Progress Report No. 2012-1

for

Norwegian National Seismic Network

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Supported by

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1 Introduction

This annual report describes the operation of the Norwegian National Seismic Network (NNSN) for the first part of 2012. The network is financially supported by the oil industry through the Norwegian Oil and Gas Association and the University of Bergen (UiB). UiB has the main responsibility to run the NNSN. This report covers operational aspects for all seismic stations operated by the Department of Earth Science at the UiB and includes the financial report.

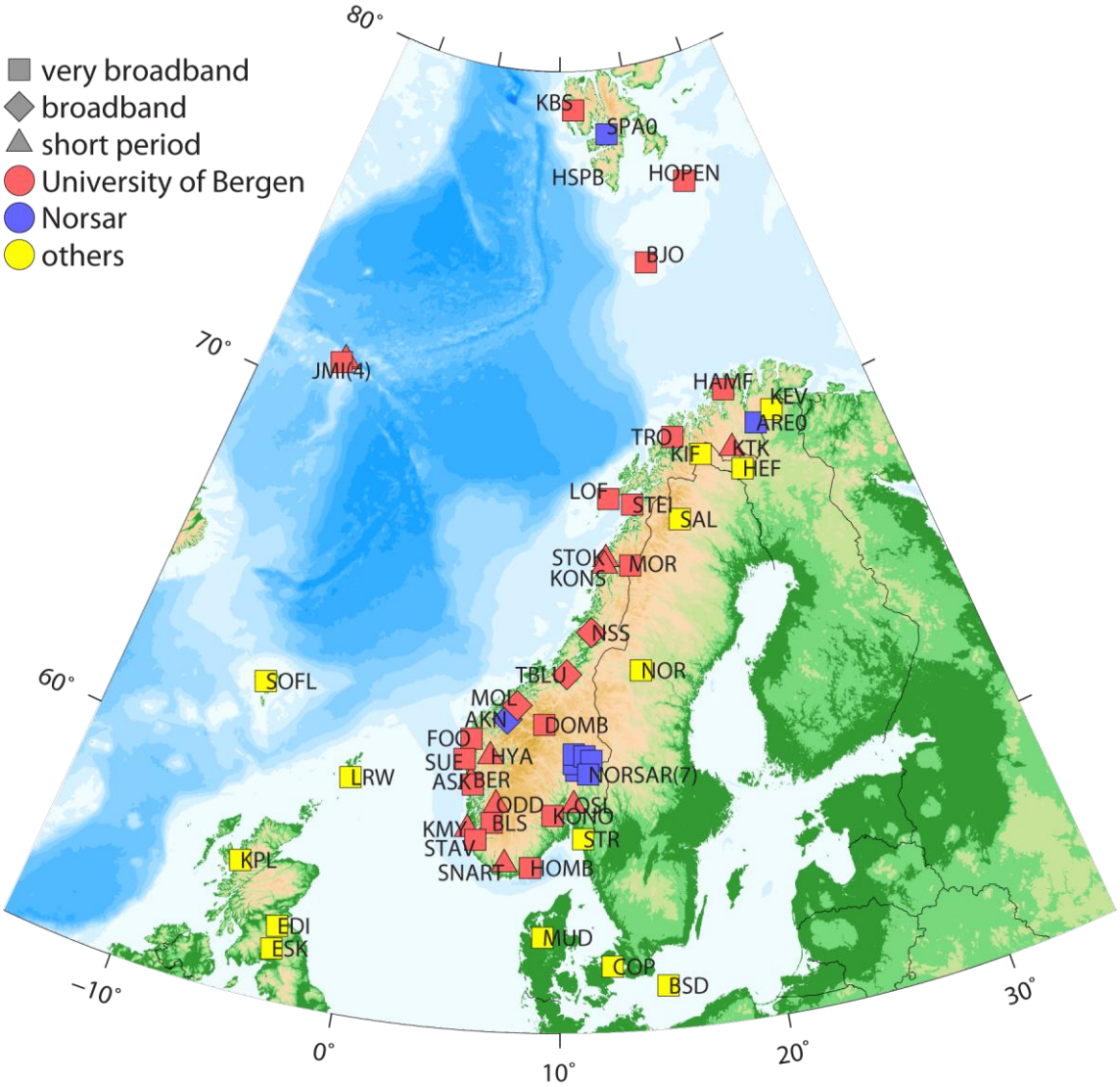

Figure 1. Stations delivering data to the NNSN database.

2 Operation

In Norway, UiB operates 31 of the seismic stations that form the Norwegian National Seismic Network (NNSN). NORSAR operates 3 seismic arrays, which also include broadband instruments, and two single seismometer stations (JMIC and AKN) (Figure 1). In total,

NORSAR provides data from 11 broadband stations to the NNSN. The station HSPB is operated jointly between NORSAR and the Geophysical Institute, Polish Academy of Sciences, Warsaw, Poland. The seismicity detected by the network is processed at UiB, but also NORSAR integrates their results in the joint database at UiB. A seismicity map for the reporting period is shown in

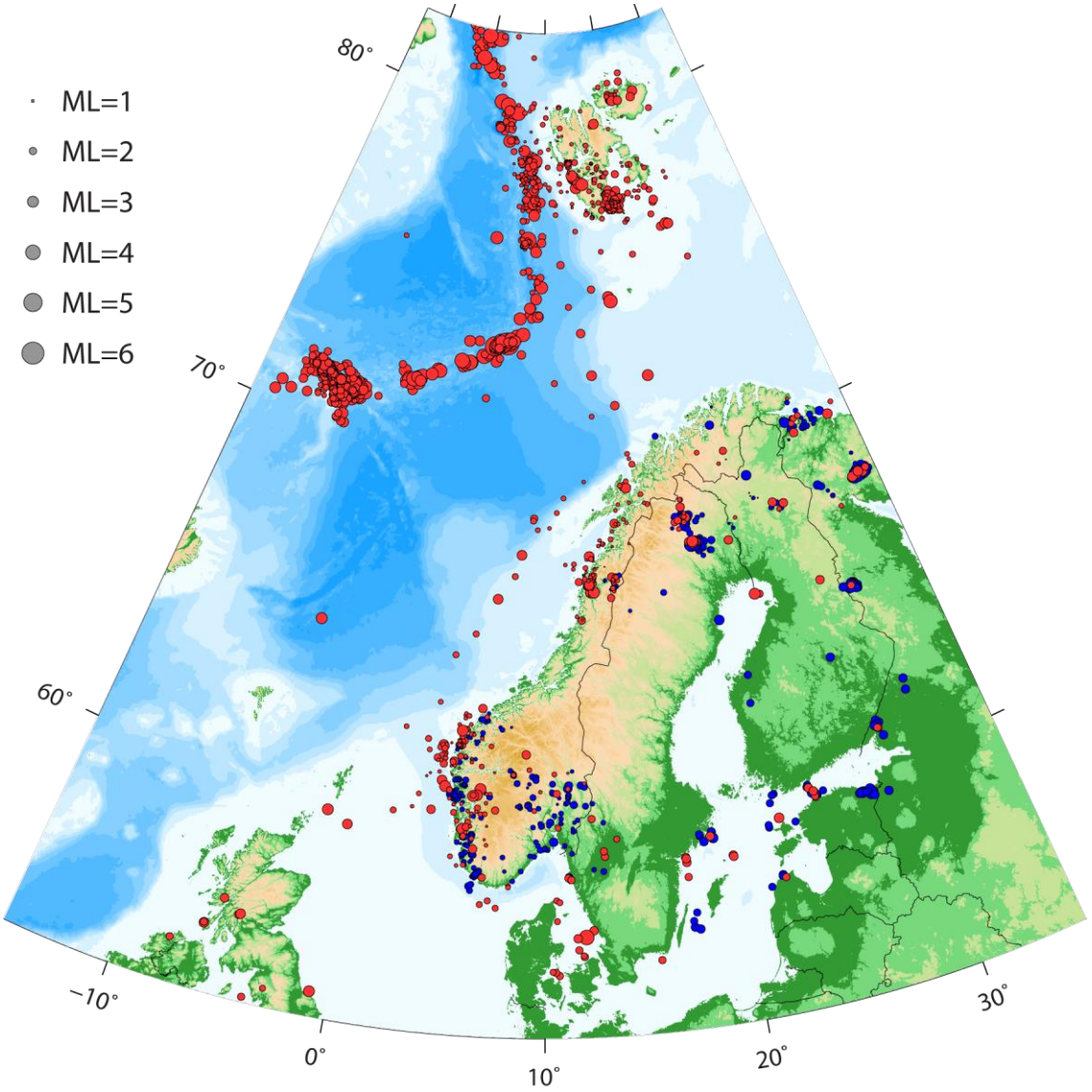

Figure 2. Seismity map showing earthquakes (red) and expolsions (blue) for the period January to October, 2012.

UiB is in the process of upgrading the NNSN by changing short period (SP) to broadband (BB) seismometers. A further effort is made to install additional high quality digitizers. The current status of this upgrade is shown in Figure 3. As of today the numbers of SP, BB stations and stations with real time transmission are listed in Table 1.

Table 1. Overview of UiB seismic stations

	Short Period	Broadband	Real time
Number of stations	11	20 (17 with natural period greater than 100 sec)	28

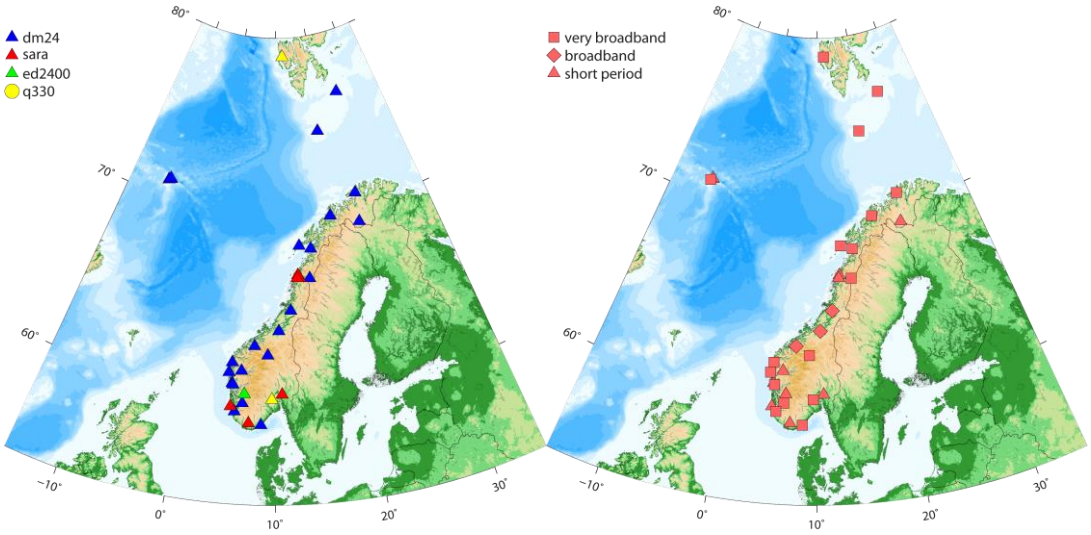

Figure 3. Status of the NNSN stations operated by UiB as of 31 October 2012. Left: Overview of digitizers, still to be upgraded are types Sara and EarthData (ED). Right: Overview of seismometers.

The operational stability for each station is shown in Table 2. The downtime is computed from the amount of data that are missing from the continuous recordings at UiB. The statistics will, therefore, also show when a single component is not working. This is done as the goal is to obtain as complete continuous data from all stations as possible. Also, communication or computing problems at the centre will contribute to the overall downtime. In the case of communication problems, a station may not participate in the earthquake detection process, but the data can be used when it has been transferred. Thus, the statistics given allow us to evaluate the data availability when rerunning the earthquake detection not in real-time.

The downtime for the majority of stations is below 5%. Larger down time were observed for the following stations: FOO, KTK and MOR (see technical service overview for details).

Table 2. Data completeness in % for January to September 2012 for all stations of the NNSN operated by UiB.

Station	Data completeness in %
Askøy (ASK)	99
Bergen (BER)	99
Bjørnøya (BJO)	96
Blåsjø (BLS)	100
Dombås (DOMB)	96
Florø (FOO)	**80**
Hammerfest (HAMF)	100
Homborsund (HOMB)	99
Hopen (HOPEN)	99
Høyanger (HYA)	100
Jan Mayen (JMI)	99
Jan Mayen (JNE)	99
Jan Mayen (JNW)	99
Karmøy (KMY)	100
Kautokeino (KTK)	**67**

Station	Data completeness in %
Kings Bay (KBS)	98
Kongsberg (KONO)	98
Konsvik (KONS)	100
Lofoten (LOF)	100
Mo i Rana (MOR8)	**65**
Molde (MOL)	98
Namsos (NSS)	96
Odda (OOD1)	97
Oslo (OSL)	100
Snartemo (SNART)	100
Stavanger (STAV)	100
Steigen (STEI)	98
Stokkvågen (STOK)	98
Sulen (SUE)	99
Blussvoll (TBLU)	95
Tromsø (TRO)	100

3 Field stations and technical service

The technical changes for each seismic station are listed below. It is noted if these changes are carried out by the respective local contact and not by the technical staff of UiB. 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.

Major changes during this reporting period of 2012 were:

Ask (ASK)	No visit or technical changes.
Bergen (BER)	20.6.12: Replaced digitizer, same type.
Bjørnøya (BJO1)	No visit or technical changes. 27-30.01.12: Station down. Restarted system. 07-09.03.12: Station down. Restarted system.
Blåsjø (BLS)	No visit or technical changes.
Blussvoll (TBLU)	No visit or technical changes.
Dombås (DOMB)	No visit or technical changes.
Florø (FOO)	12.08.12: Visit. GPS receiver replaced to Guralp DM24. Seismometer restarted.
Hammerfest (HAMF)	No visit or technical changes.
Homborsund (HOMB)	11.01.12: Station down due to power loss. PC replaced by local operator.
Hopen (HOPEN)	16.10.12: New power supply and cable to digitizer was installed by local operator.
Høyanger (HYA)	No visit or technical changes.
Jan Mayen (JMI)	18-28.08.12: Visit. JMI station upgraded with Trillium 120 and Guralp DM24. Digitizer is installed at the vault and serial line modems are used for communication. There is some loss of data on the line, which will be resolved by installing new modems. Shortperiod vertical component is kept for redundancy. Noise problem with shortperiod sensor solved. 03.10.12: Visit. Attempt was made to change modems and install accelerometer. However, due to limited time this has to be done by the

	local operator.
Karmøy (KMY)	17-19.01.12 Visit. Noise on Z component. The error is due to the cable. The vertical sensor (SS-1) was relocated to the house.
Kautokeino (KTK)	05.01-16.03.12: Station down due to malfunctioning digitizer and no new digitizer available in Bergen. Digitizer replaced after period of downtime. 27.04-10.05.12: Station down due to malfunctioning digitizer. Digitizer replaced. 9.6.12-26.06.12: Station down. Digitizer replaced.
Kings Bay (KBS)	No visit or technical changes.
Kongsberg (KONO)	No visit or technical changes.
Konsvik (KONS)	No visit or technical changes.
Lofoten (LOF)	No visit or technical changes.
Mo i Rana (MOR8)	Data noisy due to interference since December 2011. Test was carried out by local operator, guided from Bergen, to establish the cause of the problem which was related to the grounding of the satellite dish. 06.01.12: Signal improved by giving satellite dish new earth cable. 12.08.12: Loss of signal from seismometer. 25.10.12: Visit. New seismometer installed.
Molde (MOL)	No visit or technical changes.
Namsos (NSS)	09-11.01.12: Visit. New cable from sensor to house. Digitizer moved from sensor box to house. Seismometer signal now analog where it was digital over serial line before. GPS moved to new position.
Odda (ODD1)	No visit or technical changes.
Oslo (OSL)	No visit or technical changes.
Snartemo (SNART)	No visit or technical changes.
Stavanger (STAV)	No visit or technical changes.
Steigen	08-10.05.12: Visit. Station upgraded to Nanometrics Trillium 120 sensor

(STEI)	and Guralp DM24-EAM. PC upgraded with new software
Stokkvågen (STOK)	25.02-02.03.12: Station down due to power loss.
Sulen (SUE)	No visit or technical changes.
Tromsø (TRO)	01.02.12: GPS antenna and Guralp digitizer were replaced by local operator.

4 NNSN plans

The overall purpose of the NNSN is to provide data both for scientific studies, but equally important for the routine observation of earthquakes. This in principle means that broadband seismometers are desired at all sites. However, in areas where additional stations are deployed for local monitoring, short-period seismometers are sufficient. The number of broadband seismometers in the network will be increased to replace existing short period instruments. A general goal for the future development has to be to achieve better standardization in particular with the seismometers and digitizers. The total number of stations for now should remain stable, but it is important to improve the overall network performance.

We now report achievements for 2012, and then give the plans for 2012/13.

4.1 Achievements in 2012

- New station: Several sites were considered in the area around Geilo. A noise site survey was carried out at Skarslia near Ål. Preparations for the installation are being made to complete installation before the end of 2012 depending on weather conditions. The vault will be modified from existing stations to achieve a better performance at long periods by using a larger container to reach greater depth.
- Steigen: The station has been upgraded with broadband seismometer and 24-bit digitizer.
- Jan Mayen: A broadband seismometer was installed at the JMI site. The vertical component shortperiod sensor is kept for redundancy. The setup was also changed by installing the digitizer at the vault and using serial line modems to transmit the signals to the recording system at the base. The data is combined with the other stations and used for detection. In addition, the setup at the base was modified to eliminate all unused electronics. This resulted in removal of noise on the JMI shortperiod instrument that had been a problem for years. An accelerometer has been purchased and shipped to further increase the dynamic range of this station and to avoid clipping during large events.
- Real time data from Ekofisk are now integrated into the NNSN network. The data are received in form of segd data files, and these are converted to a near-realtime data stream using software developed at UiB (based on the Optoplan segd reader). In addition, a segd to miniseed converter was developed that allows to convert and process archived data.

- NNSN website: continue development
  Progress: The menu system and content of the page have been modified to improve access to the information.
- A noise test was done at Gullfaks between September and October, 2012.
- EPOS: An infrastructure proposal was submitted to NFR. This includes for the NNSN funding for 3 offshore stations, 10 new broadband stations and upgrade of 10 existing stations is included.

4.2 Plans for 2012/2013

- Upgrade: Stations OSL, KMY, ODD1 and STOK will be considered for upgrade with Guralp digitizers. (This has been delayed by faulty equipment supplied by the manufacturer and long delivery times).
- Upgrade: Stations OSL and STOK will be considered for installation of a broadband seismometer.
- Planning for upgrade of the two Jan Mayen stations JNE and JNW will begin depending on agreement with FKD.
- Planning and site survey for a new station between Stokkvagen and Steigen.
- Strengthen the collaboration with NORSAR on data processing through technical visits.
- Hopen: The station is to be improved by re-siting and new construction of the vault. The existing STS2 seismometer has to be checked and will temporarily be replaced with a Nanometrics sensor.
- Research and development: This activity will start in 2013 in close collaboration between UiB and NORSAR.