

Swedish National Seismic Network (SNSN)

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

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July 2011

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This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author. SKB may draw modified conclusions, based on additional literature sources and/or expert opinions.

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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 April through June 2011. The Swedish National Seismic Network consists of 62 stations.

During April through June, 2,160 events were located whereof 129 are estimated as real earthquakes, 1,502 are estimated as explosions, 310 are induced earthquakes in the vicinity of the mines in Kiruna and Malmberget and 219 events are still considered as uncertain but these are most likely explosions and are mainly located outside the network.

Two earthquakes had magnitudes above $M_L = 2.0$ during the period. In May one earthquake with magnitude $M_L = 2.8$ was located in Kattegatt, 31 km SW of Falkenberg and in April an earthquake with magnitude $M_L = 2.0$ was located 19 km NW of Robertsfors. Additional 16 earthquakes had magnitudes equal to or above $M_L = 1.0$.

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 april till juni 2011.

Det seismiska nätet består av 62 stationer. Under perioden april till juni 2011 var det 2 160 registrerade händelser varav 129 bedömdes som äkta jordskalv, 1502 bedömdes vara förorsakade av explosioner eller sprängningar, 310 var inducerade skalv i närheten av gruvorna i Kiruna och Malmberget och 219 var osäkra händelser, men dessa var i huvudsak lokaliserade utanför det seismiska nätet och är sannolikt förorsakade av explosioner.

Två jordskalv hade magnitud över $M_L = 2.0$ under perioden. I maj inträffade ett skalv med magnitud $M_L = 2.8$ som lokaliserades i Kattegatt 31 km sydväst om Falkenberg och i april lokaliserades ett skalv med magnitud $M_L = 2.0$, 19 km nordväst om Robertsfors. Ytterligare 16 skalv hade magnitud $M_L = 1.0$ eller större under perioden.

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1 Introduction

This document reports the seismic events recorded by the Swedish National Seismic Network (SNSN) for the second 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.

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

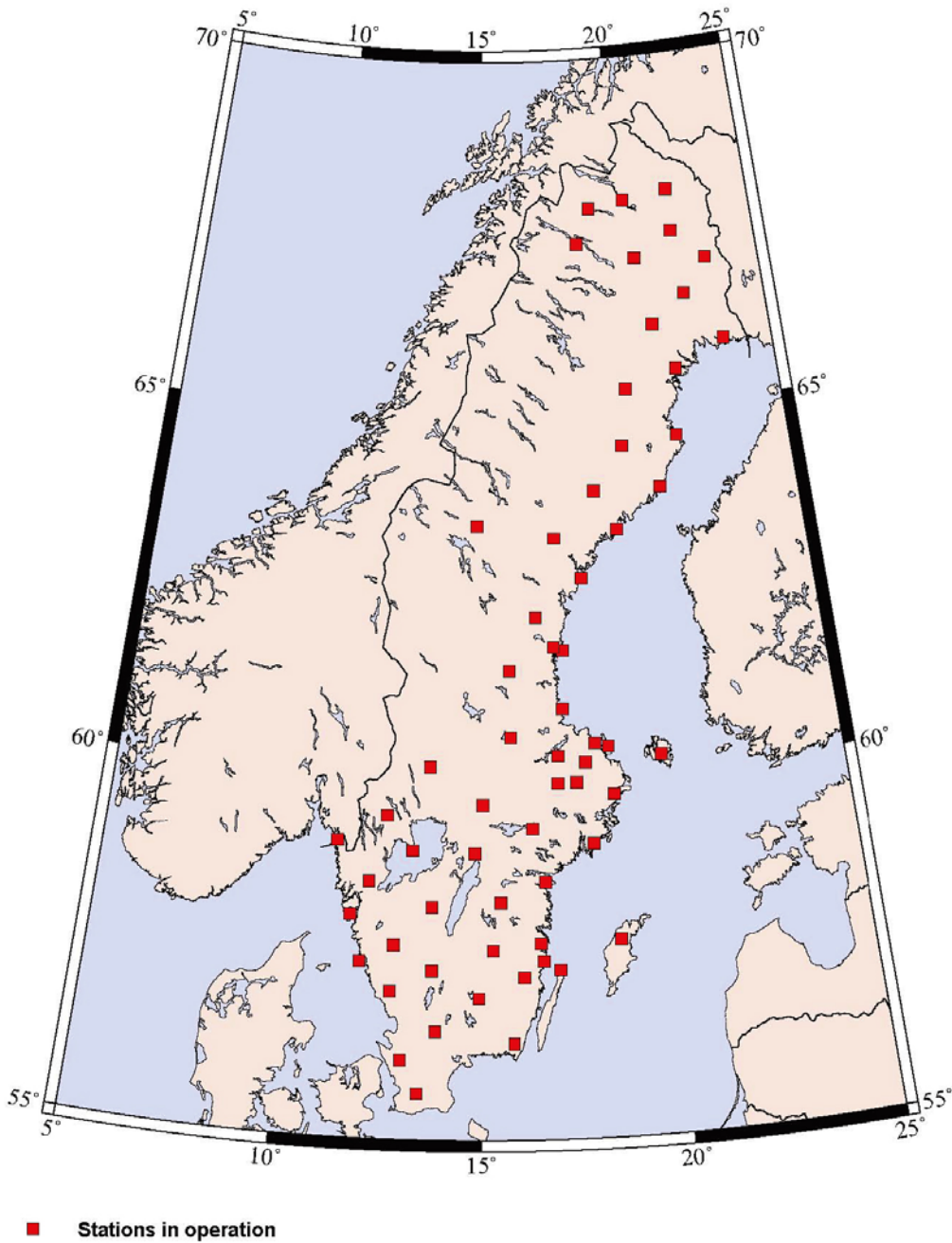


Figure 1-1. The present Swedish National Seismic Network (SNSN).

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 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 second quarter of 2011

Figure 3-1 shows the recorded events in Sweden during April through June. During the period 2,160 events were located whereof 129 are estimated as real earthquakes (which are shown in Figure 3-2). 1,502 are estimated as explosions and 219 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 310 events in the very vicinity of the mines have been excluded in the report.

Event lists for April through June 2011 are given in Sections 3.1 through 3.3.

3.1 April

An event list for April 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 April 48 events were located whereof one had a magnitude of $M_L = 2.0$ located 19 km NW of Robertsfors. Additional 5 earthquakes had magnitudes between $M_L = 1.0$ and $M_L = 1.4$. The depth range of the events varies between 0.1 and 35.0 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M_L Local Magnitude
20110401	042950.2	64.805	21.518	7,201.0	1,771.0	9.3	0.5
20110402	183310.9	66.675	22.065	7,411.2	1,776.1	9.2	-0.1
20110402	193353.7	64.976	20.109	7,214.8	1,702.9	3.5	0.7
20110403	121207.6	68.056	23.335	7,570.4	1,813.3	8.7	0.7
20110403	181737.1	67.589	22.269	7,513.6	1,774.5	16.6	-0.1
20110405	085056.4	60.348	16.180	6,692.2	1,520.5	19.1	0.6
20110405	181059.8	57.777	13.769	6,407.6	1,378.7	21.0	1.0
20110406	001525.0	67.600	19.978	7,506.4	1,677.3	14.1	0.0
20110407	010244.4	61.444	16.355	6,814.4	1,529.1	1.6	0.0
20110408	044010.4	59.103	12.577	6,558.0	1,314.9	19.2	0.3
20110408	155607.7	67.948	20.265	7,546.0	1,686.7	12.6	-0.2
20110408	174224.6	67.860	20.197	7,536.0	1,684.5	0.3	0.4
20110409	020624.9	67.595	22.841	7,516.9	1,798.7	3.0	0.0
20110409	084806.8	67.580	19.222	7,502.2	1,645.3	11.0	0.7
20110409	084828.8	67.297	21.662	7,478.6	1,751.9	22.9	0.0
20110411	174037.4	65.339	22.676	7,265.8	1,819.3	1.1	0.7
20110411	191710.7	65.514	21.360	7,279.2	1,756.6	0.8	0.2
20110412	012049.6	67.470	22.066	7,499.5	1,767.3	12.7	-0.2
20110412	061325.7	67.955	19.625	7,545.0	1,659.8	10.0	-1.2
20110412	075958.5	57.903	12.497	6,424.7	1,303.8	3.9	1.2
20110413	043607.1	67.824	19.895	7,531.1	1,672.1	2.9	1.4
20110413	141113.0	59.522	14.371	6,601.0	1,418.7	19.7	-0.4
20110413	232444.3	68.042	20.585	7,557.4	1,699.2	5.2	-2.1
20110414	150234.7	62.339	16.913	6,914.5	1,557.2	19.5	0.0
20110415	065234.9	66.839	22.885	7,433.3	1,810.1	4.2	0.2
20110415	182414.7	65.202	20.962	7,243.0	1,741.0	27.9	0.0
20110415	221913.9	65.533	22.561	7,286.7	1,811.7	15.6	0.7
20110415	222940.9	64.570	21.529	7,175.0	1,773.9	19.7	0.4
20110416	101010.7	66.962	19.757	7,434.8	1,672.4	19.5	-0.1
20110418	034744.2	64.417	20.621	7,154.4	1,731.8	18.3	1.2
20110418	040125.5	64.347	20.680	7,146.8	1,735.2	12.1	2.0

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M _L Local Magnitude
20110418	100658.8	64.331	20.789	7,145.5	1,740.6	19.5	1.4
20110419	232833.1	61.830	17.274	6,858.1	1,577.2	13.0	0.5
20110420	091459.5	67.056	23.660	7,461.4	1,840.9	9.0	-0.9
20110420	204326.4	65.745	23.323	7,314.2	1,843.9	17.9	0.6
20110420	215305.0	65.299	22.885	7,262.4	1,829.5	6.4	0.3
20110420	221829.6	61.838	16.956	6,858.7	1,560.5	22.5	0.0
20110421	043808.1	67.897	22.425	7,548.5	1,777.5	14.5	-0.2
20110421	153924.7	65.973	22.359	7,334.6	1,797.3	25.4	0.2
20110422	113647.3	62.287	17.845	6,909.9	1,605.7	16.4	0.0
20110422	134731.5	68.241	20.656	7,579.8	1,700.4	19.5	0.3
20110423	084455.7	58.081	13.620	6,441.7	1,370.9	13.1	0.8
20110423	222513.4	67.762	19.548	7,523.4	1,657.9	2.1	0.2
20110424	115726.9	62.836	18.085	6,971.4	1,616.0	22.0	-0.1
20110425	052320.2	68.085	19.719	7,559.8	1,662.8	0.1	0.7
20110426	002434.6	55.767	12.089	6,188.2	1,266.6	26.7	0.5
20110426	020237.8	66.011	23.300	7,343.6	1,839.3	24.6	0.5
20110426	200217.4	61.015	17.099	6,767.1	1,569.8	35.0	0.1

3.2 May

An event list for May 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 May 44 events were located whereof one with magnitude M_L = 2.8, located in Kattegatt, 31 km SW of Falkenberg. One earthquake with a magnitude of M_L = 1.6 was located 28 km south of Mora. Additional four events had magnitudes equal to or above M_L = 1.0. The depth range of the events varies between 0.1 and 30.2 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M _L Local Magnitude
20110501	104509.0	61.224	14.801	6,790.2	1,445.9	8.6	1.6
20110502	192552.0	64.454	20.465	7,157.9	1,724.0	18.7	0.7
20110503	101555.3	58.547	13.108	6,494.7	1,342.8	16.6	1.0
20110503	174920.5	55.624	13.035	6,169.5	1,325.4	29.7	-0.1
20110503	220602.7	67.826	19.540	7,530.4	1,657.1	1.9	0.1
20110504	120828.0	68.239	20.458	7,579.0	1,692.3	19.9	-0.5
20110505	180805.6	64.442	20.776	7,157.7	1,739.0	17.6	-0.1
20110506	061154.5	67.528	19.520	7,497.2	1,658.3	22.5	-0.1
20110506	232652.6	67.130	23.149	7,466.8	1,817.8	8.4	0.0
20110508	220400.4	62.992	18.770	6,990.3	1,650.1	1.8	0.2
20110510	000150.0	64.577	21.609	7,176.1	1,777.6	1.1	-0.3
20110510	000150.0	64.579	21.609	7,176.3	1,777.6	1.1	-0.3
20110510	131349.3	67.257	21.907	7,475.2	1,762.8	12.4	-0.5
20110512	023009.9	61.928	17.401	6,869.2	1,583.6	14.4	0.3
20110512	033701.8	56.637	12.231	6,284.6	1,280.6	14.0	2.8
20110512	201443.2	62.898	18.547	6,979.2	1,639.2	7.1	0.4
20110513	031213.8	62.600	17.467	6,944.1	1,585.2	27.1	0.5
20110513	181136.3	61.687	16.917	6,841.8	1,558.7	4.6	0.0
20110514	153500.0	61.774	17.118	6,851.7	1,569.1	10.2	-0.1
20110515	043620.0	62.163	17.791	6,896.0	1,603.3	10.2	0.5
20110517	212620.3	62.551	17.634	6,938.9	1,593.9	19.4	0.2
20110518	112135.6	62.913	18.499	6,980.8	1,636.7	2.5	1.0
20110518	234732.7	61.925	17.641	6,869.2	1,596.2	18.3	0.3

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M _L Local Magnitude
20110519	050516.1	62.643	18.099	6,949.9	1,617.5	10.3	1.4
20110520	193405.9	64.484	21.649	7,166.0	1,780.5	3.7	-0.6
20110522	121410.1	68.078	19.047	7,557.3	1,634.9	2.9	-1.0
20110522	173032.3	66.603	22.766	7,406.4	1,807.9	30.2	0.4
20110523	003459.3	62.418	17.371	6,923.7	1,580.8	0.3	0.0
20110524	012533.9	68.051	23.308	7,569.7	1,812.3	0.1	0.7
20110525	135629.1	60.760	16.905	6,738.6	1,559.8	19.6	0.0
20110525	141629.7	59.914	15.230	6,644.0	1,467.6	19.0	0.0
20110525	231344.0	67.782	19.475	7,525.4	1,654.7	8.6	-1.4
20110526	143547.8	67.887	22.781	7,549.0	1,792.5	13.4	0.0
20110528	160904.3	64.935	20.508	7,211.6	1,722.1	7.9	0.9
20110529	000136.9	62.611	17.988	6,946.1	1,611.9	5.3	0.3
20110529	000137.2	62.625	17.979	6,947.7	1,611.4	5.3	0.0
20110529	033510.8	58.281	15.308	6,462.0	1,470.7	20.5	0.4
20110529	063126.5	61.661	16.514	6,838.6	1,537.4	7.5	0.4
20110529	221707.8	60.450	17.425	6,704.6	1,589.0	18.2	-0.6
20110530	023114.9	64.695	21.708	7,189.7	1,781.1	5.4	-0.5
20110530	061346.1	67.839	19.528	7,531.9	1,656.5	2.9	1.4
20110530	154809.7	61.713	16.458	6,844.4	1,534.3	12.6	0.7
20110530	175722.6	56.391	12.677	6,255.9	1,306.7	20.6	0.0
20110531	050636.2	57.529	13.568	6,380.4	1,365.8	16.9	0.8

3.3 June

An event list for June 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 June 37 events were located whereof one had a magnitude of M_L = 1.7 located 9 km NW of Boliden. Additional 5 earthquakes had magnitudes equal to or above M_L = 1.0. The depth range of the events varies between 0.2 and 28.3 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M _L Local Magnitude
20110601	131141.5	65.623	19.183	7,284.2	1,655.4	14.8	0.5
20110601	175559.4	67.342	20.341	7,478.8	1,694.8	18.6	-0.1
20110602	180452.1	68.307	19.223	7,583.2	1,640.9	22.9	-0.2
20110603	004502.5	55.357	12.693	6,140.7	1,302.5	25.3	0.9
20110603	110406.0	62.020	17.134	6,879.2	1,569.4	16.0	0.9
20110606	111540.7	55.769	13.736	6,184.2	1,369.9	18.4	1.3
20110608	191706.7	67.771	19.539	7,524.3	1,657.5	6.7	0.7
20110609	124210.5	67.594	19.277	7,504.0	1,647.5	7.7	0.0
20110610	071521.6	65.943	23.766	7,338.7	1,861.3	28.3	0.3
20110610	110118.5	61.663	16.517	6,838.8	1,537.5	4.0	0.6
20110611	042657.9	67.664	22.329	7,522.2	1,776.2	16.6	0.3
20110612	225305.1	62.294	17.279	6,909.8	1,576.3	14.5	-0.1
20110615	092820.5	67.027	23.974	7,459.9	1,854.9	5.2	0.1
20110615	181837.6	58.288	13.750	6,464.5	1,379.3	8.2	1.0
20110615	214113.1	65.163	22.472	7,245.2	1,811.9	1.9	1.5
20110616	120253.6	63.433	18.951	7,039.7	1,656.8	19.1	0.7
20110616	165742.6	56.742	13.688	6,292.6	1,370.3	17.2	0.1
20110617	022723.5	60.413	17.796	6,701.0	1,609.5	17.4	-0.2
20110617	200718.8	65.896	21.947	7,324.1	1,779.5	1.7	-0.1
20110618	124331.5	57.141	12.165	6,340.9	1,279.5	9.2	1.5
20110618	143325.3	67.429	22.377	7,496.3	1,781.0	6.1	-0.5

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M _L Local Magnitude
20110619	222814.3	60.468	17.942	6,707.4	1,617.3	18.6	-0.6
20110619	230103.1	66.735	22.438	7,419.5	1,791.9	7.9	0.1
20110620	010205.5	66.835	22.901	7,432.9	1,810.9	1.2	0.2
20110620	060234.1	58.289	13.739	6,464.7	1,378.6	3.0	0.8
20110620	080516.9	59.704	13.362	6,623.0	1,362.3	20.0	0.7
20110621	055157.2	67.833	19.744	7,531.7	1,665.7	1.8	0.4
20110621	172655.7	55.763	13.306	6,184.4	1,343.0	21.9	0.5
20110621	222201.2	67.398	22.211	7,492.1	1,774.3	0.2	-0.4
20110624	073655.4	64.940	20.321	7,211.5	1,713.2	3.0	1.7
20110624	082757.1	60.663	17.549	6,728.5	1,595.2	19.7	-0.2
20110624	161005.9	61.577	16.583	6,829.4	1,541.2	10.6	0.1
20110625	231733.8	62.593	17.454	6,943.4	1,584.5	26.5	-0.3
20110626	052734.7	65.217	23.004	7,254.0	1,836.1	9.5	1.4
20110627	024952.7	65.807	23.267	7,320.8	1,840.5	2.0	0.9
20110629	081423.9	61.481	16.846	6,818.8	1,555.3	20.1	0.3
20110630	061338.7	62.654	18.129	6,951.3	1,619.0	1.8	0.0

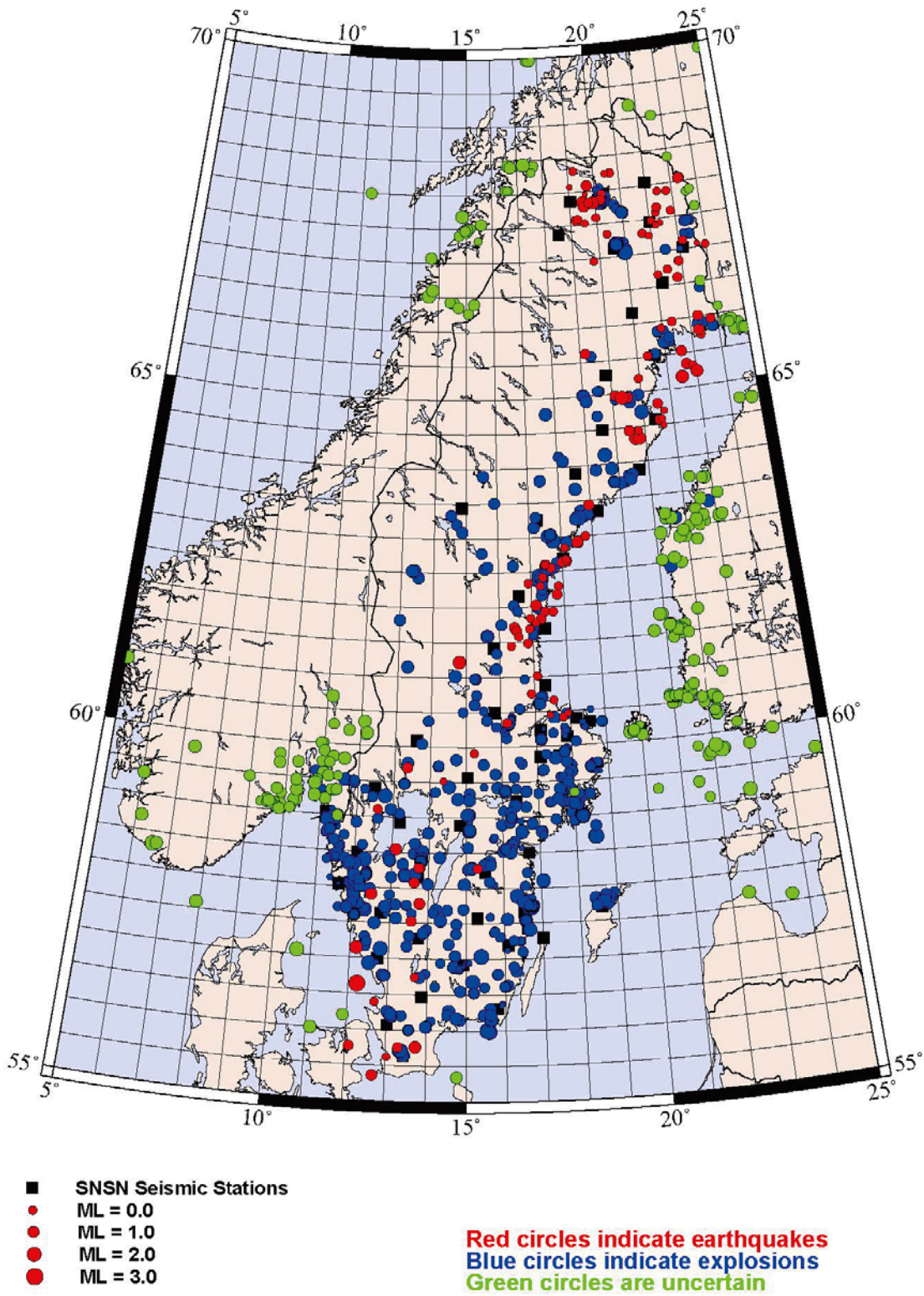


Figure 3-1. Recorded events including explosions in the SNSN network during the period April through June 2011.

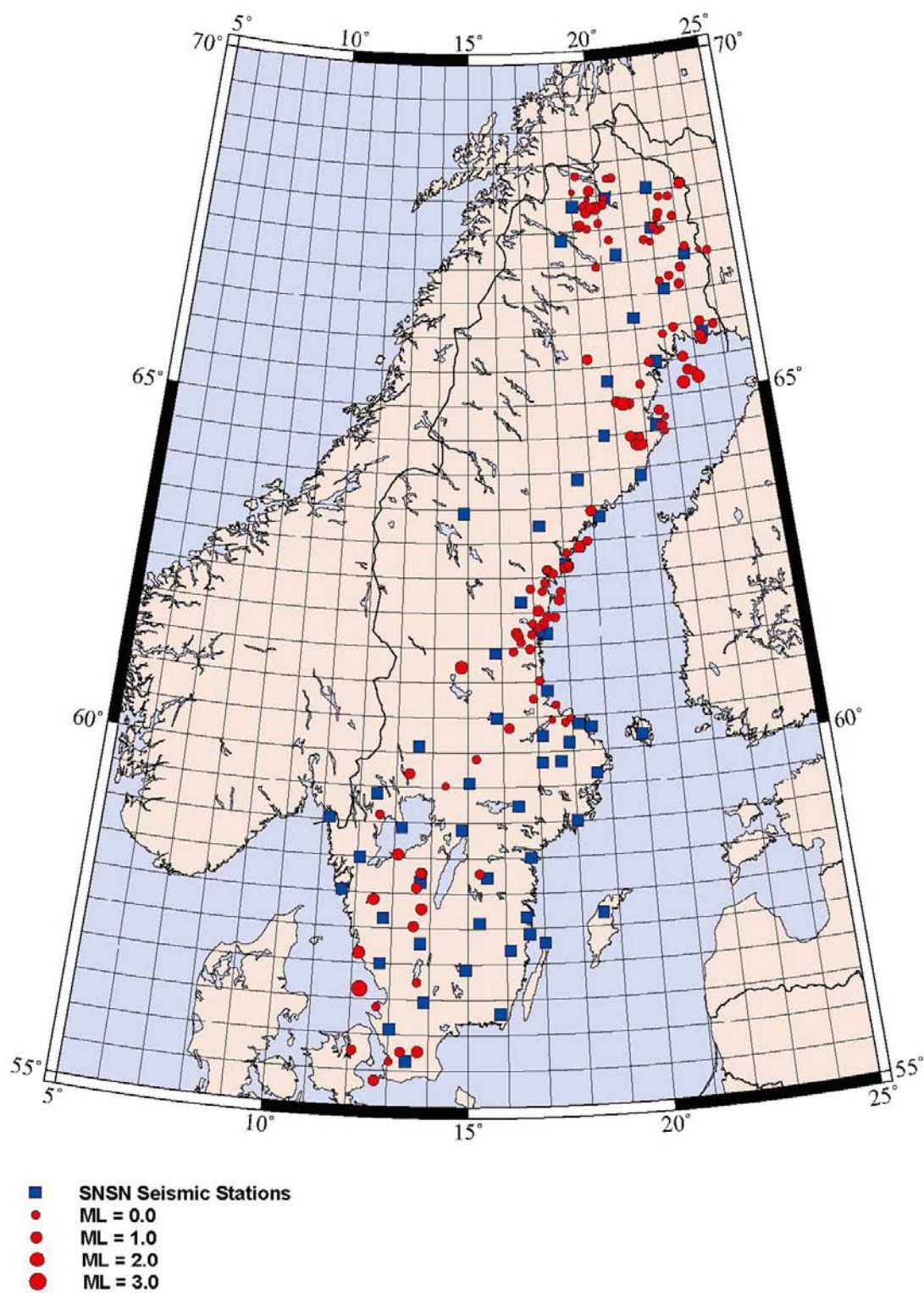


Figure 3-2. Earthquake activity in Sweden during April through June 2011.