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Swedish National Seismic Network (SNSN)

A short report on recorded earthquakes during the first quarter of the year 2011

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April 2011

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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 observations of seismic events at seismic stations within the Swedish National Seismic Network (SNSN). This short report gives brief information about the recorded seismicity during January through March 2011. The Swedish National Seismic Network consists of 62 stations.

During January through March, 2,145 events were located whereof 116 are estimated as real earthquakes, 1,521 are estimated as explosions, 308 are induced earthquakes in the vicinity of the mines in Kiruna and Malmberget and 200 events are still considered as uncertain but these are most likely explosions and are mainly located outside the network.

Four earthquakes had magnitudes equal to or above $M_L = 2.0$ during the period. In January an earthquake with magnitude $M_L = 2.4$ was located in Gulf of Bothnia, 74 km east of Umeå. Three earthquakes with magnitudes of $M_L = 2.0$ were located 20 km east of Boden, 2 km SW of Falköping and 18 km west of Robertsfors.

Sammanfattning

Enligt avtal mellan Svensk Kärnbränslehantering AB (SKB) och Uppsala Universitet, Institutionen för Geovetenskaper, fortsätter Uppsala Universitet att driva seismiska mätstationer i det Svenska Nationella Seismiska Nätet (SNSN). Denna rapport ger information om registrerade händelser under tidsperioden januari till mars 2011.

Det seismiska nätet består av 62 stationer. Under perioden januari till mars 2011 var det 2 145 registrerade händelser varav 116 bedömdes som äkta jordskalv, 1 521 bedömdes vara förorsakade av explosioner eller sprängningar, 308 var inducerade skalv i närheten av gruvorna i Kiruna och Malmberget och 200 var osäkra händelser, men dessa var i huvudsak lokaliserade utanför det seismiska nätet och är sannolikt förorsakade av explosioner.

Största jordskalvet under perioden hade en magnitud på M_L = 2,4 och lokaliserades i Bottniska viken, 74 km öster om Umeå. Tre jordskalv med magnitud M_L = 2,0 inträffade 20 km öster om Boden, 2 km sydväst om Falköping respektive 18 km väster om Robertsfors.

Contents

1 Introduction

This document reports the seismic events recorded by the Swedish National Seismic Network (SNSN) for the first quarter of the year 2011. The work was carried out in accordance with activity plan AP PU 400-06-004. In Table 1-1 controlling document for performing this activity is listed. The activity plan is an SKB internal controlling document.

At present there are 62 stations in operation in the network, Figure 1-1.

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 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.

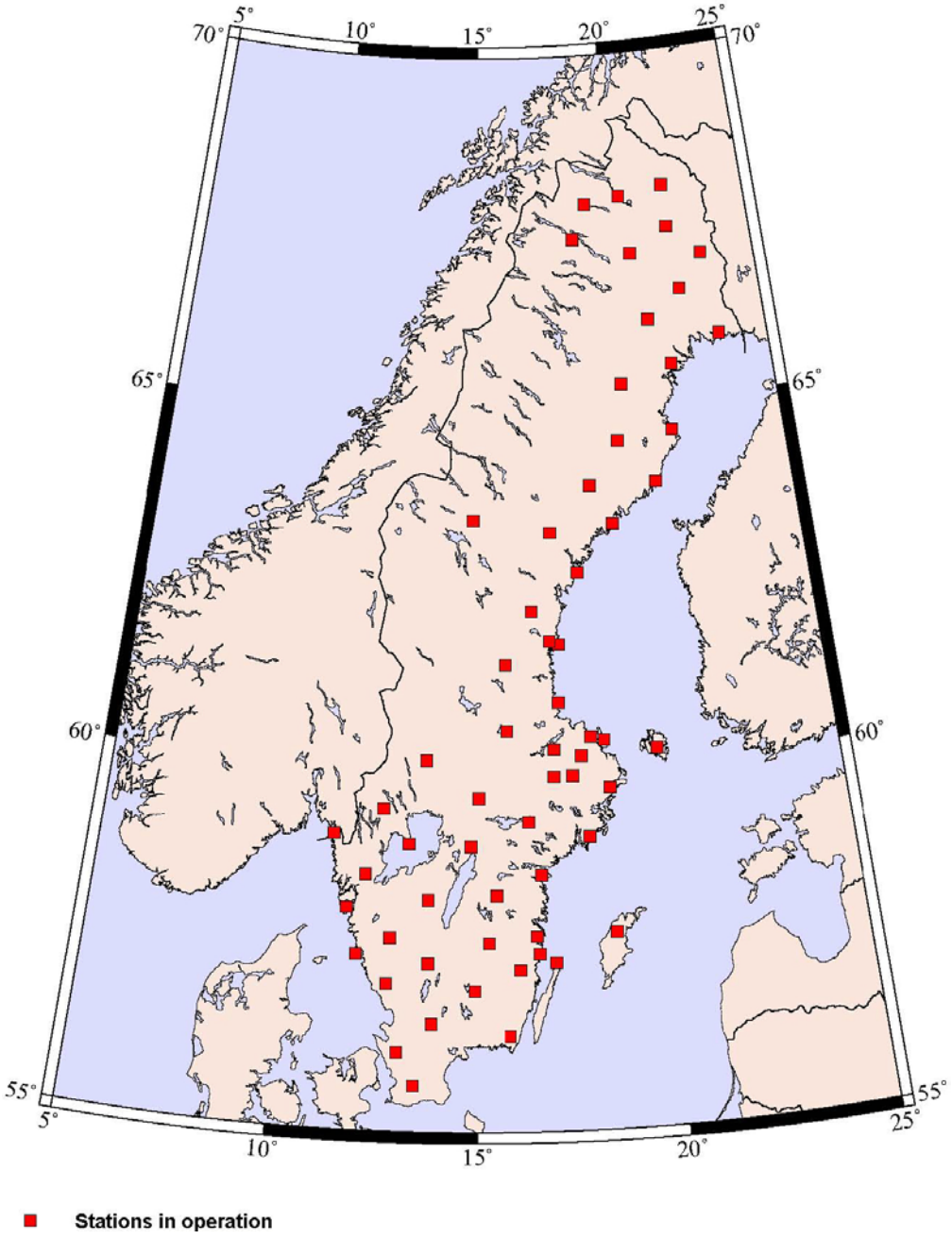

Figure 1-1. *The present Swedish National Seismic Network (SNSN).*

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	Number	Version
Drift av seismologiskt nät i Sverige	AP PU 400-06-004	1.0

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 observations of seismic events at 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 area.

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.

The sensitivity of the network allows for complete recording of all earthquakes down to a magnitude of lower than 0.5 within the network and down to a magnitude of 0.0 near the proposed nuclear waste repository site in Forsmark.

3 Recorded earthquakes during the first quarter of 2011

Figure 3-1 shows the recorded events in Sweden during January through March. During the period 2,145 events were located whereof 116 are estimated as real earthquakes (which are shown in Figure 3-2). 1,521 are estimated as explosions and 200 are still considered as uncertain but are most probably explosions and are mainly located outside the network. Large amounts of induced seismicity around the mines in Kirunavaara, Malmberget and Aitik are observed and 308 events in the very vicinity of the mines have been excluded in the report.

Event lists for January through March 2011 are given in Sections 3.1 through 3.3.

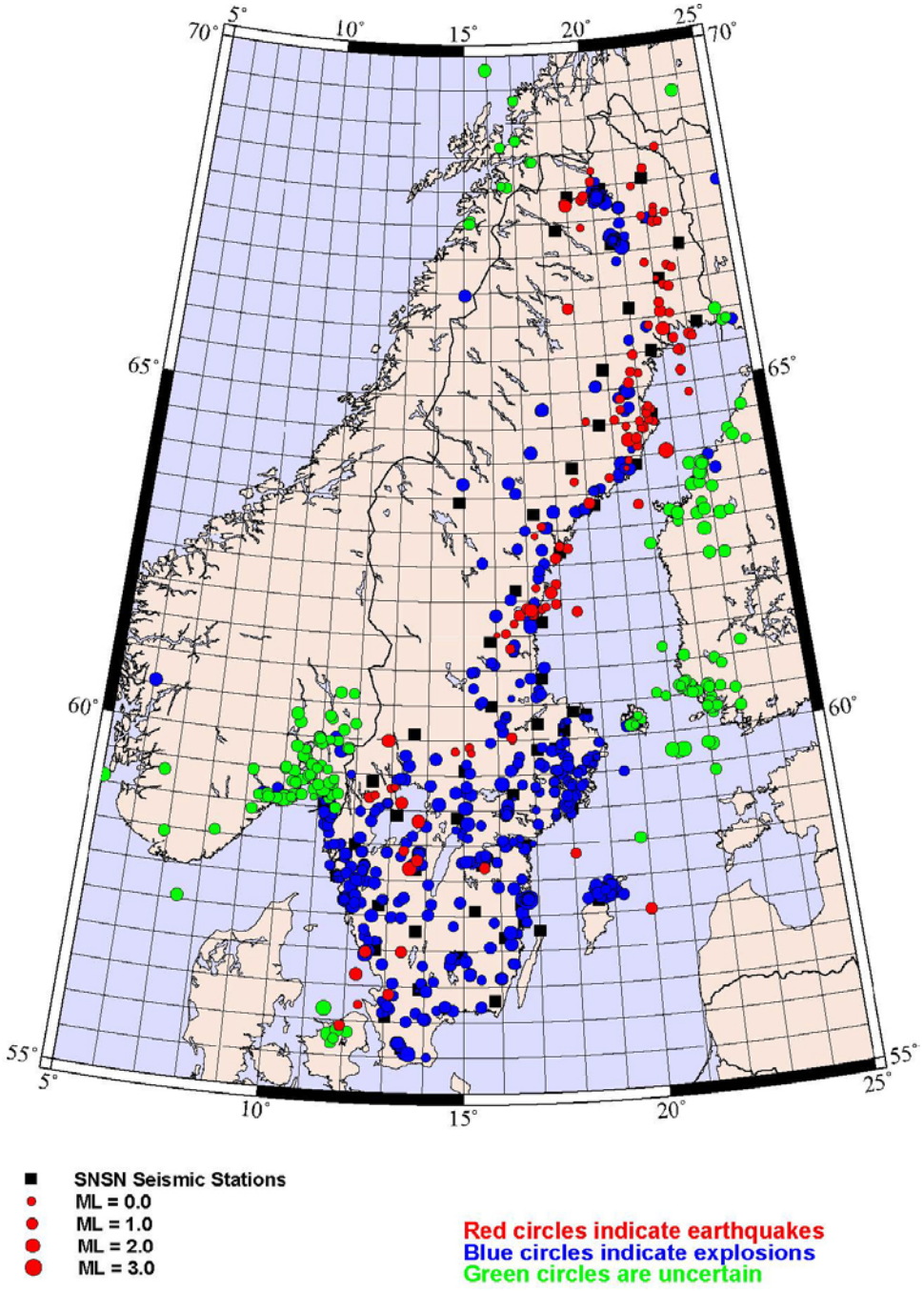

Figure 3-1. *Recorded events including explosions in the SNSN network during the period January through March 2011.*

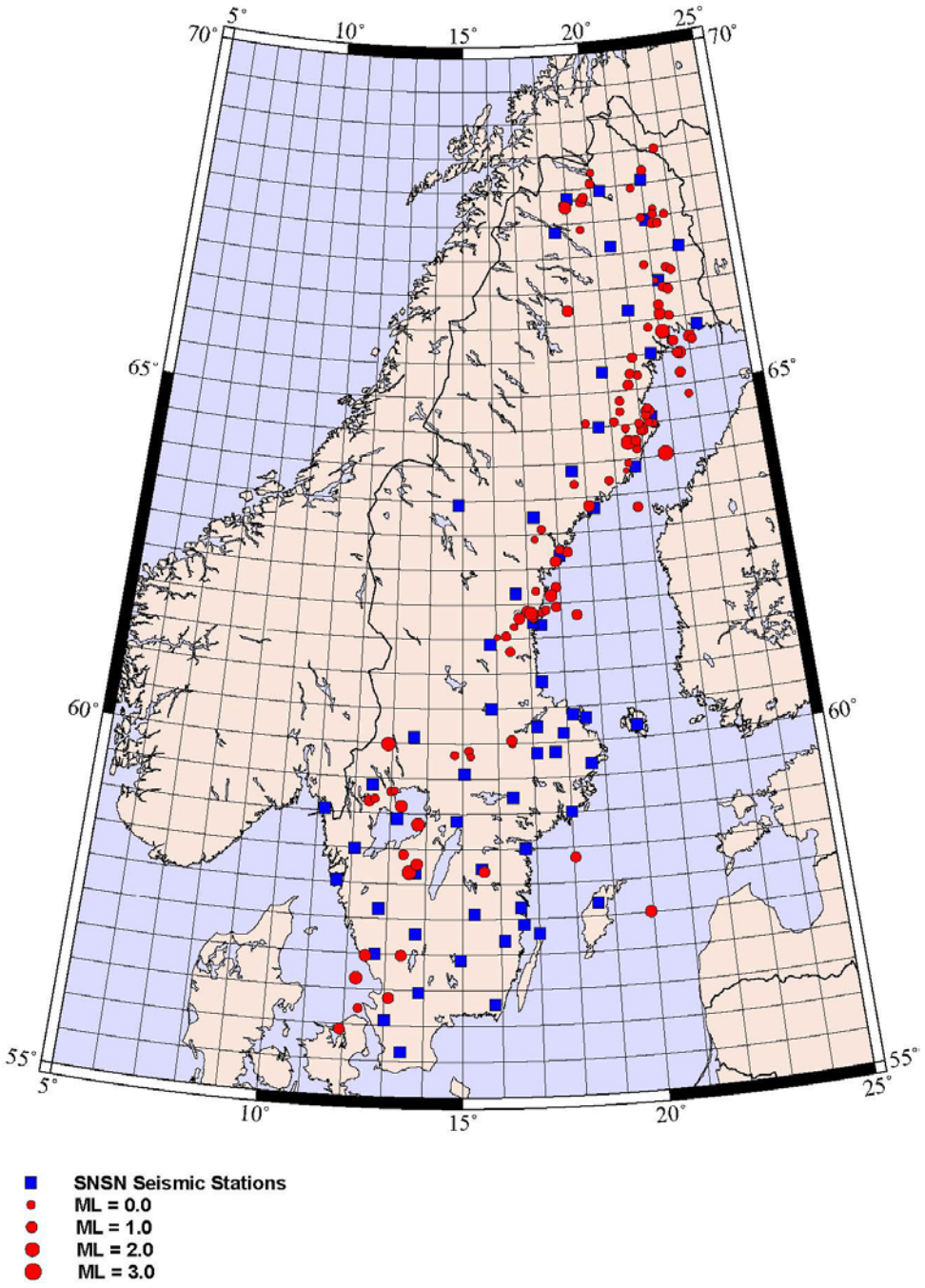

Figure 3-2. *Earthquake activity in Sweden during January through March 2011.*

3.1 January

An event list for January is given in Table 3-1 with date, time (UTC), latitude, longitude, X (RT90 km), Y (RT90 km), depth and local magnitude (M_L). In January 39 events were located whereof one had a magnitude of M_L = 2.4 located in Gulf of Bothnia, 74 km east of Umeå. Two earthquakes with magnitudes of M_L = 2.0 were located, one 20 km east of Boden and one 2 km SW of Falköping. Additional 5 earthquakes had magnitudes between M_L = 1.0 and M_L = 1.5. The depth range of the events varies between 0.1 and 29.2 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 km	Y RT90 km	Depth km	M_L Local magnitude
20110101	000304.8	61.944	17.841	6,871.7	1,606.7	17.9	0.6
20110101	113649.7	62.227	17.868	6,903.2	1,607.1	12.4	0.5
20110102	125942.6	59.310	12.998	6,579.9	1,340.0	19.8	–0.0
20110103	180733.9	56.385	13.102	6,254.0	1,332.9	3.8	1.0
20110104	203407.6	56.982	13.394	6,319.9	1,353.2	13.8	1.0
20110105	022637.8	61.535	16.292	6,824.5	1,525.7	6.8	0.4
20110105	144008.5	64.670	21.193	7,184.7	1,756.9	1.2	0.2
20110105	233254.5	59.322	13.095	6,581.0	1,345.6	19.0	–0.3
20110106	141815.6	62.727	18.289	6,959.6	1,626.9	20.6	0.5
20110107	041349.9	61.675	16.547	6,840.2	1,539.1	17.0	–0.2
20110108	015542.9	65.203	21.057	7,243.4	1,745.5	21.1	0.1
20110108	024805.7	59.839	14.769	6,635.9	1,441.7	20.2	0.1
20110108	043721.4	67.946	21.547	7,550.2	1,740.2	27.0	–0.1
20110108	212512.4	65.688	23.040	7,306.4	1,831.8	23.5	1.3
20110109	002358.2	62.601	17.949	6,945.0	1,609.9	0.1	0.2
20110109	101014.2	67.496	21.814	7,501.3	1,756.2	0.3	0.1
20110113	000257.4	64.482	21.439	7,164.8	1,770.5	25.0	0.0
20110113	000257.5	64.486	21.425	7,165.2	1,769.7	25.1	–0.1
20110113	045140.3	65.808	22.112	7,315.1	1,787.9	7.1	2.0
20110113	052520.6	65.651	23.120	7,302.7	1,835.9	24.9	0.2
20110113	215824.9	58.420	13.392	6,480.0	1,358.8	29.2	0.5
20110114	134549.9	66.068	22.090	7,343.9	1,784.1	10.1	1.2
20110115	105320.2	62.598	17.896	6,944.6	1,607.2	16.8	0.9
20110116	073146.0	66.806	21.731	7,424.3	1,760.0	1.2	0.0
20110117	021831.1	68.189	22.064	7,579.3	1,759.1	3.4	0.4
20110118	025426.5	67.772	18.908	7,522.9	1,630.9	1.1	0.8
20110118	143145.3	64.852	20.360	7,201.8	1,715.8	5.0	0.2
20110118	232638.5	65.232	20.799	7,245.6	1,733.2	19.7	0.4
20110120	010230.6	59.991	16.406	6,652.5	1,533.3	12.3	–0.5
20110120	012132.5	58.169	13.558	6,451.6	1,367.6	1.0	2.0
20110120	183629.6	65.657	22.437	7,299.9	1,804.5	7.6	0.5
20110122	100926.0	67.814	19.582	7,529.2	1,659.0	7.7	0.9
20110122	124249.5	66.033	22.419	7,341.6	1,799.3	25.8	0.3
20110124	225328.3	59.172	12.405	6,566.1	1,305.5	9.9	0.9
20110126	193953.4	61.874	17.408	6,863.2	1,584.2	23.0	0.1
20110127	115459.6	66.556	22.078	7,398.0	1,778.1	2.0	–1.0
20110127	163114.0	66.204	22.083	7,358.9	1,782.2	17.1	0.5
20110130	131354.2	56.654	12.266	6,286.3	1,282.8	16.9	1.5
20110131	014503.3	64.032	21.719	7,116.1	1,788.5	22.0	2.4

3.2 February

An event list for February is given in Table 3-2 with date, time (UTC), latitude, longitude, X (RT90 km), Y (RT90 km), depth and local magnitude (M_L). In February 32 events were located whereof one with a magnitude of M_L = 2.0, located 18 km west of Robertsfors. One earthquake with a magnitude of M_L = 1.7 was located 16 km north of Mariestad. Additional 7 events had magnitudes equal to or above M_L = 1.0. The depth range of the events varies between 0.8 and 33.2 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 km	Y RT90 km	Depth km	M_L Local magnitude
20110201	112050.2	65.075	20.707	7,227.9	1,730.2	22.7	0.7
20110203	121110.1	58.182	15.574	6,450.9	1,486.2	18.5	1.1
20110204	170853.8	58.850	13.769	6,527.1	1,382.3	10.6	1.7
20110204	203307.1	60.042	16.391	6,658.1	1,532.5	3.1	0.8
20110205	080208.9	57.507	19.937	6,383.2	1,747.4	4.3	1.2
20110207	033612.2	64.205	20.789	7,131.4	1,741.7	8.5	0.2
20110208	190558.4	65.887	21.612	7,321.7	1,764.4	33.2	–0.0
20110208	211813.8	66.736	22.528	7,420.1	1,795.8	22.7	0.3
20110209	132519.4	67.400	19.475	7,482.9	1,657.2	3.5	–0.1
20110210	053003.7	66.455	22.318	7,387.9	1,789.9	4.8	0.2
20110210	202002.2	58.358	18.041	6,472.7	1,630.6	5.7	0.7
20110211	145307.5	62.765	18.037	6,963.4	1,613.8	18.8	0.2
20110211	155827.7	61.905	17.528	6,866.9	1,590.4	19.8	0.0
20110212	153912.7	64.143	20.789	7,124.5	1,742.3	12.5	0.2
20110212	175032.2	56.971	12.478	6,321.0	1,297.5	18.2	1.3
20110212	202253.0	64.271	20.482	7,137.6	1,726.3	3.0	0.3
20110213	161852.3	64.666	21.360	7,185.0	1,764.9	4.0	0.0
20110214	024408.3	64.404	21.025	7,154.4	1,751.3	23.4	1.2
20110214	030732.1	64.397	20.991	7,153.5	1,749.7	18.6	0.1
20110214	192025.0	64.450	20.478	7,157.6	1,724.6	17.6	–0.1
20110215	005851.8	64.593	21.213	7,176.2	1,758.6	0.8	0.3
20110215	081544.7	64.697	20.330	7,184.5	1,715.5	16.8	0.1
20110216	125314.3	63.837	20.362	7,089.0	1,723.9	8.6	–0.9
20110220	161439.2	65.475	22.629	7,280.6	1,815.5	10.3	1.2
20110221	071141.8	64.562	19.135	7,165.9	1,659.4	17.6	–0.2
20110223	070121.0	58.288	13.764	6,464.5	1,380.1	18.3	1.0
20110223	070704.8	58.288	13.757	6,464.5	1,379.7	21.0	1.3
20110226	112741.8	63.718	19.779	7,073.8	1,696.1	17.6	0.3
20110226	223533.1	64.851	22.742	7,211.9	1,828.4	23.2	–0.1
20110227	143837.9	64.243	20.516	7,134.7	1,728.2	2.1	2.0
20110227	220611.4	62.184	17.239	6,897.6	1,574.5	18.3	–0.2
20110228	202906.1	64.510	21.259	7,167.2	1,761.6	21.2	0.1

3.3 March

An event list for March is given in Table 3-3 with date, time (UTC), latitude, longitude, X (RT90 km), Y (RT90 km), depth and local magnitude (M_L). In March 45 events were located whereof one had a magnitude of M_L = 1.9 located 5 km north of Uddheden or 40 km NE of Arvika. One earthquake with magnitude of M_L = 1.7 was located 16 km north of Hudiksvall. Additional 5 earthquakes had magnitudes equal to or above M_L = 1.0. The depth range of the events varies between 0.1 and 29.3 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 km	Y RT90 km	Depth km	M_L Local magnitude
20110301	013337.0	64.613	21.205	7,178.5	1,758.0	15.4	0.3
20110302	000137.9	63.946	20.460	7,101.4	1,727.9	6.2	–0.3
20110302	000137.9	63.947	20.458	7,101.5	1,727.8	6.2	–0.3
20110302	011245.5	64.503	20.946	7,165.2	1,746.6	0.9	0.1
20110304	144104.9	65.474	20.939	7,273.1	1,737.5	19.5	0.5
20110304	162241.4	64.257	20.784	7,137.1	1,741.0	16.1	0.8
20110306	031132.0	63.694	18.622	7,068.1	1,639.1	21.4	0.0
20110306	090414.5	59.895	15.164	6,641.8	1,463.9	29.3	0.2
20110306	205105.4	67.399	22.219	7,492.2	1,774.6	17.6	0.5
20110307	180627.1	61.797	16.715	6,853.9	1,547.8	9.5	1.0
20110308	083300.7	67.396	22.413	7,492.8	1,782.9	17.6	0.2
20110308	195215.3	61.789	17.139	6,853.4	1,570.2	8.2	0.3
20110308	195219.6	61.813	17.176	6,856.2	1,572.1	5.3	0.3
20110309	024736.4	61.798	17.128	6,854.4	1,569.6	21.1	0.3
20110309	050413.5	64.711	21.278	7,189.6	1,760.6	13.1	–0.0
20110310	095741.6	59.106	13.299	6,556.5	1,356.2	10.1	1.4
20110310	102710.1	67.865	19.667	7,535.1	1,662.2	3.0	0.5
20110310	140356.3	63.375	19.071	7,033.6	1,663.1	5.0	1.0
20110311	014002.8	65.176	22.552	7,247.0	1,815.6	18.5	0.7
20110311	113124.4	67.610	22.309	7,516.1	1,776.0	16.7	–0.3
20110313	160652.1	68.483	22.666	7,614.6	1,780.3	5.2	0.2
20110314	182936.7	62.110	17.703	6,889.9	1,598.9	6.4	1.4
20110315	011246.2	67.739	18.957	7,519.4	1,633.1	5.7	1.4
20110315	043650.2	61.820	18.465	6,859.0	1,640.0	5.4	0.7
20110315	143730.0	56.230	12.345	6,238.9	1,285.3	16.1	0.3
20110316	162456.4	65.476	22.539	7,280.3	1,811.4	0.1	0.5
20110317	074450.2	67.533	22.281	7,507.4	1,775.7	10.2	0.0
20110317	182723.8	68.228	20.040	7,576.5	1,675.1	18.0	–0.3
20110317	185723.8	61.897	16.957	6,865.2	1,560.4	4.6	0.9
20110318	140242.7	63.067	17.493	6,996.2	1,585.1	7.9	0.0
20110318	145327.6	61.522	16.025	6,823.0	1,511.5	6.5	–0.8
20110320	042228.7	59.815	15.217	6,632.9	1,466.8	23.0	–0.3
20110322	101956.5	68.069	19.974	7,558.7	1,673.6	20.8	0.2
20110322	202312.3	63.299	20.636	7,030.1	1,741.9	2.0	0.6
20110324	033302.5	59.206	12.557	6,569.4	1,314.3	7.0	0.0
20110325	022130.5	66.690	22.698	7,415.8	1,803.8	19.2	0.2
20110325	231706.5	61.865	17.069	6,861.8	1,566.3	5.5	1.7
20110327	020003.2	55.927	11.912	6,206.7	1,256.5	10.6	0.9
20110327	113420.6	59.987	12.875	6,655.6	1,336.3	20.8	1.9
20110327	195519.0	66.226	18.787	7,350.4	1,634.0	18.5	1.0
20110328	002813.8	66.421	22.501	7,385.0	1,798.3	8.9	0.6
20110328	165259.3	67.513	22.720	7,507.2	1,794.6	18.8	–0.0
20110329	025125.4	64.555	20.106	7,168.0	1,706.0	18.6	0.3
20110330	225000.2	61.313	16.405	6,799.8	1,532.0	13.5	0.4
20110331	001934.6	62.929	17.266	6,980.6	1,574.0	17.3	–0.4