# Operation of the

# Norwegian National Seismic Network

# 2006

Supported by

University of Bergen, Faculty of Mathematics and Natural Sciences

and

Norwegian Oil Industry Association

Prepared by

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April 2006

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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.

## 5. Economy

The National Seismic Network is supported economically by the University of Bergen through the Faculty of Natural Sciences and by OLF.

# *APPENDIX 1*

## Seismicity of Norway and surrounding areas in 2006

# Seismicity of Norway and surrounding areas

# for 2006

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**April 2007**

## CONTENTS

# 1. Introduction

This annual report on the seismicity of Norway and adjacent areas encompasses the time period January 1st - December 31st, 2006. The earthquake locations have been compiled from all available seismic stations operating on the Norwegian territory including the Arctic islands of Spitsbergen, Bjørnøya, Hopen and Jan Mayen. In addition, stations from neighbouring countries have been included for large or well-recorded events.

In Norway, the University of Bergen (UiB) operates the Norwegian National Seismic Network (NNSN) consisting of 29 seismic stations where 8 have broad band sensors. NORSAR operates 3 seismic arrays and one seismic station (Figure 1). Data from temporarily installed local networks are also included whenever data are made available. During 2006 two temporary stations were installed in northern Norway at Stokvågen and one temporary station was installed in the northern part of Jan Mayen. Phase data from arrays in Russia (Apatity), Finland (Finess), Sweden (Hagfors) and from stations operated by the British Geological Survey (BGS) are also included when available. All phase data are collected by UiB, and a monthly bulletin is prepared and distributed. All earthquakes with magnitude ≥ 2.0 on mainland Norway and M ≥ 3.0 around Jan Mayen and the midatlantic ridge, are presented on the web pages and also e-mailed to European-Mediterranean Seismological Centre (EMSC). A brief overview of the events published in the monthly bulletins is given in this annual report. Macroseismic data for the largest felt earthquakes in Norway are collected, and macroseismic maps are presented.

Local, regional and teleseismic events that are detected by the UiB network are included. The merging of data between NORSAR and UiB is based on the following principles:
**i)** All local and regional events recorded by NORSAR that are also detected by the NNSN network are included.
**ii)** All local and regional events with local magnitude larger than 2.0 detected by NORSAR and not recorded by the NNSN are included.
**iii)** All teleseismic events recorded by NORSAR and also detected by the NNSN are included.
**iv)** All teleseismic events with NORSAR magnitude $M_b \geq 5.0$ are included.

Data from British Geological Survey (BGS) are included in the database in Bergen following similar criteria as mentioned above, however only events located in the prime area of interest, shown in Figure 1, are included.

## Data availability to the public

All the data stored in the NNSN database is also available to the public via Internet, e-mail or manual request. The main web-portal for earthquake information is www.skjelv.no. It is possible to search interactively for specific data, display the data locally (waveforms and hypocenters) and then download the data. Data are processed daily and updated lists of events recorded by Norwegian stations are available soon after recording. All events with an estimated local magnitude ≥ 2.0 are plotted on individual maps shown on the web pages.

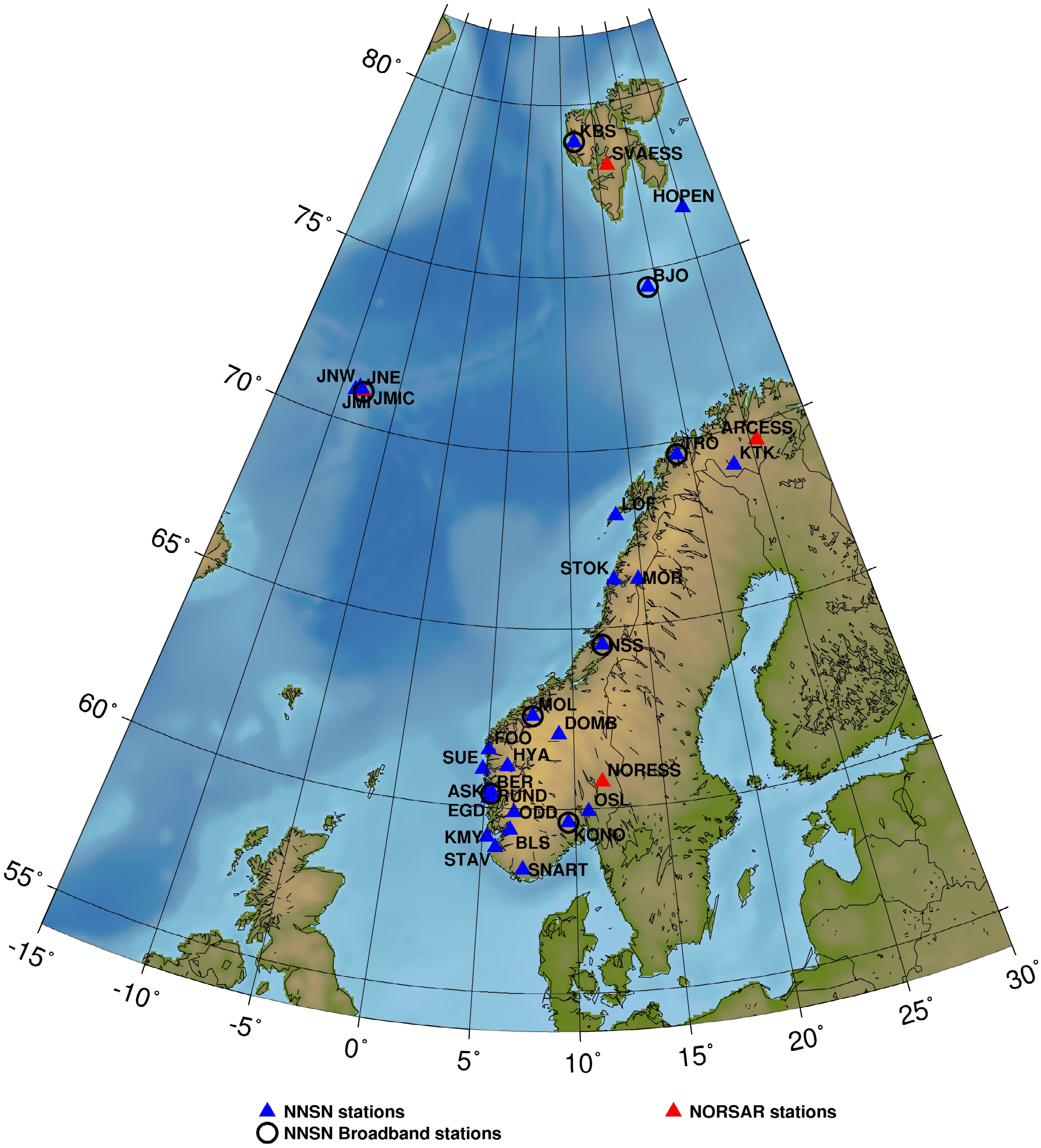


Figure 1: Norwegian seismic stations. UiB operates the 29 stations in the National Seismic Network (NNSN) and NORSAR operates the 3 arrays and the station JMIC.

## 2. Velocity models and magnitude relations

The velocity model used for locating all local and regional events, except for the local Jan Mayen events, is shown in Table 1 (Havskov and Bungum, 1987). Event locations are performed using the HYPOCENTER program (Lienert and Havskov, 1995) and all processing is performed using the SEISAN data analysis software (Havskov and Ottemöller, 1999).

Table 1: Velocity model used for locating all local and regional events, except for the local Jan Mayen events, (from Havskov and Bungum, 1987).

| P-wave velocity (km/sec) | Depth to layer interface (km) |
|---|---|
| 6.2 | 0.0 |
| 6.6 | 12.0 |
| 7.1 | 23.0 |
| 8.05 | 31.0 |
| 8.25 | 50.0 |
| 8.5 | 80.0 |

Magnitudes are calculated from coda duration, amplitudes or seismic spectra. The coda magnitude relation was revised in 2006 (Havskov & Sørensen 2006). The coda wave magnitude scale ($M_C$) is estimated through the relation

$$M_C = -4.28 + 3.16 \cdot \log10(T) + 0.0003 \cdot D$$

where T is the coda length in seconds and D is the epicentral distance in km. The new scale made $M_C$ more consistent with $M_L$ since $M_C$ in general is reduced. For this report all data are updated using the new magnitude scale. When instrument corrected ground amplitudes A (nm) are available, local magnitude $M_L$ is calculated using the equation given by Alsaker et al. (1991):

$$M_L = 1.0 \cdot \log(A) + 0.91 \cdot \log(D) + 0.00087 \cdot D - 1.67$$

where D is the hypocentral distance in km.

The moment magnitude $M_w$ is calculated from the seismic moment $M_0$ using the relation (Kanamori, 1977)

$$M_w = 0.67 \cdot \log(M_0) - 6.06$$

The unit of $M_0$ is Nm. The seismic moment is calculated from standard spectral analysis assuming the Brune model (Brune, 1970) and using the following parameters:

Density: 3.0 g/cm$^2$
$Q = 440 \cdot f^{0.7}$
P-velocity = 6.2 km/s
S velocity = 3.6 km/s

For more computational details, see Havskov and Ottemöller, (2003).

For the Jan Mayen area, a local velocity model (see Table 2) and coda magnitude scale is used (Sørnes and Navrestad, 1975).

Table 2: Velocity model used for locating local Jan Mayen events.

| P-wave velocity (km/sec) | Depth to layer interface (km) |
|---|---|
| 3.14 | 0 |
| 6.33 | 3 |
| 8.27 | 18 |

The coda magnitude scale for Jan Mayen which is used in this report is given by Havskov & Sørensen (2006). This scale was implemented in 2006 but all events used in this report are updated during April/May 2006.

$$M_C = 3.27 \cdot \log(T)\ 2.74 + 0.001 \cdot D$$

where T is the coda duration and D is the epicentral distance in km.

The regional and teleseismic events recorded by the network are located using the global velocity model IASPEI91 (Kennett and Engdahl, 1991).

Body wave magnitude is calculated using the equation by Veith and Clawson (1972):

$$Mb = \log(A/T) + Q(D,h)$$

Here h is the hypocentre depth (km), A is the amplitude (microns), T is period in seconds and Q(D,h) is a correction for distance and depth.

Surface wave magnitude Ms is calculated using the equation (Karnik et al., 1962):

$$Ms = \log(A/T) + 1.66 \cdot \log(D) + 3.3$$

where A is the amplitude (microns), T is period in seconds and D is the hypocentral distance in degrees.

Starting from January 2001, the European Macroseismic Scale, EMS98, (Grünthal, 1998) has been used. All macroseismic intensities mentioned in the text will refer to the EMS98 instead of the previously used Modified Mercalli Intensity scale. The two scales are very similar at the lower end of the scale for intensities less than VII.

## 3. Events recorded by the Norwegian stations

Based on the criteria mentioned in section 1, a total of 4138 local and regional events, were detected by the Norwegian seismic stations during 2006. Of these local and regional events analysed, 47% were located. The number of local/regional and teleseismic events, recorded per month in 2006 is shown in Figure 2. The average number of local and regional events recorded per month is 345.

A total of 978 teleseismic events were recorded during 2006, of which 97% were located. In addition to the locations determined at UiB, also preliminary locations published by the USGS (United States Geological Survey) based on the worldwide network are included in the UiB database whenever the earthquake is recorded with Norwegian stations. The monthly average of teleseismic earthquakes recorded by NNSN is 81.

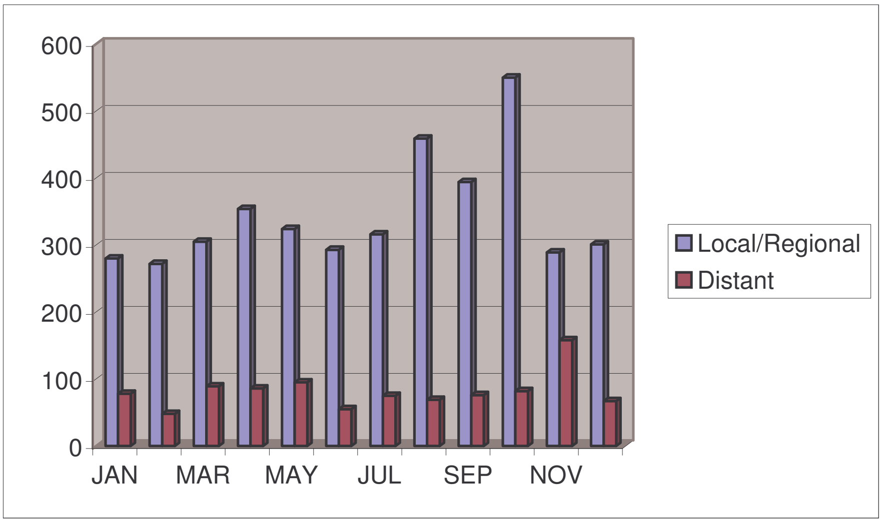


Figure 2: Monthly distribution of local/regional and distant events, recorded during 2006.

UiB, as an observatory in the global net of seismological observatories, reports as many secondary phases as possible from the teleseismic recordings. All events (teleseismic, regional and local) recorded from January to December 2006 with M ≥ 3 are plotted on Figure 3.

Monthly station recording statistics from January to December 2006 are given in Table 3. This table shows, for each station, the number of local events that were recorded only at one station, local events recorded on more than one station and recorded teleseismic events. It must be observed that Table 3 shows both earthquakes and explosions, and that the large number of detections at KTK mainly is due to explosions at the Kirruna/Malmberget mines in Sweden. The MOR station also records the Kirruna/Malmberget explosions but in addition the station also records a large number of local earthquakes. Since 2003 a new seismic station, STOK, was located close to the existing MOR station and therefore the number of recorded local earthquakes increased.

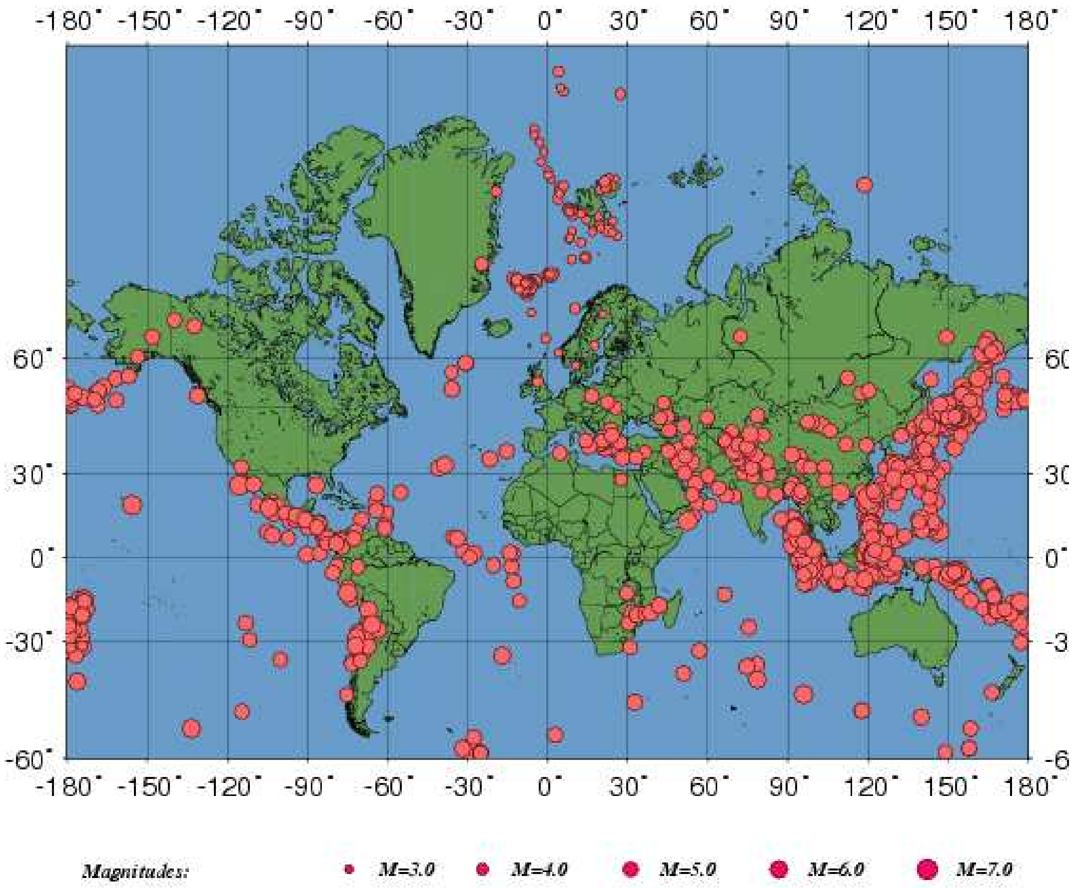


Figure 3: Epicentre distribution of earthquakes with M≥3.0, located by the Norwegian Seismic Network from January to December 2006. Teleseismic events recorded only by NORSAR have M≥5.0.

## 4. The seismicity of Norway and adjacent areas

A total of 1934 of the recorded events are located inside the NNSN prime area, 54°N-82°N and 15°W-32°E. During analysis and using the explosion filter (Ottemöller, 1995), 37% of these events were identified as probable explosions. Figure 4 shows all local/regional events in the prime area, analyzed and located during 2006.

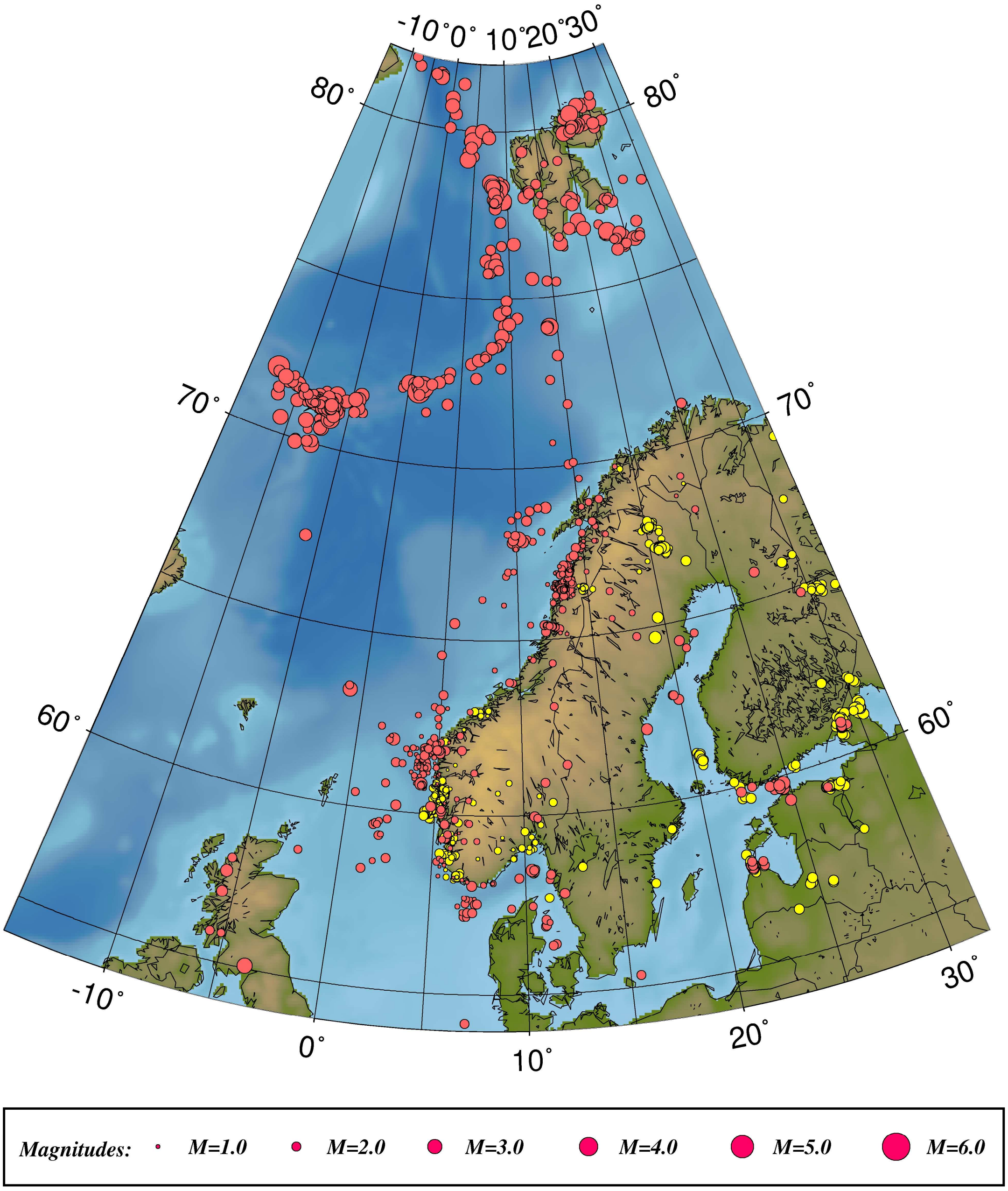


Figure 4: Epicentre distribution of events analyzed and located from January through December 2006. Earthquakes are plotted in red and probable and known explosions in yellow. For station locations, see Figure 1.

Table 3a: Monthly statistics of events recorded at each station for January-June 2006. Abbreviations are: **LM** = Number of local events recorded at more than one station, **LS** = Number of local events recorded at only one station and **D** = Number of teleseismic events. The station TRON was shut down in June.

| | **JANUARY** | | | **FEBRUARY** | | | **MARCH** | | | **APRIL** | | | **MAY** | | | **JUNE** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATION | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** |
| **ASK** | 39 | 0 | 11 | 31 | 0 | 3 | 34 | 0 | 7 | 34 | 0 | 5 | 28 | 0 | 12 | 25 | 0 | 5 |
| **BER** | 10 | 0 | 18 | 16 | 0 | 15 | 6 | 0 | 26 | 17 | 0 | 36 | 15 | 0 | 26 | 16 | 0 | 25 |
| **BJO1** | 0 | 0 | 11 | 1 | 0 | 13 | 2 | 0 | 14 | 2 | 0 | 20 | 6 | 0 | 21 | 5 | 0 | 17 |
| **BLS5** | 37 | 0 | 17 | 39 | 0 | 10 | 36 | 0 | 14 | 34 | 0 | 14 | 26 | 0 | 13 | 31 | 0 | 11 |
| **DOMB** | 7 | 0 | 12 | 8 | 0 | 10 | 5 | 0 | 10 | 10 | 0 | 17 | 11 | 0 | 11 | 2 | 0 | 10 |
| **EGD** | 28 | 0 | 8 | 27 | 0 | 3 | 22 | 0 | 6 | 30 | 0 | 5 | 26 | 0 | 10 | 24 | 0 | 5 |
| **FOO** | 20 | 0 | 9 | 22 | 0 | 5 | 12 | 0 | 5 | 16 | 0 | 5 | 18 | 0 | 13 | 12 | 0 | 1 |
| **HOPEN** | 12 | 10 | 1 | 18 | 6 | 0 | 26 | 17 | 0 | 13 | 8 | 0 | 25 | 9 | 1 | 26 | 13 | 0 |
| **HYA** | 21 | 0 | 8 | 21 | 0 | 4 | 16 | 0 | 3 | 23 | 0 | 1 | 19 | 0 | 11 | 27 | 0 | 6 |
| **JMI** | 14 | 0 | 1 | 21 | 0 | 0 | 18 | 0 | 0 | 16 | 0 | 0 | 20 | 0 | 0 | 26 | 0 | 0 |
| **JMIC** | 0 | 0 | 9 | 1 | 0 | 14 | 1 | 0 | 13 | 5 | 0 | 31 | 3 | 0 | 18 | 0 | 0 | 34 |
| **JNE** | 14 | 0 | 1 | 20 | 0 | 0 | 18 | 0 | 0 | 16 | 0 | 0 | 19 | 0 | 0 | 24 | 0 | 0 |
| **JNW** | 15 | 0 | 1 | 21 | 0 | 0 | 18 | 0 | 0 | 16 | 0 | 2 | 20 | 0 | 1 | 26 | 0 | 1 |
| **KBS** | 8 | 0 | 15 | 17 | 1 | 14 | 11 | 0 | 23 | 16 | 1 | 36 | 32 | 4 | 27 | 19 | 2 | 26 |
| **KMY** | 37 | 0 | 6 | 38 | 0 | 3 | 41 | 0 | 4 | 36 | 0 | 2 | 28 | 0 | 10 | 38 | 0 | 3 |
| **KONO** | 2 | 0 | 13 | 0 | 0 | 12 | 10 | 0 | 21 | 2 | 0 | 32 | 3 | 0 | 26 | 3 | 0 | 26 |
| **KTK1** | 15 | 0 | 22 | 36 | 2 | 7 | 16 | 0 | 17 | 41 | 2 | 33 | 28 | 1 | 18 | 22 | 2 | 20 |
| **LOF** | 18 | 0 | 10 | 32 | 0 | 11 | 18 | 1 | 14 | 29 | 0 | 22 | 37 | 1 | 17 | 20 | 1 | 13 |
| **MOL** | 24 | 2 | 18 | 18 | 0 | 11 | 19 | 3 | 15 | 26 | 5 | 29 | 2 | 0 | 6 | 1 | 0 | 17 |
| **MOR8** | 50 | 7 | 23 | 68 | 2 | 18 | 34 | 5 | 21 | 61 | 4 | 35 | 57 | 0 | 25 | 42 | 1 | 24 |
| **NSS** | 21 | 0 | 19 | 26 | 0 | 19 | 14 | 1 | 29 | 23 | 1 | 34 | 30 | 0 | 26 | 14 | 0 | 28 |
| **ODD1** | 48 | 0 | 13 | 45 | 0 | 7 | 44 | 0 | 8 | 40 | 0 | 2 | 28 | 0 | 11 | 24 | 0 | 4 |
| **OSL** | 0 | 0 | 7 | 0 | 0 | 5 | 0 | 0 | 2 | 1 | 0 | 14 | 0 | 0 | 7 | 0 | 0 | 6 |
| **RUND** | 12 | 0 | 5 | 10 | 0 | 7 | 11 | 0 | 5 | 10 | 0 | 5 | 16 | 0 | 6 | 14 | 0 | 5 |
| **SNART** | 23 | 0 | 5 | 27 | 0 | 4 | 19 | 0 | 2 | 19 | 0 | 8 | 22 | 0 | 7 | 26 | 0 | 6 |
| **STAV** | 3 | 0 | 3 | 6 | 0 | 3 | 3 | 0 | 1 | 7 | 0 | 5 | 6 | 0 | 7 | 12 | 0 | 2 |
| **STOK** | 39 | 0 | 6 | 80 | 37 | 11 | 54 | 29 | 3 | 92 | 48 | 6 | 52 | 0 | 9 | 48 | 0 | 8 |
| **SUE** | 18 | 0 | 6 | 15 | 0 | 4 | 13 | 0 | 1 | 25 | 0 | 3 | 18 | 0 | 9 | 24 | 0 | 2 |
| **TRO** | 13 | 0 | 25 | 34 | 0 | 23 | 3 | 0 | 14 | 28 | 0 | 46 | 16 | 0 | 31 | 17 | 0 | 32 |
| **TRON** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| **NORSAR** | 22 | 0 | 56 | 26 | 0 | 44 | 32 | 0 | 66 | 16 | 0 | 79 | 46 | 0 | 76 | 27 | 0 | 53 |
| **ARCES** | 37 | 0 | 0 | 44 | 0 | 0 | 60 | 0 | 0 | 35 | 0 | 0 | 70 | 0 | 0 | 44 | 0 | 0 |
| **SPITS** | 14 | 0 | 0 | 16 | 0 | 0 | 24 | 2 | 0 | 17 | 0 | 0 | 34 | 0 | 0 | 17 | 0 | 0 |

Table 3b: Monthly statistics of events recorded at each station for July-December 2006. Abbreviations are: **LM** = Number of local events recorded at more than one station, **LS** = Number of local events recorded at only one station and **D** = Number of teleseismic events.

| | **JULY** | | | **AUGUST** | | | **SEPTEMBER** | | | **OCTOBER** | | | **NOVEMBER** | | | **DECEMBER** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATION | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** | **LM** | **LS** | **D** |
| **ASK** | 33 | 0 | 8 | 42 | 0 | 6 | 40 | 0 | 14 | 43 | 0 | 4 | 30 | 0 | 24 | 23 | 0 | 8 |
| **BER** | 12 | 0 | 29 | 18 | 0 | 37 | 12 | 0 | 24 | 27 | 0 | 18 | 6 | 0 | 30 | 2 | 0 | 16 |
| **BJO1** | 14 | 1 | 21 | 7 | 0 | 15 | 4 | 0 | 9 | 3 | 0 | 19 | 9 | 1 | 22 | 2 | 0 | 13 |
| **BLS5** | 28 | 0 | 13 | 26 | 0 | 18 | 32 | 0 | 23 | 33 | 0 | 8 | 22 | 0 | 37 | 21 | 0 | 15 |
| **DOMB** | 6 | 0 | 4 | 8 | 0 | 19 | 2 | 0 | 10 | 2 | 0 | 8 | 6 | 0 | 23 | 6 | 0 | 13 |
| **EGD** | 22 | 0 | 5 | 34 | 0 | 6 | 37 | 0 | 14 | 42 | 0 | 4 | 23 | 0 | 22 | 18 | 0 | 6 |
| **FOO** | 19 | 2 | 1 | 28 | 0 | 2 | 23 | 0 | 7 | 33 | 0 | 1 | 12 | 0 | 3 | 1 | 0 | 0 |
| **HOPEN** | 84 | 58 | 0 | 77 | 32 | 0 | 42 | 14 | 0 | 23 | 8 | 0 | 13 | 5 | 0 | 6 | 3 | 0 |
| **HYA** | 23 | 0 | 5 | 35 | 0 | 4 | 30 | 0 | 7 | 49 | 0 | 1 | 26 | 1 | 19 | 20 | 2 | 7 |
| **JMI** | 32 | 0 | 0 | 35 | 1 | 0 | 24 | 0 | 0 | 23 | 1 | 0 | 19 | 0 | 0 | 21 | 0 | 0 |
| **JMIC** | 3 | 0 | 26 | 9 | 0 | 38 | 12 | 0 | 16 | 6 | 0 | 20 | 4 | 0 | 13 | 0 | 0 | 8 |
| **JNE** | 29 | 0 | 0 | 36 | 0 | 0 | 34 | 0 | 0 | 30 | 0 | 0 | 20 | 0 | 0 | 23 | 0 | 0 |
| **JNW** | 32 | 0 | 0 | 39 | 0 | 0 | 34 | 0 | 1 | 33 | 4 | 0 | 21 | 0 | 1 | 24 | 0 | 0 |
| **KBS** | 33 | 2 | 29 | 54 | 4 | 38 | 40 | 5 | 25 | 18 | 1 | 22 | 23 | 5 | 32 | 6 | 1 | 16 |
| **KMY** | 28 | 0 | 4 | 34 | 0 | 4 | 31 | 0 | 8 | 42 | 0 | 1 | 20 | 0 | 3 | 19 | 0 | 7 |
| **KONO** | 7 | 0 | 32 | 3 | 0 | 36 | 5 | 0 | 24 | 1 | 0 | 22 | 3 | 0 | 33 | 6 | 0 | 15 |
| **KTK1** | 16 | 0 | 5 | 30 | 0 | 26 | 24 | 0 | 36 | 33 | 2 | 15 | 18 | 0 | 57 | 20 | 0 | 23 |
| **LOF** | 17 | 3 | 15 | 43 | 5 | 18 | 32 | 0 | 24 | 33 | 3 | 13 | 18 | 0 | 36 | 11 | 0 | 13 |
| **MOL** | 7 | 0 | 17 | 0 | 0 | 2 | 0 | 0 | 4 | 3 | 0 | 10 | 3 | 0 | 13 | 9 | 0 | 10 |
| **MOR8** | 10 | 0 | 13 | 57 | 4 | 30 | 57 | 1 | 32 | 59 | 3 | 18 | 40 | 1 | 57 | 40 | 2 | 24 |
| **NSS** | 9 | 0 | 31 | 33 | 1 | 30 | 33 | 0 | 36 | 35 | 1 | 24 | 25 | 2 | 58 | 11 | 0 | 13 |
| **ODD1** | 26 | 0 | 10 | 36 | 0 | 5 | 26 | 0 | 12 | 36 | 0 | 3 | 23 | 0 | 21 | 19 | 0 | 11 |
| **OSL** | 1 | 0 | 1 | 0 | 0 | 5 | 0 | 0 | 7 | 0 | 0 | 5 | 0 | 0 | 12 | 0 | 0 | 9 |
| **RUND** | 10 | 0 | 3 | 10 | 0 | 3 | 9 | 0 | 11 | 17 | 0 | 3 | 3 | 0 | 10 | 7 | 0 | 9 |
| **SNART** | 21 | 0 | 7 | 17 | 0 | 5 | 23 | 0 | 8 | 16 | 0 | 2 | 13 | 0 | 16 | 13 | 1 | 7 |
| **STAV** | 9 | 0 | 0 | 9 | 0 | 4 | 5 | 0 | 6 | 2 | 0 | 3 | 3 | 0 | 4 | 1 | 0 | 3 |
| **STOK** | 19 | 3 | 5 | 25 | 2 | 6 | 53 | 0 | 12 | 21 | 6 | 1 | 36 | 0 | 12 | 40 | 1 | 7 |
| **SUE** | 19 | 0 | 2 | 26 | 0 | 3 | 24 | 0 | 8 | 37 | 0 | 2 | 11 | 0 | 6 | 8 | 0 | 4 |
| **TRO** | 11 | 0 | 41 | 28 | 0 | 45 | 20 | 0 | 42 | 22 | 0 | 29 | 13 | 0 | 64 | 13 | 0 | 25 |
| **NORSAR** | 22 | 0 | 70 | 30 | 0 | 66 | 96 | 0 | 66 | 33 | 0 | 77 | 19 | 0 | 149 | 16 | 0 | 66 |
| **ARCES** | 50 | 0 | 0 | 61 | 0 | 0 | 119 | 0 | 0 | 57 | 0 | 0 | 36 | 0 | 0 | 36 | 0 | 0 |
| **SPITS** | 25 | 0 | 0 | 30 | 0 | 0 | 30 | 0 | 0 | 20 | 0 | 0 | 18 | 0 | 0 | 11 | 0 | 0 |

Figure 5 and Table 4 show the 103 local and regional events, located in the prime area, with one of the calculated magnitudes greater than or equal to 3.0. 61 of these are located in the vicinity of the Jan Mayen Island. Depth is checked for the earthquakes listed in Table 4.

It should be emphasized that it is often difficult to get a good magnitude estimate for the earthquakes located on the oceanic ridge in the Norwegian sea, since distances are too large to compute a proper $M_L$, too short for $M_b$ and coda magnitudes for these locations are often unreliable. Most of the recorded earthquakes in this area have magnitudes above 3.0 if the earthquakes are recorded on Norwegian mainland stations.

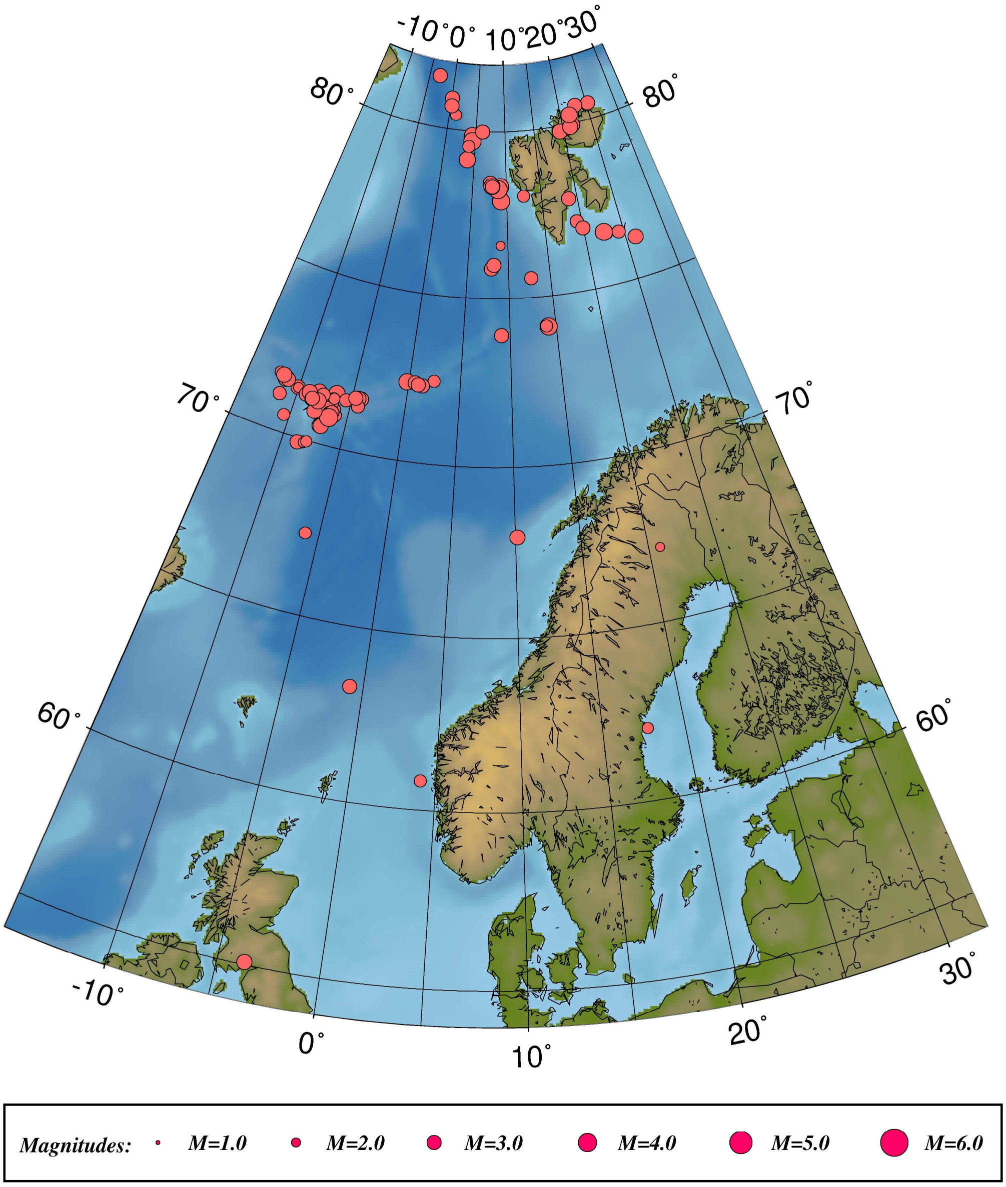


Figure 5: Epicentre distribution of located events with one of the calculated magnitudes above or equal to 3.0. All earthquakes are listed in Table 2. For station location, see Figure 1.

The largest local or regional earthquake in 2006, recorded on Norwegian stations and within the prime area, occurred on August 9th , 2006 at 22:31 (UTC) west of Spitsbergen. The earthquake had a magnitude of $M_L = 4.0$.

The largest earthquake in the vicinity of the Norwegian mainland occurred on July 19th at 20:42 (UTC). The earthquake was located west of Mo i Rana at 67.9°N, 10.1°E and had a magnitude of 3.3. This earthquake was reported felt by a tourist in Lofoten. Some of the recorded seismograms from the earthquake are shown in Figure 6.

Table 4: Local and regional events in prime area with any magnitude above or equal to 3.0 for the time period January through December 2006. Only magnitudes reported by the University of Bergen are included. In cases where all BER magnitudes are below 3 but the event still is included in the list, NORSAR has reported a magnitude of 3.0 or larger.
Abbreviations are: **HR** = hour (UTC), **MM** = minutes, **Sec** = seconds, **L** = distance identification (L=local, R=regional, D=teleseismic), **Latitud** = latitude, **Longitud** = longitude, **Depth** = focal depth (km), **F** = fixed depth, **AGA** = agency (BER=Bergen), **NST** = number of stations, **RMS** = root mean square of the travel-time residuals, **Mc** = coda magnitude, **Ml** = local magnitude and **Mw** = moment magnitude.

| Year | Date | HRMM | Sec | L | Latitud | Longitud | Depth | FF | AGA | NST | RMS | Mc | Ml | Mw |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 1 5 | 1321 | 27.1 | L | 71.083 | -7.350 | 8.0 | F | BER | 3 | 0.1 | 3.0 | 3.4 | |
| 2006 | 114 | 0329 | 3.1 | L | 80.485 | 25.253 | 20.0 | F | BER | 3 | 1.0 | 2.1 | 3.1 | |
| 2006 | 124 | 1105 | 11.2 | L | 71.249 | -8.597 | 20.0 | F | BER | 3 | 0.1 | 2.9 | 3.0 | |
| 2006 | 127 | 1016 | 20.2 | L | 71.087 | -7.356 | 7.0 | F | BER | 3 | 0.1 | 3.6 | 3.5 | |
| 2006 | 129 | 1949 | 46.9 | L | 71.596 | -4.153 | 10.0 | F | BER | 26 | 1.7 | 3.2 | 3.2 | |
| 2006 | 131 | 2213 | 2.6 | L | 70.927 | -6.712 | 7.0 | F | BER | 3 | 0.1 | 2.8 | 3.1 | |
| 2006 | 2 2 | 1625 | 35.6 | L | 70.976 | -6.759 | 13.0 | F | BER | 3 | 0.1 | 3.0 | 2.3 | |
| 2006 | 2 4 | 0117 | 57.5 | L | 71.132 | -7.374 | 7.0 | F | BER | 3 | 0.1 | 2.5 | 3.0 | |
| 2006 | 2 6 | 2255 | 50.2 | L | 71.066 | -6.721 | 6.0 | F | BER | 3 | 0.1 | 3.2 | 2.7 | |
| 2006 | 210 | 1706 | 8.0 | L | 79.808 | 19.428 | 10.0 | F | BER | 9 | 1.3 | 2.8 | 3.3 | |
| 2006 | 214 | 1309 | 52.5 | L | 77.915 | 9.198 | 10.0 | F | BER | 6 | 2.3 | | 3.7 | |
| 2006 | 222 | 2357 | 43.4 | L | 70.936 | -6.145 | 10.0 | F | BER | 5 | 0.3 | 3.5 | 2.8 | |
| 2006 | 3 4 | 2125 | 14.1 | L | 71.172 | -7.503 | 10.0 | F | BER | 3 | 0.1 | 3.3 | 2.9 | |
| 2006 | 3 5 | 1001 | 8.2 | L | 67.146 | 20.821 | 0.0 | F | BER | 10 | 1.7 | 3.1 | 2.1 | |
| 2006 | 312 | 0610 | 9.3 | L | 71.426 | -8.017 | 10.0 | F | BER | 3 | 0.5 | 3.0 | 2.8 | |
| 2006 | 318 | 1255 | 55.8 | L | 71.236 | -7.468 | 10.0 | F | BER | 6 | 0.2 | 3.4 | 3.1 | |
| 2006 | 410 | 1412 | 27.2 | L | 71.250 | -8.462 | 10.0 | F | BER | 4 | 0.1 | 3.2 | 3.4 | |
| 2006 | 410 | 1434 | 50.7 | L | 71.138 | -7.528 | 10.0 | F | BER | 10 | 0.9 | 4.0 | 3.4 | |
| 2006 | 415 | 0332 | 6.9 | L | 67.378 | -6.073 | 10.0 | F | BER | 14 | 1.5 | 2.5 | 2.7 | |
| 2006 | 428 | 1339 | 40.7 | L | 79.145 | 3.908 | 10.0 | F | BER | 3 | 0.8 | 1.4 | 3.5 | |
| 2006 | 428 | 1341 | 57.5 | L | 78.352 | 9.062 | 10.0 | F | BER | 12 | 1.2 | 3.8 | 3.7 | |
| 2006 | 429 | 0041 | 36.4 | L | 76.227 | 26.209 | 22.0 | F | BER | 9 | 1.3 | | 3.3 | |
| 2006 | 5 3 | 0918 | 0.2 | L | 71.432 | -10.106 | 10.0 | F | BER | 4 | 0.2 | 3.5 | 3.0 | |
| 2006 | 5 3 | 0949 | 4.4 | L | 75.899 | 8.046 | 10.0 | F | BER | 6 | 1.0 | 2.4 | 3.2 | |
| 2006 | 5 9 | 0302 | 14.5 | L | 71.497 | -8.103 | 10.0 | F | BER | 4 | 0.3 | 3.6 | 3.1 | |
| 2006 | 5 9 | 1015 | 30.6 | L | 71.566 | -6.478 | 10.0 | F | BER | 13 | 1.2 | 4.7 | 3.5 | |
| 2006 | 512 | 1142 | 24.0 | L | 71.420 | -10.026 | 10.0 | F | BER | 4 | 0.4 | 3.0 | 2.2 | |
| 2006 | 516 | 0853 | 49.1 | L | 76.580 | 9.085 | 7.0 | F | BER | 4 | 0.8 | 3.0 | 2.0 | |
| 2006 | 520 | 0624 | 7.3 | L | 71.450 | -5.516 | 10.0 | F | BER | 16 | 2.2 | 4.1 | 2.9 | |
| 2006 | 524 | 0327 | 50.7 | L | 80.445 | 1.277 | 10.0 | F | BER | 4 | 1.4 | 3.0 | 2.5 | |
| 2006 | 528 | 1323 | 29.2 | L | 74.107 | 14.197 | 5.0 | F | BER | 21 | 1.8 | 3.9 | 3.7 | |
| 2006 | 528 | 2310 | 27.0 | L | 80.925 | 0.156 | 10.0 | F | BER | 6 | 2.0 | 2.8 | 3.1 | |
| 2006 | 529 | 2201 | 18.6 | L | 74.118 | 13.956 | 10.0 | F | BER | 15 | 1.2 | 3.1 | 2.7 | |
| 2006 | 6 3 | 1211 | 24.9 | L | 79.952 | 21.718 | 22.2 | F | BER | 3 | 0.7 | 2.6 | 3.1 | |
| 2006 | 6 4 | 1140 | 41.0 | L | 70.746 | -7.457 | 10.0 | F | BER | 4 | 0.9 | 3.2 | 2.3 | |
| 2006 | 6 4 | 1243 | 19.3 | L | 71.116 | -6.286 | 5.0 | F | BER | 4 | 0.1 | 3.5 | 2.4 | |
| 2006 | 611 | 1411 | 12.0 | L | 77.806 | 18.807 | 10.0 | F | BER | 5 | 1.5 | 2.5 | 3.1 | |
| 2006 | 617 | 1937 | 5.6 | L | 71.393 | -6.936 | 5.0 | F | BER | 3 | 0.3 | 3.2 | 2.3 | |
| 2006 | 630 | 0243 | 34.1 | L | 73.906 | 9.063 | 10.0 | F | BER | 20 | 1.2 | 3.3 | 3.1 | |
| 2006 | 7 3 | 1839 | 6.0 | L | 71.306 | -9.173 | 10.0 | F | BER | 3 | 0.1 | 3.7 | 3.2 | |
| 2006 | 7 4 | 1848 | 23.4 | L | 79.864 | 4.488 | 18.0 | F | BER | 11 | 1.7 | 3.6 | 3.6 | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 7 4 | 1853 | 42.0 | L | 79.705 | 4.544 | 10.0 | F | BER | 11 | 1.8 | 3.6 | 3.7 | |
| 2006 | 7 4 | 1949 | 52.6 | L | 79.992 | 6.157 | 10.0 | F | BER | 4 | 0.4 | 3.3 | 3.2 | |
| 2006 | 719 | 1404 | 7.5 | L | 71.108 | -6.963 | 12.0 | F | BER | 3 | 0.1 | 3.2 | 2.4 | |
| 2006 | 719 | 2042 | 38.6 | L | 67.939 | 10.156 | 12.0 | F | BER | 19 | 1.1 | 3.5 | 3.3 | |
| 2006 | 723 | 0648 | 38.0 | L | 78.469 | 7.649 | 10.0 | F | BER | 9 | 1.6 | 2.8 | 3.0 | |
| 2006 | 729 | 1743 | 50.0 | L | 81.525 | -2.970 | 10.0 | F | BER | 4 | 1.5 | 3.1 | 3.0 | |
| 2006 | 730 | 0716 | 56.7 | L | 72.334 | -0.168 | 15.0 | F | BER | 27 | 1.8 | | 3.6 | 5.3 |
| 2006 | 8 9 | 0815 | 14.4 | L | 60.833 | 4.107 | 15.0 | F | BER | 18 | 0.9 | 2.7 | 2.7 | |
| 2006 | 8 9 | 2231 | 13.8 | L | 78.277 | 8.796 | 10.0 | F | BER | 17 | 1.9 | 3.8 | 4.0 | |
| 2006 | 812 | 1238 | 24.9 | L | 79.911 | 21.273 | 23.0 | F | BER | 4 | 1.3 | 3.3 | 3.4 | |
| 2006 | 813 | 1903 | 9.4 | L | 71.585 | -4.432 | 10.0 | F | BER | 25 | 1.6 | 4.4 | 3.3 | |
| 2006 | 813 | 1929 | 34.5 | L | 71.640 | -4.614 | 10.0 | F | BER | 7 | 1.3 | 3.9 | 2.3 | |
| 2006 | 813 | 1943 | 11.4 | L | 71.347 | -4.302 | 10.0 | F | BER | 15 | 2.1 | 4.4 | 2.8 | |
| 2006 | 814 | 0125 | 49.7 | L | 71.582 | -4.662 | 10.0 | F | BER | 16 | 1.0 | 4.1 | 3.0 | |
| 2006 | 815 | 1949 | 45.6 | L | 78.368 | 7.853 | 10.0 | F | BER | 4 | 1.1 | 2.7 | 3.6 | |
| 2006 | 815 | 2018 | 14.3 | L | 78.341 | 7.931 | 10.0 | F | BER | 4 | 0.7 | 2.6 | 3.1 | |
| 2006 | 816 | 1331 | 39.9 | L | 77.100 | 19.303 | 7.0 | F | BER | 5 | 0.6 | 2.7 | 2.9 | |
| 2006 | 818 | 2045 | 44.2 | L | 63.274 | -0.833 | 10.0 | F | BER | 33 | 1.5 | 3.3 | 3.1 | |
| 2006 | 820 | 1714 | 0.2 | L | 71.560 | -11.396 | 10.0 | F | BER | 7 | 0.9 | 4.5 | 3.6 | 3.6 |
| 2006 | 820 | 1718 | 23.2 | L | 69.913 | -8.283 | 10.0 | F | BER | 3 | 0.5 | 3.4 | 2.6 | |
| 2006 | 820 | 1726 | 49.4 | L | 71.077 | -11.492 | 5.0 | F | BER | 3 | 0.2 | 3.6 | 2.8 | |
| 2006 | 820 | 1907 | 28.3 | L | 71.549 | -11.182 | 5.0 | F | BER | 6 | 0.4 | 3.8 | 3.1 | |
| 2006 | 820 | 2017 | 42.6 | L | 69.875 | -8.698 | 10.0 | F | BER | 3 | 0.6 | 3.9 | 3.1 | |
| 2006 | 820 | 2230 | 26.9 | L | 69.912 | -8.358 | 5.0 | F | BER | 3 | 0.3 | 3.1 | 2.3 | |
| 2006 | 821 | 0617 | 58.3 | L | 69.974 | -7.960 | 10.0 | F | BER | 3 | 0.3 | 3.1 | 2.5 | |
| 2006 | 821 | 2114 | 48.5 | L | 75.579 | 12.662 | 10.0 | F | BER | 13 | 1.6 | 3.2 | 2.8 | |
| 2006 | 822 | 0831 | 18.1 | L | 80.517 | 22.899 | 13.0 | F | BER | 5 | 0.8 | 2.8 | 3.1 | |
| 2006 | 824 | 0819 | 40.1 | L | 71.158 | -6.604 | 11.0 | F | BER | 3 | 0.1 | 3.0 | 2.2 | |
| 2006 | 9 4 | 0033 | 54.5 | L | 71.685 | -12.130 | 5.0 | F | BER | 3 | 0.1 | 3.2 | 2.4 | |
| 2006 | 9 4 | 1623 | 32.8 | L | 78.044 | 12.483 | 10.0 | F | BER | 4 | 1.8 | 3.0 | 2.6 | |
| 2006 | 9 6 | 0557 | 21.2 | L | 71.249 | -6.706 | 10.0 | F | BER | 10 | 0.8 | 4.3 | 2.9 | |
| 2006 | 913 | 1106 | 44.9 | L | 71.076 | -6.907 | 10.0 | F | BER | 3 | 0.3 | 2.7 | 3.1 | |
| 2006 | 918 | 0642 | 57.6 | L | 80.255 | 21.577 | 15.0 | F | BER | 9 | 1.5 | 2.8 | 3.5 | |
| 2006 | 919 | 0920 | 40.4 | L | 72.459 | 2.441 | 10.0 | F | BER | 11 | 1.4 | 2.8 | 2.7 | |
| 2006 | 922 | 1813 | 31.8 | L | 71.417 | -6.653 | 8.0 | F | BER | 3 | 0.1 | 3.0 | 2.4 | |
| 2006 | 923 | 0406 | 56.2 | L | 70.522 | -7.264 | 10.0 | F | BER | 7 | 1.3 | 4.2 | 3.1 | |
| 2006 | 923 | 0426 | 45.3 | L | 70.510 | -7.116 | 10.0 | F | BER | 6 | 0.6 | 3.5 | 3.3 | |
| 2006 | 923 | 0437 | 51.0 | L | 70.956 | -6.615 | 10.0 | F | BER | 10 | 1.7 | 2.9 | 3.3 | |
| 2006 | 923 | 0637 | 48.3 | L | 70.988 | -6.488 | 9.5 | F | BER | 3 | 0.0 | 3.1 | 3.0 | |
| 2006 | 923 | 0720 | 2.5 | L | 70.826 | -6.640 | 10.0 | F | BER | 20 | 1.8 | | 4.1 | 4.5 |
| 2006 | 923 | 0814 | 24.3 | L | 71.398 | -6.598 | 10.0 | F | BER | 3 | 0.2 | 3.3 | 2.4 | |
| 2006 | 929 | 1257 | 34.0 | L | 75.997 | 8.205 | 10.0 | F | BER | 6 | 1.0 | 3.0 | 3.1 | |
| 2006 | 10 6 | 1035 | 34.6 | L | 80.681 | 0.383 | 10.0 | F | BER | 4 | 1.0 | 2.8 | 3.0 | |
| 2006 | 1014 | 0022 | 13.6 | L | 79.533 | 4.031 | 10.0 | F | BER | 4 | 0.5 | 3.0 | 2.6 | |
| 2006 | 1017 | 0536 | 26.5 | L | 71.395 | -8.913 | 10.0 | F | BER | 7 | 1.1 | 3.3 | 3.4 | |
| 2006 | 1020 | 0507 | 40.6 | L | 62.067 | 17.733 | 15.0 | F | BER | 12 | 2.1 | 3.2 | 2.4 | |
| 2006 | 1020 | 1935 | 48.9 | L | 71.634 | -11.677 | 5.0 | F | BER | 6 | 0.2 | 4.0 | 3.3 | |
| 2006 | 1020 | 2253 | 4.7 | L | 71.217 | -8.540 | 10.0 | F | BER | 3 | 0.2 | 3.0 | 3.1 | |
| 2006 | 1026 | 1642 | 25.0 | L | 76.568 | 22.649 | 17.0 | F | BER | 7 | 1.5 | 2.5 | 3.1 | |
| 2006 | 1028 | 2348 | 4.9 | L | 76.615 | 22.507 | 6.0 | F | BER | 12 | 1.2 | 3.4 | 3.8 | 3.8 |
| 2006 | 11 1 | 0840 | 6.9 | L | 71.429 | -7.635 | 10.0 | F | BER | 3 | 0.4 | 3.2 | 2.8 | |
| 2006 | 11 2 | 2247 | 13.0 | L | 72.335 | 0.619 | 10.0 | F | BER | 26 | 1.4 | | 3.2 | |
| 2006 | 11 2 | 2248 | 13.7 | L | 72.132 | 1.004 | 10.0 | FF | PDE | 3 | 2.2 | | | |
| 2006 | 11 2 | 2248 | 54.8 | L | 72.271 | 1.329 | 10.0 | FF | PDE | 6 | 2.5 | | 3.0 | 3.2 |
| 2006 | 11 2 | 2252 | 42.0 | L | 72.290 | 0.950 | 11.0 | F | BER | 18 | 1.4 | 3.2 | 3.0 | |
| 2006 | 1110 | 1149 | 55.3 | L | 70.894 | -8.034 | 10.0 | F | BER | 11 | 1.6 | 3.6 | 3.3 | |
| 2006 | 1116 | 0809 | 13.6 | L | 71.210 | -7.985 | 8.0 | F | BER | 7 | 0.5 | 3.6 | 3.5 | |
| 2006 | 1119 | 0343 | 12.4 | L | 76.508 | 24.338 | 12.0 | F | BER | 7 | 1.3 | | 2.8 | |
| 2006 | 12 5 | 0937 | 29.1 | L | 71.242 | -8.540 | 10.0 | F | BER | 3 | 0.1 | 2.9 | 3.2 | |
| 2006 | 12 6 | 1421 | 1.2 | L | 76.868 | 19.919 | 13.0 | F | BER | 7 | 1.2 | 2.5 | 3.1 | |
| 2006 | 1226 | 1040 | 5.2 | L | 55.078 | -3.679 | 15.0 | F | BER | 47 | 1.0 | 3.2 | 3.4 | |
| 2006 | 1229 | 0041 | 52.7 | L | 70.535 | -10.491 | 5.0 | F | BER | 3 | 0.5 | 3.1 | 2.7 | |

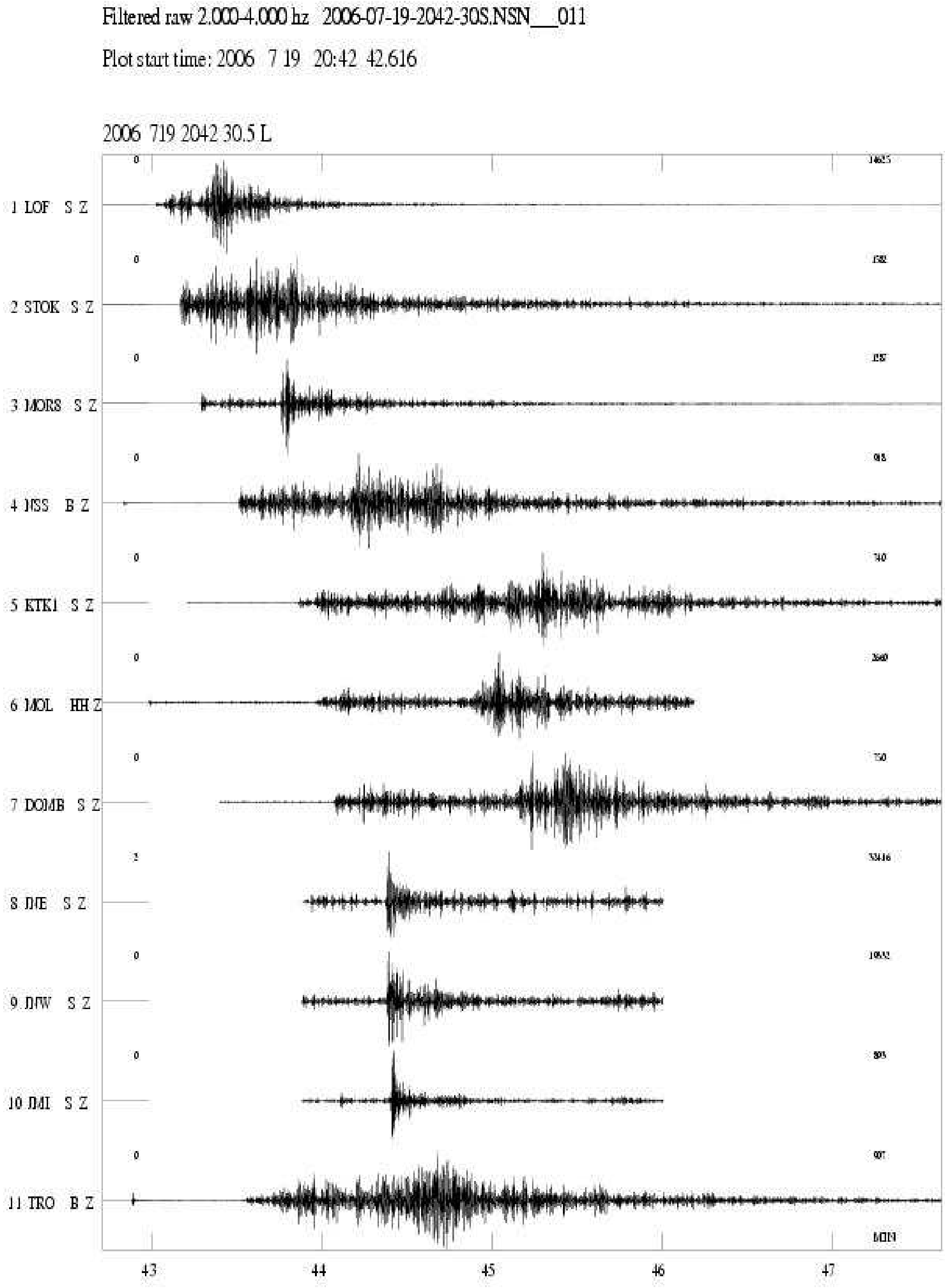


Figure 6: Seismograms for the earthquake on July 19th 2006 at 20:42 (UTC). This earthquake is located northwest of Mo i Rana, at 67.94N and 10.14E. The seismograms are filtered between 2-4 Hz. The horizontal time scale is minutes, first marking at 20:43 (UTC). The station abbreviations are: LOF: Lofoten, STOK: Stokkvågen, MOR: Mo i Rana, NSS: Namsos, KTK1: Kautokeino, MOL: Molde, DOMB: Dombås, JNE, JNW and JMI: Jan Mayen and TRO: Tromsø.

## Earthquake recordings in the Stokkvågen area

The temporary network around Stokkvågen has continued operation in most of 2006. The area continues to be highly active and around 400 earthquakes were located in 2006 (Figure 8). There is a renewed research interest in the area and independent funding might be obtained for additional monitoring of seismicity and crustal motions (with GPS).

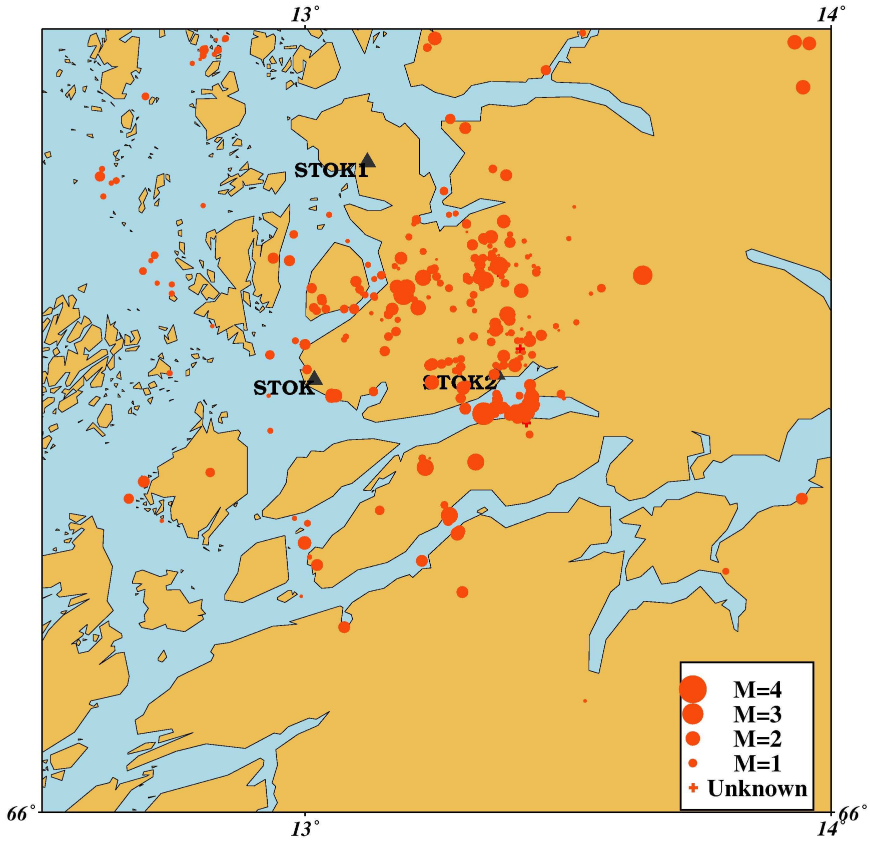


Figure 8: Earthquakes located in the Stokkvågen area during 2006. STOK1 and STOK2 are temporary stations.

## Jan Mayen

The Jan Mayen Island is located in an active tectonic area with two major structures, the Mid Atlantic ridge and the Jan Mayen fracture zone, interacting in the vicinity of the island. Due to both tectonic and magmatic activity in the area, the number of recorded earthquakes is higher than in other areas covered by Norwegian seismic stations. During 2006 a total of 266 earthquakes were located as seen on Figure 8 and of these, 70 were calculated to have a magnitude equal to or above 3.0. It is interesting to notice that the number of small earthquakes (M<3.0) is reduced with app. 50% compared with 2005.
The temporarily installed station JMIN, which was located at the northern tip if the island, broke down in 2006. It has not been possible to reinstall this station due to bad weather conditions when attempt to visit has been made. The only access to this area is by boat.

The largest earthquake in the Jan Mayen region occurred September 23rd at 07:20 (UTC). This earthquake was located to 70.82N and 6.54W with magnitude 4.1.

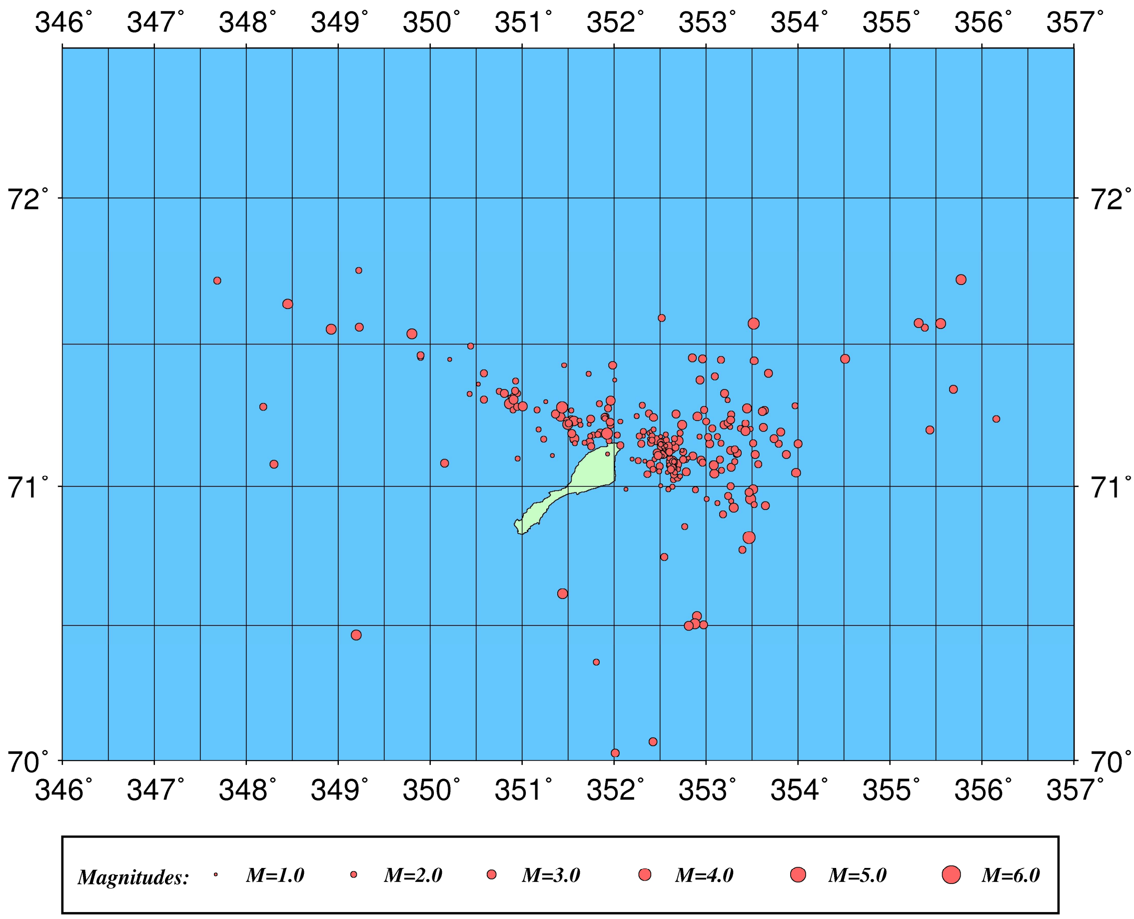


Figure 8: Earthquakes located in the vicinity of the Jan Mayen Island during 2006.

The number of recorded earthquakes in the Jan Mayen area has varied over the last years, see Figure 9. The number of relative strong earthquakes show smaller time variation than smaller earthquakes.

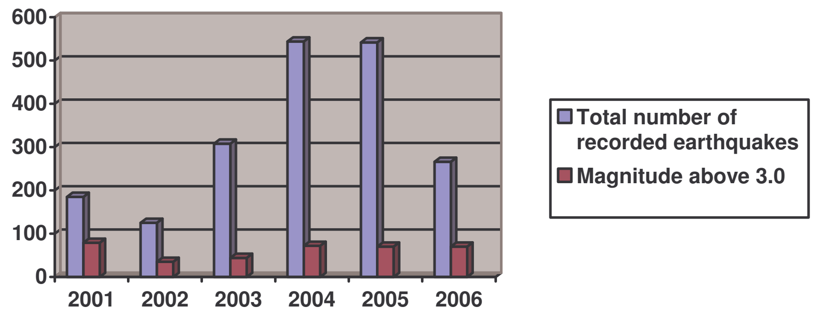


Figure 9: Yearly distribution of earthquakes located in the Jan Mayen area.

In the summers of 2005 and 2006, there were expeditions to the area around Jan Mayen. This gave the opportunity to place a seismic station on the north tip of Jan Mayen Island.

The main purpose of the new station was:

1) Give an accurate location of the earthquakes on the transform fault in order to determine if the fault goes through the Northern tip of Jan Mayen or if it is located outside the island.
2) Investigate if there are volcanic earthquakes not seen by the Jan Mayen Seismic Network (currently no volcanic earthquakes are seen).

The station had two independent seismic recorders: One Guralp 6TD broad band station and one SARA short period station, each with its own power system (Figure 10). Due to technical problem with communication and power systems, data is only available for about 3 months. The plan is to get the station working again at the next oportunity

A total of 64 local events were recorded of which 6 were only recorded on JMIN. The 58 local events recorded on both JMIN and the Jan Mayen network are seen on Figure 11. Most of the events (to the east) are aftershocks of a magnitude 5.5 event occurring on July 25, 2005.

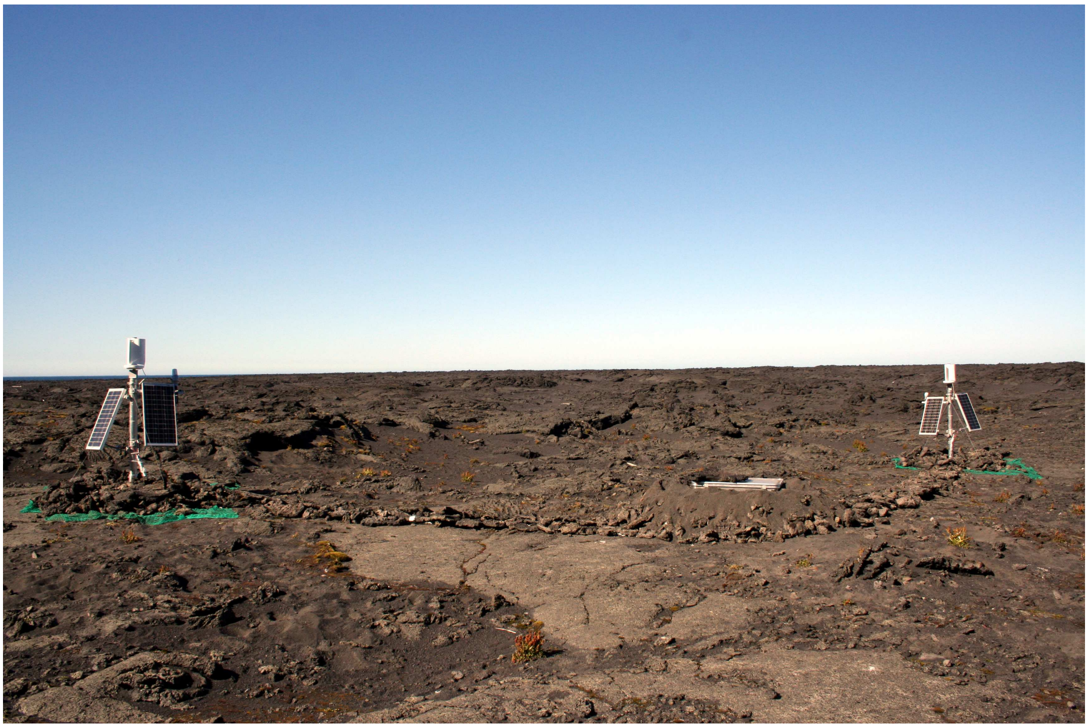

Figure 10: The two power systems and the instrument box at JMIN.

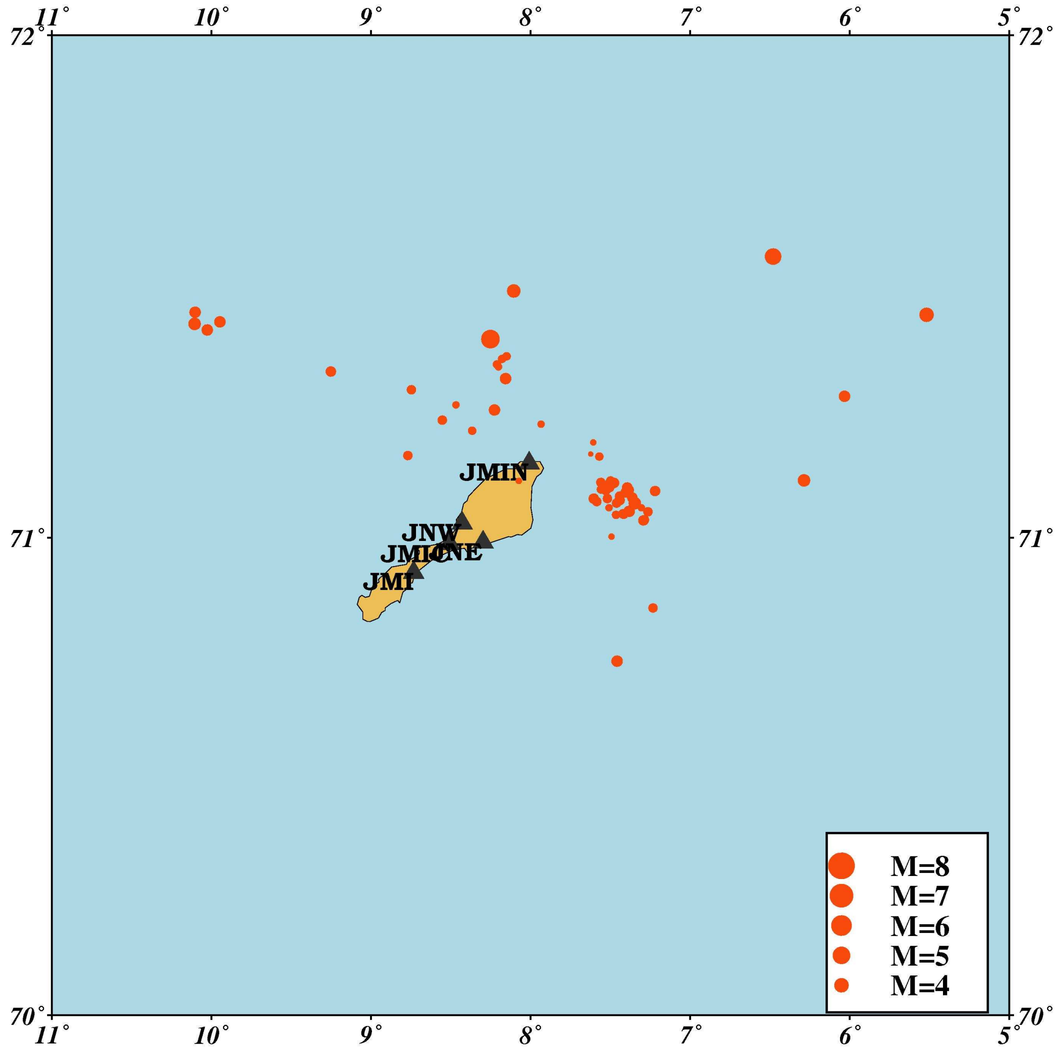


Figure 11: Local events recorded by JMIN and other stations on Jan Mayen

There are no events very close to Jan Mayen so it is hard to answer the question whether the fracture zone passes outside Jan Mayen or under Jan Mayen. However, by making a linear interpretation of the location of the event locations, it seems that the active zone is very close to the tip of Jan Mayen.
The continuous data was also checked for volcanic type events. No events were found.
It was surprising that there were no events nearer Jan Mayen. However, it has been observed that seismicty near Jan Mayen and in volcanic areas in general can have a large time variation so a longer recording period might have shown a very different result.

## 6. Felt earthquakes

From 2006 it is now possible to report felt earthquakes using the internet. On the site www.skjelv.no., questionnaires are available for the public. 6 earthquakes were reported felt during 2006 (see Table 5 and Figure 12). None of the earthquakes reported felt in Norway was felt by a sufficient number of people for questionnaires to be distributed by post.

Table 5: Earthquakes reported felt in the BER database in 2006. Abbreviations are: **$M_c$** = coda magnitude, **$M_L$** = local magnitude and **$M_w$** = moment magnitude, Q: questionnaires sent (Y/N), W: questionnaires received on web.

| Nr | Date | Time (UTC) | Max. Intensity (MMI) | Magnitude (BER) | Instrumental epicentre location | Q | W |
|---|---|---|---|---|---|---|---|
| 1 | 11.05.06 | 14:30 | | $M_c$=1.7, $M_L$=2.0 | 59.73N / 5.58E | N | N |
| 2 | 21.05.06 | 18:13 | | $M_c$=2.4, $M_L$=2.6 | 66.40N / 13.19E | N | N |
| 3 | 03.07.06 | 04.42 | | $M_c$=2.1, $M_L$=2.2 | 59.97N / 10.62E | N | N |
| 4 | 19.07.06 | 20:42 | | $M_c$=3.5, $M_L$=3.3 | 67.94N / 10.14E | N | N |
| 5 | 28.10.06 | 23:48 | | $M_c$=3.4, $M_L$=3.8 | 76.64N / 22.76E | N | N |
| 6 | 06.11.06 | 23:32 | | $M_c$=1.7, $M_L$=2.0 | 61.83N / 6.40E | N | N |

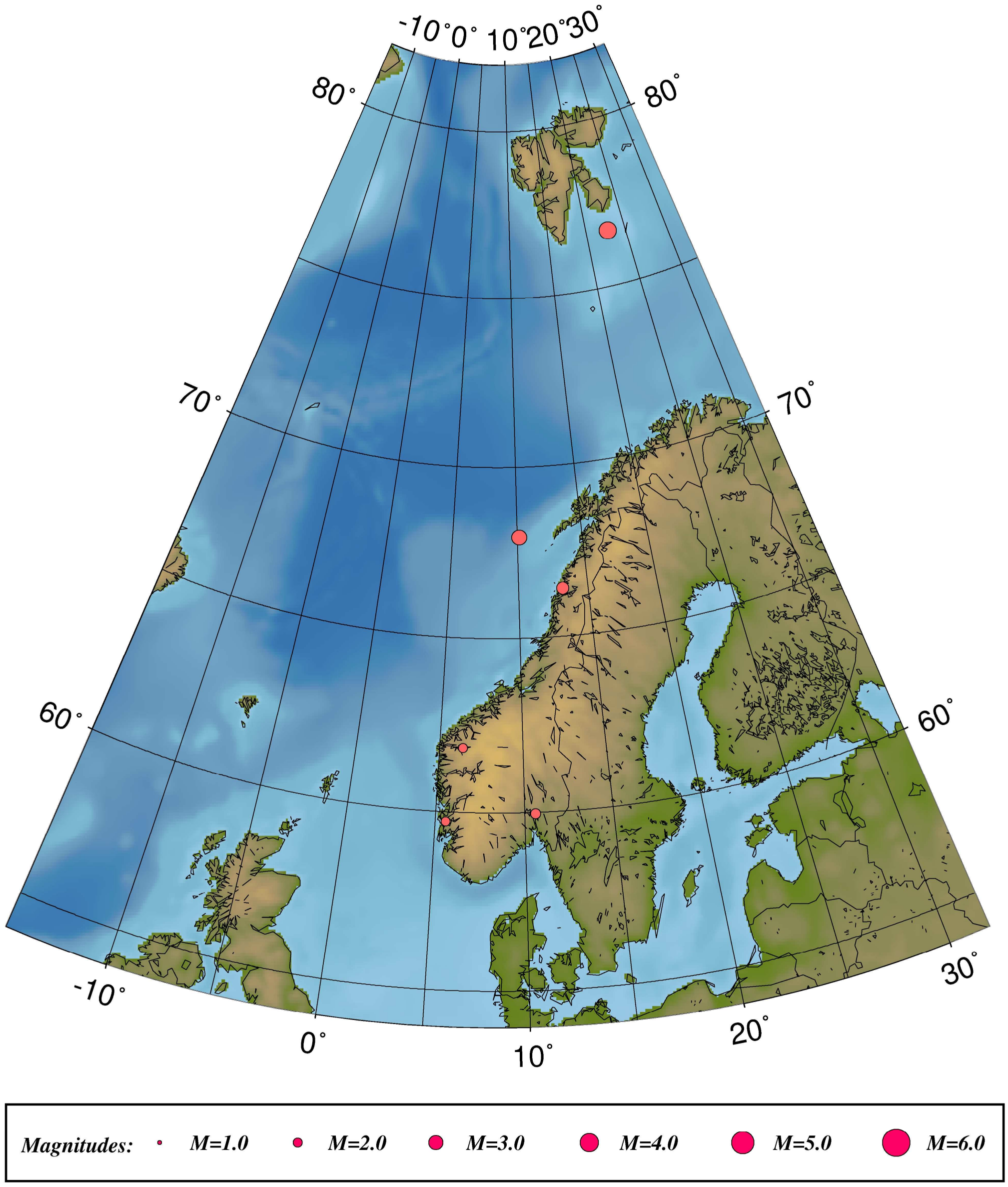


Figure 12: Location of the 6 earthquakes reported felt during 2006.

# 8. Use of NNSN data during 2006.

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

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NIEP, Bucharest, 16 October 2006 (invited lecture)

J. Schweitzer and T. Kværna: Infrasound observations of two meteor impacts with arrays and single stations. AG Seismologie, Haidhof, October 2006

J. Schweitzer, A. Levshin, Ch. Weidle, N. Maercklin, N. Shapiro and M. Ritzwoller: Surface wave tomography of the European Artic 66. Jahrestagung der Deutschen Geophysikalischen Gesellschaft, Bremen 6. - 9. März 2006, (poster)

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J. Pzybilla, M. Korn, J. Schweitzer and U. Wegler: Acoustic and elastic radiative transfer theory with nonisotropic scattering: applications to a local event in South Norway. EGU, General Assembly, Vienna 2006

F. Ringdal, T. Kværna, S. Mykkeltveit, S. Gibbons and J. Schweitzer: Basic research on seismic and infrasonic monitoring of the European Arctic.
28th Seismic Research Review: Ground-based nuclear explosion monitoring technologies. Orlando, Florida, September 19 - 21, 2006 (poster)

Mathilde B. Sørensen, Steven Gibbons and Jens Havskov. Earthquake activity in the Rana region recorded by a local seismic network and a seismic array. Nordic Detection Seminar, Iceland, September 2006.

Ch. Weidle, A. Levshin, J. Schweitzer, N. Maercklin, N. Shapiro and M. Ritzwoller: Surface wave tomography of the European Artic. EGU, General Assembly, Vienna 2006 (poster)

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# *APPENDIX 2*

## 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