Operation of the

Norwegian National Seismic Network

2005

Supported by

University of Bergen, Faculty of Mathematics and Natural Sciences

and

Norwegian Oil Industry Association

Prepared by

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1. Introduction

This annual report describes the operation of the Norwegian National Seismic Network (NNSN) for the year 2005. 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 responcibility 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 in 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 4.3 %, compared to 5.2 % for 2004. This is higher than the goal of average downtime which is below 2%. The high average is caused by a long downtime at Bjørnøya, Rundemanen, Florø and Kings Bay. If these four stations are excluded, the average downtime is 1.3%. Bjørnøya and Kings Bay are arctic stations and especially Bjørnøya can not easily be visited. Kings Bay and Kongsberg are operated by USGS, all maintenance must be arranged through the USGS. The location for the Rundemanen station is owned by TELENOR. Permission to visit the station is only given when accompanied with TELENOR staff. The downtime at Rundemanen coincided with summer hollidays.

Table 1. Downtime in % for the period 2005 for the NNSN stations.

Station	Downtime in %
Askøy (ASK)	1.0
Bergen (BER)	1.0
Bjørnøya (BJO)	58.0
Blåsjø (BLS)	2.0
Dombås (DOMB)	0
Espegrend (EGD)	0
Florø (FOO)	10.0
Hopen (HOPEN)	0
Høyanger (HYA)	3.0
Jan Mayen BB (JMI)	0
Jan Mayen SP (JMI)	0
Jan Mayen (JNE)	0
Jan Mayen (JNW)	0
Karmøy (KMY)	7.5
Kautokeino (KTK)	3.0
Kings Bay (KBS)	12.0
Kongsberg (KONO)	2.0
Lofoten (LOF)	0.5
Mo i Rana (MOR8)	0
Molde (MOL)	6.0
Namsos (NSS)	0
Odda (OOD1)	0
Oslo (OSL)	0
Rundemanen (RUND)	14.0
Snartemo (SNART)	1.0
Stavanger (STAV)	0
Stokkvågen (STOK)	5.0
Sulen (SUE)	2.0
Trondheim (TRON)	1.0
Tromsø (TRO)	0
Average	**4,3**

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)

From 15.02.05. No data was received from the digitizer. The local operator observed that due to a weather change with heavy rain and snow melting on the frozen ground, the aluminium box was flooded with water. The box contains the sensor, digitiser and breakout box, and the water damaged the digitizer and maybe the sensor.
Station down for 135 days
15-20.09.05. Visit. Reinstallation.
The moisture in the aluminium box was dried out. A new Guralp BB sensor, CMG-6TD and a beakout box was installed. Outside a new GPS antenna, mounted on a mast, was installed.
In the recording room, a new PC with Seislog for Windows was installed. During testing the PC screen failed and a used screen was installed. A new screen will be sent from Bergen.
As backup, a 4.5 Hz geophone and GPS was installed outside, and a digitzer was installed in the recording room.

Blåsjø (BLS)

13.01.05 The PC was restarted. The station was down for 1 day.
13.07.05 The PC was restarted. The station was down for 5.5 days.

Florø (FOO)

03.02.05. The PC was restarted. Station down for 2 days
04.02.05. The PC was restarted. Station down for 1 day
09.02.05. The PC was restarted. Station down for 1.5 days
08.03.05. The PC was restarted. Station down for 1 day
05.04.05. The PC was restarted. Station down for 1 day
26.05.05. The PC was restarted. Station down for 2.5 days
01.08.05. The PC was restarted. Station down for 2.5 days
18.08.05. The PC was restarted. Station down for 12 days
18.10.05. The PC was restarted. Station down for 2 days
14.11.05. The PC was restarted. Station down for 2 days
23.11.05. The PC was restarted. Station down for 1.5 days
12.12.05. The PC was restarted. Station down for 3 days
22.12.05. The PC was restarted. Station down for 4 days

Høyanger (HYA)

12.09.05. Station down for 10.5 days due to a broken Ciscobox. A new Ciscobox and lightning protection was installed by the local operator.
30.11.05. The PC was restarted. Station down for 1 day.

Karmøy (KMY)

From 15.01.05. No data was received due to the last pair of the phone lines were broken (see report 2001). Karmøy municipality, the owner of this part of the phone lines, started in 2001 to transmit data wireless and had no intention of repairing the line. The estimated cost for replacing a new phoneline was kr. 100 000.
07.02.05. Tromsø Geophysical Observatory (Nordlysobservatoriet) and Department of Earth Science installed a GSM GPRS modem for data transmission.
Station down for 22 days.

24.08.05. The PC was restarted. Station down for 6 days.

Lofoten (LOF)

11.09.05. Communication down for 2 days due to a broken UPS (uninterruptible power supply). No data lost. The UPS was removed and a new one was not installed since there has been problems with UPS's.
01.10.05. "Clock type" in the parameterfile set to 1. For some weeks timing problems has occurred due to bad PPS (pulse/sec).

Mo i Rana (MOR8)

13.12.05. The PC was restarted. Station down for 1.5 days

Molde (MOL)

21.01.05. A new digitiser and telecommunication protector was installed. Station was down for 17 days due to lightning.
28.01.05. A new PC and Ciscobox was installed. Station down for 4 days due to lightning.

Namsos (NSS)

No visit or technical changes.

Odda (ODD1)

No visit or technical changes.

Tromsø (TRO)

18.08.05. GPS restartet by the local operator.
02.12.05. GPS restartet by the local operator.

Sulen (SUE)

12.01.05. The PC was restarted. Station down for 1 day
08.06.05. Visit. Accelerometer reinstalled.
07.07.05. The PC was restarted. Station down for 1.5 days
06.09.05. The PC was restarted. Station down for 4.5 days
14.11.05. The PC was restarted. Station down for 0.5 day

Kautokeino (KTK)

28.06.05. Digitiser restarted with use of remote control. Station down for 9 days. Reason unknown.
30.08.05. The PC was restarted. Station down for 1.5 days

Stavanger (STAV)

No visit or technical changes.

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

ASK. Visit 12.12.05. Station down for 5 days due to lightning.
Installed a new VCO and DC/DC converter.

Rundemanen (RUND)

25.08.05. Visit.
Station has been down for 51 days due to a defective power and phone cabel. (mouse had eaten the cables)
29.09.05. For some time timing problems has occurred due no PPS signal (pulse/sec), caused by a broken cable.

Trondheim (TRON)

30.01.05. The PC was restarted. Station down for 3 days

Oslo (OSL)

No visit or technical changes.

Dombås (DOMB)

No visit or technical changes.

Jan Mayen (JMI)

30.03 - 05.04.05. Visit
The 3 stations have worked properly since last visit in 2004.
A new AD converter SADC20 was installed. Since the new AD converter has 6 channels, signals from all seismometers will be recorded.
A new windmill was installed and tested. The windmill was operating well in strong wind.

Kongsberg (KONO) No visit or technical changes.

Kings Bay (KBS) No visit or technical changes.

Stokkvågen (STOK)

08.02.05. A new Mauro 24bits digitizer installed by the local operator. Station down for 20 days due to a bad digitizer.
22-26.06.05. Visit. The GPS cable was grounded to prevent 50 Hz. During the visit two temporary stations were installed in the area, in Konsvik (STOK1) and Flostrand (STOK2) to monitor the high seismicity.

Snartemo (SNART)

10.01.05. Digitizer restarted by the local operator. Station down for 2 days.
28.01.05. PC restarted due to bad timing – ok.
08.04.05. PC restarted due to software problems. Station down for 2 days.
Visit. 06.05.05. PC and digitizer were changed. PC had problem reading both Com1 and Com2 at same time. New PC setup for ADSL, VPN client. This is our first ADSL station. Old digitizer SeisAD18 had to be restarted by pressing reset button a couple of times.
25.10.05. The PC was restarted by the local operator. Station down for 1 day.

Hopen (HOPEN)

19.09.05. Visit.
The mass position of the Ranger SS-1 sensors was centered.
Some noise was observed on the Z-comp. Some tests did not improved the noise level.
Inspected the aluminium box where the sensors are located – ok.

4. Technical changes and plans

The network now has 6 broadband stations where continuous data is collected. One more station MOL, will be upgraded to broad band in the spring of 2006. Ideally there should also be a broad band station in the Stokvågen area, due to the high activity and the chance of getting a larger event.
New possibilities in communication (see next section) will make it possible to get continuous communication to all field stations at a reasonable cost. This would make it possible to transfer all data from all stations to Bergen and also make a real time detection system. The plan is to is to try to implement this as fast as time and economy allows it.
In the summer of 2005, a temporary station (financed by the Department of Earth Science) was installed at the north end of Jan Mayen (Figure 1). The intention is that is shall record for 1-2 years. Part of the data is sent to Bergen by Iridium telephone and the rest of the data will be collected during the summer of 2006. All data is integrated into the NNSN data base. The purpose of the station is to exactly locate the fracture zone north of Jan Mayen and determine the local crustal structure.

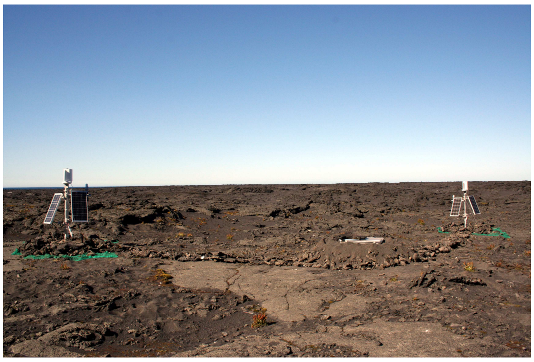

Figure 1. Left: North Jan Mayen, Right: Seismic station (in the middle) and power systems at left and right.

5. Communication

The use of ADSL is now more widely available and is now used at some of the stations. A new possibility for data transfer is using GPRS, which is data transfer with a GSM phone. This has been tested and is now used at station KMY. The data rate is lower than with ADSL, but the price is comparable. The advantage of permanent open lines is that communication costs will be constant and independent on amount of data transferred.

6. Economy

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

APPENDIX 1

Seismicity of Norway and surrounding areas.

Seismicity of Norway and surrounding areas

for 2005

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1. Introduction

This annual report on the seismicity of Norway and adjacent areas encompasses the time period January 1st - December 31st, 2005. The earthquake locations have been compiled from all available seismic stations operating on the Norwegian territory including the Arctic islands of Spitsbergen, Bjørnøya 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 6 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 2005 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. 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.

All local and regional events with magnitude larger than 1.5 and all 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 entry for 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.

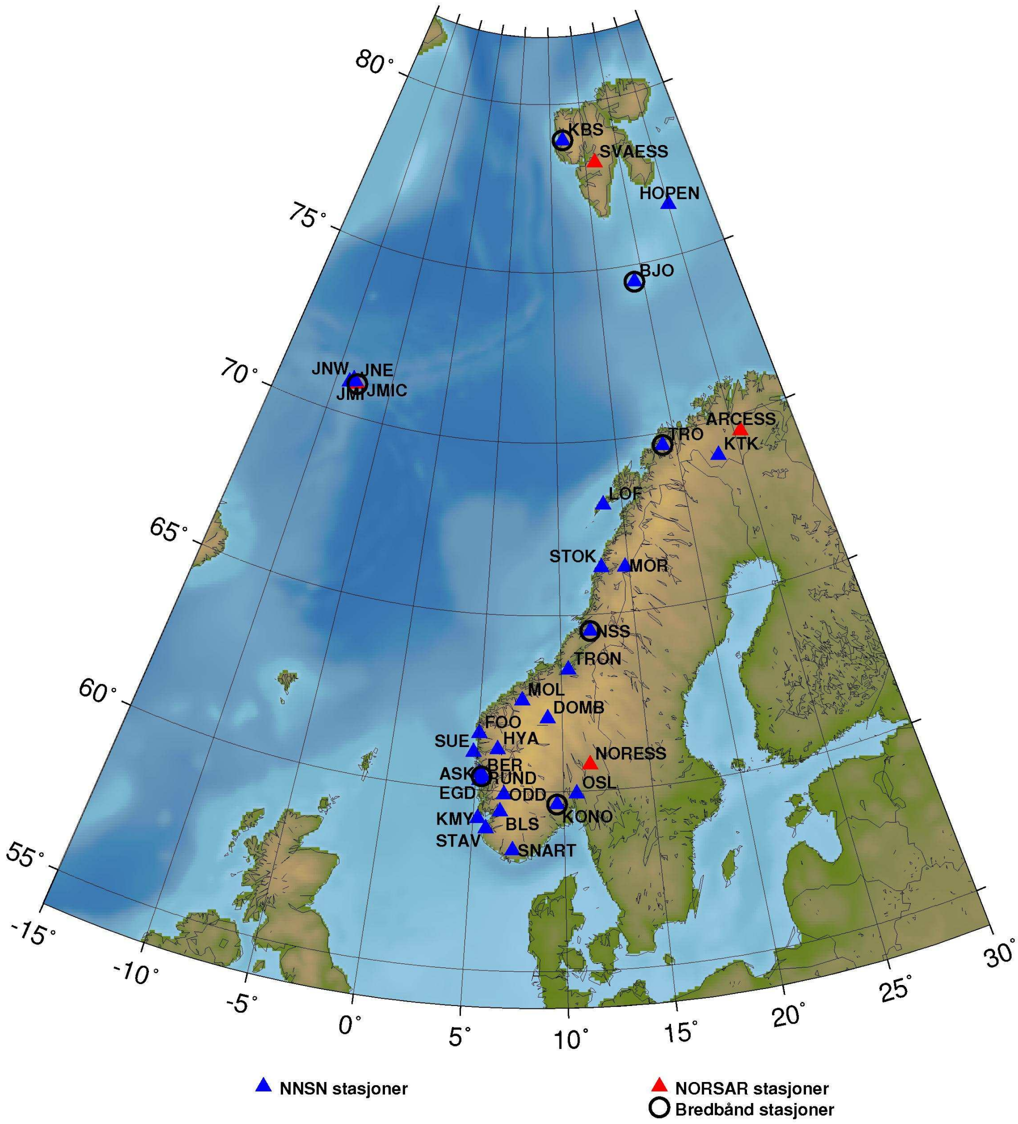

Figure 1: Norwegian seismic stations. UiB operates the 29 stations in the National Seismic Network (NNSN) and NORSAR operates the 3 arrays and the station JMIC.

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 4016 local and regional events, were detected by the Norwegian seismic stations during 2005. Of these local and regional events analysed, 56% were located. The number of local/regional and teleseismic events, recorded per month in 2005 is shown in Figure 2. The average number of local and regional events recorded per month is 335.

A total of 1085 teleseismic events were recorded during 2005, 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 90.

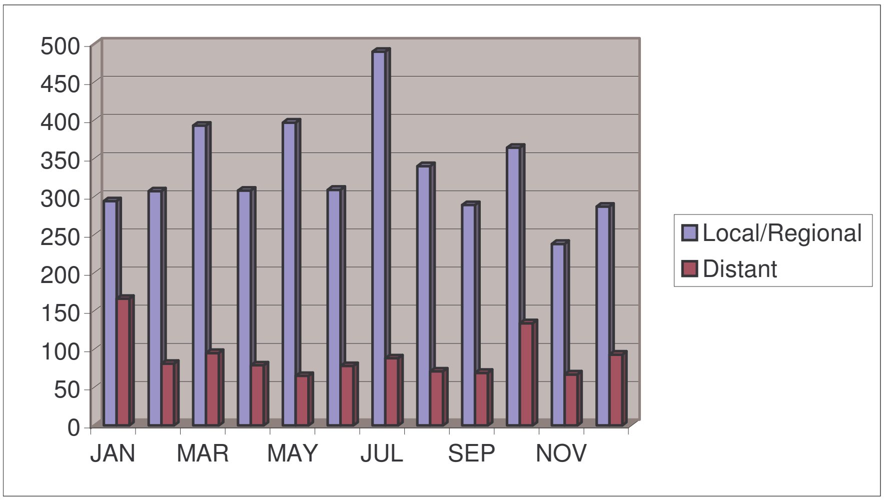

Figure 2: Monthly distribution of local/regional and distant events, recorded during 2005.

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 2005 with M ≥ 3 are plotted on Figure 3.

Monthly station recording statistics from January to December 2005 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.

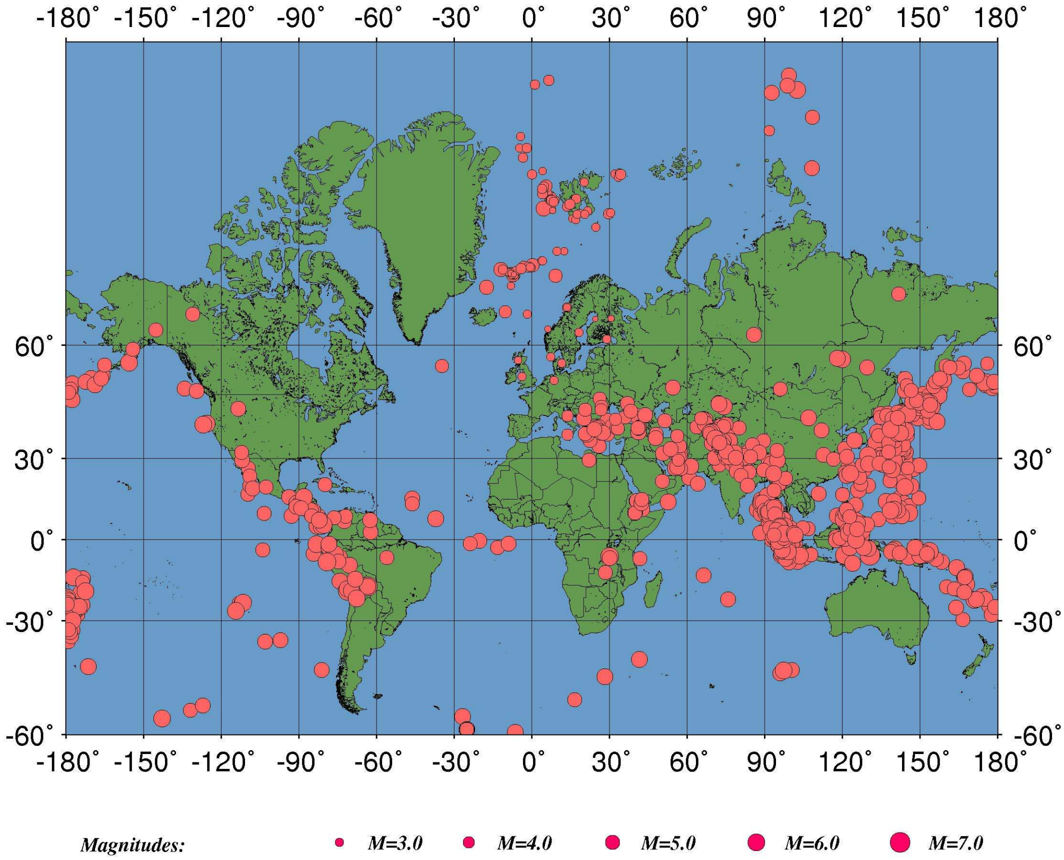

Figure 3: Epicentre distribution of earthquakes with M≥3.0, located by the Norwegian Seismic Network from January to December 2005. Teleseismic events recorded only by NORSAR have M≥5.0.

4. The seismicity of Norway and adjacent areas

A total of 2116 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), 32% of these events were identified as probable explosions. Figure 4 shows all local/regional events in the prime area, analyzed and located during 2005.

Figure 5 and Table 4 show the 134 local and regional events, located in the prime area, with one of the calculated magnitudes greater than or equal to 3.0. 69 of these are located in the vicinity of the Jan Mayen island. There are observed a reduction of earthquakes with magnitude above 3.0 and located on mainland Norway. This is mostly due to an change in the calculation of M_C.

Table 3a: Monthly statistics of events recorded at each station for January-June 2005. 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.

	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	31	0	5	33	0	7	25	0	5	28	0	6	30	0	4	27	0	2
BER	14	0	13	7	0	19	7	0	14	10	0	29	14	0	32	19	0	47
BJO1	3	0	17	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0
BLS5	20	0	12	32	0	24	26	0	19	29	0	12	31	0	8	27	0	5
DOMB	10	0	17	14	0	22	3	0	18	6	0	14	3	0	8	3	0	8
EGD	27	0	4	31	0	7	23	0	4	26	0	5	26	0	4	25	0	2
FOO	23	0	9	15	0	8	15	0	7	10	0	2	13	0	1	19	0	6
HOPEN	21	15	0	20	16	0	59	41	0	38	11	0	21	2	0	36	19	1
HYA	24	0	7	20	0	5	18	0	7	16	0	1	18	0	0	19	0	1
JMI	13	0	0	7	0	0	9	0	0	15	0	0	26	0	0	48	0	0
JMIC	1	0	8	0	0	14	3	0	11	2	0	24	2	0	29	1	0	47
JNE	13	0	0	7	0	0	11	0	0	16	0	0	26	0	0	46	0	0
JNW	13	0	0	7	0	0	11	0	2	16	0	0	26	0	0	48	0	0
KBS	0	0	0	1	0	16	7	0	4	21	1	6	19	1	34	9	2	49
KMY	1	0	1	21	0	3	26	0	6	35	0	1	38	0	0	37	0	1
KONO	8	0	20	11	0	13	13	0	24	11	0	28	7	0	32	5	0	44
KTK1	173	42	52	165	60	34	216	58	33	140	23	23	184	11	17	65	2	6
LOF	60	1	19	57	0	23	102	0	20	77	0	17	131	0	13	101	1	19
MOL	1	0	3	26	3	27	24	6	25	23	6	20	28	6	14	26	4	14
MOR8	116	8	54	116	2	36	172	0	32	145	0	27	173	0	21	95	1	15
NORSAR	12	0	163	21	0	77	21	0	91	23	0	75	73	0	59	45	0	72
NSS	38	2	41	47	0	39	62	0	26	38	0	29	25	0	33	44	1	46
ODD1	25	0	4	40	1	17	33	0	9	34	0	1	20	0	1	15	0	1
OSL	0	0	9	0	0	11	0	0	10	0	0	8	1	0	6	1	0	7
RUND	14	0	3	11	0	6	10	0	10	15	0	5	8	0	6	19	0	7
SNART	12	0	2	17	0	4	11	0	5	9	0	0	22	0	2	20	0	3
STAV	1	0	2	4	0	6	3	0	5	0	0	1	2	0	5	6	0	3
STOK	1	0	0	28	0	10	78	0	8	81	0	10	22	0	2	71	0	6
SUE	20	0	1	11	0	4	13	0	4	14	0	0	14	0	2	21	0	3
TRO	99	0	52	58	0	32	105	0	32	96	0	35	116	0	43	84	0	51
TRON	3	0	2	10	0	6	1	0	3	2	0	2	2	0	1	4	0	2
SPITS	23	1	0	14	1	0	31	1	0	29	0	0	27	0	0	13	0	0
ARCES	41	0	0	57	0	0	69	0	0	44	0	0	86	0	0	62	0	0

Table 3b: Monthly statistics of events recorded at each station for July-December 2005. 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	20	0	8	29	0	6	27	0	5	43	0	17	20	0	11	26	0	11
BER	9	0	44	22	0	33	5	0	12	27	0	40	5	0	22	7	0	27
BJO1	0	0	0	0	0	0	0	0	2	5	0	3	3	0	9	4	0	12
BLS5	14	0	12	25	0	10	26	0	9	35	0	23	19	0	13	30	0	11
DOMB	4	0	10	10	0	7	3	0	9	13	0	24	6	0	18	5	0	17
EGD	19	0	7	29	0	6	26	0	4	39	0	17	17	0	11	22	0	12
FOO	15	0	6	19	0	1	16	0	4	29	0	7	7	0	5	15	0	7
HOPEN	38	26	0	13	5	0	9	5	0	23	11	0	22	16	0	40	24	0
HYA	15	0	2	21	0	2	11	0	3	33	0	5	9	0	3	15	0	4
JMI	185	0	0	79	0	0	48	0	,0	80	0	0	30	0	0	14	0	0
JMIC	5	0	39	5	0	32	2	0	12	5	0	28	2	0	12	2	0	16
JNE	180	0	0	79	0	0	49	0	0	81	0	0	29	0	0	14	0	0
JNW	182	0	1	80	0	1	49	0	0	83	0	1	30	0	0	14	0	1
KBS	20	6	43	22	1	32	19	0	14	21	0	39	12	1	19	14	0	24
KMY	21	0	5	16	0	2	28	0	2	39	0	2	21	0	0	33	0	3
KONO	4	0	39	7	0	34	1	0	16	1	0	32	3	0	14	2	0	22
KTK1	138	34	30	155	10	15	115	28	18	146	9	82	102	27	21	109	26	27
LOF	84	2	22	129	1	14	45	1	6	88	1	40	51	0	16	58	2	18
MOL	19	4	18	31	4	12	15	2	16	37	5	36	20	4	18	19	1	21
MOR8	102	4	34	139	0	17	93	1	19	143	1	94	82	0	27	116	2	32
NORSAR	36	0	83	29	0	59	46	0	68	40	0	129	27	0	64	23	0	61
NSS	43	0	40	52	0	32	22	0	21	49	0	47	36	0	26	46	0	33
ODD1	11	0	4	21	0	4	20	0	5	39	0	7	14	0	3	34	0	7
OSL	0	0	7	0	0	2	0	0	4	2	0	15	0	0	8	1	0	7
RUND	0	0	0	4	0	3	11	0	2	28	0	9	4	0	6	11	0	6
SNART	16	0	5	24	1	2	15	0	5	27	0	10	14	0	6	21	0	7
STAV	3	0	5	1	0	2	1	0	2	12	0	4	1	0	0	3	0	2
STOK	85	2	9	76	1	6	44	0	6	67	0	27	52	0	14	81	1	9
SUE	12	0	3	19	0	2	14	0	2	28	0	3	8	0	5	12	0	3
TRO	83	0	49	117	0	38	76	0	23	106	0	95	58	0	29	65	0	37
TRON	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
SPITS	22	0	0	24	0	0	21	0	0	27	0	0	13	0	0	21	0	0
ARCES	63	0	0	56	0	0	72	0	0	62	0	0	40	0	0	42	0	0

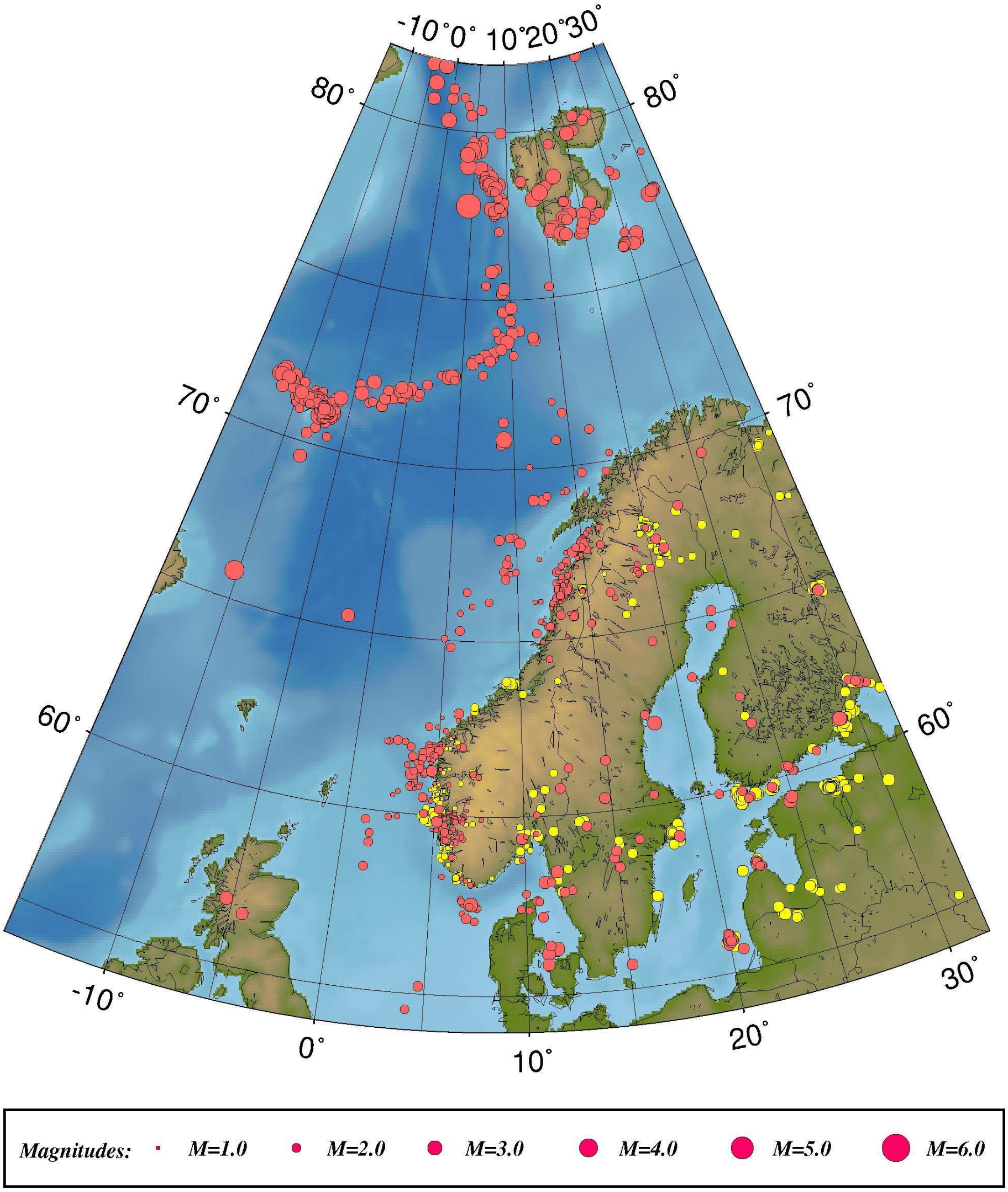

Figure 4: Epicentre distribution of events analyzed and located from January through December 2005. Earthquakes are plotted in red and probable and known explosions in yellow. For station locations, see Figure 1.

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.

The largest local or regional earthquake in 2005, recorded on Norwegian stations and within the prime area, occurred on July 25th 2005 at 16:02 (UTC) north of the northern tip of Jan Mayen. The earthquake had a magnitude of Mc = 5.2.

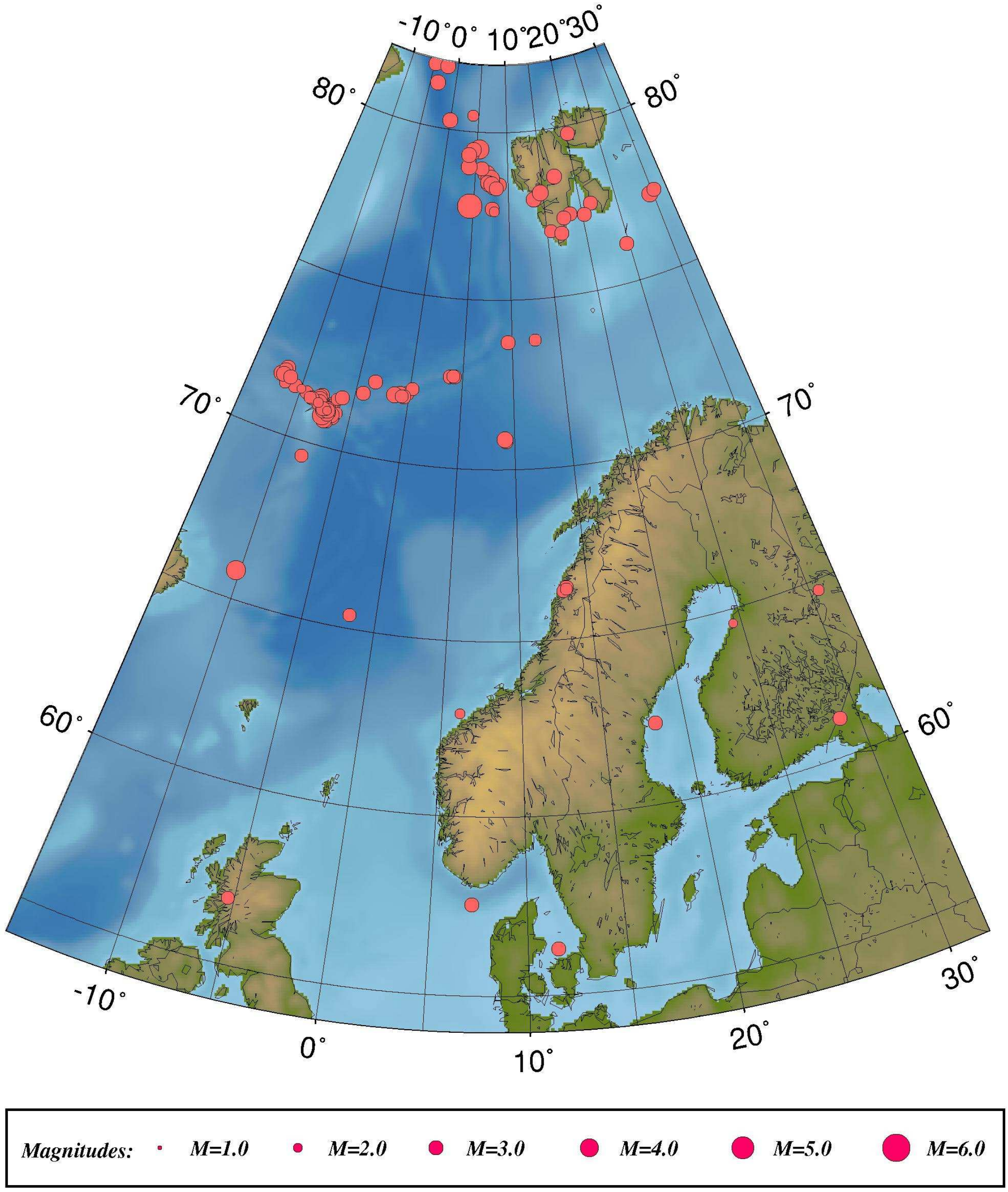

Figure 5: Epicentre distribution of located events with one of the calculated magnitudes above or equal to 3.0. All earthquakes are listed in Table 2. For station location, see Figure 1.

The largest earthquake in the vicinity of the Norwegian mainland occurred on June 24th at 04:25 (UTC). The earthquake was located in the Mo i Rana area at 66.5°N, 13.5°E and had a magnitude of 3.3. 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 2005. For depth determination, see section 5. 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	F	AGA	NST	RMS	Mc	Ml	Mw
2005	1 1	1302	1.3	L	71.393	-9.432	18.0		BER	3	0.1	3.4	2.9	
2005	112	0549	3.8	L	81.852	-4.742	0.0		BER	3	1.7	2.9	3.1	
2005	116	1253	0.5	L	62.913	6.108	15.0	F	BER	15	1.3	2.4	2.3	
2005	128	1400	40.3	L	71.683	-12.185	10.0	F	BER	3	0.1	3.5	3.4	
2005	128	1445	12.9	L	70.809	9.192	10.0	F	BER	24	1.3	2.9	3.0	
2005	128	1658	16.5	L	71.888	-11.804	10.0	F	BER	3	0.3	3.6	3.3	
2005	131	2029	7.8	L	65.814	-10.278	10.0	F	BER	27	1.9	3.7	4.2	4.7
2005	2 3	1549	52.0	L	56.289	11.363	15.0	F	BER	8	1.3	2.7	1.8	
2005	2 3	1749	28.6	L	56.268	11.511	11.0	F	BER	8	0.6	2.5	3.0	
2005	2 4	2143	59.3	L	71.285	-6.788	8.0	F	BER	8	1.1	4.1	3.1	
2005	210	1822	26.2	L	65.389	-1.822	10.0	F	BER	26	1.5	2.9	2.9	
2005	215	1228	10.8	L	71.284	-8.793	10.0	F	BER	3	0.3	3.3	3.0	
2005	218	1410	13.1	L	61.049	28.911	0.0		BER	3	1.8		3.0	
2005	220	0708	3.3	L	78.382	7.820	10.0	F	BER	7	1.2	2.7	3.6	
2005	3 1	0958	35.3	L	77.326	29.598	15.0	F	BER	6	2.1	2.7	3.6	
2005	3 1	1219	56.2	L	77.409	30.311	15.0	F	BER	4	1.3	2.1	3.0	
2005	3 2	0030	56.2	L	70.895	-6.585	10.0	F	BER	3	0.3	3.1	3.4	
2005	3 9	0351	24.9	L	78.423	8.724	15.0	F	BER	4	1.2	2.5	3.2	
2005	316	0114	9.5	L	81.318	-3.513	10.0	F	BER	7	1.5	2.8	3.3	
2005	318	0945	12.4	L	77.703	7.680	10.0	F	BER	3	0.5	2.5	3.1	
2005	320	2303	7.0	L	71.472	-10.599	10.0	F	BER	12	2.8	3.7	3.1	
2005	331	0900	57.2	L	64.684	30.573	15.0	F	BER	10	1.1	3.2	2.4	
2005	4 2	0606	41.9	L	78.752	6.763	10.0	F	BER	20	1.7	3.4	3.8	
2005	4 2	0634	34.0	L	78.560	7.585	10.0	F	BER	14	1.9	3.0	3.4	
2005	4 2	1252	37.5	L	78.583	7.307	10.0	F	BER	30	2.5	3.9	4.3	6.2
2005	4 2	1304	30.3	L	78.907	5.990	15.0		BER	2	0.7		3.2	
2005	4 2	1359	18.8	L	78.465	7.131	10.0	F	BER	6	1.0	2.9	3.6	
2005	4 4	0441	19.7	L	71.227	-7.992	10.0	F	BER	5	0.7	3.3	3.2	
2005	4 7	1920	24.7	L	71.158	-6.884	10.0	F	BER	6	0.5	3.4	3.4	
2005	410	1715	37.7	L	77.380	18.364	12.0	F	BER	5	1.3	1.7	3.1	
2005	410	2255	15.5	L	78.503	6.960	10.0	F	BER	5	1.1	2.2	3.0	
2005	411	1213	4.3	L	72.019	-0.240	0.0		BER	13	1.5		3.1	
2005	424	1254	20.2	L	78.443	7.554	10.0	F	BER	11	1.6	2.7	3.6	
2005	5 1	0105	52.2	L	78.943	3.997	15.0	F	BER	4	0.8	3.5	3.6	
2005	5 6	1920	58.9	L	76.949	15.507	31.0		BER	4	99.9	3.0	2.8	
2005	513	1853	29.9	L	62.298	18.175	15.0	F	BER	27	1.4	3.5	3.1	
2005	516	0239	45.6	L	71.057	-7.526	10.0	F	BER	3	0.2	3.5	2.7	
2005	523	0218	33.0	L	73.773	12.438	10.0	F	BER	14	1.1	3.2	2.6	
2005	523	2018	27.9	L	72.193	0.248	10.0	F	BER	23	1.9		2.9	
2005	526	0539	27.3	L	71.184	-7.221	15.0	F	BER	3	0.1	3.2	2.5	
2005	526	0545	58.4	L	71.194	-7.115	10.0	F	BER	3	0.6	3.9	3.2	
2005	527	2354	34.8	L	80.267	0.046	10.0	F	BER	6	1.6	3.3	3.4	
2005	528	0533	42.9	L	77.574	21.437	12.0	F	BER	5	0.8		3.1	
2005	528	1239	17.0	L	71.431	-7.952	10.0	F	BER	3	0.4	3.4	3.1	
2005	531	1611	9.3	L	71.388	-8.092	10.0	F	BER	8	1.5	4.4	3.1	
2005	6 9	0714	33.5	L	78.558	16.998	15.0	F	BER	6	2.2	2.7	3.4	
2005	6 9	1006	50.8	L	71.069	-7.350	10.0	F	BER	3	0.1	3.2	2.7	
2005	6 9	2335	52.7	L	77.951	13.561	15.0	F	BER	3	0.7	2.5	3.3	
2005	612	1947	55.1	L	71.124	-7.663	10.0	F	BER	3	0.2	3.4	2.8	
2005	614	1430	49.2	L	71.626	-2.227	10.0	F	BER	8	1.1			3.1
2005	616	1018	0.4	L	81.853	-2.126	10.0	F	BER	11	1.3	3.8	3.4	
2005	624	0425	40.6	L	66.475	13.461	5.0	F	BER	24	1.6	3.1	3.2	3.4

2005	626	0919	52.9	L	71.038	-6.277	10.0	F	BER	3	0.1	3.5	2.7	
2005	629	1438	36.9	L	71.084	-7.578	5.0	F	BER	3	0.1	3.3	3.2	
2005	630	0734	31.8	L	71.095	-7.590	5.0	F	BER	3	0.1	3.3	2.6	
2005	7 9	1248	4.8	L	72.205	-3.387	10.0	F	BER	11	1.2	3.0	3.0	
2005	713	1712	26.8	L	76.846	16.854	13.0	F	BER	4	0.6	3.0	3.0	
2005	714	0715	34.5	L	76.145	24.681	15.0	F	BER	9	1.3	2.6	3.1	
2005	715	2130	34.6	L	71.822	-11.899	10.0	F	BER	3	0.1	3.7	3.1	
2005	724	0907	22.1	L	71.052	-7.222	10.0	F	BER	7	0.7	3.4	3.1	
2005	725	1602	9.3	L	71.197	-7.884	10.0	F	BER	33	1.3	5.2	4.1	5.5
2005	725	1613	27.4	L	71.206	-7.921	10.0	F	BER	10	0.9	3.6	3.3	
2005	725	1628	9.2	L	71.070	-7.347	10.0	F	BER	5	0.2	3.3	3.3	
2005	725	1716	54.9	L	71.049	-7.333	10.0	F	BER	3	0.3	3.2	3.4	
2005	725	1716	55.4	L	71.003	-7.405	10.0	F	BER	3	0.1	3.1	3.3	
2005	725	1739	54.5	L	71.097	-7.357	10.0	F	BER	3	0.2	3.1	3.0	
2005	725	1901	12.6	L	71.147	-7.406	10.0	F	BER	3	0.1	3.3	2.6	
2005	725	2204	39.0	L	71.102	-7.371	10.0	F	BER	3	0.1	3.0	3.0	
2005	726	2052	16.0	L	71.033	-7.422	10.0	F	BER	3	0.1	3.0	2.8	
2005	726	2235	33.1	L	71.159	-7.504	10.0	F	BER	3	0.2	3.1	3.0	
2005	8 6	1427	20.5	L	71.069	-7.267	10.0	F	BER	3	0.1	3.3	3.0	
2005	813	2323	24.2	L	79.483	5.448	12.0	F	BER	22	1.6	3.8	4.2	
2005	815	1614	3.9	L	71.185	-7.225	10.0	F	BER	3	0.1	3.2	2.2	
2005	816	1842	4.6	L	71.436	-9.945	12.0	F	BER	4	0.3	3.0	1.9	
2005	817	0648	6.2	L	71.322	-8.154	10.0	F	BER	4	0.5	3.2	2.7	
2005	817	2301	35.8	L	71.179	-7.239	10.0	F	BER	3	0.3	3.3	2.2	
2005	819	2308	9.0	L	71.054	-7.381	10.0	F	BER	4	0.1	2.9	3.1	
2005	820	1051	22.9	L	70.882	9.123	6.0	F	BER	32	1.6	3.5	3.5	3.3
2005	822	2349	25.0	L	71.259	-8.226	10.0	F	BER	4	0.2	2.5	2.3	3.2
2005	825	2119	6.9	L	80.481	4.059	10.0	F	BER	4	1.0	3.1	2.5	
2005	826	0106	25.3	L	77.291	17.477	15.0	F	BER	5	1.6	2.4	3.1	
2005	830	0910	32.4	L	71.448	-6.535	10.0	F	BER	3	0.2	3.0	2.6	
2005	830	1857	29.2	L	72.011	-0.877	10.0	F	BER	12	1.3		3.0	
2005	830	2033	21.1	L	71.923	-0.491	10.0	F	BER	19	1.8		3.2	
2005	830	2053	52.3	L	71.931	-1.385	10.0	F	BER	21	2.4	3.0	3.6	
2005	831	0226	26.0	L	71.926	-0.696	10.0	F	BER	14	2.0		2.9	
2005	831	1501	35.2	L	71.295	-8.071	10.0	F	BER	9	1.3	3.4	3.6	
2005	831	1902	3.7	L	71.119	-7.335	10.0	F	BER	3	0.2	3.5	3.1	
2005	9 2	0021	49.1	L	72.675	3.757	10.0	F	BER	12	1.1		3.1	
2005	9 2	0035	24.5	L	72.677	4.165	11.0	F	BER	14	1.3		3.0	
2005	9 2	0049	51.6	L	72.691	4.072	10.0	F	BER	13	1.5		2.9	
2005	9 4	2346	14.2	L	70.702	-6.882	0.3		BER	3	0.5	3.1	2.4	
2005	913	0251	1.6	L	71.174	-7.884	10.0	F	BER	22	2.1	4.2	3.5	
2005	913	0327	1.1	L	71.132	-7.359	10.0	F	BER	3	0.1	3.0	2.8	
2005	914	0721	13.1	L	71.080	-7.339	10.0	F	BER	3	0.1	3.1	3.0	
2005	914	0835	26.1	L	71.087	-7.316	10.0	F	BER	3	0.1	3.2	2.7	
2005	915	1643	29.0	L	78.318	8.268	10.0	F	BER	3	0.7	2.4	3.2	
2005	917	0424	23.0	L	71.065	-7.411	13.0	F	BER	11	0.9	3.7	3.4	
2005	925	2228	50.9	L	79.359	4.275	10.0	F	BER	6	1.8	2.9	3.6	
2005	10 3	1331	37.9	L	71.457	-11.602	10.0	F	BER	3	0.1	3.3	2.5	
2005	10 4	1751	41.2	L	71.212	-8.013	10.0	F	BER	13	2.2	3.8	3.5	
2005	10 9	2100	40.4	L	71.058	-7.213	0.3		BER	3	0.3	3.3	3.0	
2005	1010	0656	59.0	L	70.965	-6.702	10.0	F	BER	8	0.6	4.1	3.6	
2005	1011	0144	30.5	L	64.584	24.434	0.0		BER	9	1.4	3.1	2.1	
2005	1012	1114	56.5	L	73.735	9.540	10.0	F	BER	3	0.4		3.1	
2005	1013	1408	40.3	L	66.391	13.202	5.0	F	BER	14	1.4	3.0	2.8	2.8
2005	1018	1833	45.5	L	79.761	20.260	13.0	F	BER	11	2.1	2.9	3.1	
2005	1019	0901	10.4	L	70.754	-7.233	10.0	F	BER	31	2.2	5.9	3.6	
2005	1019	0902	58.8	L	71.013	-7.040	12.0	F	BER	3	0.1	2.9	3.4	
2005	1019	1232	42.6	L	70.877	-7.487	10.0	F	BER	25	2.0	4.1	4.2	
2005	1019	1340	36.4	L	71.089	-7.217	13.0	F	BER	3	0.2	2.9	3.1	
2005	1019	1352	44.8	L	71.110	-7.166	14.0	F	BER	3	0.1	3.1	3.1	
2005	1019	1721	51.7	L	70.938	-7.041	10.0	F	BER	3	0.1	2.9	3.0	
2005	1020	1714	20.4	L	77.291	20.286	15.0	F	BER	7	1.5	2.2	3.1	
2005	1027	1233	5.8	L	77.637	7.967	10.0	F	BER	6	1.2	3.0	2.3	
2005	1028	0722	23.0	L	57.518	7.146	15.0	F	BER	20	1.3	2.8	3.1	
2005	1030	1834	32.7	L	71.027	-7.452	10.0	F	BER	3	0.3	3.3	3.5	
2005	11 1	1859	48.3	L	71.052	-7.109	14.8		BER	3	0.0	3.1	3.3	
2005	11 5	0111	22.2	L	71.064	-7.352	9.0	F	BER	3	0.1	3.0	2.6	
2005	11 6	2218	20.0	L	71.530	-6.099	10.0	F	BER	3	0.3	3.7	3.0	

2005	11 7	0149	35.7	L	71.678	-11.953	10.0	F	BER	13	1.2	5.4	3.4	
2005	11 7	1450	4.1	L	69.566	-8.196	10.0	F	BER	3	0.4	3.4	2.8	
2005	1116	0520	6.4	L	71.072	-7.548	14.6		BER	3	0.1	2.8	3.0	
2005	1119	2009	48.9	L	71.808	-4.290	10.0	F	BER	11	1.3	3.0		
2005	1120	2121	20.4	L	78.128	14.611	13.0	F	BER	5	1.1	2.5	3.6	
2005	1125	1921	45.8	L	71.265	-8.712	10.0	F	BER	3	0.2	3.2	2.8	
2005	1128	1449	5.2	L	71.286	-8.949	10.0	F	BER	3	0.4	3.0	2.7	
2005	12 2	1852	2.4	L	71.198	-8.127	10.0	F	BER	3	0.3	3.0	2.2	
2005	1210	2321	30.4	L	56.823	-5.334	12.0	F	BER	16	0.7		2.8	
2005	1215	1647	13.1	L	66.435	13.433	9.0	F	BER	16	1.9	2.9	2.7	2.8
2005	1216	1224	59.1	L	71.664	-11.276	10.0	F	BER	5	0.3	3.7	3.2	
2005	1224	0542	50.2	L	79.454	4.540	10.0	F	BER	8	1.9	2.9	3.4	
2005	1225	0845	5.4	L	71.046	-7.129	10.0	F	BER	3	0.0	3.0	2.1	
2005	1230	1540	31.0	L	79.295	3.880	10.0	F	BER	5	0.9	2.6	3.3	

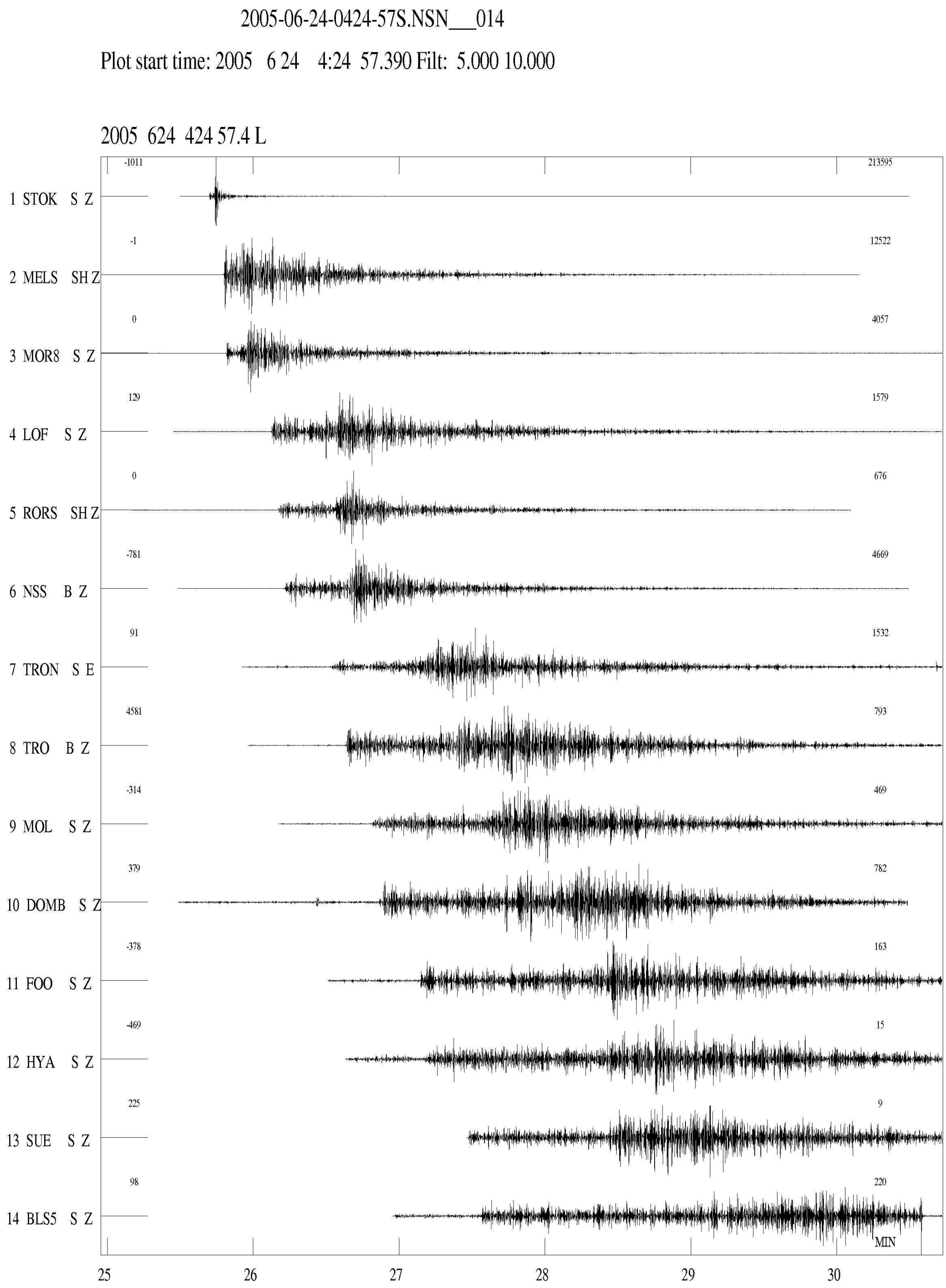

Figure 6: Seismograms for the earthquake on June 24th 2005 at 04:25 (UTC). The seismograms are filtered between 5-10 Hz. The horizontal time scale is minutes, first marking at 04:24 (UTC). The station abbreviations are: STOK: Stokkvågen, MELS:Meløy, MOR: Mo i Rana, LOF: Lofoten, RORS:Røros, NSS: Namsos, TRON:Trondheim, TRO: Tromsø, MOL:Molde, DOMB:Dombås, FOO:Florø, HYA: Høyanger, SUE:Sulen, BLS:Blåsjø.

Earthquake recordings in the Stokkvågen area.

During summer 2005, two temporary stations were installed in the Stokkvågen area in Nordland. This has long been known to be a highly seismically active area, which was also confirmed after the installation of the STOK station in 2003. The two stations (STOK1 and STOK2) were installed at the locations shown in Figure 7. In the following, a review is given of the events recorded in the region in 2005.

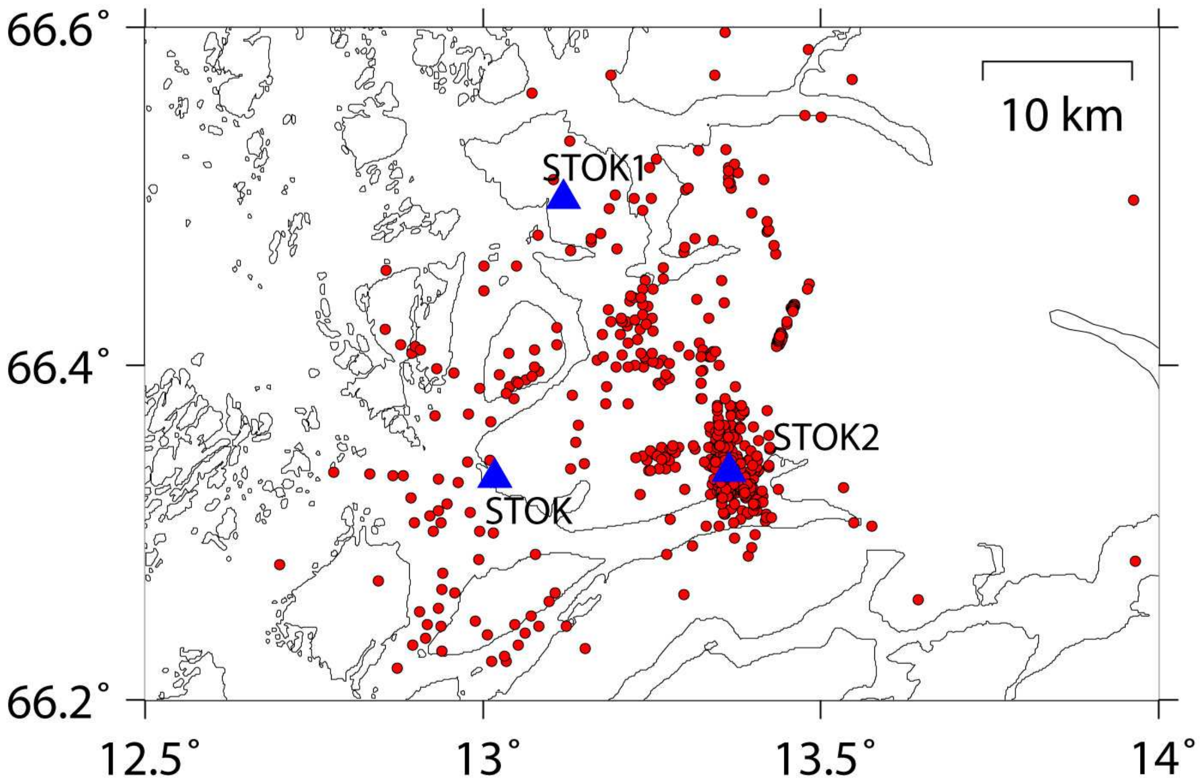

Figure 7. Earthquakes recorded in the Stokkvågen area by the NNSN in 2005.

A total of 778 earthquakes were recorded by at least one of the stations STOK, STOK1, STOK2 and MOR8 during 2005. Of these, 693 were located within the area shown in Figure 7 (66.2-66.6N, 12.5-14E). In comparison, 52 events were recorded in the same area in 2004. The locations in Figure 7 are obtained using joint hypocenter determination (JHD) with all available recordings within 200 km distance. Due to very small magnitudes, some of the events are located based on data from only one station, and further investigations are necessary to obtain a complete and reliable picture of the seismicity. As seen in the figure, the events have a tendency of clustering, which was also noticed prev iously by Hicks et al. (2000). It is expected that the location accuracy can be improved when more data becomes available.

The magnitude distribution of the events is shown in Figure 8. Here it is seen that most recorded events are of magnitude smaller than 2 and that events down to magnitude 0 or even lower are recorded. Fitting a b-value to the low-magnitude events (line in Figure 8) gives a b-value of 0.99.

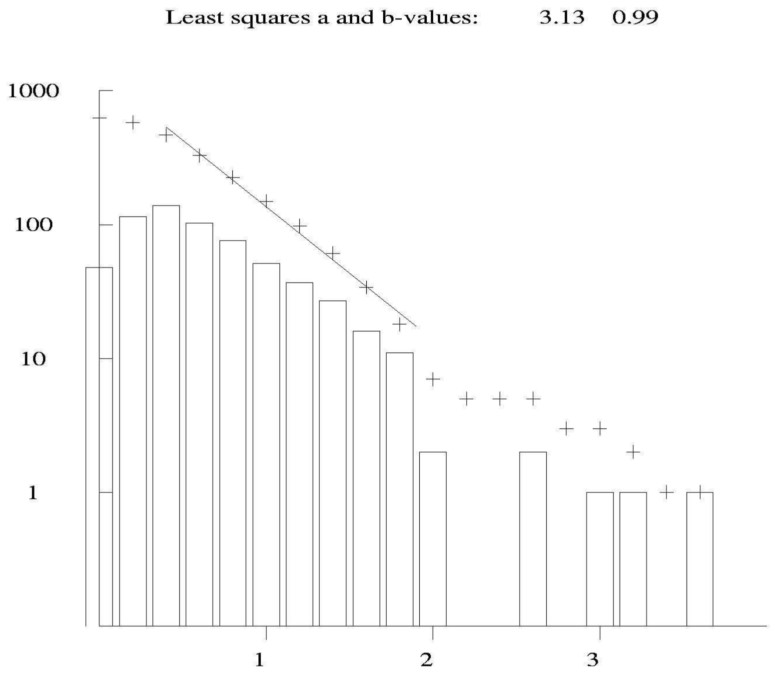

Figure 8. Magnitude distribution of events recorded in the Stokkvågen area.

The temporal distribution of the earthquakes in the region (Figure 9) shows a clear increase in the number of recorded events after installation of the temporary stations during summer 2005 (around day 200).

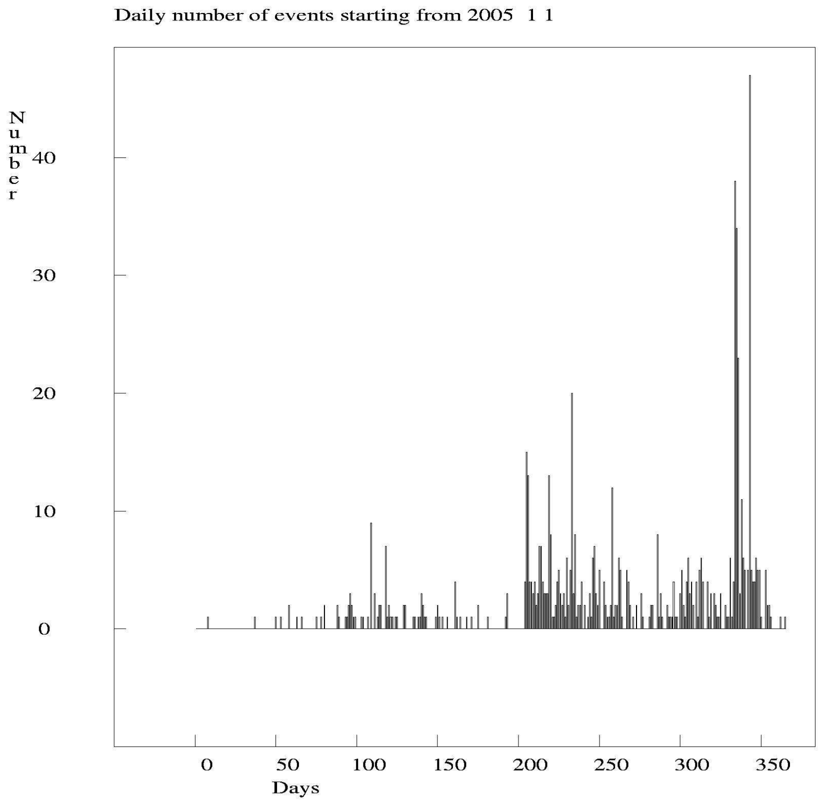

Figure 9. Temporal distribution of earthquakes in the Stokkvågen area in 2005.

Statistics about the number of events recorded at the individual stations are given in Table 5.

Table 5. Events recorded by NNSN stations in the Stokkvågen area. 'Recorded events' indicates total number of events recorded by a station; 'Recorded, only station' indicates number of events recorded only by the given station.

Station	Recorded events	Recorded, only station
STOK	239	12
STOK1	76	10
STOK2	559	433
MOR8	162	1

The table shows that most of the events are recorded by the STOK2 station and that many events are recorded only by this one station. This is due to the location of the station within few kilometres of one of the most active clusters in the area. STOK1 has suffered from technical problems and therefore parts of the data have been lost. It is expected that many of the events recorded only at STOK2 would have been recorded also by STOK1 if the station had been recording at the time of the event.

It is clear that the installation of the temporary stations in the Stokkvågen area has improved the detection capability in this area significantly and it has been confirmed that the area is highly active. Based on these observations, it has been decided to continue the dense monitoring in the region by continuing recording with more permanent installations at the two sites. Plans are also made for installation of a high-quality broad-band seismometer in the same area.

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 2005 a total of 542 earthquakes were located as seen on Figure 10 and of these, 70 were calculated to have a magnitude equal to or above 3.0.
The largest earthquake in the Jan Mayen region occurred July 25th at 16:02 (UTC). This earthquake was located to 71.197N and 7.884W with magnitude 5.2.

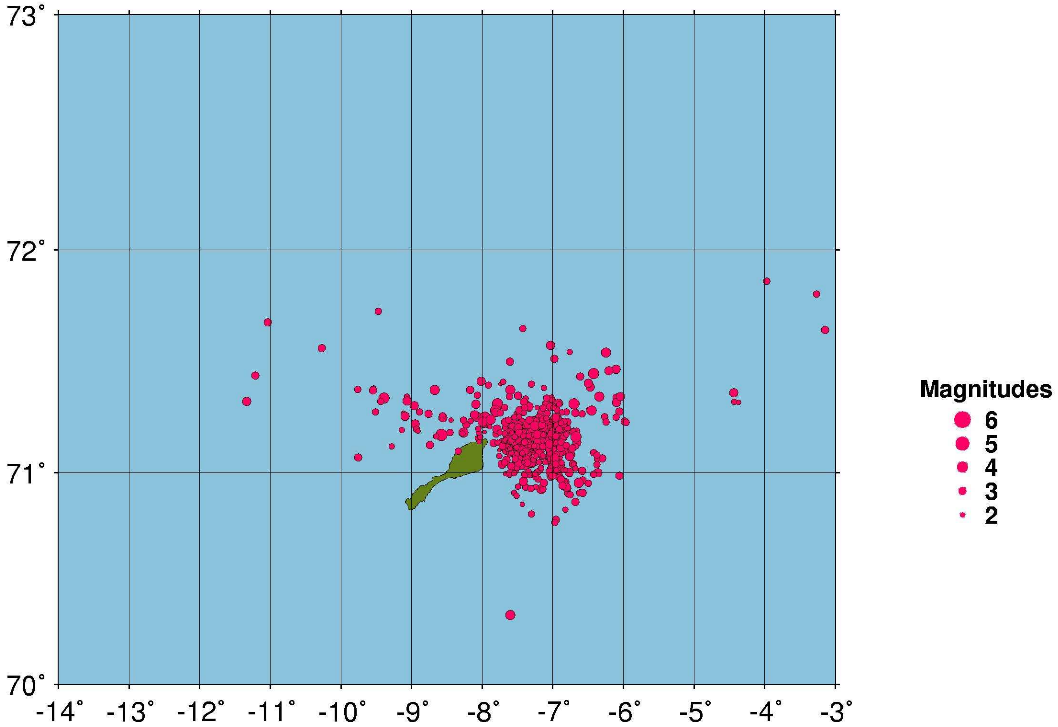

Figure 10: Earthquakes located in the vicinity of the Jan Mayen island during 2005.

5. Well recorded earthquakes

Since January 1995, well recorded earthquakes have been selected during the daily analysis and specially marked in the NNSN data base. The event selection is based on signal to noise ratio and the number of recording stations, which entails that both small events near the network and large events further away have been selected. In a few cases also location has been a qualification to mark an event as an event of special interest. These events are studied in greater detail than the other events recorded by the network. Additional phase readings and waveform data are collected if available, mainly from NORSAR and BGS. Particularly the location and the depth estimates are checked. For each event, the rms-vs-depth plot is checked and if possible the event is located using only the nearest stations (D < 200 km) to check if this gives a better location with a well constrained depth. If this is the case, the depth is fixed and the event is relocated using all stations. If no reasonable depth can be determined, the depth is fixed at 15 km for continental earthquakes and at 10 km for oceanic earthquakes. The same principle for depth determination is also used for the local and regional events with magnitude equal to or above 3.0. For this report, 11 special events have been analyzed (see Table 6). The locations of these events are shown in Figure 11.

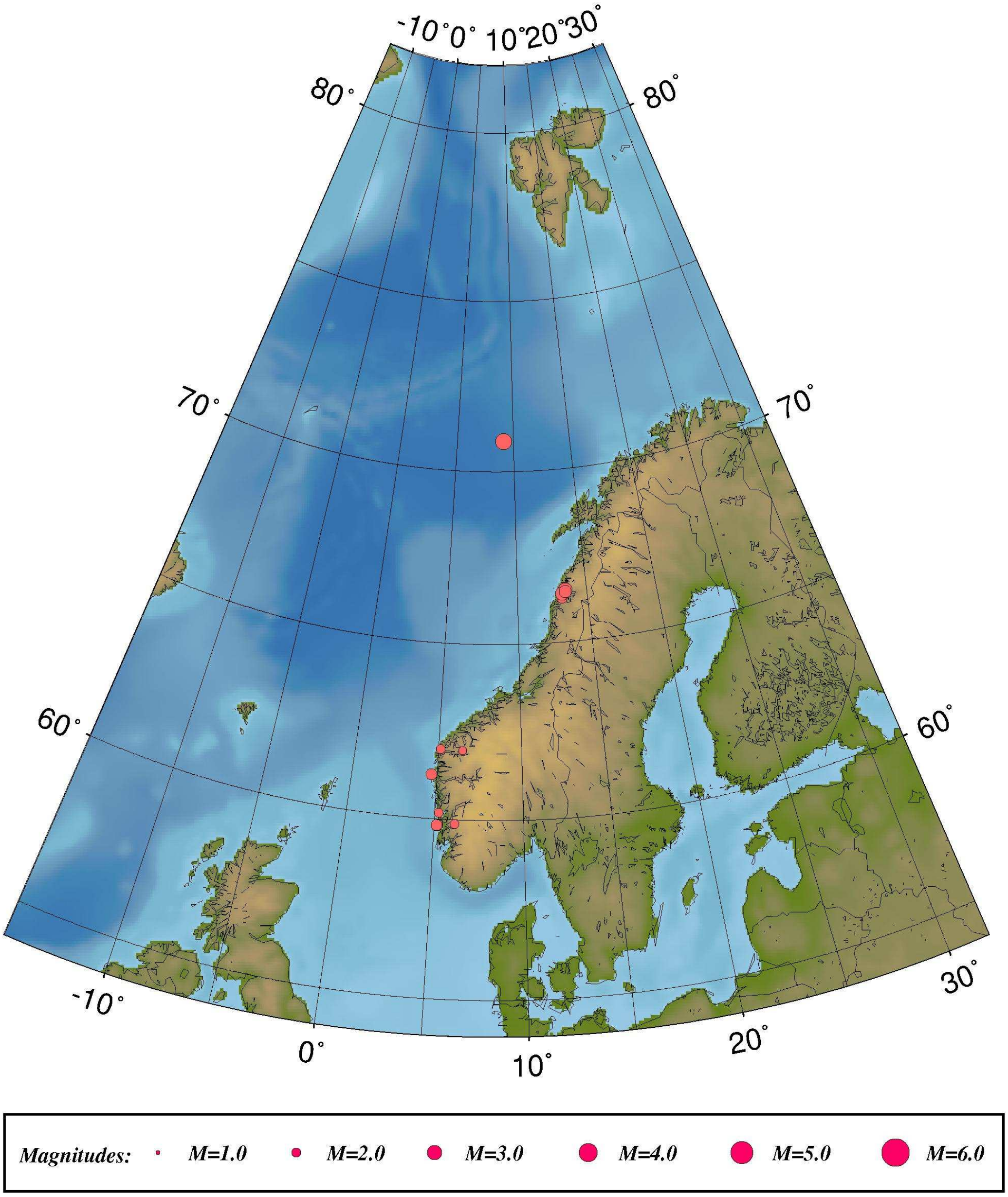

Figure 11: Epicentre distribution of well-recorded events in 2005. For station locations, see Figure 1.

Focal mechanisms

It has not been possible to determine a focal mechanism for any of the 11 well recorded events due to their relative small magnitude.

6. Felt earthquakes

From 2005 it is now possible to report felt earthquakes using the internet. On the site www.skjelv.no., questionnaires are available for the public. 10 earthquakes were reported felt during 2005 (see Table 7 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. For some earthquakes questionnaires has been received by web and intensities are plotted on maps.

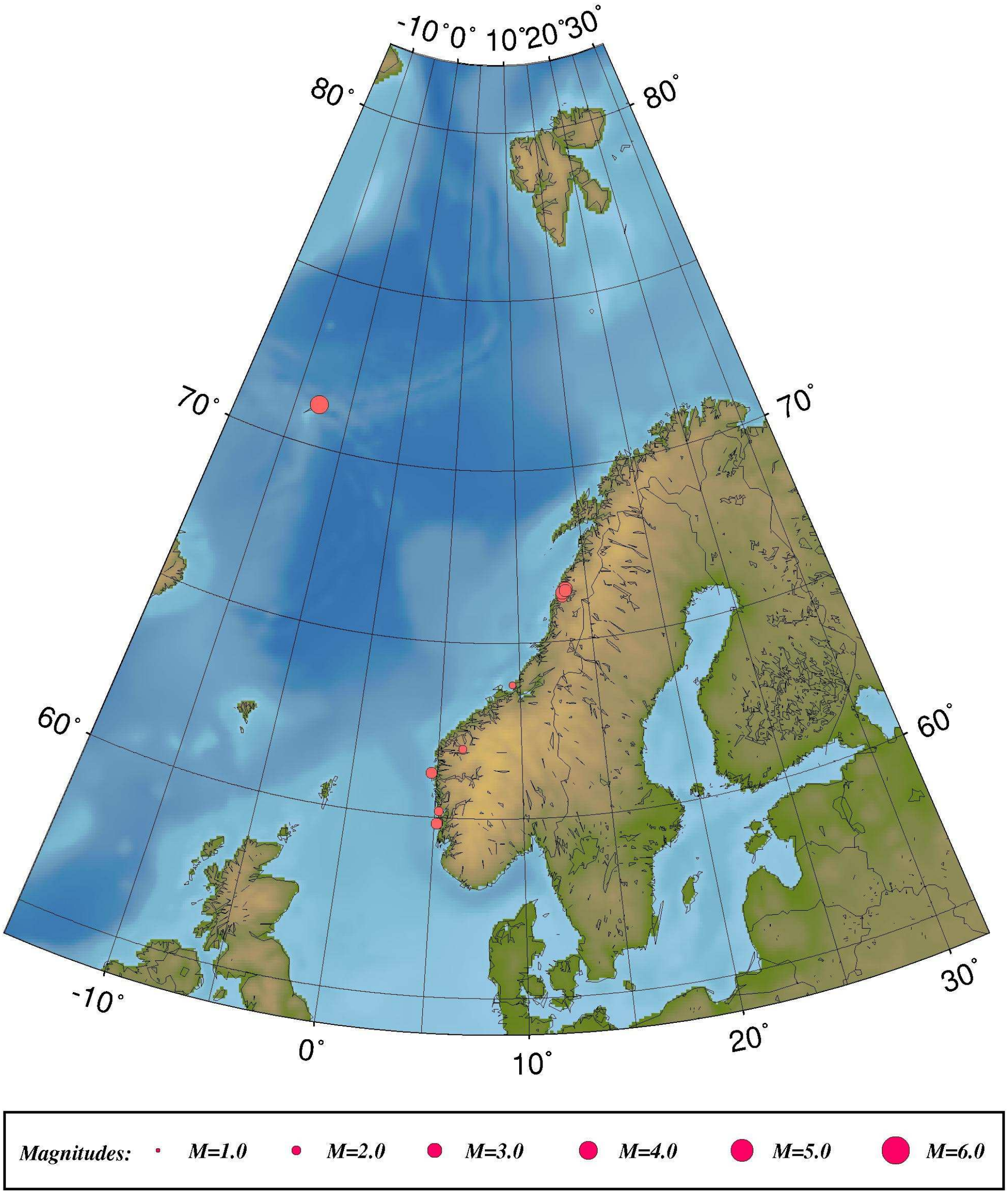

Figure 12: Location of the 10 earthquakes reported felt during 2005.

Table 6: List of 11 well-recorded events in 2005.

Abbreviations are: **HH** = hour (UTC), **MM** = minutes, **Sec** = seconds, **L** = distance identification (L=local), **Latitud** = latitude, **Longitud**=longitude, **Depth** = focal depth (km); **F**= fixed depth, **AGA** = reporting agency (BER=Bergen), **NST** = number of stations, **RMS** = root mean square of the travel-time residuals, **Mc** = coda magnitude, **Ml** = local magnitude, **Mb** = body wave magnitude, **Ms** = surface wave magnitude, **Mw** = moment magnitude, **STRIK** = strike, **Mom** = log of seismic moment in Nm, **Strs** = stress drop in bar, **f0** = corner frequency in Hz and **r** = source radius in km.

Year	Date	HRMM	Sec	L	Latitud	Longitud	Depth	FF	AGA	NST	RMS	Mc	Ml	Mb	Ms	Mw	STRIK	DIP	RAKE	Mom	Strs	f0	r
2005	1 9	1253	37.5	L	61.964	5.132	12.0	F	BER	12	1.1	2.1	2.1			2.2				12.4	8.5	10.82	.1202
2005	2 4	2116	38.8	L	61.948	6.452	10.0	F	BER	18	1.2	1.7	1.7			1.8				11.8	2.2	11.24	.1168
2005	211	0209	42.5	L	59.874	6.146	12.0	F	BER	18	1.2	1.9	2.1			2.3				12.5	2.4	6.93	.1985
2005	5 1	0727	32.3	L	66.248	13.189	5.0	F	BER	15	1.8	2.7	2.3			2.5				12.8	2.9	5.54	.2373
2005	624	0425	40.6	L	66.475	13.461	5.0	F	BER	24	1.6	3.1	3.2			3.4				14.2	98.4	4.66	.4276
2005	728	2029	58.3	L	59.815	5.133	14.0	F	BER	16	0.9	2.3	2.5			2.5				12.8	6.2	7.28	.1979
2005	820	1051	22.9	L	70.882	9.123	6.0	F	BER	32	1.6	3.5	3.5	4.8		3.3				14.0	40.1	4.99	.2729
2005	1013	1408	40.3	L	66.391	13.202	5.0	F	BER	14	1.4	3.0	2.8			2.8				13.2	7.4	5.03	.2682
2005	1127	2316	16.2	L	60.172	5.203	11.0	F	BER	18	1.0	2.2	2.1			2.1				12.3	1.7	6.88	.2100
2005	1215	1647	13.1	L	66.435	13.433	9.0	F	BER	16	1.9	2.9	2.7			2.8				13.3	5.7	3.77	.3649
2005	1231	0248	28.9	L	61.242	4.652	11.0	F	BER	18	1.5	2.1	2.5			2.3				12.6	13.1	11.34	.1526

Table 7: Earthquakes reported felt in the BER database in 2005. Abbreviations are: $\mathbf{M_c}$ = coda magnitude, $\mathbf{M_l}$ = local magnitude and $\mathbf{M_w}$ = moment magnitude, Q: questionnaires sent.

Nr	Date	Time (UTC)	Max.intensity (on MMI scale)	Magnitude (BER)	Instrumental epicentre location	Q
1	04.02.05	21:16	III	M_c=1.9, M_l=1.8	62.05N / 6.27E	N
2	24.02.05	08:39	III	M_c=2.0, M_l=1.6	63.79N / 9.52E	N
3	01.05.05	07.27	III	M_c=2.9, M_l=2.2	66.25N / 13.19E	N
4	24.06.05	04:25	III	M_c=3.1, M_l=3.2	66.47N / 13.42E	N
5	25.07.05	16:02	III	M_c=4.7, M_l=4.5	71.19N / 7.88W	N
6	28.07.05	20:29	IV	M_l=2.6, M_w=2.8	59.81N / 5.14E	N
7	13.10.05	14:08	III	M_c=3.0, M_l=2.8	66.39N / 13.21E	N
8	27.11.05	23:16	III	M_c=2.2, M_l=2.1	60.17N / 5.20E	N
9	15.12.05	16:47	III	M_c=2.8, M_l=2.7	66.44N / 13.38E	N
10	31.12.05	02.48	III	M_c=2.1, M_l=2.7	61.27N / 4.17E	N

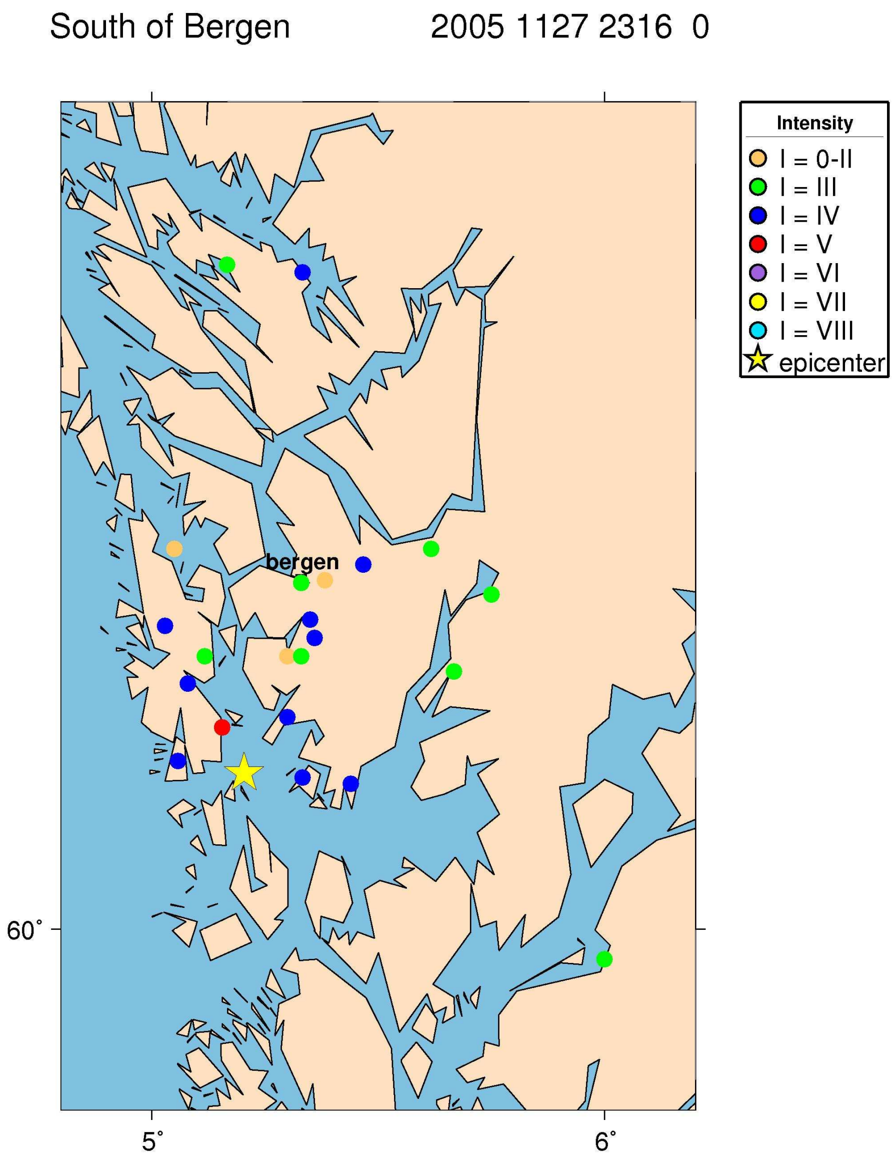

Figure 13: Macroseismic information for the event on November 27th, 2005 as returned in questionnaires using internet.

7. 100 years of seismic monitoring in Bergen.

The seismological observatory in Bergen 100 years.
Centennial Exhibition (1905-2005)
"Når jorden skjelver!"

The first seismic station in Norway was installed at Bergen Museum by C.F. Kolderup in 1905. In celebration of the 100-year anniversary of earthquake recording in Norway, the exhibition "Når jorden skjelver!" ("When the Earth quakes!") was opened at Bergen Museum on May 12, 2005 as a cooperation between the museum and the Dept. of Earth Science. The exhibition aims to give an insight to earthquakes as a natural phenomenon, the historical evolution of seismology both in Norway and the rest of the world and seismic instrumentation. Separate sections of the exhibition focus on the Norwegian National Seismic Network (Figure 14) and on oil exploration in Norway. Various posters explain the basic principles through text and figures and are complemented by monitors showing e.g. updated earthquake information and real-time seismograms (Figure 14) and by seismic instrumentation shown in the exhibit room. In addition, a number of interactive elements have been included such as a earthquake simulator where the audience can feel an earthquake (Figure 15), a 'tsunami-simulator' where one can generate a tsunami (Figure 16) and a smaller shaking table for testing the seismic resistance of simple structures represented by Lego building blocks.

In connection with the opening of the exhibition, a seminar was arranged with invited speakers who gave lectures about the history and evolution of Jordskjelvstasjonen (The seismological observatory in Bergen) to celebrate the 100th anniversary and the centennial exhibition opening.

Figure 14. Display describing the NNSN and monitors showing updated earthquake information and real-time seismograms

Figure 15. There
was a great media interest in connection with the exhibition opening. Here the shaking table is demonstrated for a tv station.

Figure 16. The tsunami simulator in use. In the background are posters describing the history of seismology and the global distribution of earthquakes.

8. Use of NNSN data during 2005.

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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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 plans for a reconstruction of the NORES array are now in progress.

Fig. 1. Seismic Arrays currently operated by NORSAR. Only red circles represent the seismic stations.

Systems Recording Performance

The arrays have continuous data recording. In 2005 the average recording time for the SPITS array was 98.38%, for the ARCES array 97.93%, and for the NORSAR array 99.67%.

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

	ARCES	SPITS	NORSAR
January	99.442	97.472	99.820
February	98.629	93.599	99.884
March	99.890	99.931	99.951
April	88.671	99.867	99.999
May	98.032	95.154	99.953
June	95.866	99.996	99.798
July	99.938	100	99.799
August	100	94.857	99.982
September	99.990	99.997	98.192
October	94.860	99.740	99.706
November	99.963	99.990	99.210
December	99.937	99.992	99.688

Table 1. Systems recording performance (uptime in % of theoretical) for three arrays operated by NORSAR in 2005.

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	162944	130738	165138	132073	122762	134846
Associated phases	5380	4386	6283	4076	5569	4659
Un-associated phases	157564	126352	158855	127997	117193	130187
Events automatically declared by RMS	1225	968	1245	758	885	811
No. of events defined by the analyst	56	76	91	63	98	65
	July	Aug.	Sep.	October	Nov.	Dec.
Phase detections	151880	157416	183672	172681	152602	140494
Associated phases	4981	4772	7176	6955	5050	4391
Un-associated phases	146899	152644	176496	165726	147552	136103
Events automatically declared by RMS	953	988	1460	1440	1003	872
No. of events defined by the analyst	75	65	89	75	73	50

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

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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. The published list therefore only covers publications that we are aware of (mainly where one NORSAR employee is a co-author).
Several investigations make use of the data from the Norwegian National Seismic Network.