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Swedish National Seismic Network (SNSN)

A short report on recorded earthquakes during the second quarter of the year 2006

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July 2006

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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.

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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 observation and additional construction of new seismic stations within the Swedish National Seismic Network (SNSN). This short report gives some information about the recorded seismicity during April through June 2006.

The Swedish National Seismic Network consists of 50 stations in operation and additional ten are under construction. During April through June, 1,422 events were located whereof 158 are estimated as real earthquakes, 1,018 are estimated as caused by explosions or blastings and 246 events are still considered as uncertain but these are mainly located outside the network.

The largest earthquake with magnitude $M_L = 2.5$ occurred on April 8th 7.5 km south of Kiruna. An earthquake with magnitude $M_L = 2.2$ occurred on Kungsholmen in Stockholm city on May 24th. This earthquake was felt by many persons living in the area. Additionally six earthquakes reached a magnitude of or above $M_L = 2.0$ during the period.

Sammanfattning

Enligt avtal mellan Svensk Kärnbränslehantering AB (SKB) och Uppsala Universitet, Institutionen för Geovetenskaper, fortsätter Uppsala Universitet att driva och bygga ut seismiska mätstationer i det svenska seismiska nätet (SNSN). Denna rapport ger information om registrerade händelser under tidsperioden april till juni 2006.

Det seismiska nätet består av 50 stationer som nu är i drift. Ytterligare 10 stationer är under uppbyggnad. Under perioden april till juni, 2006 var det 1 422 registrerade händelser varav 158 bedömdes som äkta jordskalv. 1 018 bedömdes vara förorsakade av explosioner eller sprängningar samt 246 var osäkra händelser, men dessa var i huvudsak lokaliserade utanför det seismiska nätet.

Det största jordskalvet med en magnitud på 2.5 inträffade 8 april, 7.5 km söder om Kiruna. Ett jordskalv med en magnitud på 2.2 inträffade den 24 maj på Kungsholmen i centrala Stockholm. Detta skalv kändes av många personer bosatta i området. Ytterligare sex skalv nådde magnitud 2.0 eller över 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 2006. The work was carried out in accordance with activity plan AP TD F73-01-013. In Table 1-1 controlling document for performing this activity is listed. The activity plan is an SKB internal controlling document.

At present 50 stations are in operation, Figure 1-1. Ten Additional stations are under construction. Eight are located in SW part of Sweden and two in the North.

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 längs Östersjöns kust	AP TD F73-01-013	

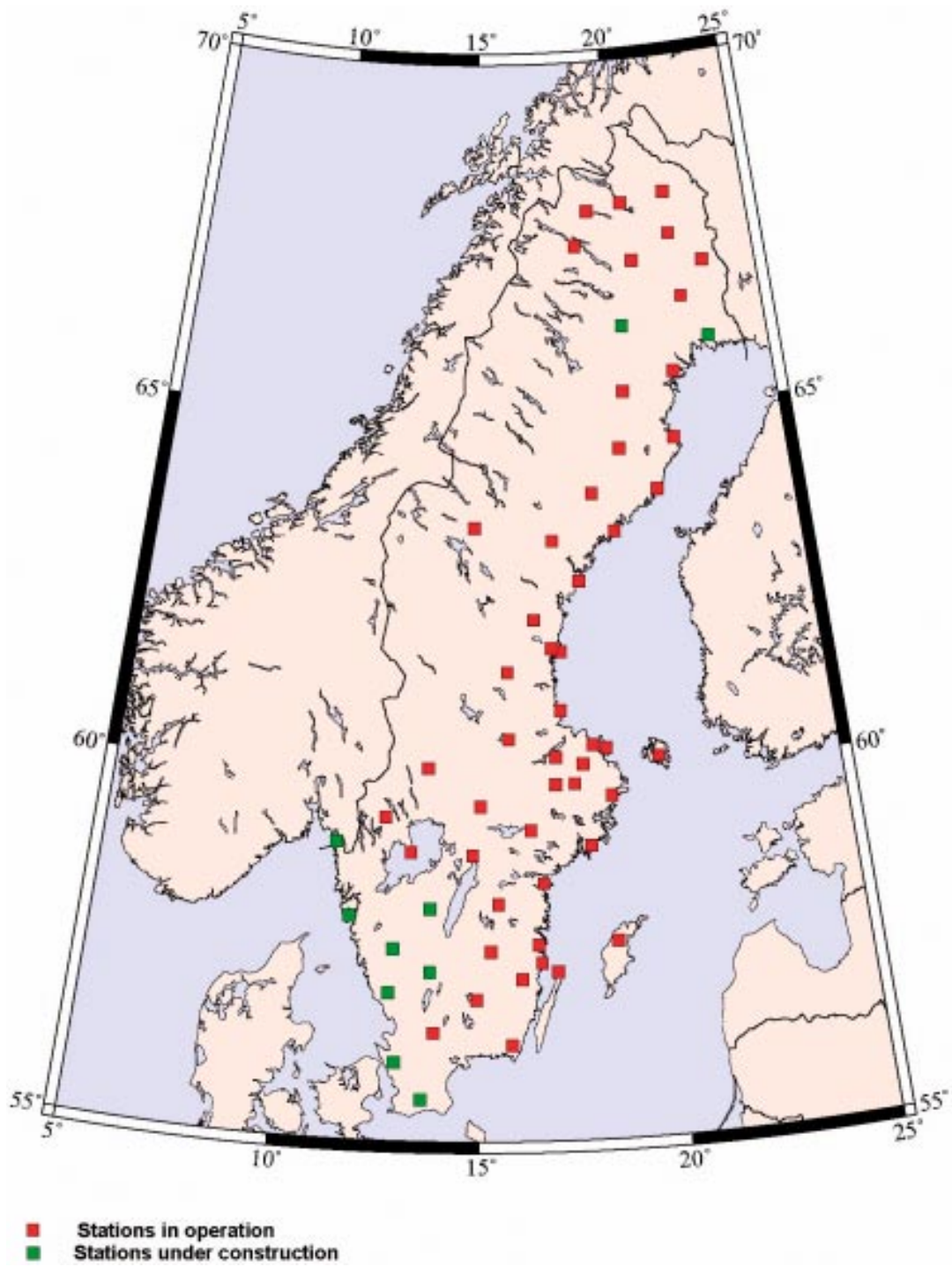


Figure 1-1. The present Swedish National Seismic Network (SNSN).

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 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 are 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 magnitude 0.0 near the proposed nuclear waste deposit sites.

3 Recorded earthquakes during the second quarter of 2006

Figure 3-1 shows the recorded events in Sweden during April through June. During the period 1,422 events were located whereof 158 are estimated as real earthquakes (which are shown in Figure 3-2). 1,018 are estimated as caused by explosions or blasting and 246 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 78 events in the vicinity of the mines have been excluded from the lists.

Event lists for April through June 2006 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 longitude, latitude, X (RT90 km), Y (RT90 km), depth and local magnitude (M_L). In April 67 events were located whereof one with magnitude 2.5 located 7.5 km south of Kiruna, and one with magnitude 2.2, 2 km south of Kiruna. Two earthquakes with magnitudes 2.2 and 2.0 occurred 3 km north of Gällivare. All these earthquakes are probably induced by the mining operations in the areas. Seven additional earthquakes had a magnitude of or above 1.0. The depth range of the events varies between 0.1 and 31.9 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	ML Local Magnitude
20060401	012708.5	67.880	19.429	7,536.1	1,652.1	16.2	
20060401	060036.6	63.741	18.980	7,074.2	1,656.6	31.9	0.4
20060401	060036.7	63.738	18.980	7,073.8	1,656.6	30.5	0.5
20060401	203127.6	67.200	20.663	7,464.1	1,709.8	0.4	
20060401	221853.5	67.837	20.181	7,533.4	1,684.0	0.1	0.3
20060402	141036.3	64.837	20.535	7,200.8	1,724.1	2.4	0.9
20060402	185403.1	63.281	20.710	7,028.3	1,745.8	21.9	0.5
20060403	013141.4	64.652	21.632	7,184.6	1,778.0	21.9	0.0
20060403	143039.0	63.980	20.513	7,105.3	1,730.2	0.1	0.5
20060403	182417.1	67.805	19.696	7,528.5	1,663.8	11.1	0.2
20060404	195010.8	67.648	20.022	7,512.0	1,678.8	26.5	0.3
20060404	224625.0	58.328	14.997	6,467.4	1,452.5	18.1	0.6
20060404	224625.1	58.330	14.996	6,467.7	1,452.4	18.8	0.6
20060404	235409.3	67.844	20.210	7,534.3	1,685.2	0.1	0.8
20060405	064816.9	67.883	20.164	7,538.5	1,682.9	0.1	0.9
20060405	064816.9	67.884	20.161	7,538.6	1,682.8	0.1	0.9
20060405	084919.5	63.307	18.679	7,025.1	1,643.9	25.1	0.4
20060406	002511.7	65.974	23.361	7,339.8	1,842.6	0.1	0.8
20060406	010810.6	67.853	20.178	7,535.1	1,683.8	0.1	0.0
20060407	000740.2	67.830	20.211	7,532.7	1,685.3	1.1	0.4

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	ML Local Magnitude
20060407	003557.6	67.836	20.199	7,533.4	1,684.8	0.1	0.9
20060407	062350.2	68.296	20.406	7,585.2	1,689.6	19.1	0.3
20060407	105615.9	67.173	20.676	7,461.1	1,710.6	6.0	0.8
20060407	180555.6	67.475	22.558	7,502.2	1,788.2	10.4	0.9
20060408	020107.6	67.833	20.192	7,533.0	1,684.5	0.4	-0.1
20060408	034043.7	67.778	22.114	7,533.9	1,765.8	0.1	0.3
20060408	091336.1	67.795	20.259	7,528.9	1,687.6	12.0	2.5
20060408	142221.0	67.842	20.221	7,534.1	1,685.7	9.9	2.2
20060408	181624.9	62.865	16.458	6,972.8	1,533.1	0.1	0.3
20060408	210912.1	61.717	16.698	6,845.0	1,547.1	16.5	-0.1
20060409	045839.0	64.384	20.668	7,150.9	1,734.3	20.7	0.1
20060409	052327.2	67.833	20.204	7,533.0	1,685.0	0.1	0.4
20060409	095035.8	61.915	17.364	6,867.7	1,581.7	5.3	-0.5
20060410	173259.3	67.188	20.663	7,462.8	1,709.9	2.8	1.5
20060410	192736.0	62.239	15.721	6,902.9	1,495.5	6.9	0.5
20060410	222301.1	67.175	20.625	7,461.2	1,708.4	3.2	1.4
20060412	075208.6	68.223	20.131	7,576.2	1,678.9	12.5	1.7
20060412	075208.7	68.220	20.136	7,575.9	1,679.1	12.4	1.7
20060413	095546.7	64.223	20.491	7,132.3	1,727.1	0.1	0.3
20060413	112639.5	65.958	23.315	7,337.9	1,840.7	0.1	0.7
20060413	165242.3	67.188	20.670	7,462.7	1,710.2	7.2	0.7
20060413	184401.1	67.835	20.187	7,533.2	1,684.3	0.1	0.3
20060415	191029.7	68.192	20.029	7,572.4	1,674.9	17.5	0.3
20060417	004538.2	61.678	16.504	6,840.5	1,536.9	16.1	-0.2
20060417	062604.9	61.605	17.311	6,833.1	1,579.7	24.2	0.2
20060417	103515.9	64.387	21.034	7,152.7	1,751.9	26.6	0.7
20060417	110956.9	67.831	20.187	7,532.7	1,684.3	0.1	0.6
20060418	020734.8	65.242	20.882	7,247.1	1,737.0	11.7	0.0
20060418	062646.9	62.567	17.371	6,940.4	1,580.4	24.3	0.0
20060420	001742.2	61.776	16.654	6,851.5	1,544.6	11.2	-0.1
20060420	220359.5	67.188	20.680	7,462.8	1,710.6	3.4	2.0
20060421	132806.0	67.555	15.502	7,495.4	1,487.0	1.2	1.2
20060422	145941.0	67.847	20.191	7,534.6	1,684.3	0.1	0.4
20060422	170015.0	67.184	20.696	7,462.4	1,711.4	2.3	2.2
20060424	194659.4	67.215	18.813	7,460.6	1,629.8	10.6	0.1
20060425	021032.7	61.591	16.505	6,830.8	1,537.0	16.5	-0.3
20060425	024808.1	61.972	18.180	6,875.3	1,624.4	0.1	0.3
20060425	220828.2	67.189	20.656	7,462.8	1,709.6	0.1	1.3
20060427	015740.4	61.827	17.303	6,857.8	1,578.8	0.1	-0.4
20060427	220701.0	67.177	20.656	7,461.5	1,709.7	0.1	0.5
20060429	142210.7	67.190	20.649	7,463.0	1,709.3	0.1	1.8
20060429	151143.5	67.851	20.181	7,534.9	1,683.9	0.1	0.1
20060429	165224.8	67.835	20.206	7,533.2	1,685.1	1.1	0.1
20060430	001149.3	67.841	19.973	7,533.2	1,675.2	29.9	0.3
20060430	080958.9	61.936	17.052	6,869.7	1,565.3	0.2	-0.2
20060430	162534.0	67.184	20.655	7,462.3	1,709.6	7.0	0.8
20060430	164210.4	67.178	20.448	7,460.9	1,700.7	10.4	-0.6

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 45 events were located whereof one with magnitude 2.2 located on Kungsholmen in Stockholm. The depth of the event was estimated to 1.3 km but the estimated depth is very uncertain. The earthquake was felt by many persons in the area. One additional event had a magnitude above 2.0 and twelve events had magnitude of or above 1.0. The depth range of the events varies between 0.1 and 27.2 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	ML Local Magnitude
20060501	192145.5	61.897	17.303	6,865.6	1,578.6	12.8	-0.5
20060502	122803.2	60.306	16.226	6,687.6	1,523.1	16.4	0.2
20060502	130453.5	67.780	19.562	7,525.3	1,658.4	0.1	0.3
20060503	034930.5	67.563	23.027	7,514.2	1,807.0	0.1	1.0
20060505	090809.1	67.640	18.968	7,508.3	1,634.1	0.1	0.0
20060506	061603.5	67.782	20.337	7,527.7	1,691.0	0.2	0.0
20060506	133525.1	65.133	22.554	7,242.3	1,816.1	0.1	1.0
20060506	145658.8	67.151	20.711	7,458.8	1,712.3	0.1	0.4
20060507	0135804	63.959	20.963	7,104.8	1,752.3	19.5	-0.1
20060508	080525.7	65.913	21.975	7,326.2	1,780.6	18.4	0.3
20060510	065859.8	67.739	20.332	7,523.0	1,691.1	10.0	-0.5
20060512	025030.8	67.658	18.946	7,510.3	1,633.1	17.8	0.0
20060512	105301.9	57.111	16.902	6,332.2	1,566.3	13.7	0.4
20060512	111028.1	64.695	20.289	7,184.1	1,713.6	4.1	1.8
20060512	140128.6	61.881	16.905	6,863.4	1,557.7	27.2	0.8
20060516	014757.8	67.815	20.216	7,531.1	1,685.7	6.3	0.0
20060517	180401.0	67.714	19.762	7,518.5	1,667.3	15.8	0.1
20060517	222202.8	60.057	15.108	6,659.9	1,461.0	24.0	1.1
20060518	211044.2	64.336	20.492	7,144.9	1,726.3	12.0	0.3
20060519	000642.1	67.862	20.186	7,536.2	1,684.0	0.1	0.7
20060519	012540.0	66.975	20.122	7,437.3	1,688.2	0.3	1.2
20060519	051108.6	67.886	20.161	7,538.8	1,682.8	0.1	0.1
20060521	160242.0	56.646	13.533	6,282.2	1,360.4	17.8	2.1
20060521	184830.3	62.710	17.674	6,956.7	1,595.5	3.9	0.4
20060521	220716.5	67.169	20.683	7,460.7	1,711.0	5.6	1.1
20060522	010955.8	67.837	20.188	7,533.5	1,684.3	16.0	0.3
20060522	020433.3	64.449	21.810	7,162.8	1,788.6	7.4	0.0
20060522	165222.0	67.170	20.632	7,460.6	1,708.7	0.1	1.0
20060523	004835.9	68.109	20.084	7,563.4	1,677.8	17.8	0.2
20060523	123652.7	59.859	13.445	6,640.0	1,367.6	0.1	1.0
20060523	132827.3	58.014	14.670	6,432.7	1,432.7	0.1	0.9
20060523	134458.2	59.247	14.940	6,569.8	1,450.4	3.0	0.2
20060523	164945.5	67.597	21.730	7,512.2	1,751.6	0.1	0.5
20060523	232719.9	63.797	18.208	7,078.7	1,618.2	4.2	-0.5
20060524	215946.6	67.170	20.692	7,460.8	1,711.3	4.7	1.6
20060524	232721.9	59.328	18.017	6,580.6	1,625.7	1.3	2.2

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	ML Local Magnitude
20060525	035323.0	57.425	13.625	6,368.7	1,368.8	0.1	1.4
20060526	214459.9	68.579	22.956	7,626.5	1,790.9	7.0	1.7
20060527	022043.0	61.614	16.839	6,833.7	1,554.7	4.5	-0.7
20060527	133915.6	61.852	17.154	6,860.4	1,570.8	8.1	-0.3
20060527	195506.7	59.368	12.326	6,588.2	1,302.1	18.3	0.5
20060528	211449.5	67.574	19.726	7,502.8	1,666.7	0.2	0.1
20060529	130153.8	62.819	17.823	6,969.1	1,602.7	0.1	-0.2
20060529	162854.8	67.880	20.579	7,539.5	1,700.3	5.1	-0.4
20060530	062202.9	59.860	13.255	6,640.5	1,357.0	21.5	1.7

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 46 events were located whereof one with magnitude 2.2, located c. 2.2 km south of Kiruna and one with magnitude 2.0, located 28 km east of Gäsö in Uppland. 15 additional earthquakes had magnitudes of or above 1.0. The depth range of the events varies between 0.1 and 29.7 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	ML Local Magnitude
20060601	110118.4	59.389	10.211	6,598.7	1,182.2	20.5	1.3
20060601	195301.7	61.979	17.343	6,874.8	1,580.4	3.0	0.2
20060601	200926.9	61.984	17.329	6,875.3	1,579.7	16.1	0.3
20060601	232026.1	62.005	17.385	6,877.8	1,582.6	3.0	-0.1
20060602	060133.4	67.822	20.224	7,531.9	1,685.9	0.1	-0.1
20060602	093922.0	62.697	18.067	6,955.9	1,615.6	1.9	-1.4
20060602	154113.7	59.868	16.280	6,638.8	1,526.4	21.3	0.7
20060603	060218.3	63.799	17.723	7,078.1	1,594.3	29.7	1.2
20060603	143910.6	62.270	17.690	6,907.7	1,597.7	6.9	1.7
20060603	201545.7	59.104	12.970	6,557.0	1,337.4	0.1	1.0
20060604	005017.1	67.832	20.223	7,533.0	1,685.8	5.9	0.8
20060604	114942.2	65.107	22.022	7,236.8	1,791.6	0.7	1.2
20060604	142521.1	67.202	23.282	7,475.5	1,822.6	19.6	0.7
20060604	172107.6	60.213	18.920	6,681.2	1,672.4	17.9	0.2
20060604	231657.9	67.840	20.213	7,533.8	1,685.3	0.9	2.2
20060606	042147.6	60.433	18.952	6,705.7	1,673.0	7.4	2.0
20060606	095334.4	63.125	18.917	7,005.3	1,656.8	18.1	0.4
20060606	133933.9	66.731	23.586	7,424.9	1,842.2	11.7	0.3
20060607	133635.3	58.295	16.754	6,463.9	1,555.5	11.7	1.1
20060609	221552.7	67.192	20.682	7,463.2	1,710.7	3.4	1.1
20060611	022003.4	63.956	20.733	7,103.5	1,741.2	17.9	0.2
20060616	013234.7	64.467	20.855	7,160.8	1,742.6	0.1	1.7
20060616	022422.8	63.942	22.908	7,112.1	1,847.5	0.1	1.3
20060617	095437.8	67.836	20.198	7,533.3	1,684.7	0.1	1.0
20060617	114327.5	67.915	20.661	7,543.6	1,703.5	16.4	-0.3
20060617	133840.6	65.466	22.971	7,281.4	1,831.4	0.1	0.4
20060617	140307.4	68.207	22.905	7,585.1	1,793.6	0.1	1.0
20060618	013553.4	67.641	20.610	7,512.9	1,703.7	16.3	-0.5
20060618	020445.7	60.338	16.254	6,691.1	1,524.6	0.1	0.1
20060618	055544.9	63.224	18.903	7,016.3	1,655.6	0.1	0.1
20060618	220720.6	67.820	20.210	7,531.6	1,685.4	0.1	0.0
20060619	002340.6	61.706	17.181	6,844.2	1,572.6	0.1	0.3
20060619	043834.6	62.841	17.844	6,971.6	1,603.7	17.3	-0.3
20060619	071725.9	67.829	20.241	7,532.7	1,686.6	0.1	-0.2
20060620	010921.1	68.004	22.999	7,563.1	1,800.1	13.9	1.9
20060620	034225.2	63.681	21.358	7,075.5	1,774.4	0.1	1.5
20060620	064049.6	62.842	17.868	6,971.7	1,604.9	17.6	-0.8
20060620	103930.8	63.945	24.436	7,121.6	1,922.0	0.1	1.7
20060620	134530.6	64.345	21.134	7,148.3	1,757.1	0.4	-0.2
20060620	151309.7	67.862	19.732	7,534.9	1,665.0	16.4	0.4
20060620	163056.6	64.563	20.977	7,172.0	1,747.6	1.1	0.3
20060621	140357.5	60.325	16.226	6,689.7	1,523.1	0.1	-0.2
20060621	205443.6	66.868	21.930	7,432.0	1,768.1	14.1	-0.4
20060621	233302.2	67.861	20.194	7,536.1	1,684.4	0.1	0.5
20060625	053814.5	61.414	17.053	6,811.6	1,566.5	20.7	0.4
20060629	121202.5	62.886	18.117	6,977.1	1,617.4	0.1	1.1

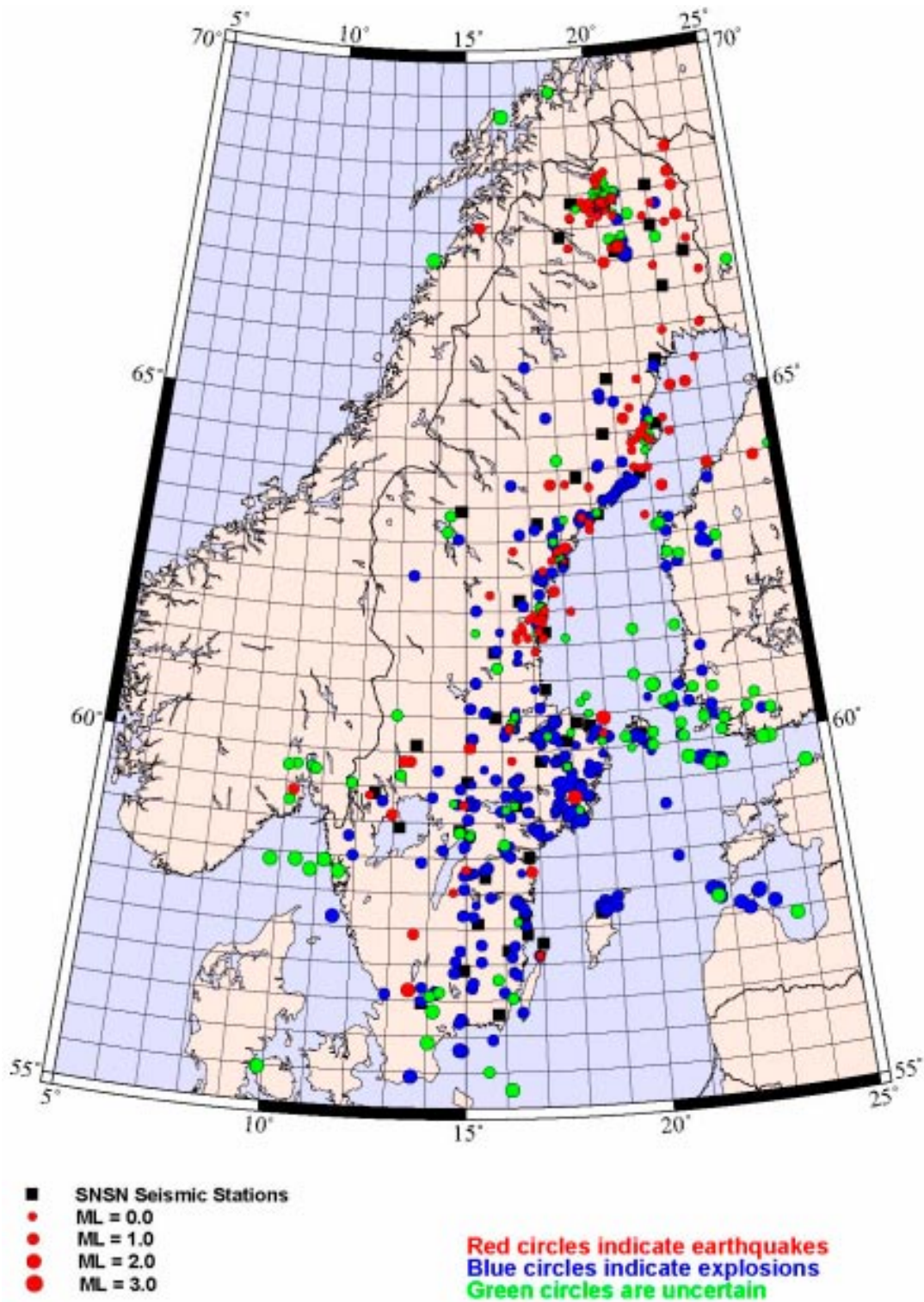


Figure 3-1. Recorded events including explosions in the SNSN network during the period April through June 2006.

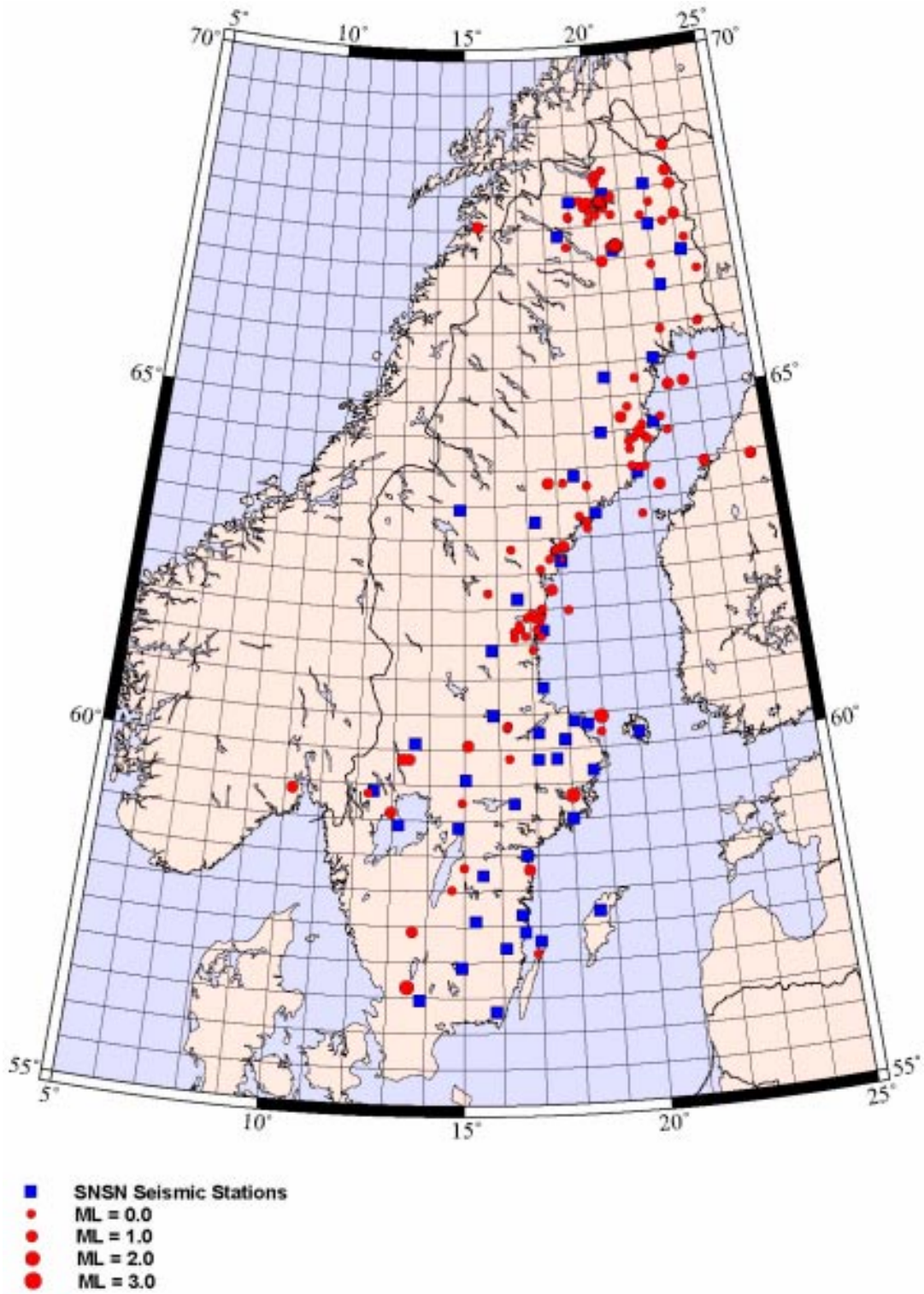


Figure 3-2. Earthquake activity in Sweden during April through June 2006.