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7.2 The Lop Nor nuclear explosions of 10 June and 7 October 1994

Introduction

This contribution describes observations made at our institution for the two Lop Nor nuclear explosions on 10 June and 7 October this year. Some comparisons are also made with the Lop Nor explosions conducted on 21 May 1992 and 5 October 1993.

The Lop Nor nuclear explosion of 10 June 1994

The explosion took place on 10 June 1994, with origin time 0626 GMT. Table 7.2.1 lists the basic parameters of the event as provided by various sources. The m_b magnitudes range from 5.68 to 5.84. The most accurate location is provided by the PDE bulletin, which uses a world-wide network for location purposes. The solutions by the Intelligent Monitoring System (IMS) (Bache et al, 1993), both automatic (IMS) and after analyst processing (ARS), are also listed. The NORSAR automatic and reprocessed solutions are included in the table. The NORSAR automatic detection/event processor output is shown in Fig. 7.2.1, whereas the plot associated with the reprocessed solution is shown in Fig. 7.2.2.

Figs. 7.2.3 and 7.2.4 show plots of the interactive IMS processing results. The trace plots of Fig. 7.2.4 are based on array beams for the four arrays FINESS, ARCESS, NORESS and GERESS, and a single channel (Z9, broad-band channel) for Apatity. The Spitsbergen array had a communication line problem at the time of this explosion.

Table 7.2.2 summarizes the automatic processing results for the six arrays. The NORESS, ARCESS and NORSAR arrays show outstanding SNR. The velocity/azimuth estimates are within the expected uncertainty for all arrays.

The Lop Nor nuclear explosion of 7 October 1994

The explosion took place on 7 October 1994, with origin time 0326 GMT. Table 7.2.3 lists the basic parameters of the event as provided by various sources. The m_b magnitudes range from 5.67 to 5.90. The most accurate location is again provided by the PDE bulletin, but the NORSAR Rerun solution is very close to the PDE solution. The solutions by the Intelligent Monitoring System, both automatic (IMS) and after analyst processing (ARS), are also listed. The NORSAR reprocessed solution is included in the table. The automatic NORSAR solution was wrong for this event. Although the EP-SigPro-estimated onset time and slowness for this event are precise, the event processing tried to associate coda detections, and in this case a bad coda detection was used for event definition.

Figs. 7.2.5 and 7.2.6 show plots of the interactive IMS processing results. The trace plots of Fig. 7.2.6 are based on array beams for the five arrays Apatity, ARCESS, NORESS, FINESS and GERESS, and a single channel (A0) for Spitsbergen.

Table 7.2.4 summarizes the automatic processing results for the six arrays. The NORESS array has the best signal-to-noise ratio (1231.1) for this event, and by extrapolation, this array would be expected to have a detectable signal for an event about 2.5 magnitude units lower.

Comparison with previous events

In the following we make a brief comparison between the two 1994 Lop Nor explosions dealt with above and the tests conducted at Lop Nor on 21 May 1992 and 5 October 1993.

Table 7.2.5 summarizes the PDE parameters for these four events. The 21 May 1992 explosion was significantly larger than the other three. The 1993 and 1994 explosions have very similar magnitudes, especially when estimated by IMS and the NORSAR array data. This similarity is illustrated in Fig. 7.2.7, which shows the NORESS P-wave recordings (A0Z seismometer) for the four events.

As seen in Tables 7.2.2 and 7.2.4, the NORESS STA/LTA values are, on the other hand, different by a factor of more than 2 for the two 1994 events, with the October event having the highest value. Since the signal amplitudes are very similar, this means that the NORESS noise level varied between the two 1994 events. The ARCESS STA/LTA values for the two 1994 events also differ by a factor of more than 2, but with the June event having the largest STA/LTA value. This finding is consistent with previous investigations about diurnal and seasonal noise variations at NORESS and ARCESS. These investigations have shown that NORESS is more exposed to cultural noise sources and also has an increased noise level during May-June due to snow melting. The June explosion occurred during working hours in Norway, while the October event occurred at 0426 a.m. local time in Norway. The STA/LTA variations for the other arrays are smaller.

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Reference

Bache, T.C., S.R. Bratt, H.J. Swanger, G.W. Beall and F.K. Dashiell (1993): Knowledge-based interpretation of seismic data in the Intelligent Monitoring System, *Bull. Seism. Soc. Am.*, 83, 1507-1526.

Ref.	Origin time	Lat	Lon	m_b
IMS (automatic)	06.26.13.2	42.242	87.940	5.68
ARS	06.25.55.1	41.220	89.928	5.68
NORSAR (automatic)	06.25.47.3	40.540	91.870	5.84
NORSAR Rerun	06.25.59.7	41.600	88.600	5.82
PDE	06.25.58.0	41.570	88.702	5.70

Table 7.2.1. Location estimates by various systems of the 10 Jun 1994 Lop Nor nuclear explosion. Two of the estimates were made automatically (indicated in the table).

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORESS	161:06.34.46.7	0.6	538.2	18.0	3.5	80.4	4.2
ARCESS	161:06.33.56.4	0.1	893.6	13.8	0.1	91.2	-6.0
GERESS	161:06.35.06.4	-0.3	95.9	15.3	2.0	66.4	-1.7
Apatity	161:06.33.31.0	0.4	57.2	11.1	-2.2	85.6	-16.9
FINESS	161:06.33.50.5	0.6	160.0	13.7	-0.1	90.5	1.8
NORSAR	161:06.34.47.0	0.6	333.3	14.7	0.2	77.1	0.9

Table 7.2.2. Automatic detection list for the Lop Nor nuclear explosion 10 June 1994. The columns show array name, automatic EP-SigPro onset time, onset residual relative to PDE origin time, maximum signal-to-noise ratio (STA/LTA), apparent velocity (km/sec), residual in km/sec, back-azimuth in degrees, back-azimuth residual. All residuals are relative to predictions using IASPEI91 tables and PDE origin time and location.

Ref.	Origin time	Lat	Lon	m_b
IMS (automatic)	03.26.10.2	42.070	88.336	5.67
ARS	03.25.55.3	41.018	89.500	5.67
NORSAR Rerun	03.25.59.3	41.600	88.600	5.79
PDE	03.25.57.8	41.574	88.680	5.90

Table 7.2.3. Location estimates by various systems of the 7 October 1994 Lop Nor nuclear explosion. Two of the estimates were made automatically (indicated in the table).

Array	Onset time	Res	STA/LTA	Vel	Res	Azi	Res
NORESS	280:03.34.46.1	1.1	1231.1	16.1	1.6	77.8	1.6
ARCESS	280:03.33.56.0	0.4	418.1	15.0	1.3	78.9	18.3
GERESS	280:03.35.06.1	-0.1	122.8	16.1	1.3	67.3	0.8
FINESS	280:03.33.50.2	0.8	218.4	14.0	0.4	80.2	8.5
Apatity	280:03.33.30.3	1.0	194.9	13.5	0.3	95.7	-6.8
Spitsbergen	280:03.34.25.3	0.1	97.4	7.8	-6.3	95.0	-1.9
NORSAR	280:03.34.46.7	1.1	277.5	14.7	0.2	75.9	-0.3

Table 7.2.4. Automatic detection list for the Lop Nor nuclear explosion 7 October 1994. The columns show array name, automatic EP-SigPro onset time, onset residual relative to PDE origin time, maximum signal-to-noise ratio (STA/LTA), apparent velocity (km/sec), residual in km/sec, back-azimuth in degrees, back-azimuth residual. All residuals are relative to predictions using IASPEI91 tables and PDE origin time and location.

Event	PDE parameters				IMS m_b	NORSAR Rerun m_b
	Origin time	Lat	Lon	m_b		
Lop Nor 92	21 May 92 04.59.57.5	41.604	88.813	6.5		
Lop Nor 93	05 Oct 93 01.59.56.5	41.647	88.681	5.9	5.65	5.83
Lop Nor 94a	10 Jun 94 06.25.58.0	41.570	88.702	5.7	5.68	5.82
Lop Nor 94b	07 Oct 94 03.25.57.8	41.574	88.680	5.9	5.67	5.79

Table 7.2.5. PDE parameters for four events discussed in the text.

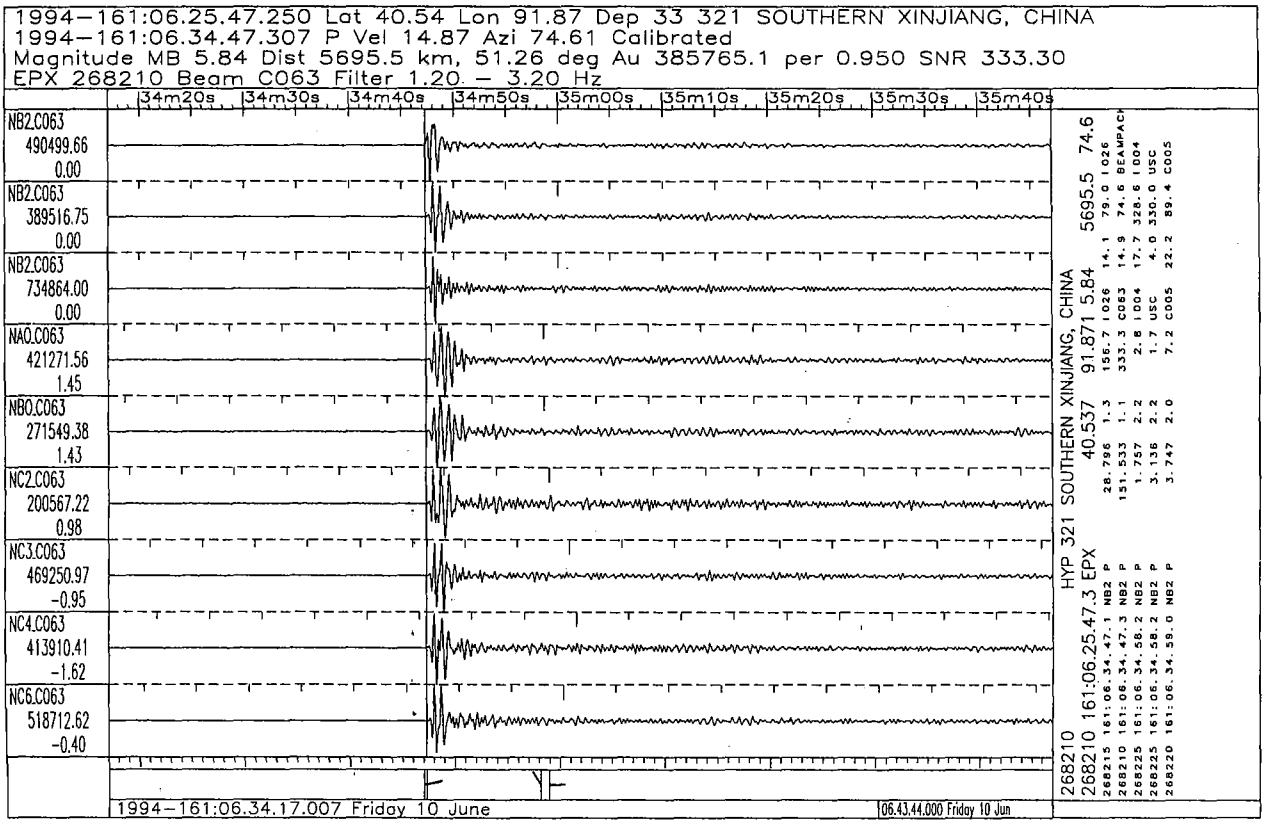

Fig. 7.2.1. Plot of the automatic NORSAR detection/event processor output for the Lop Nor nuclear explosion of 10 June 1994.

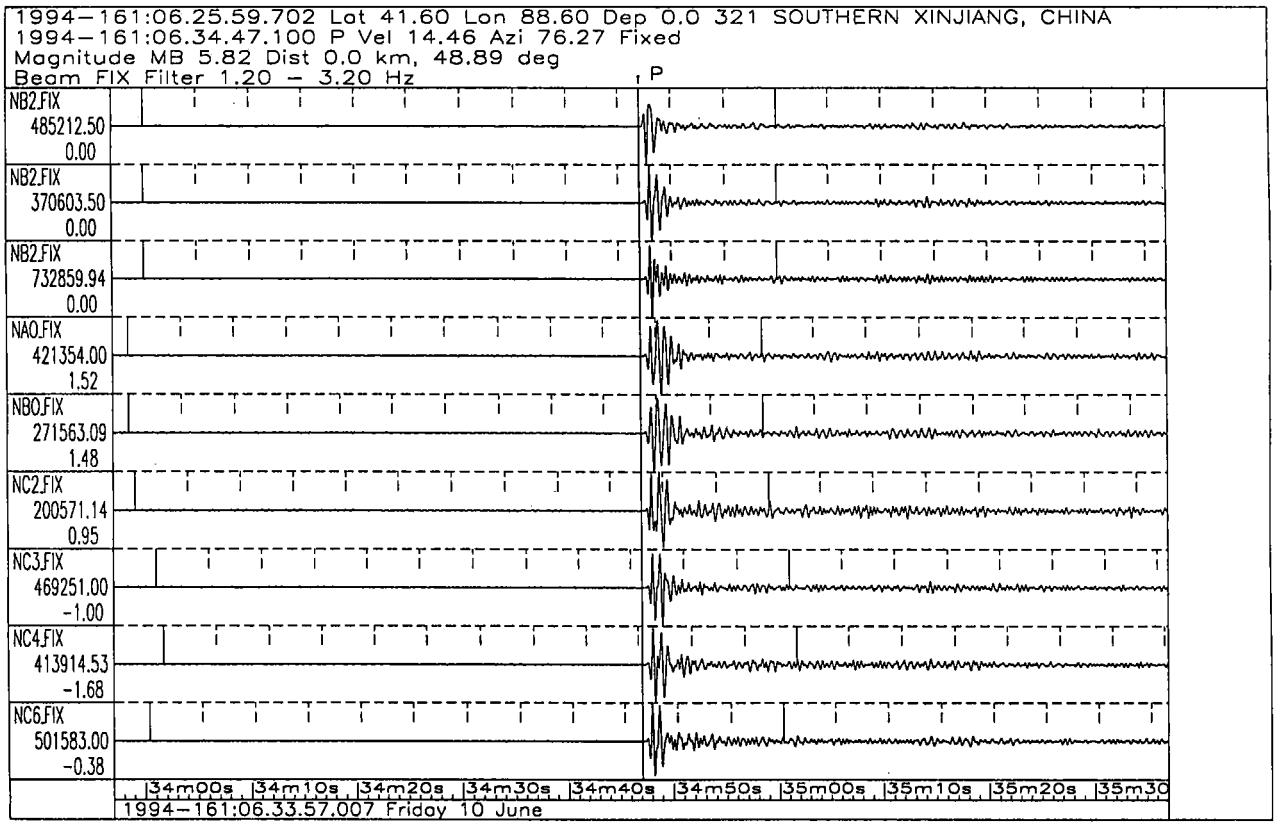

Fig. 7.2.2. Plot of the NORSAR reprocessed solution for the Lop Nor explosion of 10 June 1994.

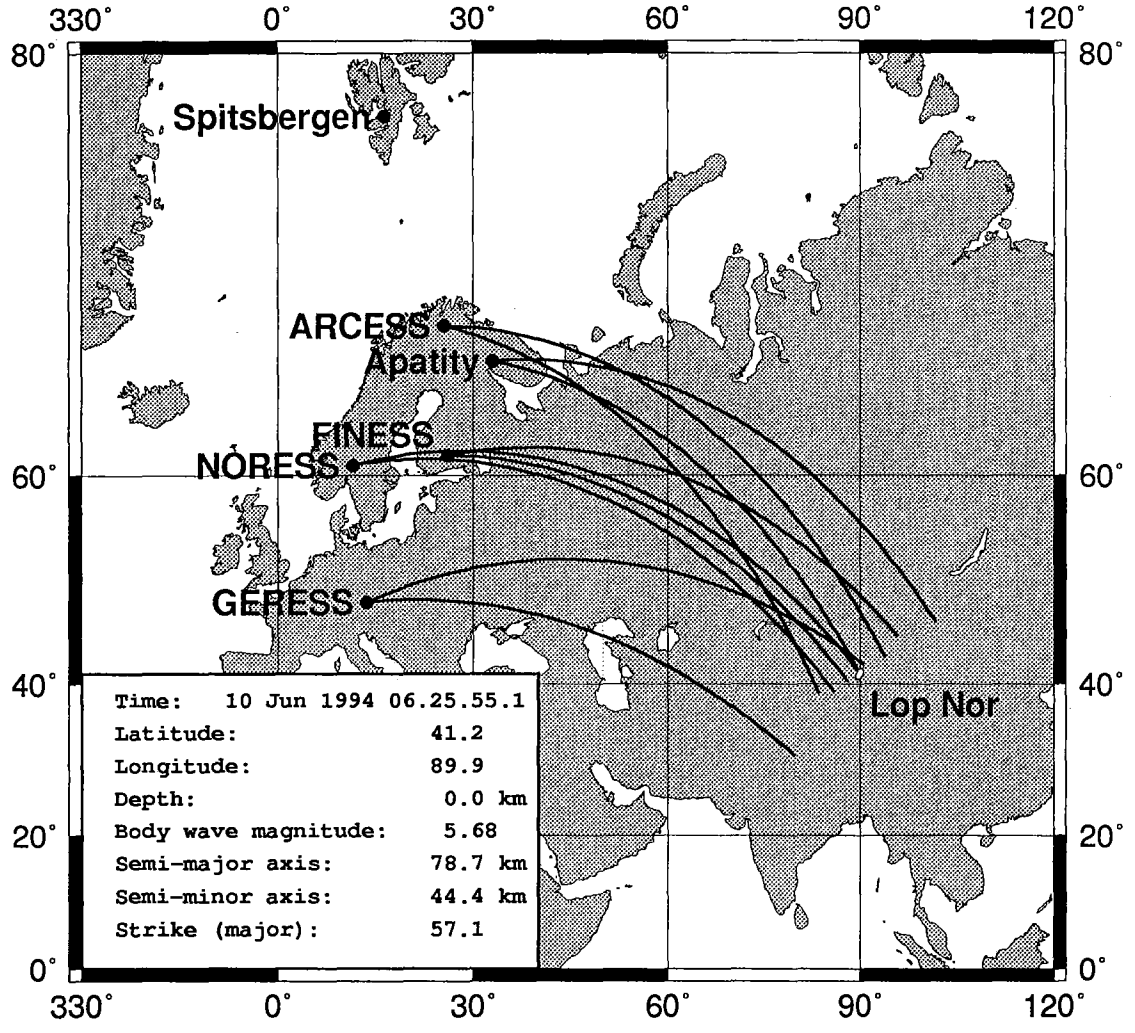

Fig. 7.2.3. Map showing the IMS solution (after analyst review) of the 10 June 1994 Lop Nor explosion. The great circle paths for the detecting arrays (based on P and PcP estimated azimuths) are also shown.

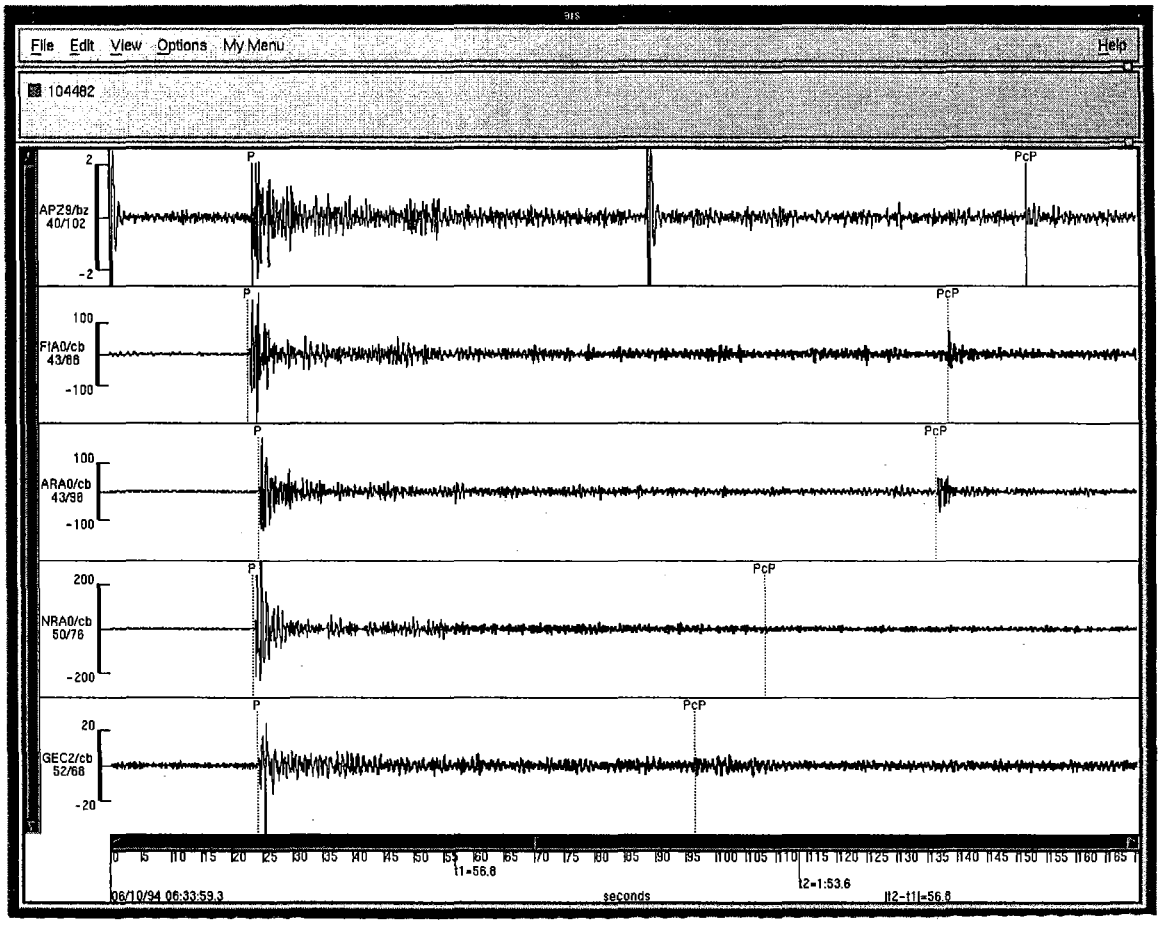

Fig. 7.2.4. P-phase waveforms of the 5 array traces (single sensor for Apatity, otherwise array beams) for the 10 June 1994 Lop Nor explosion.

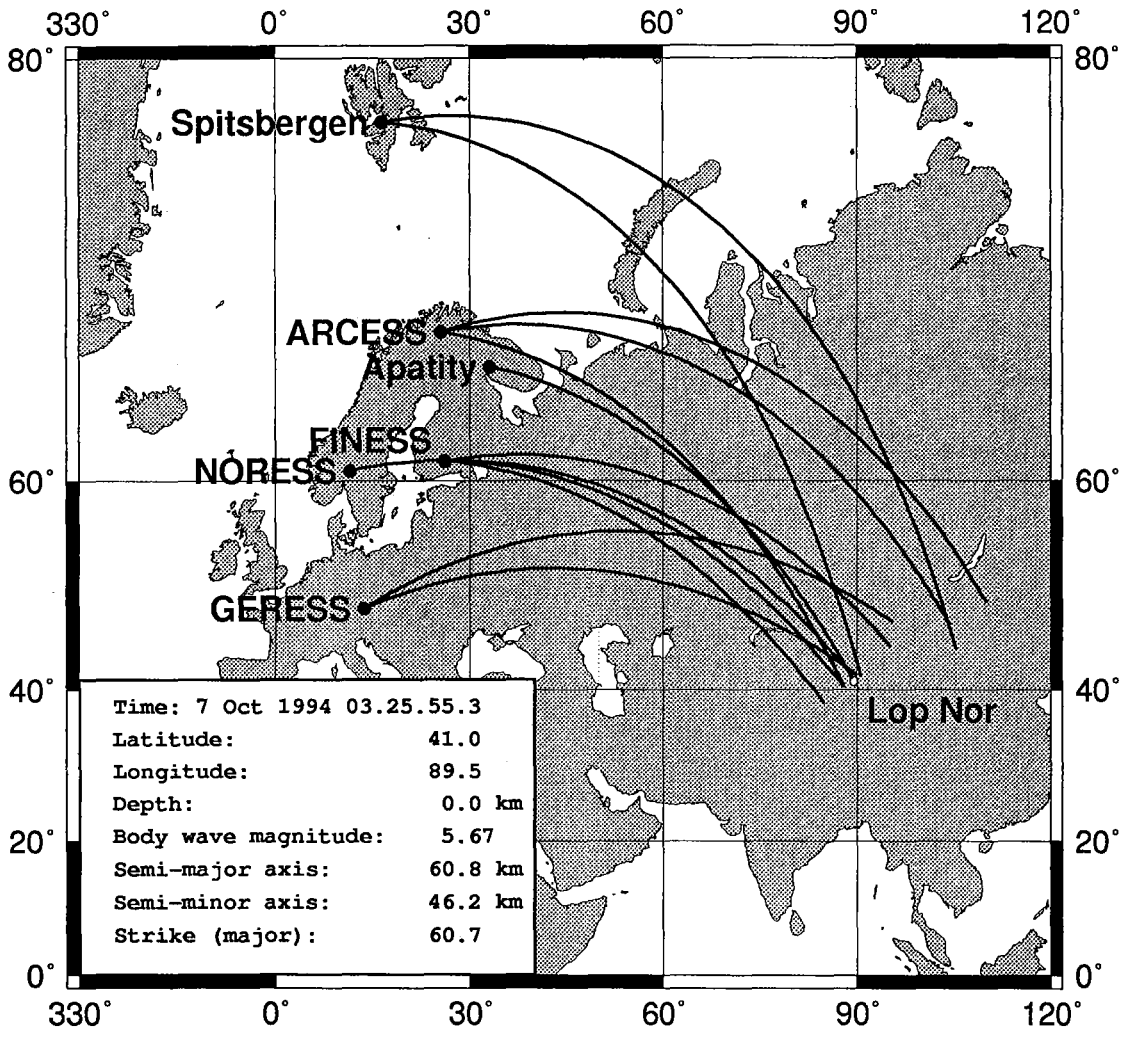

Fig. 7.2.5. Map showing the IMS solution (after analyst review) of the 7 October 1994 Lop Nor explosion. The great circle paths for the detecting arrays (based on P and PcP estimated azimuths) are also shown

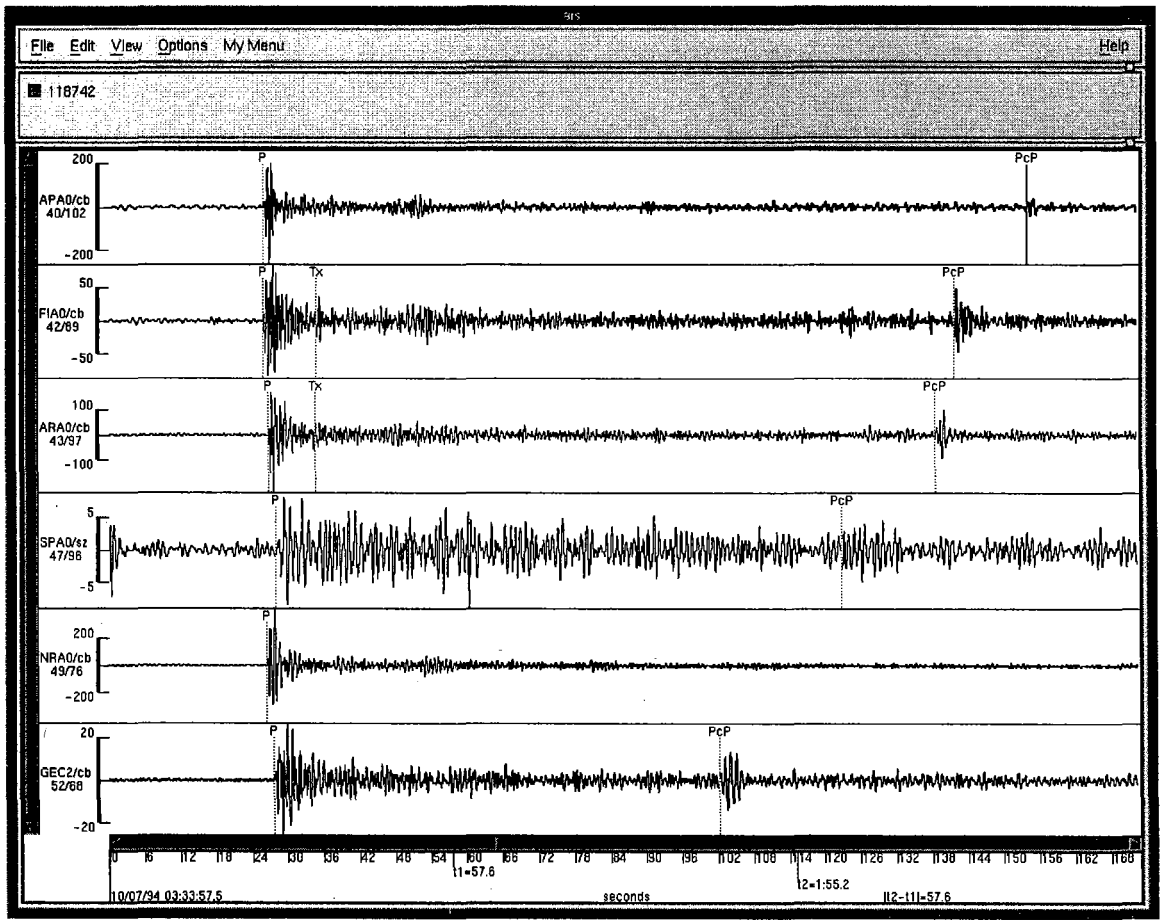

Fig. 7.2.6. P-phase waveforms of the six array traces (single sensor for Spitsbergen, otherwise array beams) for the 7 October 1994 Lop Nor explosion.

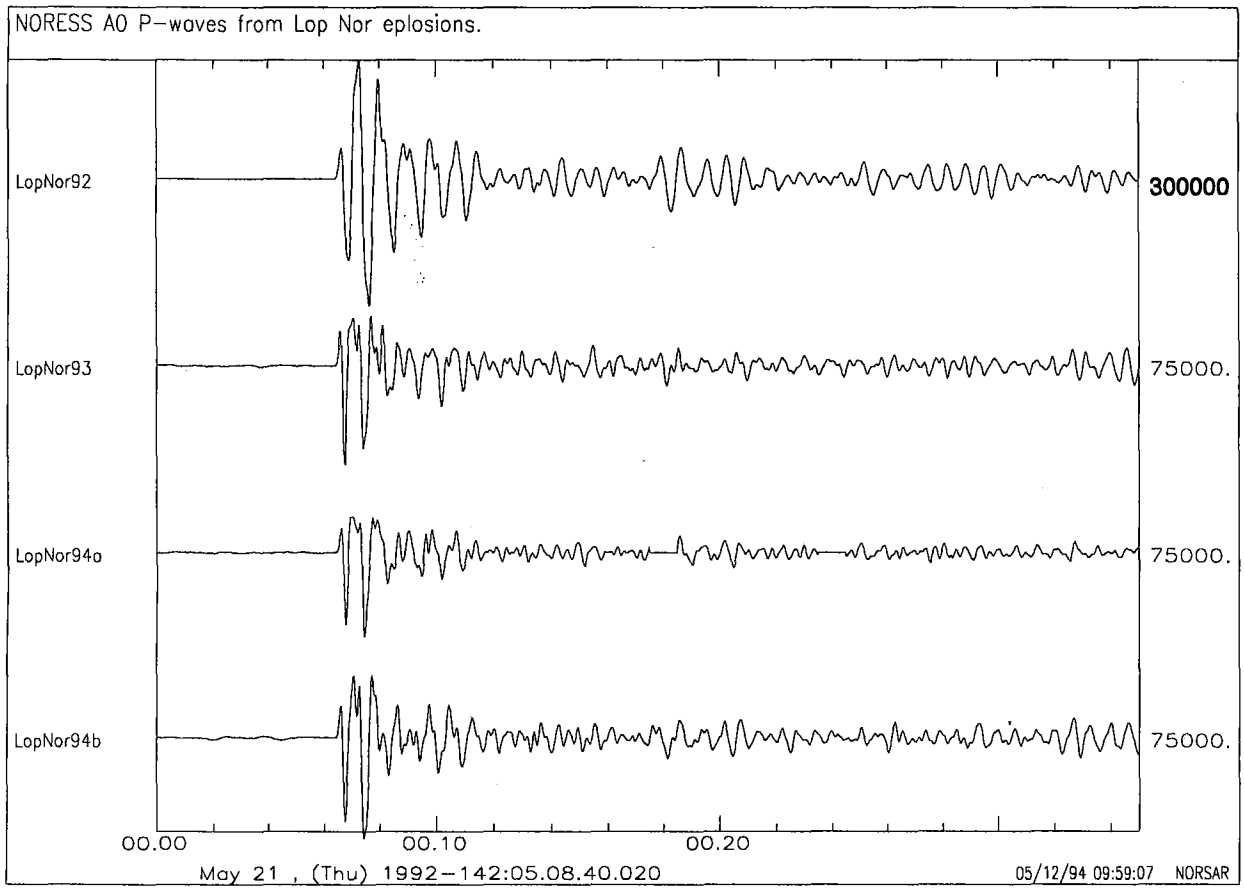

Fig. 7.2.7. NORESS P-waves (A0Z seismometer) for the four events discussed in the text. Note that the three lower traces are in the same scale, whereas the LopNor92 trace has a scaling factor that is different from the others. See Table 7.2.5 for magnitude estimates.