

# **Swedish National Seismic Network (SNSN)**

## **A short report on recorded earthquakes during the fourth quarter of the year 2003**

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January 2004

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*Keywords:* Seismic network, earthquakes.

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author and do not necessarily coincide with those of the client.

A pdf version of this document can be downloaded from [www.skb.se](http://www.skb.se)

# Abstract

According to an agreement with Swedish Nuclear Fuel and Waste Management Company (SKB) and Uppsala University, the Department of Earth Sciences has continued to carry out observation and additional construction of new seismic stations within the Swedish National Seismic Network (SNSN). This report gives some information about the recorded seismicity during October through December 2003.

At present 42 stations are in operation and three additional stations will be put into operation during January or February 2004. During the period October through December 2003, there were 101 located events whereof 6 with magnitude above 2.0 and additional 24 above or of 1.0. The range of the hypocentral depth varies between 2.8 and 34.6 km.

The largest earthquake with magnitude 2.9 occurred on October 22 about 15 km north of Luleå. This earthquake was felt by many people in the area. Three earthquakes above 2.0 were located in the Skellefteå area and one earthquake with magnitude 2.1 was located in the Stockholm archipelago about 11 km south-east of Blidö.

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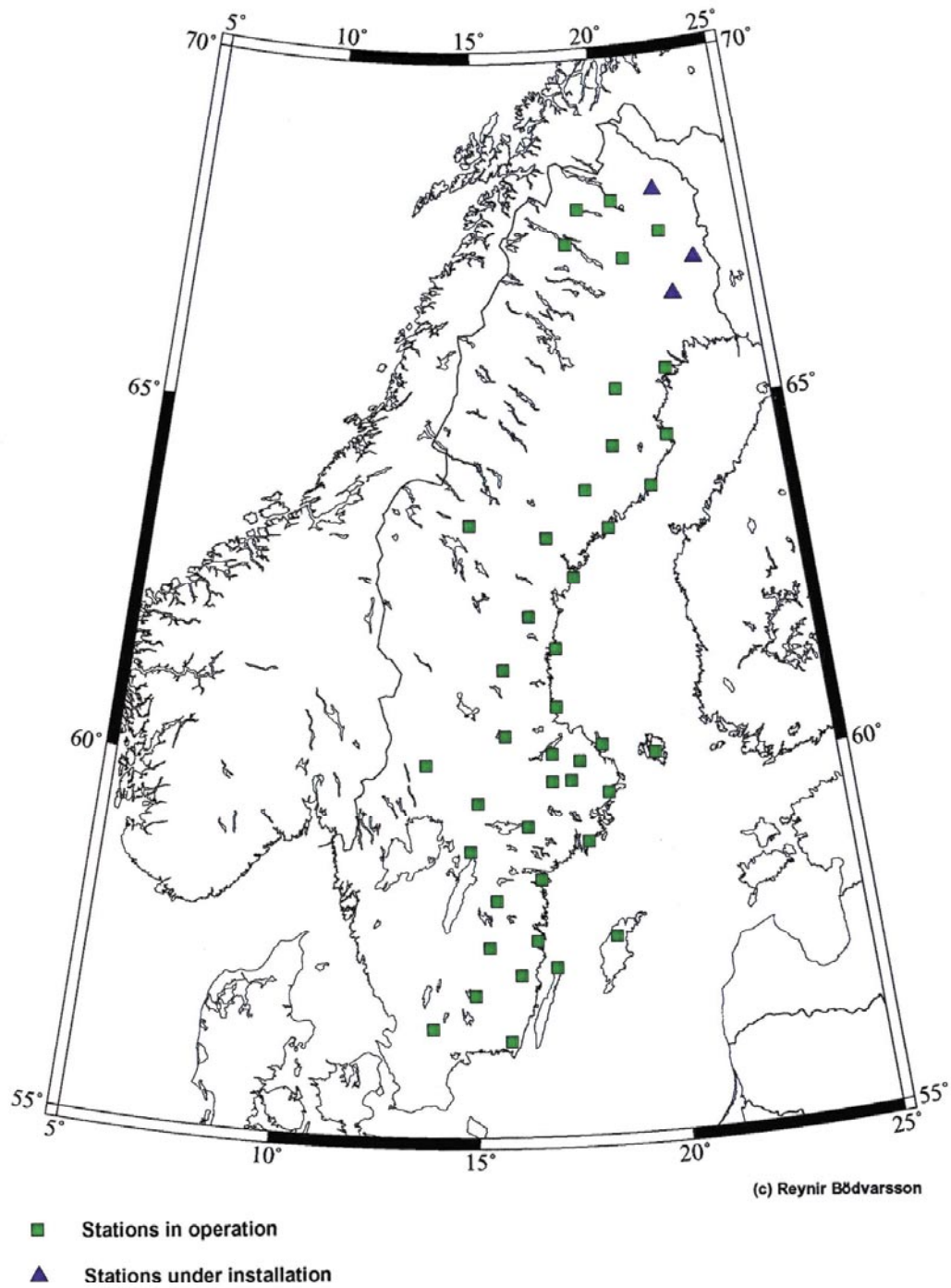
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# 1 Introduction

This is the fourth quarterly report on seismic events recorded by the Swedish National Seismic Network (SNSN) for the year 2003. At present 42 stations are in operation and three additional stations will be put into operation during January or February 2004, Figure 1-1. The instruments for these three remaining stations should have been delivered from Güralp Systems last summer but are still undelivered by January 14, 2004. The instruments will first go through our functional tests before installation. Earthquake activity in Lapland is now monitored because of the new stations already installed in the area.

The report includes fundamental information about the seismic events, including origin time and hypocenter location. Information about the source parameters is not included in the present report but is delivered as a separate ASCII-text. This report is a preliminary report including only the automatic and the brief interactive analysis done on the routine bases at SNSN.

## Swedish National Seismic Network December 2003



*Figure 1-1. The present Swedish National Seismic Network (SNSN).*

## 2 Objective and scope

According to an agreement with Swedish Nuclear Fuel and Waste Management Company (SKB) and Uppsala University, the Department of Earth Sciences continues to carry out observation and additional construction of new seismic stations within the Swedish National Seismic Network (SNSN).

The goal is to complement the existing regional seismic network to establish a local seismic network that also permits registration of small earthquakes in order to obtain relatively long time series and thereby gain a better understanding of the causes of seismic events in the site investigation areas.

Fundamental information about the seismic events, including origin time, hypocenter location and information about the source parameters, will be given after every three month period.

Expected results are to contain information on location, magnitude and source parameters of small earthquakes down to a magnitude of 0.0 near the investigation sites.

### **3 Recorded earthquakes during the fourth quarter of 2003**

Figure 3-1 shows earthquake activity in Sweden during October through December 2003. During this period there were 1347 located events, Figure 3-2. Out of these 1129 are explosions, 101 are true earthquakes and 17 are still uncertain.

The largest earthquake with magnitude 2.9 occurred on October 22 about 15 km north of Luleå. This earthquake was felt by many people in the area. Three earthquakes above 2.0 were located in the Skellefteå area and one earthquake with magnitude 2.1 was located in the Stockholm archipelago about 11 km south-east of Blidö.

Event lists for October through December 2003 are given in sections 3.1 to 3.3.

#### **3.1 October**

Event list for October is given in Table 3-1 with date, time (UTC), latitude, longitude, X (RT90), Y (RT90), depth and local magnitude (ML). In October 30 events were located whereof one had a magnitude above 2.0. Additional 9 had a magnitude of 1.0 or above. An event with magnitude 2.9 was located close to Luleå. This event was felt by many people in the area. The depth range of the events varies between 3.5 to 27.2 km.



**Table 3-1. Date, time (UTC), latitude, longitude, X (RT90), Y (RT90), depth and local magnitude (ML) of recorded earthquakes in October.**

Date	Time (UTC)	Latitude	Longitude	X RT90 km	Y RT90 km	Depth km	ML Local Magnitude
20031003	133501.2	64.812	21.322	7201.0	1761.7	17.3	-0.1
20031007	084911.0	60.462	17.322	6705.8	1583.3	22.0	-0.0
20031010	122536.7	59.959	15.404	6648.9	1477.4	6.3	1.1
20031010	182925.6	60.047	19.341	6663.8	1696.8	19.0	0.4
20031012	055916.1	65.095	20.559	7229.6	1723.1	22.7	1.3
20031013	011934.0	67.883	19.646	7537.0	1661.2	7.4	0.2
20031014	002846.9	61.145	15.835	6780.9	1501.4	6.0	0.2
20031014	134128.8	61.244	16.166	6792.0	1519.2	9.4	0.4
20031014	192540.3	59.733	17.442	6624.7	1591.9	9.2	1.1
20031014	192551.8	59.739	17.455	6625.5	1592.6	18.3	0.9
20031016	110653.1	62.904	17.208	6977.7	1571.1	11.2	0.3
20031016	212508.4	61.896	16.867	6865.1	1555.7	18.7	-0.0
20031017	025007.5	64.673	20.273	7181.7	1713.0	3.5	1.2
20031017	082045.9	64.774	17.871	7186.9	1598.1	5.3	1.4
20031017	132629.2	64.384	20.589	7150.6	1730.5	16.2	0.2
20031018	043918.7	63.962	18.949	7098.7	1653.8	23.1	-0.0
20031018	165654.8	58.555	14.632	6493.1	1431.5	15.2	1.0
20031018	165741.8	62.861	17.914	6973.9	1607.2	22.7	0.5
20031019	140008.4	63.921	20.344	7098.2	1722.4	8.7	-0.7
20031019	233837.5	66.916	21.460	7435.4	1747.1	23.2	0.8
20031020	055146.7	64.378	20.632	7150.1	1732.6	4.4	0.6
20031020	184456.5	64.355	21.167	7149.6	1758.6	27.2	1.3
20031022	015502.5	65.704	22.146	7303.7	1790.7	22.0	2.9
20031023	154057.6	59.035	12.203	6551.4	1293.1	10.0	1.8
20031023	173318.3	65.176	22.714	7247.9	1823.1	17.8	0.8
20031024	024054.3	63.149	18.950	7008.1	1658.3	8.5	0.8
20031025	144904.9	65.097	21.011	7231.4	1744.3	8.3	0.3
20031026	040603.1	64.392	20.589	7151.5	1730.4	9.8	0.7
20031026	145815.2	63.691	18.833	7068.2	1649.6	26.4	0.8
20031030	132226.8	63.222	18.793	7015.9	1650.0	6.1	1.9

### 3.2 November

Event list for November is given in Table 3-2 with date, time (UTC), latitude, longitude, X (RT90), Y (RT90), depth and local magnitude (ML). In November 31 events were located whereof one had a magnitude of 2.0 and additional 6 had a magnitude of 1.0 or above. The largest event (ML=2.0) was actually located outside Sweden but on Sjaelland in Denmark and 68 km West of Landskrona. The depth range of the events varies between 2.8 to 29.6 km.

**Table 3-2. Date, time (UTC), latitude, longitude, X (RT90), Y (RT90), depth and local magnitude (ML) of recorded earthquakes in November.**

Date	Time (UTC)	Latitude	Longitude	X RT90 km	Y RT90 km	Depth km	ML Local Magnitude
20031101	020358.6	67.863	19.283	7533.9	1646.1	9.9	-0.3
20031101	041147.0	64.445	20.437	7156.8	1722.7	8.8	1.1
20031102	235002.4	60.258	16.112	6682.2	1516.8	16.9	0.2
20031103	064845.2	62.726	18.462	6959.9	1635.7	5.7	0.7
20031103	082950.8	65.096	21.004	7231.3	1744.0	17.7	0.4
20031103	112209.1	67.108	23.296	7465.2	1824.5	23.1	1.6
20031105	030804.6	64.351	20.656	7147.2	1734.0	18.1	0.0
20031106	052930.6	64.244	18.996	7130.2	1654.6	27.1	0.4
20031107	042209.9	60.848	17.671	6749.2	1601.3	15.8	1.3
20031107	222346.4	64.510	20.739	7165.1	1736.6	19.3	0.2
20031107	224322.1	67.962	19.623	7545.8	1659.7	17.1	0.9
20031108	062454.2	64.381	20.626	7150.4	1732.3	3.7	0.7
20031109	122443.6	61.857	17.623	6861.6	1595.5	24.6	1.2
20031109	174956.7	64.619	19.822	7174.2	1691.9	21.3	0.2
20031112	002805.2	60.054	17.272	6660.3	1581.5	16.6	-0.3
20031112	010123.8	64.763	21.195	7195.0	1756.1	18.4	-0.3
20031112	041355.3	61.702	16.473	6843.2	1535.2	18.7	1.0
20031112	193922.4	64.526	20.578	7166.3	1728.8	9.8	-0.1
20031113	230956.9	59.606	16.032	6609.5	1512.6	19.6	0.1
20031117	033935.3	64.568	21.421	7174.3	1768.8	21.6	0.1
20031118	023354.7	62.993	18.601	6989.9	1641.5	3.0	0.3
20031119	113436.2	64.301	20.531	7141.2	1728.4	18.0	-0.1
20031122	125625.2	64.508	21.118	7166.4	1754.8	10.3	0.0
20031123	185810.2	63.364	18.994	7032.2	1659.4	2.8	0.1
20031124	112043.7	63.785	18.368	7077.7	1626.2	29.6	1.0
20031125	031816.6	62.163	17.776	6895.9	1602.5	16.8	0.1
20031125	220019.7	64.363	20.621	7148.4	1732.2	4.3	0.1
20031125	235502.2	65.233	20.891	7246.1	1737.5	13.3	0.6
20031127	082804.6	61.711	16.918	6844.5	1558.7	20.2	0.8
20031127	090624.0	55.618	11.827	6172.6	1249.3	5.1	2.0
20031129	232346.1	63.763	18.246	7075.0	1620.2	5.4	0.3

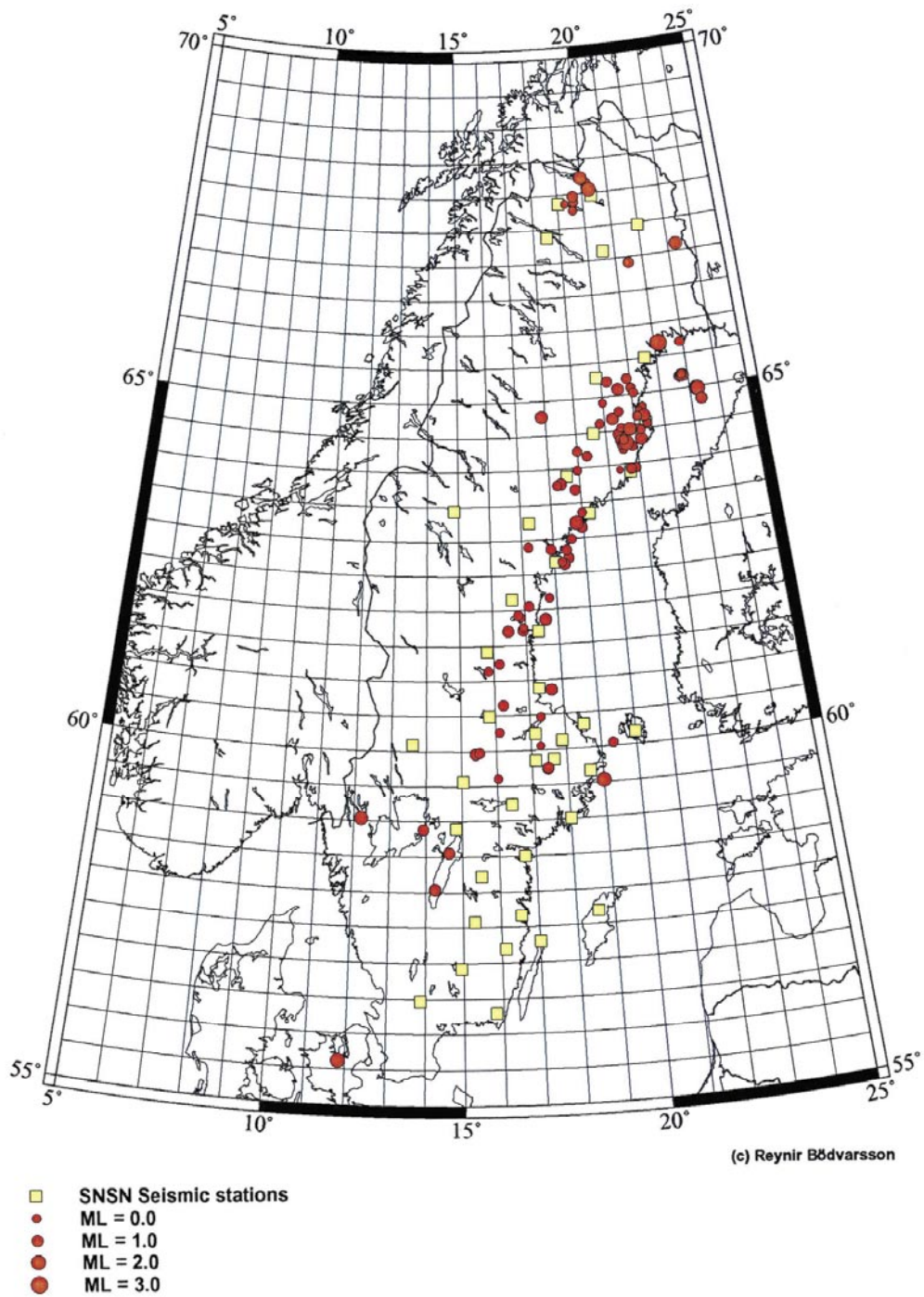
### 3.3 December

Event list for December is given in Table 3-3 with date, time (UTC), latitude, longitude, X (RT90), Y (RT90), depth and local magnitude (ML). In December 40 earthquakes were located whereof 4 had a magnitude above 2.0 and additional 9 had a magnitude of 1.0 or above. Two with a magnitude above 2.0 were located about 110 km east of Skellefteå and one 50 km south of Skellefteå. The 2.1 earthquake on December 10 was located in the Stockholm archipelago about 11 km south-east of Blidö. The depth range of the earthquakes varies between 4.1 to 34.6 km.

**Table 3-3. Date, time (UTC), latitude, longitude, X (RT90), Y (RT90), depth and local magnitude (ML) of recorded earthquakes in December.**

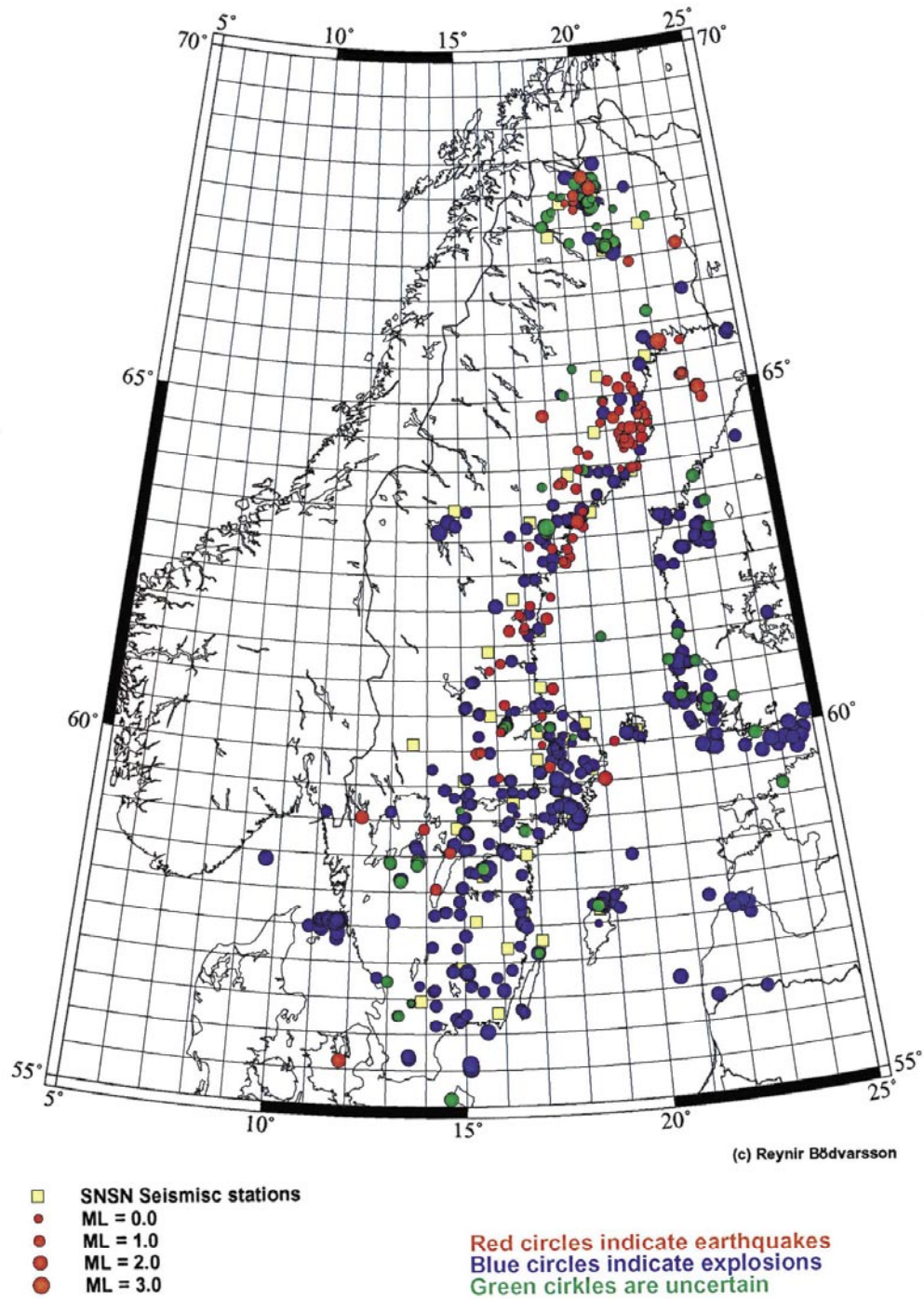
Date	Time (UTC)	Latitude	Longitude	X RT90 km	Y RT90 km	Depth km	ML Local Magnitude
20031202	011738.0	68.143	20.208	7567.5	1682.7	10.4	0.1
20031202	232432.1	64.534	20.530	7167.1	1726.4	8.0	-0.0
20031204	104245.8	64.684	21.350	7186.9	1764.2	11.4	1.3
20031205	010827.5	65.215	20.205	7241.8	1705.6	15.1	0.8
20031205	070825.0	64.261	20.847	7137.8	1744.0	15.8	0.4
20031206	045048.9	64.481	21.185	7163.7	1758.3	18.6	0.0
20031206	070438.1	62.640	18.312	6950.0	1628.4	8.1	1.1
20031207	011245.1	63.935	20.884	7101.8	1748.7	19.8	0.4
20031207	184300.2	68.227	19.984	7576.2	1672.8	17.8	1.5
20031208	204842.3	62.052	17.135	6882.7	1569.4	17.8	0.5
20031209	001132.6	68.052	20.278	7557.6	1686.4	16.3	1.9
20031209	150012.7	64.976	23.244	7228.5	1850.4	12.0	2.3
20031210	024215.8	59.527	18.992	6605.0	1680.1	9.4	1.8
20031210	041240.1	64.225	20.524	7132.6	1728.7	18.3	0.1
20031210	100022.4	65.190	22.806	7249.9	1827.2	12.9	1.4
20031210	113220.0	64.770	20.507	7193.2	1723.4	7.9	0.3
20031210	155723.3	65.024	21.067	7223.6	1747.6	16.1	0.3
20031210	185140.4	59.527	18.990	6605.0	1680.0	15.0	2.1
20031211	091534.4	64.508	20.819	7165.3	1740.5	14.4	1.5
20031212	110918.3	58.880	13.927	6530.2	1391.5	18.6	0.9
20031213	064302.5	61.747	16.934	6848.5	1559.5	4.6	0.0
20031214	105635.6	64.683	21.113	7185.8	1752.9	5.3	0.2
20031214	202131.4	65.680	22.898	7304.7	1825.3	13.8	0.4
20031216	174214.4	65.205	22.793	7251.5	1826.4	21.5	0.2
20031217	051035.5	63.929	20.725	7100.5	1741.0	4.1	0.7
20031218	152606.1	64.971	23.275	7228.2	1852.0	10.9	2.1
20031220	095503.4	62.671	18.246	6953.3	1624.9	17.6	0.3
20031221	095629.1	62.841	18.413	6972.7	1632.7	18.6	0.6
20031221	131010.7	64.361	20.451	7147.5	1724.1	11.5	0.4
20031222	181358.1	64.819	23.350	7211.7	1857.5	13.7	1.0
20031223	172201.4	59.975	15.518	6650.7	1483.8	17.3	0.5
20031227	034822.7	64.287	20.494	7139.4	1726.7	10.2	0.2
20031227	184457.6	64.316	20.656	7143.3	1734.3	18.9	2.2
20031228	010415.1	60.641	16.246	6724.8	1524.0	14.0	0.8
20031228	071129.7	64.165	19.302	7122.2	1669.9	34.6	0.6
20031228	165025.1	67.761	19.581	7523.3	1659.3	8.5	0.1
20031228	174524.4	58.042	14.245	6436.4	1407.7	10.3	1.0
20031228	190147.8	64.364	20.578	7148.3	1730.2	8.0	0.2
20031231	111202.1	61.925	16.792	6868.3	1551.7	17.9	0.4
20031231	134412.2	64.914	19.985	7207.5	1697.6	16.3	-0.2

## SNSN recorded earthquakes October through December 2003



*Figur 3-1. Earthquake activity in Sweden during October through December 2003.*

## SNSN recorded events October through December 2003



*Figur 3-2. Recorded events including explosions in the SNSN network during the period October through December 2003.*

## 4 Recorded earthquakes during the year 2003

Figure 4-1 shows earthquake activity in Sweden during the year 2003. During 2003 there were 2943 located events, Figure 4-2. Out of these 2386 are explosions, 284 are true earthquakes and 273 are still uncertain.

Of the recorded earthquakes, there were 101 located events whereof 1 with magnitude of 3.0, 11 with magnitude above 2.0 and additional 54 above or of 1.0. The range of the hypocentral depth varies between 0.1 and 37.6 km.

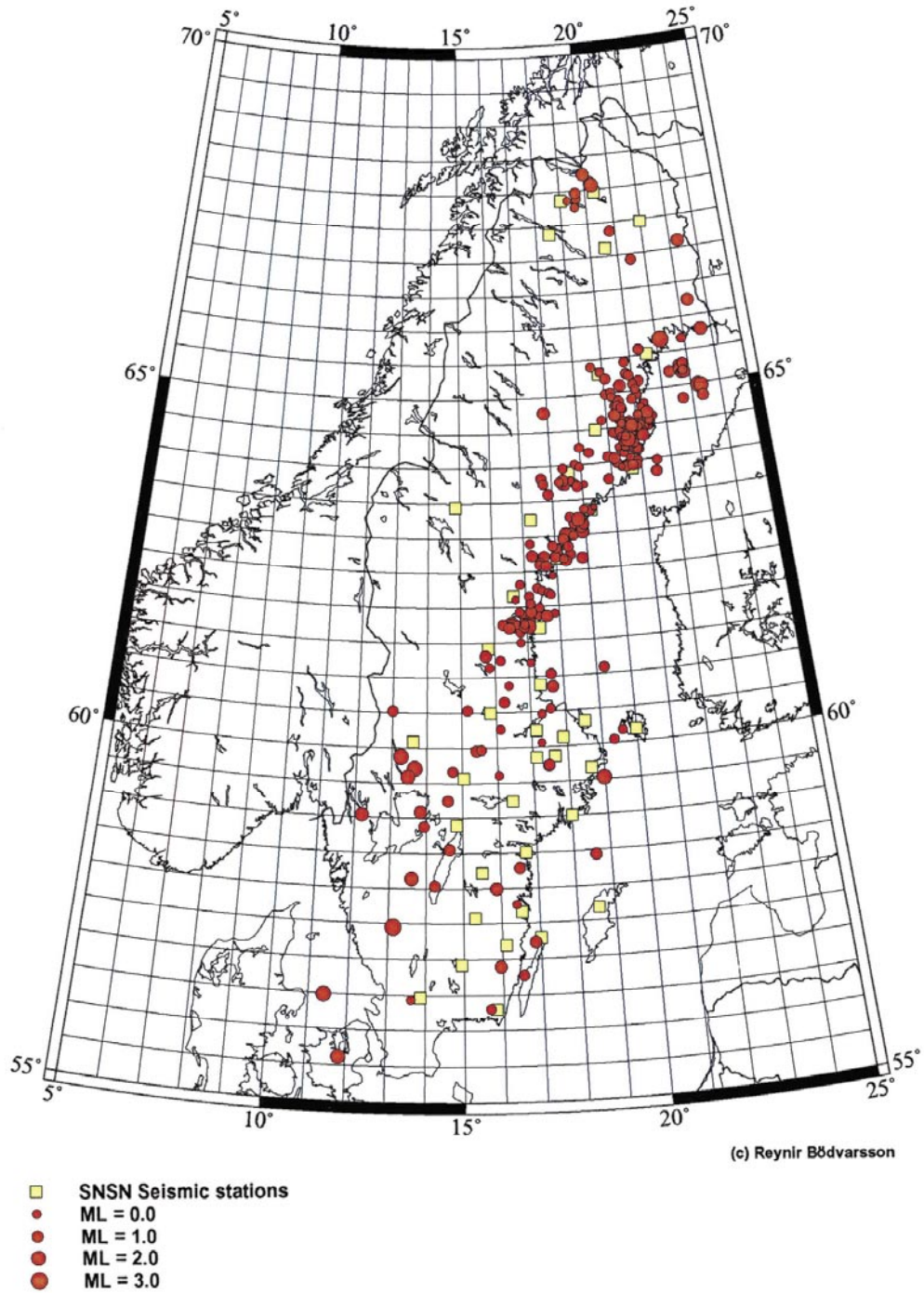
The largest earthquake  $ML=3.0$  occurred on February 25 south of Borås. The second largest earthquake with magnitude 2.9 occurred on October 22 about 15 km north of Luleå. This earthquake was felt by many people in the area. The third largest earthquake occurred west of Hudiksvall on January 4 with magnitude  $ML=2.6$ . Two earthquakes of magnitude 2.4 occurred in Värmland on June 21 and on September 2.

There were many observations by the population in the south-east of Sweden, including Öland and Gotland which was thought to be earthquakes. Several of these observations were investigated and we could exclude that they were due to earthquakes. We found two main explanations:

- a) In the Stockholm area this was due to large temperature variations that made the ice strike in some kind of ice-quakes.
- b) In the area around Öland and Oskarshamn we could explain that these events were coming from above through the air and not from the earth's crust. Later the explanation was found to be tests of the aeroplane Jas 39 Gripen and this has been confirmed by the Saab company.

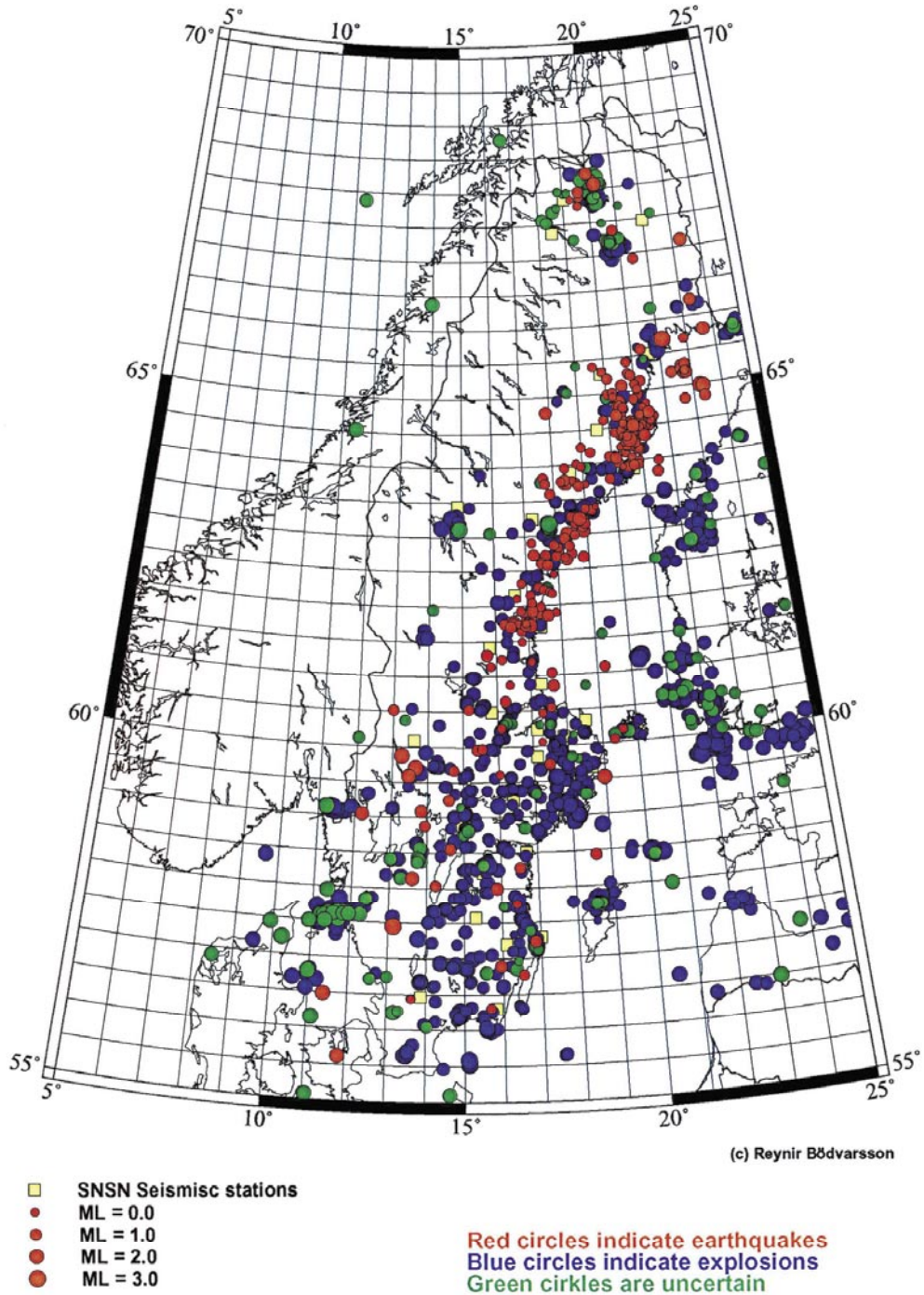


## SNSN recorded earthquakes 2003



Figur 4-1. Earthquake activity in Sweden during the year 2003.

## SNSN recorded events in 2003



*Figur 4-2. Recorded events including explosions in the SNSN network during the year 2003.*