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7.3 Observations at NORSAR of the 22 September 1993 NPE/CKE explosion at the Nevada Test Site

Introduction

On 22 September 1993, the US Department of Energy detonated a one kiloton conventional explosion at the Nevada test site (NTS), in an experiment named the Non-Proliferation Experiment (NPE) (Springer, 1993). The experiment has also been referred to as the Chemical Kiloton Experiment (CKE). The experiment was conducted in the context of future CTBT/NPT monitoring, and it has the potential of providing data useful for discrimination between chemical and nuclear explosions. The NPE explosion was detonated in the N-tunnel in Rainier Mesa very close to the hypocenters of several previous nuclear explosions, some of which had yields similar to that of the NPE explosion. Through comparison with observations from previous shots at NTS, the NPE experiment should thus offer an opportunity to determine differences in characteristics of chemical and nuclear explosions.

The NPE explosion was recorded on many especially-deployed instruments in the local and regional distance range. Preliminary reports indicate that the shot was recorded with amplitudes that were in general larger than those that would be expected from a similar-size nuclear shot.

The NPE explosion was automatically detected and located by some of the arrays in northern Europe contributing data to the NORSAR Data Processing Center (NDPC). The purpose of this short contribution is to present relevant detection and event location data for these stations, and to make comparisons with observations for a nuclear test conducted at NTS in 1992.

Data analysis

The nuclear explosion that we will compare the NPE/CKE with is the explosion conducted at NTS on 18 September 1992 and referred to as "Hunters Trophy". According to the EDR of the USGS, this explosion was conducted at 17:00:00.008 GMT, at 37°12'24.93"N, 116°12'35.94"W, surface elevation 2239 m and depth of burial 385 m. Magnitude is given as m_b 4.4. The NPE/CKE explosion was conducted within 1 km of "Hunters Trophy" and at about the same depth of burial.

At the time of the "Hunters Trophy" explosion, NDPC received and processed automatically data from the NORSAR large-aperture array as well as the high-frequency arrays NORESS, ARCESS, FINESA and GERESS. At the time of the NPE/CKE event, data from two additional high-frequency arrays were available, namely, the arrays at Apatity and Spitsbergen. The FINESA array was not operational at the time of the NPE/CKE event, due to work related to a refurbishment of this array.

At NDPC all data are subject to standard detection processing including beamforming, filtering and estimation of STA/LTA ratios for signal detection (EP_SigPro processing). Tables 7.3.1 and 7.3.2 show automatic detection parameters for the "Hunters Trophy" and

NPE/CKE events, respectively. It is seen that the events are detected at NORSAR, NORESS and GERESS (and "Hunters Trophy" at FINESA) at distances ranging from 73 to 83 degrees. The high-frequency small-aperture NORESS array has not only the best SNR, but broadband frequency wave number analysis is capable of estimating back azimuth and apparent velocity about as well as the larger NORSAR array. It should be noted, however, that the automatic processing of the NORSAR array is using the full array. With site-specific processing using the "best" subarrays, NORSAR beam SNR can be improved. From Figs. 7.3.1 and 7.3.2 we see that NORSAR subarray NC6 colocated with NORESS has a larger SNR than the other subarrays. However, for event location the full NORSAR array will be superior to that of individual subarrays. ARCESS detected neither of the two events. The NPE/CKE event was not detected on the Apatity nor the Spitsbergen array.

The data from the high-frequency arrays are processed using the Intelligent Monitoring System (IMS). Arrivals on the various arrays are automatically associated to form events at both local, regional and teleseismic distances. IMS results, as reviewed by the analyst, are given in Figs. 7.3.3 and 7.3.4. It can be seen that the event solution for "Hunters Trophy" is better than that for the NPE/CKE event. The main reason appears to be the fact that FINESA was not operational at the time of the NPE/CKE event. The m_b magnitudes as determined by IMS are 4.14 and 4.10, for the "Hunters Trophy" and NPE/CKE events, respectively.

Concluding remarks

The NORSAR, NORESS and GERESS arrays at epicentral distances ranging from 73 to 83 degrees all detected both the "Hunters Trophy" explosion and the NPE/CKE event automatically. The NPE/CKE event was recorded with amplitudes that were only slightly smaller (generally by 0.1 m_b units) than those of "Hunters Trophy" (see e.g. Figs. 7.3.1 and 7.3.2, where the scaling factors to the left of the traces can be directly compared for the two events. Amplitudes at NORESS can be compared through the scaling factors in Fig. 7.3.5.) With an m_b of 4.4 as given by USGS for "Hunters Trophy", it is clear that also NORSAR's recordings of the NPE/CKE event confirm that this one kiloton conventional explosion produced amplitudes somewhat larger than those expected from a one kiloton fully contained nuclear explosion.

As expected, the signals recorded at NDPC for these two events had SNRs that were too low to permit meaningful attempts at discriminating between their nuclear and chemical origins through analysis of signal characteristics. This is illustrated in Fig. 7.3.5, which shows the optimum beams at NORESS for these two events.

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References

Springer, D.L. (1993): The Non-Proliferation Experiment (NPE): Preliminary Status Report. Presentation given at GSETT-3 Workshop, Erice, Italy, 11-13 November 1993.

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORSAR	262:17.11.31.631	-0.83	4.8	17.7	-1.04	320.9	2.4
NORESS	262:17.11.33.970	-0.47	7.9	17.5	-1.36	323.3	4.5
ARCESS	No detection						
FINESA	262:17.11.53.250	-1.57	4.5	28.8	9.06	316.8	-13.1
GERESS	262:17.12.29.348	-0.21	5.8	18.9	-2.74	21.8	59.9
Apatity	Not installed						
Spitsbergen	Not installed						

Table 7.3.3. Automatic detection information for the "Hunters Trophy" event of 18 September 1992. The columns show array, automatic EP_SigPro onset time, onset time residual, detection STA/LTA, apparent velocity in km/s, residual in km/s, back azimuth in degrees and back azimuth residual. All residuals are relative to the IASPEI91 travel time tables and USGS event parameters.

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORSAR	265:07.12.32.608	0.09	3.5	17.6	-1.21	322.9	4.6
NORESS	265:07.12.34.212	-0.28	6.7	15.9	-2.98	323.4	4.8
ARCESS	No detection						
FINESA	Not operational						
GERESS	265:07.13.29.073	-0.32	5.2	13.0	-8.67	342.5	20.7
Apatity	No detection						
Spitsbergen	No detection						

Table 7.3.2. Automatic detection information for the NPE/CKE event of 22 September 1993. The columns show array, automatic EP_SigPro onset time, onset time residual, detection STA/LTA, apparent velocity in km/s, residual in km/s, back azimuth in degrees and back azimuth residual. All residuals are relative to the IASPEI91 travel time tables. The origin time is assumed to be 07:01:00.000, and location is assumed to be the same as that for "Hunters Trophy".

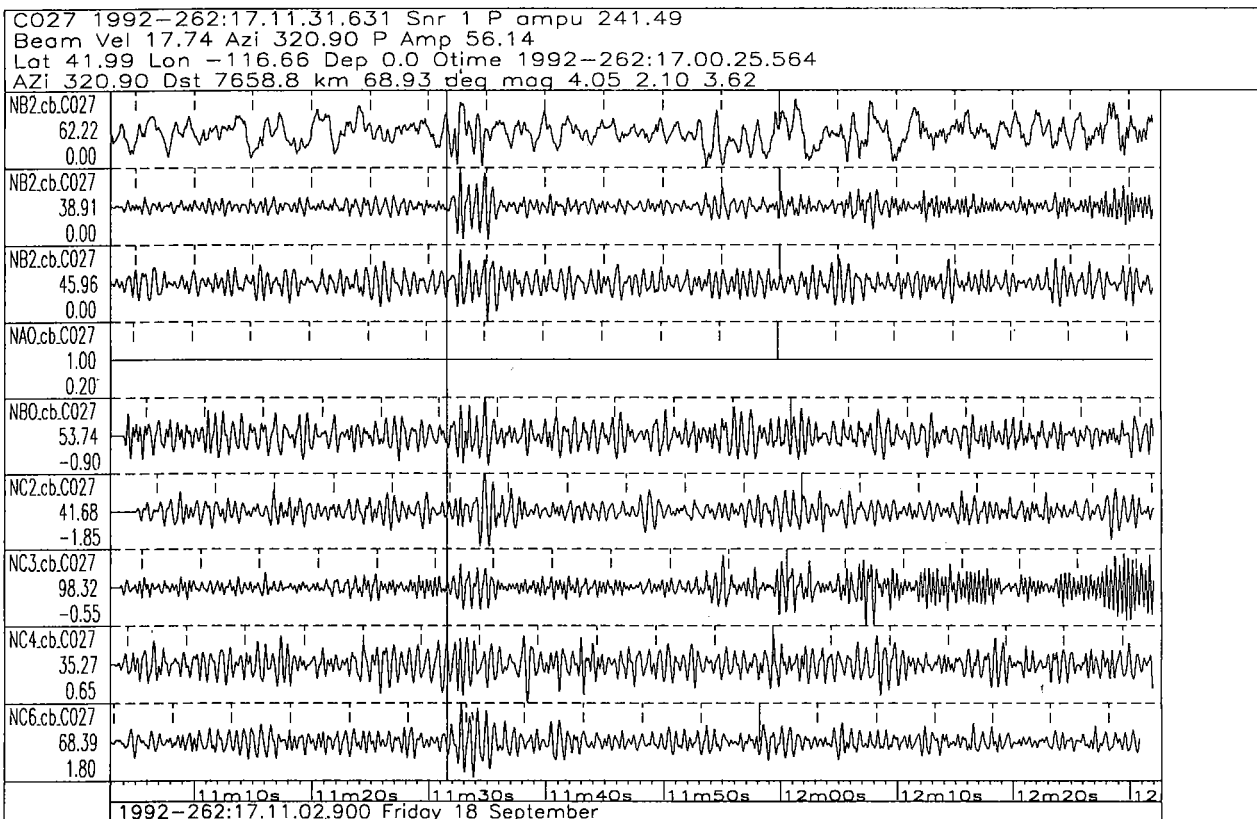


Fig. 7.3.1. NORSAR array *automatic* event plot for the “Hunters Trophy” event. The traces show from top to bottom the unfiltered (full) array beam, the filtered (full) array beam, followed by seven filtered subarray beams (subarrays NB2, NAO, NB0, NC2, NC3, NC4 and NC6). The passband used is 1.2 to 3.2 Hz. Note that subarray NAO was out of operation at the time of this event. The vertical line marks the automatic detection time, with reference to subarray NB2. The automatic event location given is within about 4 degrees of the true location.

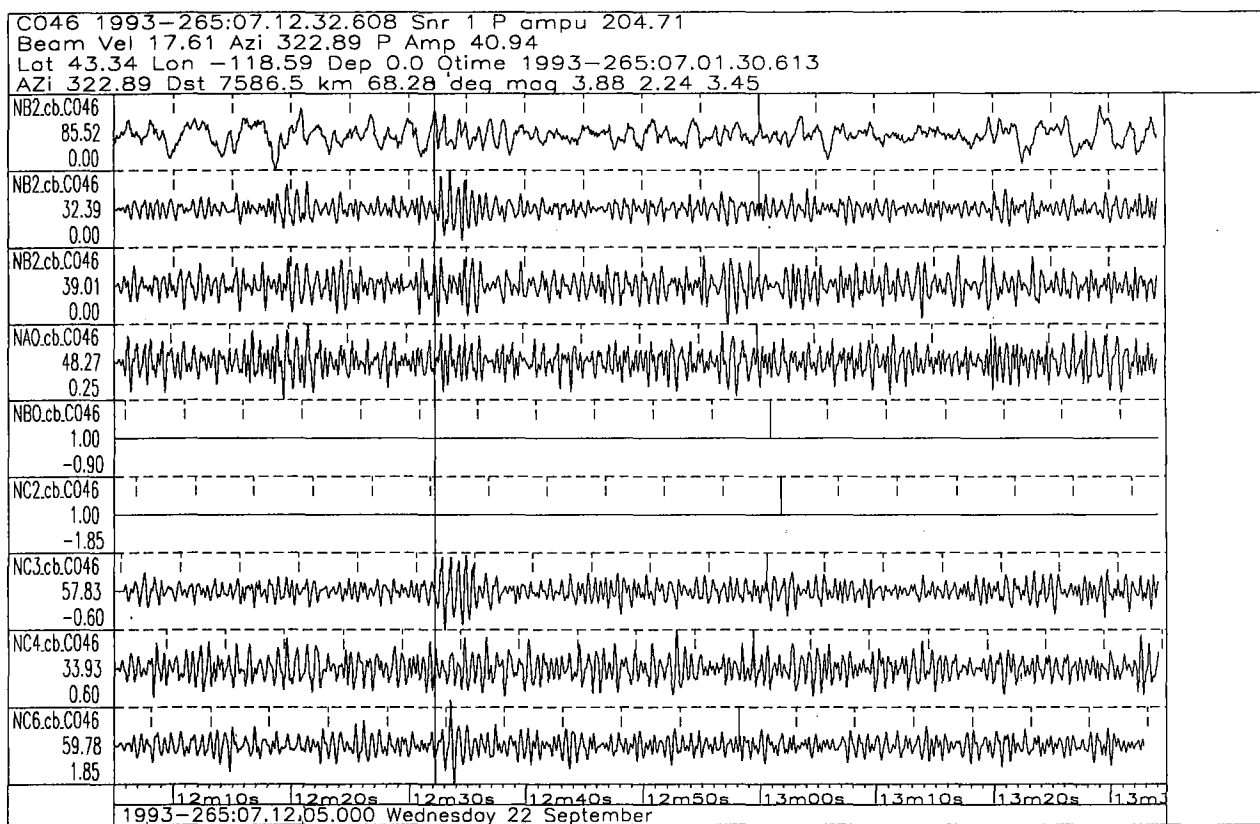


Fig. 7.3.2. NORSAR array *automatic* event plot for the NPE/CKE event. See caption for Fig. 7.3.1 for details of figure content and passband. Note that subarrays NB0 and NC2 were out of operation at the time of this event. The automatic event location is within about 6 degrees of the true location.

Date 9/18/92 Time 17:00:08.7 Lat 38.3493 Lon -115.9888 Smaior 1272.5156 Sminor 722.8019 Strike 63.83 Depth 0.0000 Mb 4.14 Ma - MI - Orid 44382
NEVADA

NR00 72.078 24.04 319.18
Iphase Phase Time Timecor Azimuth Azres Vel Str Amp Freq Azid Orid Qual
P *17:11:34.2 0.2 223 -4 17.5 7.9 1 2.6 453895 44382 -

FI00 75.564 17.66 330.14
Iphase Phase Time Timecor Azimuth Azres Vel Str Amp Freq Azid Orid Qual
P *17:11:54.0 -0.5 317 -12 28.8 4.5 0 2.6 453896 44382 -

GEC2 82.094 30.75 322.46
Iphase Phase Time Timecor Azimuth Azres Vel Str Amp Freq Azid Orid Qual
P *17:12:30.6 0.1 22 59 18.9 5.8 2 1.1 453897 44382 -

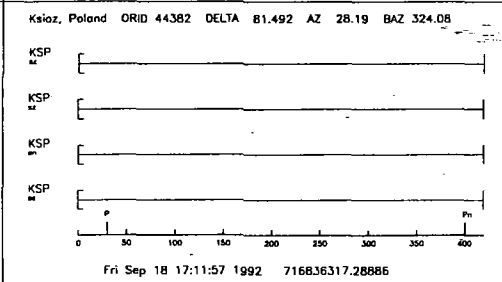
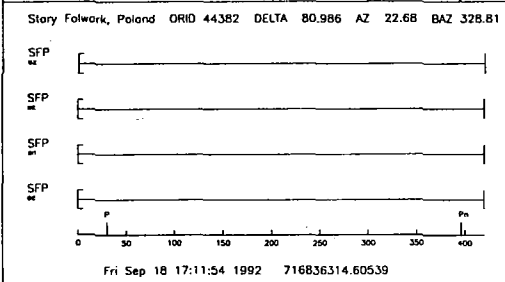
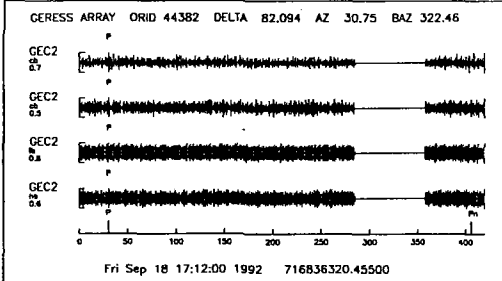
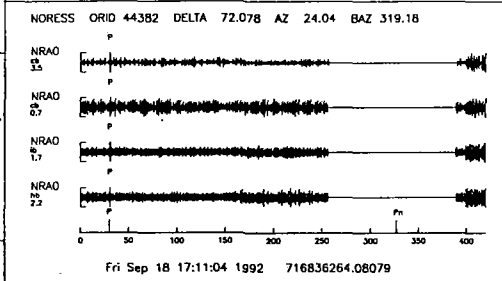
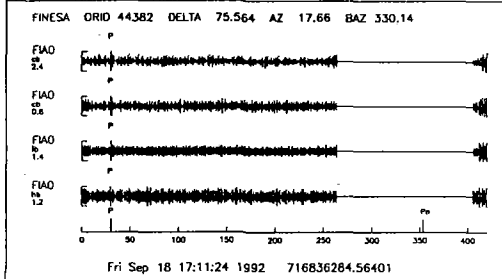
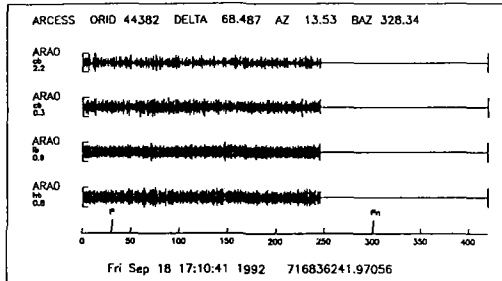


Fig. 7.3.3. IMS results for the "Hunters Trophy" event, as reviewed by an analyst. Detections with associated slowness values at NORESS, FINESA and GERESS are used to form the event solution.

Date 9/22/93 Time 07:00:53.5 Lat 37.4115 Lon -124.3466 Smajor 3044.8621 Sminor 1063.8081 Strike 78.82 Depth 33.0000 Mb 4.10 Ms - Ml - Orid 79254
 OFF COAST OF CALIFORNIA

MRAO 75.451 20.58 325.17
 IPhase Phase F Time Times Azimuth Azres Vel Sur Amp Freq Arid Orid Qual
 F *07:12:34.2 0.4 323 -2 15.9 6.7 1 2.6 1110511 79254 -
 GRC2 86.062 26.17 327.84
 IPhase Phase F Time Times Azimuth Azres Vel Sur Amp Freq Arid Orid Qual
 F *07:13:29.9 -0.5 343 15 13.0 5.2 2 1.1 1110516 79254 -

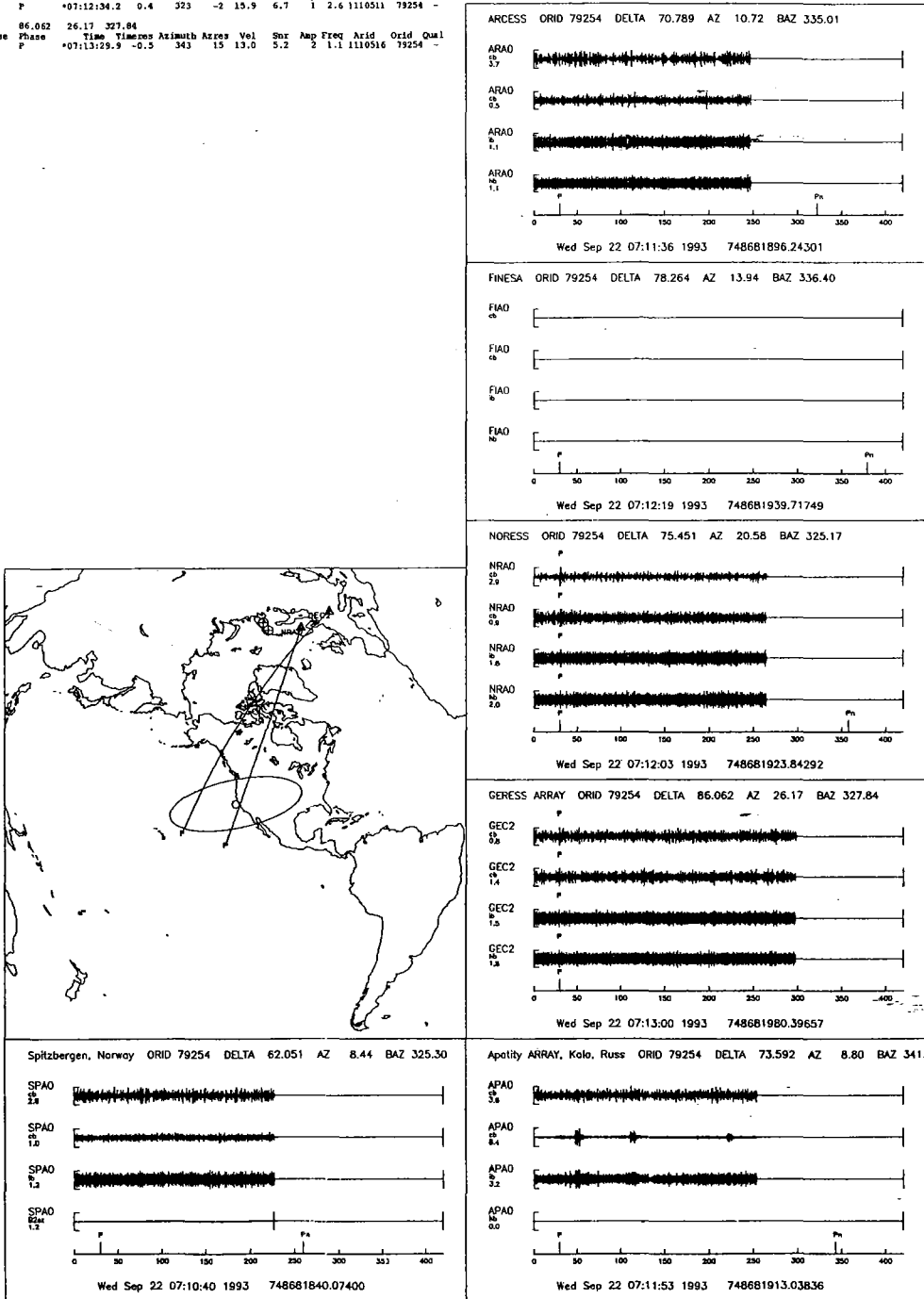


Fig. 7.3.4. IMS result for the NPE/CKE event, as reviewed by an analyst. Only information from NORESS and GERESS was available to form the event solution shown.

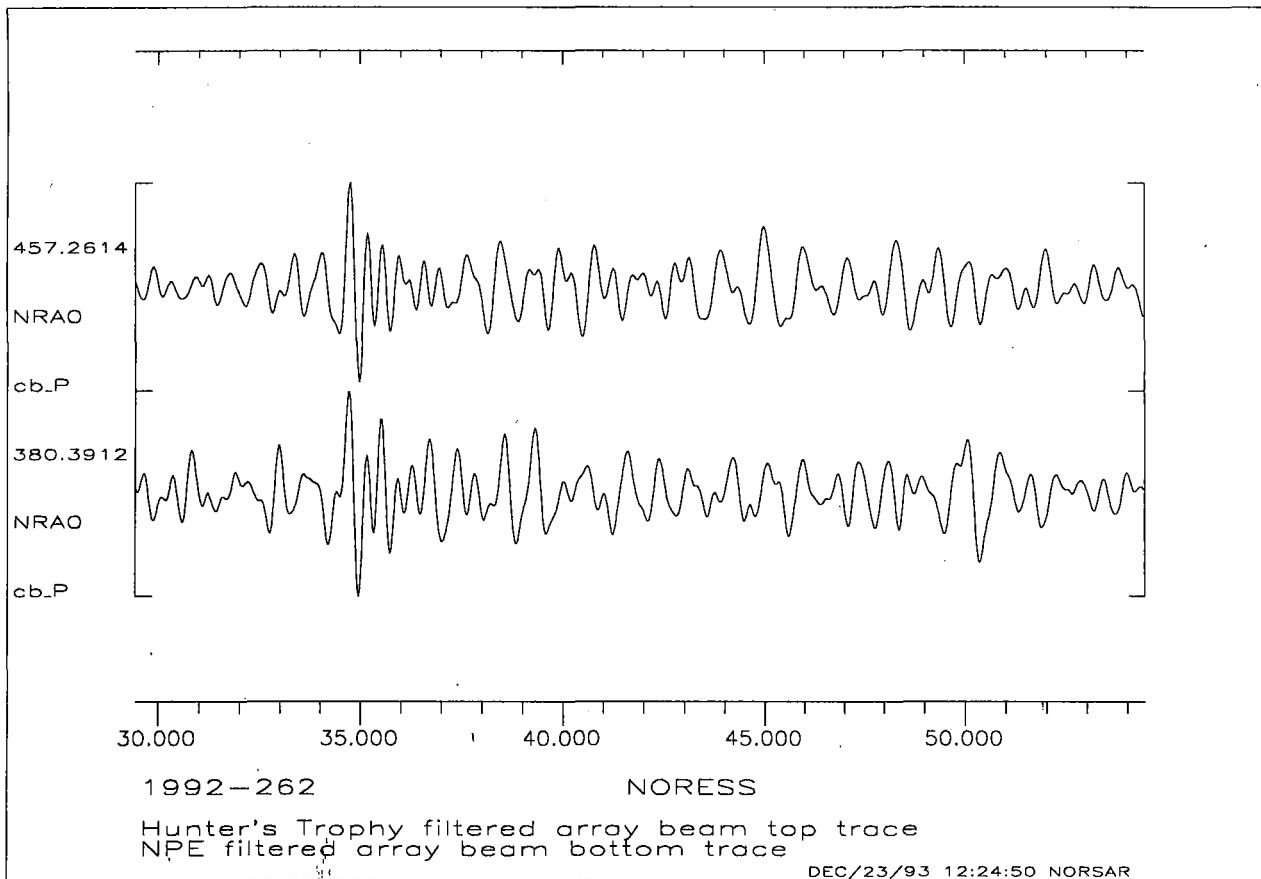


Fig. 7.3.5. Optimum NORESS array beams (with respect to steering parameters) filtered in the passband 1.2 to 3.2 Hz for the “Hunters Trophy” event (top) and the NPE/CKE event (bottom). The two traces are aligned so that the signal onset is 5 s after the start time of the trace. The numbers to the left of the traces are amplitude scaling factors.