

Swedish National Seismic Network (SNSN)

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

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October 2011

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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 authors. SKB may draw modified conclusions, based on additional literature sources and/or expert opinions.

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Abstract

According to an agreement with the 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 brief information about the recorded seismicity during July through September 2011.

The Swedish National Seismic Network now consists of 64 stations after that two additional stations were constructed in August this year.

During July through September, 2,096 events were located whereof 137 are estimated as real earthquakes, 1,250 are estimated as explosions, 488 are induced earthquakes in the vicinity of the mines in Kiruna and Malmberget and 221 events are still considered as uncertain but these are most likely explosions and are mainly located outside the network.

Four earthquakes located by the network had magnitudes above $M_L = 2.0$ during the period. In July an earthquake with magnitude $M_L = 2.9$ was located in Oppland-Hedmark in Norway. In August three earthquakes were located, one with a magnitude of $M_L = 2.4$ located 13 km north of Laimoluokta, 66 km north of Kiruna, one earthquake with a magnitude of $M_L = 2.3$ was located in Finland, 125 km north of Pajala and one earthquake with a magnitude of $M_L = 2.1$ was located in the North Sea offshore Denmark.

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 juli till september 2011.

Det seismiska nätet består nu av 64 stationer där ytterligare två stationer byggdes under augusti månad i närheten av Pärvie förkastningen väster om Kiruna.

Under perioden juli till september 2011 var det 2 096 registrerade händelser varav 137 bedömdes som äkta jordskalv, 1 250 bedömdes vara förorsakade av explosioner eller sprängningar, 488 var inducerade skalv i närheten av gruvorna i Kiruna och Malmberget och 221 var osäkra händelser, men dessa var i huvudsak lokaliserade utanför det seismiska nätet och är sannolikt förorsakade av explosioner.

Fyra jordskalv hade magnitud över $M_L = 2.0$ under perioden. I juli inträffade ett skalv med magnitud $M_L = 2.9$ som lokaliserades i Oppland-Hedmark i Norge. I augusti lokaliserades tre skalv, ett med magnitud $M_L = 2.4$, 13 km norr om Laimoluokta, 66 km norr om Kiruna, ett skalv med magnitud $M_L = 2.3$ lokaliserades i Finland 125 km norr om Pajala samt ett skalv med magnitud $M_L = 2.1$ som lokaliserades i Nordsjön utanför Jylland.

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1 Introduction

This document reports the seismic events recorded by the Swedish National Seismic Network (SNSN) for the third 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 64 stations in operation in the network, Figure 1-1. Two new stations were constructed during August 2011 in the Pärvie fault area west of Kiruna.

The report includes fundamental information about the seismic events, including origin time, 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

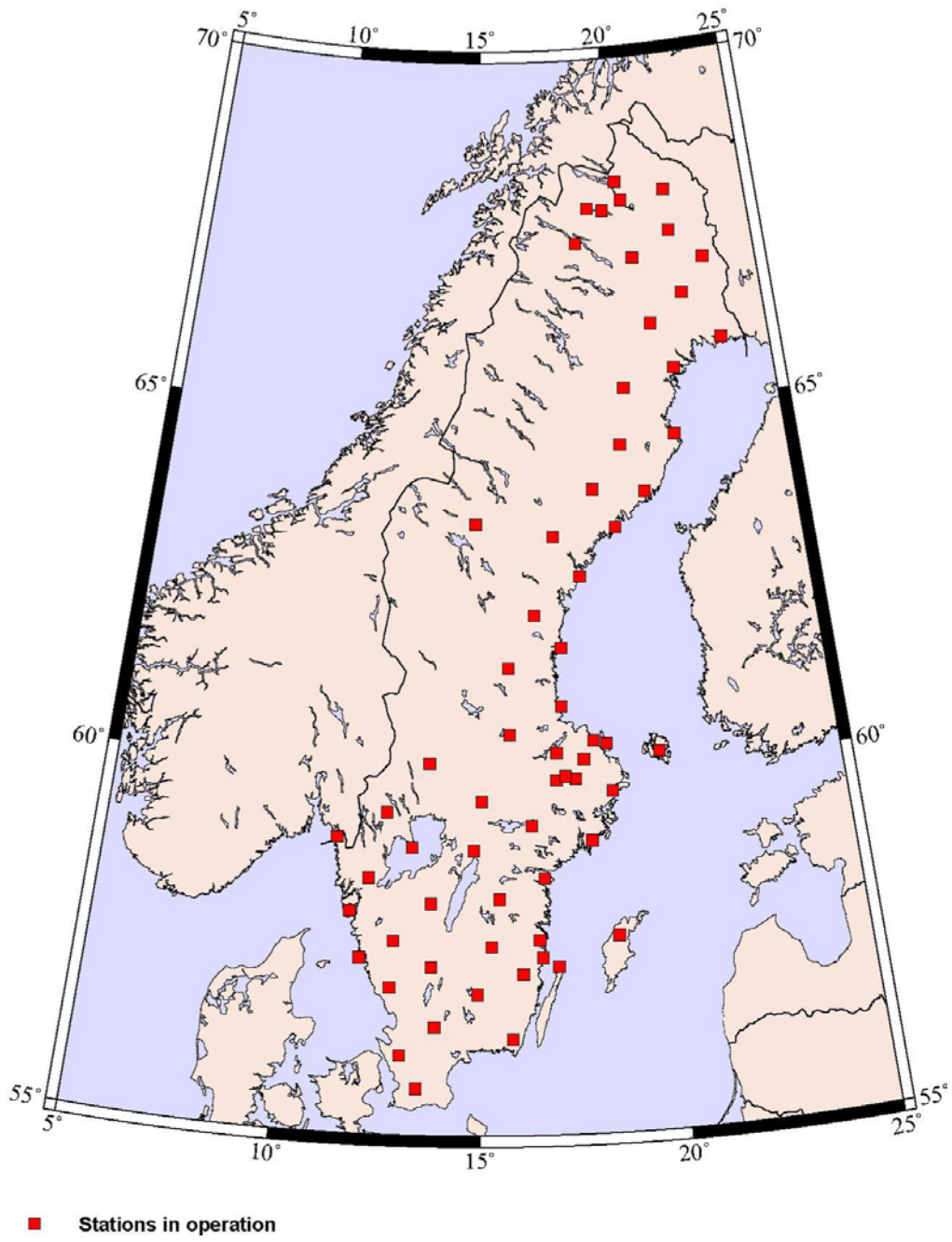


Figure 1-1. The present Swedish National Seismic Network (SNSN).

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 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 area.

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 repository site in Forsmark.

3 Recorded earthquakes during the third quarter of 2011

Figure 3-1 shows the recorded events in Sweden during July through September. During the period 2,096 events were located whereof 137 are estimated as real earthquakes (which are shown in Figure 3-2). 1,250 are estimated as explosions and 221 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 488 events in the very vicinity of the mines have been excluded in the report.

Event lists for July through September 2011 are given in sections 3.1 through 3.3.

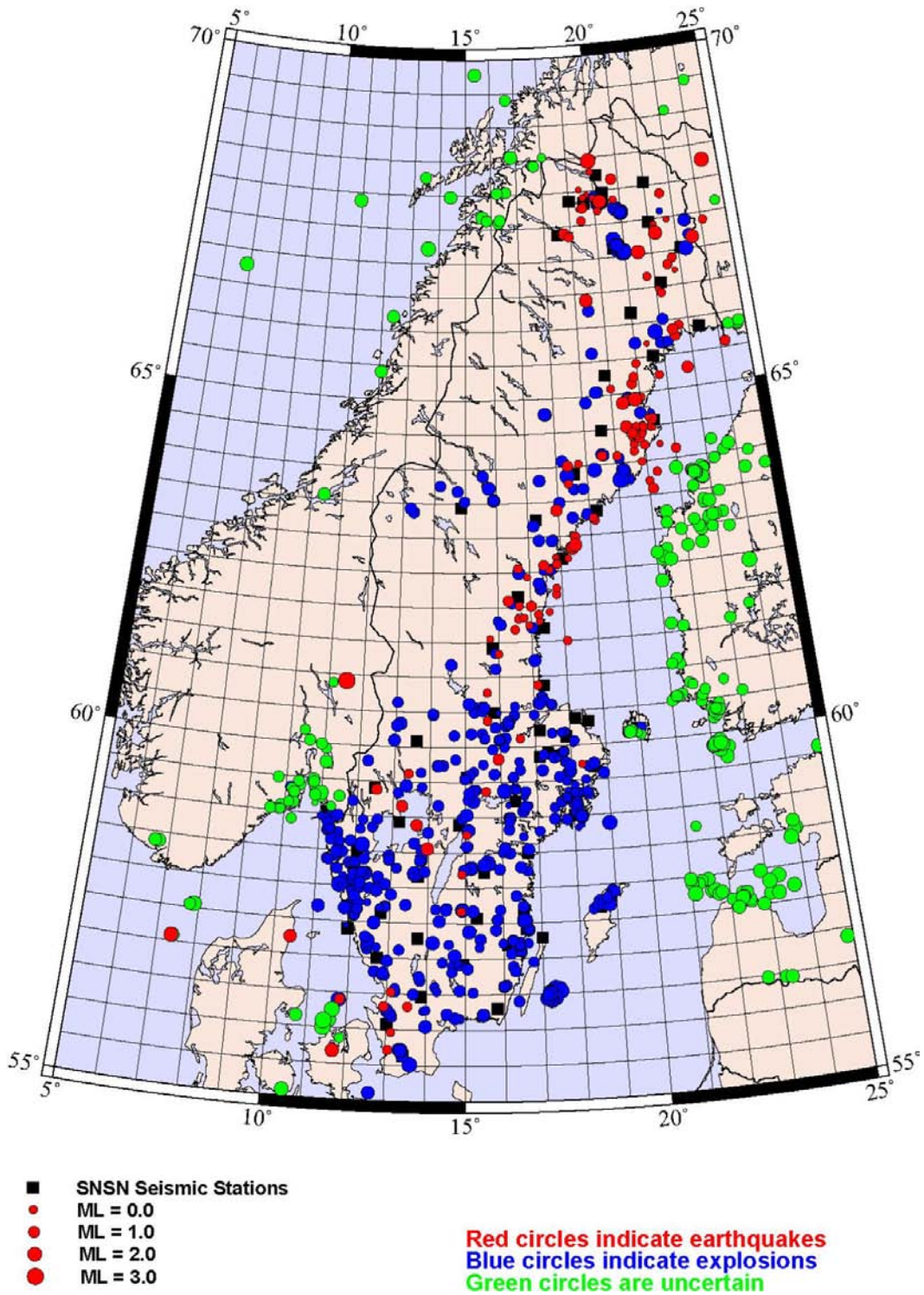


Figure 3-1. Recorded events including explosions in the SNSN network during the period July through September 2011.

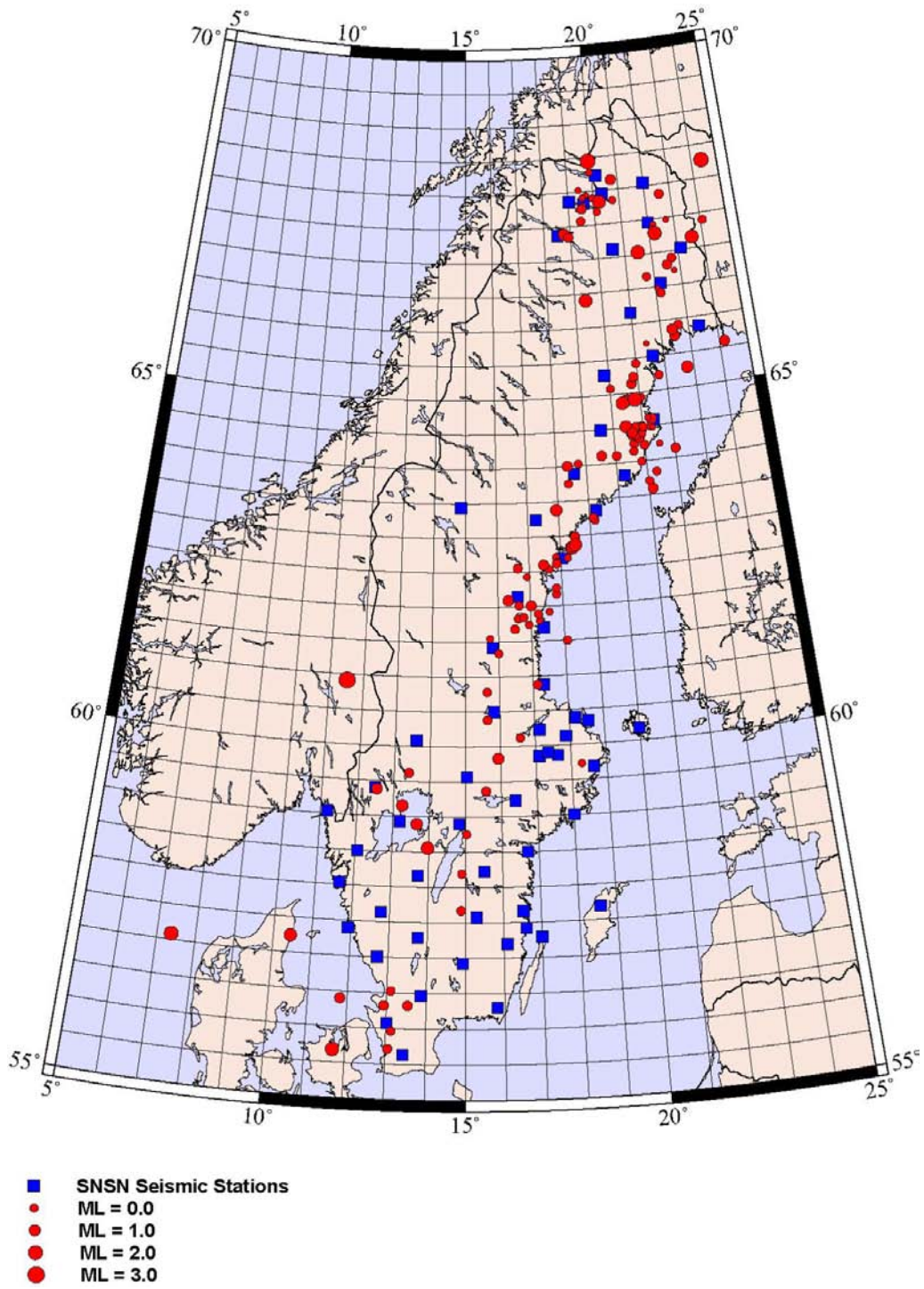


Figure 3-2. Earthquake activity in Sweden during July through September 2011.

3.1 July

An event list for July 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 July 50 events were located whereof one had a magnitude of $M_L = 2.9$ located in Oppland-Hedmark in Norway. One earthquake with a magnitude of $M_L = 1.9$ was located 31 km east of Gällivare and one with the same magnitude was located in Sjælland, Denmark. Additional 5 earthquakes had magnitudes between $M_L = 1.0$ and $M_L = 1.7$. The depth range of the events varies between 0.6 and 30.1 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M_L Local Magnitude
20110701	005746.4	59.727	18.293	6,625.6	1,639.7	19.2	-0.3
20110701	061619.2	68.144	20.737	7,569.3	1,704.6	17.7	0.8
20110702	135755.5	67.741	19.360	7,520.5	1,650.1	10.0	-1.3
20110704	133629.3	61.832	16.620	6,857.7	1,542.8	12.9	0.0
20110704	212101.3	61.794	17.259	6,854.1	1,576.5	1.1	-0.4
20110705	084821.0	67.779	19.582	7,525.2	1,659.2	10.5	-1.0
20110705	155734.6	66.472	22.064	7,388.6	1,778.4	3.3	-0.9
20110706	105850.4	64.600	21.303	7,177.3	1,762.8	17.2	0.9
20110707	022537.4	67.165	23.584	7,473.0	1,836.1	18.1	1.7
20110708	120814.4	65.695	21.423	7,299.6	1,757.7	4.1	-0.9
20110709	174118.7	60.783	15.644	6,740.6	1,491.0	12.7	-0.0
20110709	231921.2	67.389	24.075	7,500.6	1,853.9	1.5	-0.0
20110710	031536.1	62.531	17.614	6,936.7	1,592.9	21.3	-0.2
20110710	210206.2	67.037	21.488	7,449.0	1,747.1	26.8	1.9
20110711	072957.5	66.898	22.719	7,439.0	1,802.2	0.7	0.2
20110711	073141.4	65.085	20.015	7,226.7	1,697.7	16.0	-0.2
20110711	220811.6	63.751	18.378	7,073.9	1,626.8	22.4	0.0
20110712	005812.2	64.901	20.554	7,208.0	1,724.5	0.6	1.2
20110712	214403.6	64.898	20.548	7,207.6	1,724.3	3.0	0.4
20110712	233158.5	61.736	16.935	6,847.3	1,559.6	3.4	-0.3
20110713	055742.1	55.677	11.700	6,179.7	1,241.6	20.9	1.9
20110713	070851.9	62.013	17.021	6,878.2	1,563.5	18.5	0.8
20110714	182404.7	56.320	12.932	6,247.3	1,322.1	27.0	0.6
20110714	232431.7	64.260	20.651	7,137.0	1,734.6	18.3	0.2
20110716	143746.0	62.700	17.844	6,955.8	1,604.2	2.3	-0.5
20110716	211138.7	58.891	13.660	6,531.8	1,376.2	16.2	1.2
20110717	170050.8	64.370	20.618	7,149.2	1,732.0	21.8	0.2
20110717	180156.9	62.166	17.810	6,896.4	1,604.3	20.1	0.1
20110717	220850.4	64.231	20.988	7,135.1	1,751.1	30.1	0.3
20110718	101337.7	56.527	13.102	6,269.9	1,333.5	22.6	0.3
20110719	162514.3	59.365	15.580	6,582.7	1,487.0	19.9	0.4
20110720	000816.7	62.825	18.362	6,970.8	1,630.1	3.4	1.7
20110720	001319.9	62.835	18.356	6,971.9	1,629.8	6.2	0.7
20110720	195730.2	62.982	18.482	6,988.5	1,635.5	3.0	0.5
20110721	005915.4	60.912	11.516	6,762.6	1,267.2	17.5	2.9
20110721	071627.2	65.420	20.979	7,267.3	1,739.9	25.8	-0.0
20110721	124605.0	55.959	13.131	6,206.6	1,332.8	23.1	0.0
20110722	095454.3	58.194	14.905	6,452.6	1,446.9	24.7	0.1
20110722	102421.9	63.203	19.157	7,014.6	1,668.4	9.4	0.1
20110722	102717.3	63.242	19.107	7,018.9	1,665.7	9.1	0.0
20110723	162654.7	67.690	20.101	7,516.8	1,681.8	4.4	-0.3
20110725	011110.4	62.678	18.224	6,954.1	1,623.7	2.8	-0.4
20110725	025804.2	67.393	18.759	7,480.4	1,626.6	5.2	1.0
20110725	103004.8	63.995	20.843	7,108.3	1,746.2	19.6	-0.2
20110725	181822.8	65.134	20.761	7,234.6	1,732.3	13.5	0.5
20110728	214159.7	64.136	22.010	7,128.9	1,801.6	15.5	0.4
20110729	185216.1	63.703	21.034	7,076.6	1,758.1	17.5	0.1
20110730	162149.2	61.336	16.001	6,802.2	1,510.3	7.3	-0.1
20110731	060908.6	67.417	22.182	7,494.1	1,772.8	5.5	-0.8
20110731	224848.3	67.845	20.734	7,536.0	1,707.2	19.2	-0.3

3.2 August

An event list for August 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 August 42 events were located whereof one with a magnitude of $M_L = 2.4$, located 13 km north of Laimoluokta, 66 km north of Kiruna. One earthquake with magnitude $M_L = 2.3$ was located in Finland 125 km north of Pajala. One earthquake with magnitude $M_L = 2.1$ was located in the North Sea offshore Denmark. Additional 6 events had magnitudes equal to or above $M_L = 1.0$. The depth range of the events varies between 3.4 and 37.6 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M_L Local Magnitude
20110801	182625.8	68.029	19.430	7,552.8	1,651.2	10.0	-0.8
20110803	053704.5	59.156	13.248	6,562.2	1,353.6	22.9	1.3
20110803	071246.5	64.923	21.041	7,212.3	1,747.3	18.2	-0.1
20110803	081326.5	63.830	21.308	7,091.8	1,770.5	17.6	0.0
20110803	194231.0	65.909	22.635	7,328.8	1,810.5	3.7	0.2
20110803	202316.3	68.443	19.899	7,600.1	1,667.7	16.8	2.4
20110803	203343.8	68.259	24.411	7,598.7	1,854.8	17.9	2.3
20110803	223742.2	61.920	17.576	6,868.5	1,592.9	19.1	-0.4
20110805	030232.0	64.104	20.036	7,117.5	1,705.9	17.2	0.3
20110806	073723.6	55.714	13.061	6,179.5	1,327.4	19.8	0.4
20110806	114054.1	60.121	16.572	6,667.1	1,542.5	19.8	0.1
20110809	065027.9	61.549	15.740	6,826.0	1,496.3	7.3	-0.5
20110809	213357.1	65.228	20.845	7,245.4	1,735.4	21.1	0.4
20110810	034429.8	65.281	22.752	7,259.7	1,823.6	13.8	1.3
20110810	042152.1	64.509	20.976	7,165.9	1,748.0	17.9	0.0
20110811	001201.8	59.383	12.528	6,589.2	1,313.6	6.2	0.9
20110811	104700.5	66.716	22.761	7,419.0	1,806.3	10.8	-0.9
20110812	082726.5	64.374	20.863	7,150.5	1,743.8	17.1	0.1
20110812	175320.5	67.360	22.125	7,487.5	1,771.1	3.6	-0.8
20110813	082206.6	62.593	17.452	6,943.3	1,584.4	24.3	0.7
20110813	112234.8	61.497	18.070	6,822.3	1,620.4	18.1	0.1
20110813	121649.2	57.671	14.888	6,394.3	1,445.1	19.7	0.3
20110814	085119.0	62.617	17.883	6,946.7	1,606.5	9.9	0.2
20110815	224407.7	64.123	19.534	7,118.1	1,681.4	36.9	0.6
20110816	035324.7	64.514	20.435	7,164.5	1,722.1	18.6	1.4
20110818	104539.2	66.668	21.709	7,408.9	1,760.5	16.4	-0.0
20110818	232257.8	62.606	17.867	6,945.4	1,605.7	9.7	0.3
20110819	171739.6	57.080	7.368	6,359.9	989.0	37.6	2.1
20110819	211713.5	62.866	18.478	6,975.5	1,635.9	3.4	1.6
20110821	020201.1	65.588	24.188	7,301.9	1,885.7	17.0	0.8
20110821	103956.5	64.482	21.261	7,164.1	1,761.9	20.5	-0.3
20110821	160803.7	56.324	13.536	6,246.4	1,359.4	19.7	0.5
20110822	173758.6	66.399	19.395	7,371.2	1,660.2	17.1	1.7
20110822	200828.3	64.372	20.741	7,149.8	1,737.9	18.5	0.1
20110823	084944.7	61.680	16.501	6,840.7	1,536.7	4.3	0.3
20110824	131237.8	59.831	15.937	6,634.6	1,507.2	17.3	1.0
20110825	220339.9	64.468	21.325	7,162.8	1,765.1	5.7	-0.9
20110826	024526.8	68.276	19.920	7,581.5	1,669.8	23.7	-0.6
20110827	181731.6	67.948	19.725	7,544.4	1,664.1	4.8	-0.9
20110828	093559.0	65.221	21.744	7,248.3	1,777.4	21.3	0.1
20110829	220605.2	64.008	18.367	7,102.5	1,625.1	17.6	0.8
20110831	185015.3	67.894	19.964	7,539.1	1,674.4	24.5	-0.5

3.3 September

An event list for September 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 September 45 events were located whereof two had magnitudes of $M_L = 1.9$, one was located 20 km NW of Skellefteå and one was located 49 km west of Pajala. One earthquake with a magnitude of $M_L = 1.8$ was located 3 km south of Kiruna. Additional four earthquakes had magnitudes equal to or above $M_L = 1.0$. The depth range of the events varies between 0.1 and 30.4 km.

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

Date	Time (UTC)	Latitude	Longitude	X RT90 Km	Y RT90 Km	Depth Km	M_L Local Magnitude
20110901	003738.9	58.556	13.972	6,494.0	1,393.1	24.9	1.6
20110901	030936.3	67.857	22.564	7,544.6	1,783.8	12.5	0.4
20110901	041117.4	67.790	19.567	7,526.4	1,658.5	10.3	-0.6
20110901	132623.8	65.760	22.467	7,311.5	1,804.7	7.4	0.5
20110901	223621.0	64.898	20.819	7,208.6	1,737.1	2.4	1.9
20110901	231740.8	64.436	20.959	7,157.8	1,747.9	16.2	-0.1
20110902	154057.9	60.877	17.124	6,751.8	1,571.5	17.7	0.3
20110902	183336.6	64.501	20.766	7,164.3	1,738.0	18.9	0.2
20110904	113517.6	64.031	18.733	7,105.8	1,642.9	20.9	-0.2
20110904	162358.2	64.402	20.818	7,153.4	1,741.4	18.6	-0.5
20110905	135653.3	64.480	20.999	7,162.9	1,749.4	0.1	-0.1
20110905	214501.3	60.382	15.637	6,695.9	1,490.6	2.5	0.3
20110907	210706.9	67.344	18.932	7,475.3	1,634.3	15.5	0.4
20110908	050723.5	67.570	19.445	7,501.6	1,654.8	20.2	0.2
20110908	134519.1	67.736	19.480	7,520.3	1,655.2	5.3	-0.6
20110909	050656.9	67.749	19.520	7,521.8	1,656.8	8.3	0.4
20110910	153950.8	58.752	15.031	6,514.7	1,455.0	24.3	0.1
20110910	175222.0	64.338	20.835	7,146.4	1,742.8	26.0	0.6
20110910	221435.6	64.226	21.501	7,136.6	1,776.0	15.0	-0.7
20110910	222452.0	64.380	20.773	7,150.8	1,739.4	19.0	0.1
20110911	180156.3	64.152	20.617	7,124.9	1,733.8	6.2	0.0
20110914	112832.7	67.290	22.215	7,480.2	1,775.7	1.1	1.9
20110915	081905.0	67.909	19.564	7,539.7	1,657.6	4.1	-0.6
20110915	103516.5	62.428	16.911	6,924.3	1,557.0	8.7	-0.5
20110916	153824.6	64.395	20.953	7,153.2	1,748.0	20.7	-0.4
20110917	171625.8	56.399	11.815	6,259.5	1,253.6	24.0	0.8
20110917	173032.4	62.259	17.822	6,906.7	1,604.6	16.7	-0.2
20110918	002409.0	64.863	20.386	7,203.2	1,716.9	2.8	1.5
20110919	085312.4	64.621	21.189	7,179.2	1,757.2	5.7	-0.8
20110919	195857.6	64.496	21.000	7,164.6	1,749.3	19.6	0.1
20110920	163548.6	57.236	10.447	6,358.2	1,176.5	15.4	1.6
20110921	115529.3	65.858	22.404	7,322.0	1,800.7	20.7	0.9
20110921	223744.0	62.017	16.651	6,878.3	1,544.1	4.4	-0.0
20110922	111334.5	61.893	17.232	6,865.1	1,574.8	1.1	0.1
20110922	200415.0	62.095	16.324	6,886.9	1,526.9	18.3	0.9
20110922	224623.3	67.466	22.703	7,501.9	1,794.4	16.8	-0.8
20110927	214545.4	67.835	20.209	7,533.3	1,685.2	0.1	1.8
20110928	015334.0	59.619	13.414	6,613.4	1,364.9	19.1	0.4
20110928	092919.4	63.379	17.933	7,031.6	1,606.2	28.4	1.3
20110928	110136.8	64.420	20.624	7,154.7	1,731.9	19.6	0.5
20110928	134520.6	61.847	16.782	6,859.6	1,551.3	17.6	0.0
20110929	083155.3	62.556	16.642	6,938.5	1,542.9	30.4	0.3
20110930	020329.5	66.408	22.174	7,382.0	1,784.0	10.5	0.1
20110930	073809.5	66.810	22.529	7,428.3	1,794.9	13.1	0.4
20110930	135629.0	63.587	21.126	7,064.1	1,763.8	10.7	0.7