Operation of the

Norwegian National Seismic Network

2006

Supported by

University of Bergen, Faculty of Mathematics and Natural Sciences

and

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1. Introduction

This annual report describes the operation of the Norwegian National Seismic Network (NNSN) for the year 2006. It covers operational aspects as well as a financial report for all seismic stations operated by the Department of Earth Science at the University of Bergen (UiB), which has the responsibility of the NNSN.

The network is supported by the oil industry through the Norwegian Oil Industry Association ('Oljeindustriens Landsforening" (OLF)) and the Faculty of Mathematics and Natural Sciences, University of Bergen (UiB).

The seismicity of Norway and surrounding areas is presented in Appendix 1. The seismic arrays operated by NORSAR are covered in Appendix 2 of this report. NORSAR is subcontracted to deliver data of interest to NNSN.

2. Operation

The operational stability for each station is shown in Table 1. The average downtime for all stations during this reporting period is 1.5%, compared to 4.3 % for 2005. This downtime is considered to be good. The goal of average downtime is below 2%.

Table 1. Downtime in % for the period 2006 for the NNSN stations.

Station	Downtime in %
Askøy (ASK)	0
Bergen (BER)	0
Bjørnøya (BJO)	0
Blåsjø (BLS)	0
Dombås (DOMB)	4.5
Espegrend (EGD)	1.5
Florø (FOO)	9.0
Hopen (HOPEN)	0
Høyanger (HYA)	1.0
Jan Mayen BB (JMI)	0
Jan Mayen SP (JMI)	0
Jan Mayen (JNE)	0
Jan Mayen (JNW)	0
Karmøy (KMY)	0
Kautokeino (KTK)	3.0
Kings Bay (KBS)	0
Kongsberg (KONO)	0
Lofoten (LOF)	0
Mo i Rana (MOR8)	2.0
Molde (MOL)	10.0
Namsos (NSS)	0
Odda (OOD1)	0
Oslo (OSL)	0
Rundemanen (RUND)	2.0
Snartemo (SNART)	0
Stavanger (STAV)	0
Stokkvågen (STOK)	0
Sulen (SUE)	4.0
Trondheim (TRON)	0
Tromsø (TRO)	6.5
Average	**1,5**

3. Field stations and technical service

The technical changes for each seismic station are listed below. It is noted if these changes are not related to a visit from the technical staff at the University of Bergen. When a station stops working, tests are made to locate the problem. Sometimes the reason cannot be found and the cause of the problem will be marked as unknown.

Bjørnøya (BJO1)

25.09.06 Visit.

Inspected the aluminium box – ok. Recording equipment is working well.

Blåsjø (BLS)

No visit or technical changes.

Florø (FOO)

30.01.06. The PC was restarted. Station down for 2 days
20.03.06. The PC was restarted. Station down for 0.5 day
26.04.06. The PC was restarted. Station down for 0.5 day
08.06.06. Visit.
A new PC, Seislog for Windows, using ADSL was installed.
30.08.06. Visit.
Replaced digitizer RD3 with ED2400, installed in the aluminium box.
07.12.06. Visit.
Replaced the malfunctioned digitizer ED2400 with a new one. Station down for 17 days.
28.12.06. Visit.
Due to two broken digitizers the last month, it was decided to reinstall the equipment. A new cable with 4 pairs was installed between the aluminium box and the recording room. A new ED2400 digitizer was installed next to the PC. The GPS for the digitizer was mounted outside.
Due to a mistake, the damping resistors was not connected to the SS-1 sensors. The resistors will be connected during next visit.
Station down for 13 days.

Høyanger (HYA)

16.01.06. The PC was restarted. Station down for 3.5 days
08.06.06. Visit
Replaced the old Sprengnether 3 comp. sensor with 3 SS-1 Ranger seismometers.
Before disconnecting the Sprengnether sensor a polarity test was done, the polarity was wrong. For the SS-1 Ranger the polarity is ok.

Karmøy (KMY)

18.04.06. Seislog QNX PC setup with Garmin GPS with no PPS (pulse pr. second). Probably like this since GPRS network started (07.02.06). Changed to Garmin PPS in parameterfile.

Lofoten (LOF)

No visit or technical changes.

Mo i Rana (MOR8)

12.07.06. Station down for 8 days due to lightning. A new Cisco box was installed by the local operator

Molde (MOL)

06.02.06. The PC was restarted. Station down for 0.5 day
04.05.06. Visit
The old QNX – PC, RD3 digitizer and 3 SS-1 Ranger sensors were disconnected and brought back to Bergen.
A new Guralp BB sensor and a PC (Seislog for Windows) was installed and connected to ADSL.
08.09.06. Visit.
Station down for 36 days due to lightning. A new PC and Guralp 6TD sensor was installed.

Namsos (NSS)

No visit or technical changes.

Odda (ODD1)

No visit or technical changes.

Tromsø (TRO)

23.03.06. Visit.
A new digitizer was installed, station was down for 24 days due to a malfunctioning digitizer.
14.05.06. The PC was restarted. Station down for 1day.

Sulen (SUE)

31.01.06. The PC was restarted. Station down for 1day.
06.12.06. Visit.
Station down for 14 days due to a broken PC. It was replaced with a new PC (Seislog w/QNX) and a Nanometrics RD6 digitizer.

Kautokeino (KTK)

19.07.06. A new ISDN box and Cisco box was installed. PC was restarted by the local operator. Station down for 11 days due to lightning.

Stavanger (STAV)

No visit or technical changes.

WNN network: stations: Bergen (BER), Espegrend (EGD), Ask (ASK)

Espegrend visit 27.07.06. Station down for 6 days due to a broken power supply. A new power supply was installed.

Rundemanen (RUND)

01.12.06. Visit.
Station down for 9 days due to a malfunctioning digitizer. A new Nanometrics RD3 digitizer was installed.

Trondheim (TRON)

04.05.06. The building housing the station was torn down and the station was closed.

Oslo (OSL)

No visit or technical changes.

Dombås (DOMB)

03.10.06. Station down for 17 days due to a broken UPS (uninterruptible power supply). The UPS was removed by the local operator, and a new one was not installed since there have been problems with UPS's.

Jan Mayen (JMI)

October 2006. Visit.
During the visit the equipment was calibrated and maintained.

Kongsberg (KONO)

No visit or technical changes.

Kings Bay (KBS)

No visit or technical changes.

Stokkvågen (STOK)

No visit or technical changes

Snartemo (SNART)

No visit or technical changes.

Hopen (HOPEN)

17.02.06. The GPS cable broke, repaired by the local operator.
20.02.06. A new GPS antenna was sent from Bergen.
25.09.06. Visit.
Centered the NS sensor. Replaced a new model of Sara SR04 digitizer. When connecting the digitizer to ground, the noise (50Hz) was eliminated.

4. Technical changes and plans

The network now has 8 broadband stations where continuous data is collected. Station MOL was upgraded to broad band in 2006. Funds permitting, one more broad band station should be installed in 2007.
The move to get more continuous data on line is progressing and different systems for real time monitoring are being tested. It is expected that by the end of 2007, 15 stations will be operating in real time mode enabling the network to make faster earthquake locations and a better real time operational monitoring.

APPENDIX 1

The NORSAR Regional Array

The NORSAR Regional Arrays

NORSAR operates the two regional seismic arrays, ARCES (near Karasjok, Finnmark) and SPITS (on Svalbard). In addition, data from NORSAR (the original large aperture array in southern Norway), FINES (in Finland), HAGFORS (southern Sweden), KBS (Kings Bay on Svalbard), KONO (Kongsberg, southern Norway) and JMIC (Jan Mayen) are collected and analyzed. All data are openly available and the interested layman can see daily data on www.norsar.no/NDC/data

The NORES array, which was damaged by lightening in 2002 represents a significant loss in the regional monitoring capability. Alternative processing algorithms for the NORSAR array have been developed, and the reconstruction of the NORES array as a broader research facility is now in progress.

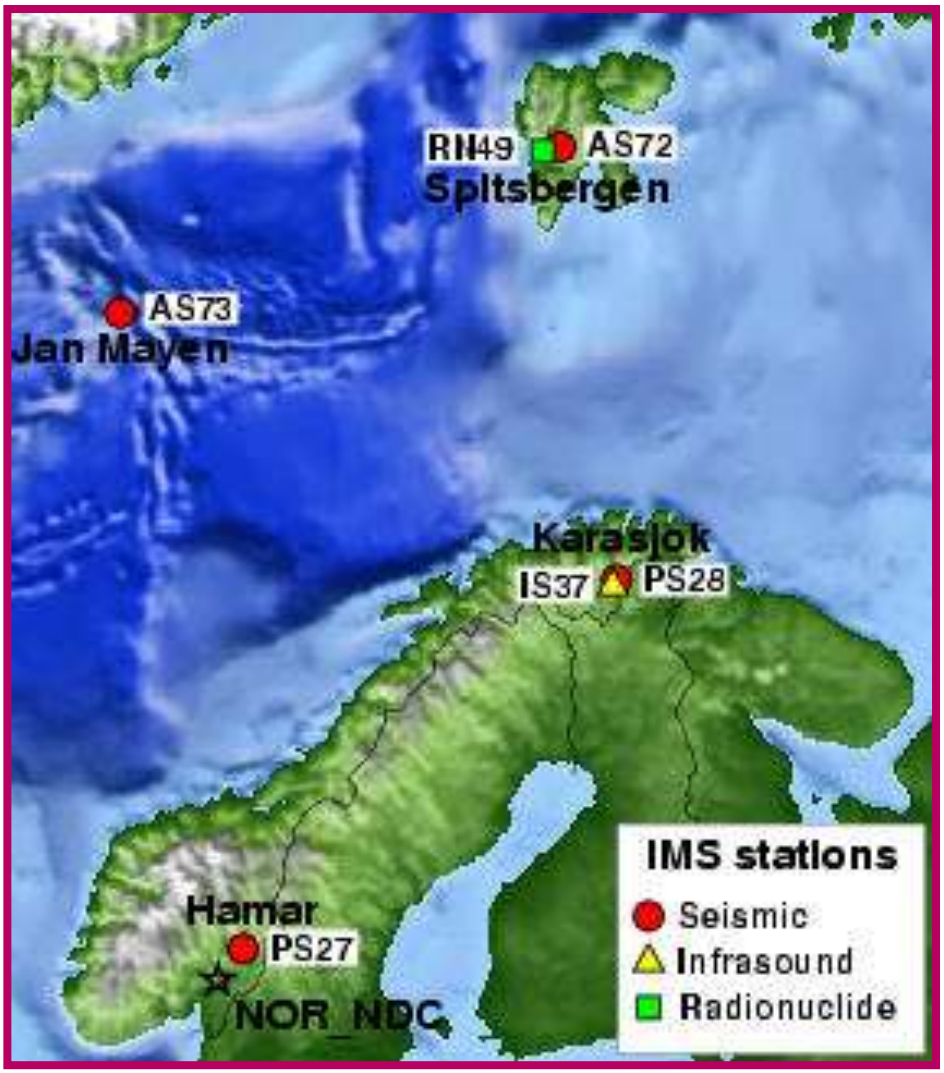

Fig. 1. Seismic arrays (and a planned infrasound station) currently operated by NORSAR.

1 Systems Recording Performance

The arrays have continuous data recording. In 2006 the average recording time for the SPITS array was 94.38%, for the ARCES array 98.47%, and for the NORSAR array 98.19%.

The recording performance in terms of monthly uptime statistics is shown in Table 1.

	ARCES	SPITS	NORSAR
January	97.905	93.490	98.626
February	99.686	90.082	98.412
March	99.582	92.384	98.322
April	99.959	99.664	98.347
May	95.037	97.038	97.671
June	95.891	99.686	98.698
July	98.819	99.816	96.649
August	99.329	99.987	94.075
September	100	99.775	97.585
October	100	99.883	99.932
November	100	99.730	99.987
December	95.446	61.022	99.939

Table 1. Systems recording performance (uptime in % of theoretical) for three arrays operated by NORSAR in 2006.

1 Detections

The NORSAR analysis results are based on automatic phase detection and automatic phase associations which produce the automatic bulletin. Based on the automatic bulletin a manual analysis of the data is done, resulting in the reviewed bulletin (which is available under the NORSAR web pages). This procedure is often referred to as the Regional Monitoring System (RMS), and has been in operation since 1989. To reduce the work load on the analyst, the Generalized Beam Forming (GBF) is used as a pre-processor to RMS, so that only phases associated with selected events in northern Europe are considered in the automatic RMS phase association. However, all detections are available for analyst screening and review.

Table 2 gives a summary of the phase detections and events declared by the RMS.

	Jan.	Feb.	March	April	May	June
Phase detections	122608	129031	130794	116939	157735	141959
Associated phases	4013	4338	4547	4349	5212	4794

Un-associated phases	118595	124693	126247	112590	152523	137165
Events automatically declared by RMS	876	838	860	767	894	998
No. of events defined by the analyst	43	56	71	49	80	59
	July	Aug.	Sep.	October	Nov.	Dec.
Phase detections	172997	213818	238213	234247	155896	138222
Associated phases	6688	9111	12665	11303	6320	4201
Un-associated phases	166309	204707	225548	222944	149576	134021
Events automatically declared by RMS	1337	1965	2645	2472	1380	872
No. of events defined by the analyst	63	68	130	71	41	39

Table 2. RMS phase detections and event summary.

The phase arrival time data from the arrays processed by NORSAR is provided to the UiB processing centre and merged with UiB readings, and a location based on all data is computed as published in the monthly bulletins.

1 The use of Norwegian data

Data collected on Norwegian seismic stations are made available through the Internet and is provided on request to interested parties. The use and publication of this data is beyond our control.

Several investigations make use of the data from the Norwegian National Seismic Network. Only one investigation is described in the Appendix which deals with the rather rare analysis of a meteorite. This analysis is based on data from ARCES and in particular from the the seismic station in Tromsø.

A particular use of the NNSN data is for the Åknes slide monitoring project in which local seismicity is associated with data from NNSN. For details see:
http://www.norsar.no/seismology/research/aaknes/ and
http://www.aknes-tafjord.no/artikkel.aspx?AId=182&back=1&MId1=568