On-line event detection and location based on NORESS data

In previous semiannual reports and elsewhere (cf. Mykkeltveit and Ringdal, 1981; Mykkeltveit et al, 1983), we have reported on analysis of data from the small-aperture NORESS array.

Recently, a Regional On-line Array Processing Package (RONAPP) was developed and tested in an off-line mode on NORESS data (Mykkeltveit et al, 1982). The package consists of a conventional STA/LTA detector, a phase identification procedure based on phase velocity derived from frequency-wavenumber analysis, and a location procedure based on observed travel time differences and a common azimuth between the observed primary and secondary phases. By permitting association of P and Lg phases with travel time differences less than 6 minutes, RONAPP locates regional events within about 20°. In the following, an account is given of our experience with the same processing package operated in an on-line mode.

On-line experiment

Since October 29, 1982, standard 20 Hz data have been recorded from 6 sensors within NORESS (stations 1, 3, 8, 9, 10 and 11 in Fig. VI.1.1). RONAPP reads the data sequentially directly off the recording medium through a shared disk access between the recording computer (IBM 4331) and the computer (IBM 4341) on which RONAPP is running, and performs the detection and event location analysis. This process results in a detection as well as a location record, with the latter based on our phase association procedure. Fig. VI.1.2 gives an extract of the detection record for day 319, 1982, and location results for the local event at 17.42.13.0. The two phases finally associated are marked by arrows in the detection record.

On-line detection and location performance

RONAPP was operated in an on-line mode over a total of 80 hours distributed over 10 days in November 1982 (mainly day time to ensure recording artificial events, which are generally more abundant than local/regional earthquakes).

The off-line evaluation of the performance of RONAPP was done as follows: all events located by RONAPP were checked by plotting the relevant data traces (like those in Fig. VI.1.2) and carefully reviewing the corresponding detection and location records before accepting or rejecting the 'events'. In addition, RONAPP performance for all detections by the NORSAR on-line system corresponding to an SNR $\geq$ 5.0 were checked. The output from this evaluation is summarized in Table VI.1.1.

Out of the 19 regional events declared by RONAPP, 14 were found to be wholly acceptable. 'Acceptable' simply means that P and Lg phases have been correctly determined and associated, and that the azimuth and distance estimates are deemed to be reasonable. Locations cannot, however, be checked independently as the majority of these events are small (M_L typically around 1.5-2.5) and cannot be reliably located by the regional network. Previous experience (Mykkeltveit & Ringdal, 1981), indicates that RONAPP locations are typically uncertain by 30 km. Out of the 14 events, 3 were not detected by the NORSAR detection processor (DP), having a threshold SNR equal to 3.0. Three events (all very weak) declared by RONAPP were rated questionable as it was not possible to determine whether these were real or corresponded to association of noise detections. None of the 3 'events' were detected by the NORSAR DP. Two were definitely erroneously declared as local. Both corresponded to the situation where f-k analysis of detections in the P-coda (within 10 seconds of the first P) of teleseismic events resulted in Lg-type velocities. We expect to prevent such situations by the improvement of the array geometry.

From a total of 16 other detections by DP with SNR $\geq$ 5.0, 12 corresponded to teleseismic events and were recognized as such by RONAPP (all RONAPP detections processed resulted in (relatively high) P-type phase velocities). Three DP detections had no corresponding detections by RONAPP, and one single detection by DP, probably corresponding to a local event, did not result in a location by RONAPP, as only one phase (Lg) was detected by RONAPP.

In view of the limited number of sensors participating in this experiment, we deem the above on-line location results to be very encouraging.

Further improvements in RONAPP

In spite of the promising results in RONAPP on-line performance, there is room for further improvement. We are underway with the inclusion of 'true' beams in the detector, in addition to the vertical beams in the present version of RONAPP. Sixteen beams corresponding to eight equally distributed azimuths spaced at 45° intervals and phase velocities of 4.5 km/s and 8.0 km/s have been implemented. These new beams have contributed to a lowering of the detection threshold, especially for high-frequency Lg phases, which tend to be 'smeared out' by the vertical beamforming.

S. Mykkeltveit
H. Bungum

References

Mykkeltveit, S. & F. Ringdal (1981): Phase identification and event location at regional distance using small-aperture array data. In: Identification of Seismic Sources - Earthquake or Underground Explosion (eds. E.S. Husebye & S. Mykkeltveit), D. Reidel Publ. Co.

Mykkeltveit, S., H. Bungum & F. Ringdal (1982): A processing package for on-line analysis of data from small-aperture arrays. NORSAR Semiannual Tech. Summ. 1 Oct 1981 - 31 March 1982.

Mykkeltveit, S., K. Åstebøl, D. Doornbos & E.S. Husebye (1983): Seismic array configuration optimization. Bull. Seism. Soc. Am. 73, 173-186.

RONAPP ONLINE DETECTION AND LOCATION PERFORMANCE

Test period :	80 hours	
Events located by RONAPP :	19	
Acceptable :	14	(3 not detected by DP)
Questionable, not detected by DP :	3	
Wrong, both teleseismic P :	2	
Other detections by DP with SNR 5.0 :	16	
Teleseismic, recognized as such by RONAPP :	12	
No detection with RONAPP, not local :	3	
Probably local, RONAPP detection, but no location :	1	

Table VI.1.1 RONAPP evaluation statistics. DP is the detection processor for the entire NORSAR system.

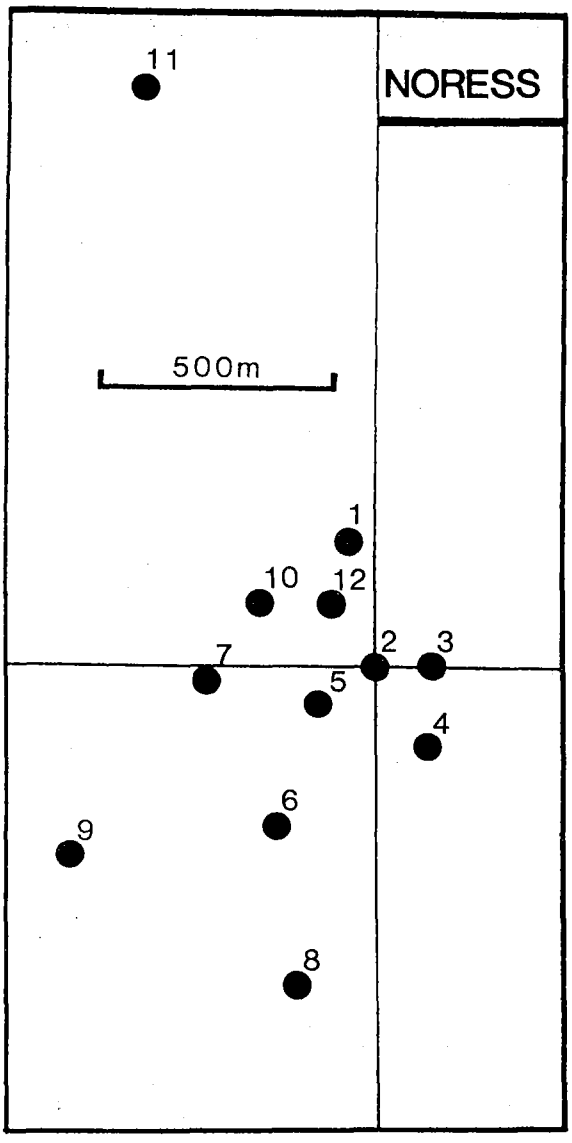
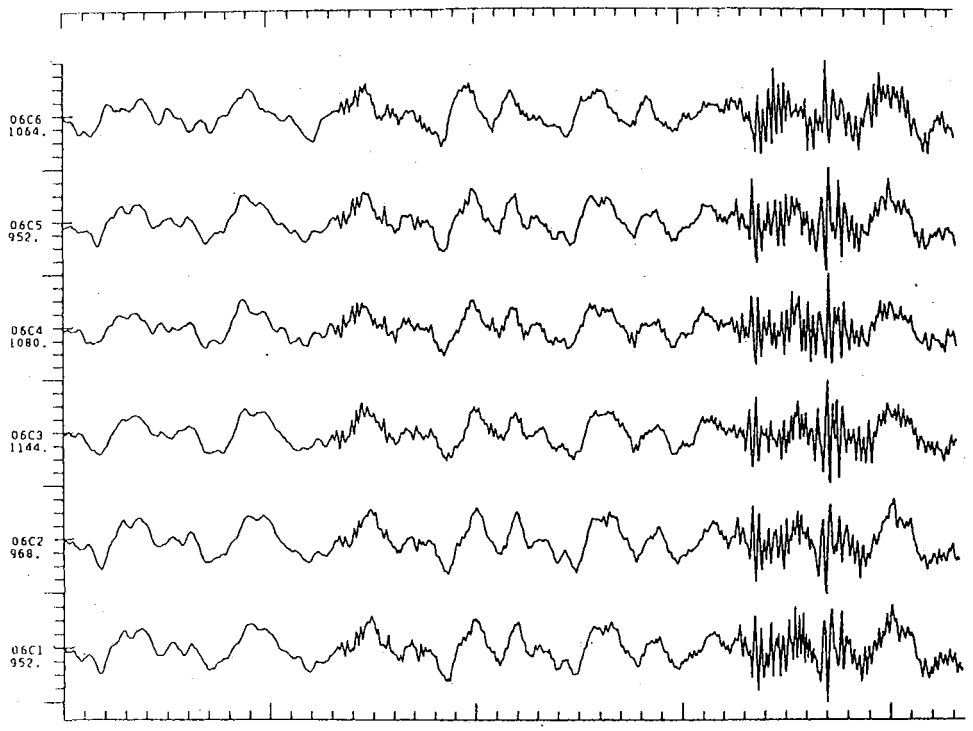


Fig. VI.1.1 NORESS geometry. The experiment described here is based on data from stations 1, 3, 8, 9, 10 and 11.



Detection record

Time									Per	Vel	Az	Pwr
1982	319	17	3	38	6	8	8	125.	0.82	3.09	1.20	3.07	312.5	36.7
1982	319	17	17	48	3	8	9	103.	1.00	3.07	3.00	1.86	42.0	11.7
1982	319	17	35	8	0	8	8	112.	0.93	3.09	1.00	5.30	212.0	37.4
1982	319	17	42	13	0	10	10	67.	0.22	5.55	4.50	6.57	156.8	33.9
1982	319	17	42	19	2	10	10	42.	0.25	4.32	3.90	6.06	166.0	26.0
1982	319	17	42	21	6	10	10	42.	0.25	3.25	3.90	6.20	187.1	22.1
1982	319	17	42	25	9	10	10	48.	0.25	3.16	4.00	4.04	166.0	24.4
1982	319	17	42	32	2	10	10	227.	0.26	4.80	3.80	4.14	155.6	44.0
1982	319	17	42	36	7	8	9	257.	0.32	4.16	3.00	4.64	158.2	42.6
1982	319	18	10	20	3	8	9	106.	1.01	3.15	3.00	2.93	20.6	12.6

Location record

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****************
LG TYPE PHASE DETECTED AT     1982 319 17 42 25  9
ASSOCIATED WITH P ARRIVAL AT 1982 319 17 42 13  0
                    EVENT LOCATED AT LAT= 59.947 LON= 12.212
****************
LG TYPE PHASE DETECTED AT     1982 319 17 42 32  2
ASSOCIATED WITH P ARRIVAL AT 1982 319 17 42 13  0
                    OVERRIDING EARLIER SOLUTION,NOW LAT= 59.584 LON= 12.511
****************
LG TYPE PHASE DETECTED AT     1982 319 17 42 36  7
P PHASE FOUND AT              1982 319 17 42 13  0
                    HAS ALREADY BEEN ASSOCIATED WITH STRONGER LG PHASE
****************
LG TYPE PHASE DETECTED AT     1982 319 18 10 20  3
ASSOCIATION ATTEMPT UNSUCCESFUL.NO P PHASE FOUND.
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Fig. VI.1.2 Extracts from RONAPP detection and location records with plot of relevant data.