

Swedish National Seismic Network (SNSN)

A short report on recorded earthquakes during the second quarter of the year 2010

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July 2010

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

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A pdf version of this document can be downloaded from 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 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 2010.

The Swedish National Seismic Network consists of 61 stations. During April through June, 2,108 events were located whereof 159 are estimated as real earthquakes, 1,347 are estimated as explosions, 396 are induced earthquakes in the vicinity of the mines in Kiruna and Malmberget and 206 events are still considered as uncertain but these are most likely explosions and are mainly located outside the network.

An earthquake with magnitude $M_L=3.5$ was located 31 km SE of Skellefteå in June. One foreshock with magnitude $M_L=0.3$ and 10 aftershocks with magnitudes between $M_L=-0.1$ and $M_L=0.7$ were located. Additional 6 earthquakes had magnitudes above $M_L=2.0$ whereof three were located in Norway and one in Finland. In April one earthquake with magnitude $M_L=2.0$ was located 55 km north of Kiruna. In June an earthquake with magnitude $M_L=2.3$ was located 14 km east of Örnsköldsvik.

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 2010.

Det seismiska nätet består av 61 stationer. Under perioden april till juni, 2010 var det 2108 registrerade händelser varav 159 bedömdes som äkta jordskalv, 1347 bedömdes vara förorsakade av explosioner eller sprängningar, 396 var inducerade skalv i närheten av gruvorna i Kiruna och Malmberget och 206 var osäkra händelser, men dessa var i huvudsak lokaliserade utanför det seismiska nätet och är sannolikt förorsakade av explosioner.

Ett jordskalv med magnitud $M_L=3.5$ inträffade 31 km sydost om Skellefteå. Ett förskalv med magnitud $M_L=0.3$ och 10 efterskalv med magnituder mellan $M_L=-0.1$ och $M_L=0.7$ lokaliserades. Ytterligare 6 jordskalv hade magnitud över $M_L=2.0$ där tre lokaliserades i Norge och ett i Finland. I april inträffade ett skalv med magnitud $M_L=2.0$, 55 km norr om Kiruna. I juni lokaliserades ett skalv 14 km öster om Örnsköldsvik med magnitud på $M_L=2.3$.

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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 2010. 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 61 stations are in operation in the network, Figure 1-1.

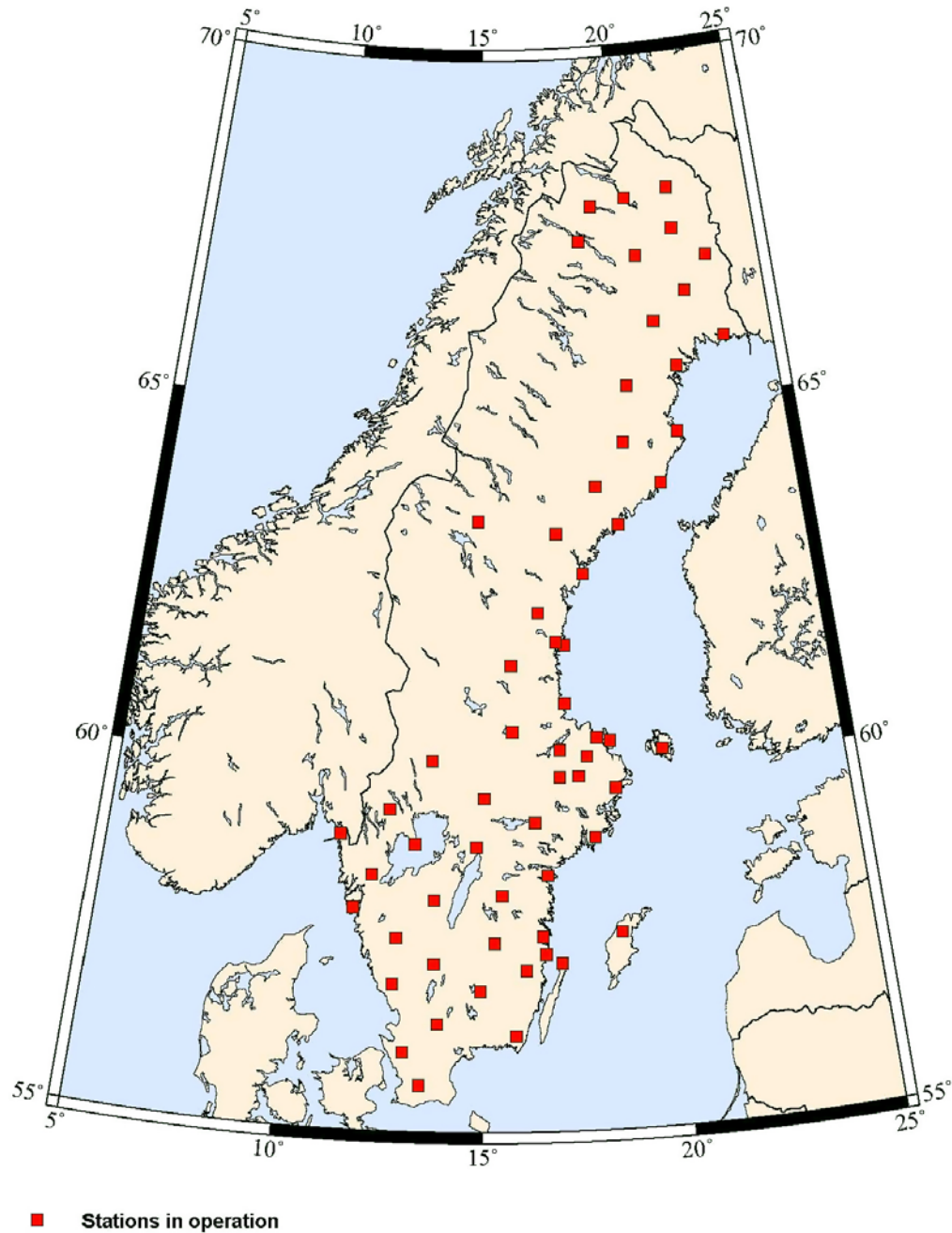


Figure 1-1. The present Swedish National Seismic Network (SNSN).

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

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 magnitude 0.0 near the proposed nuclear waste deposit site in Forsmark.

3 Recorded earthquakes during the second quarter of 2010

Figure 3-1 shows the recorded events in Sweden during April through June. During the period 2,108 events were located whereof 159 are estimated as real earthquakes (which are shown in Figure 3-2). 1,347 are estimated as explosions and 206 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 396 events in the very vicinity of the mines have been excluded in the report.

Event lists for April through June 2010 are given in sections 3.1 through 3.3.

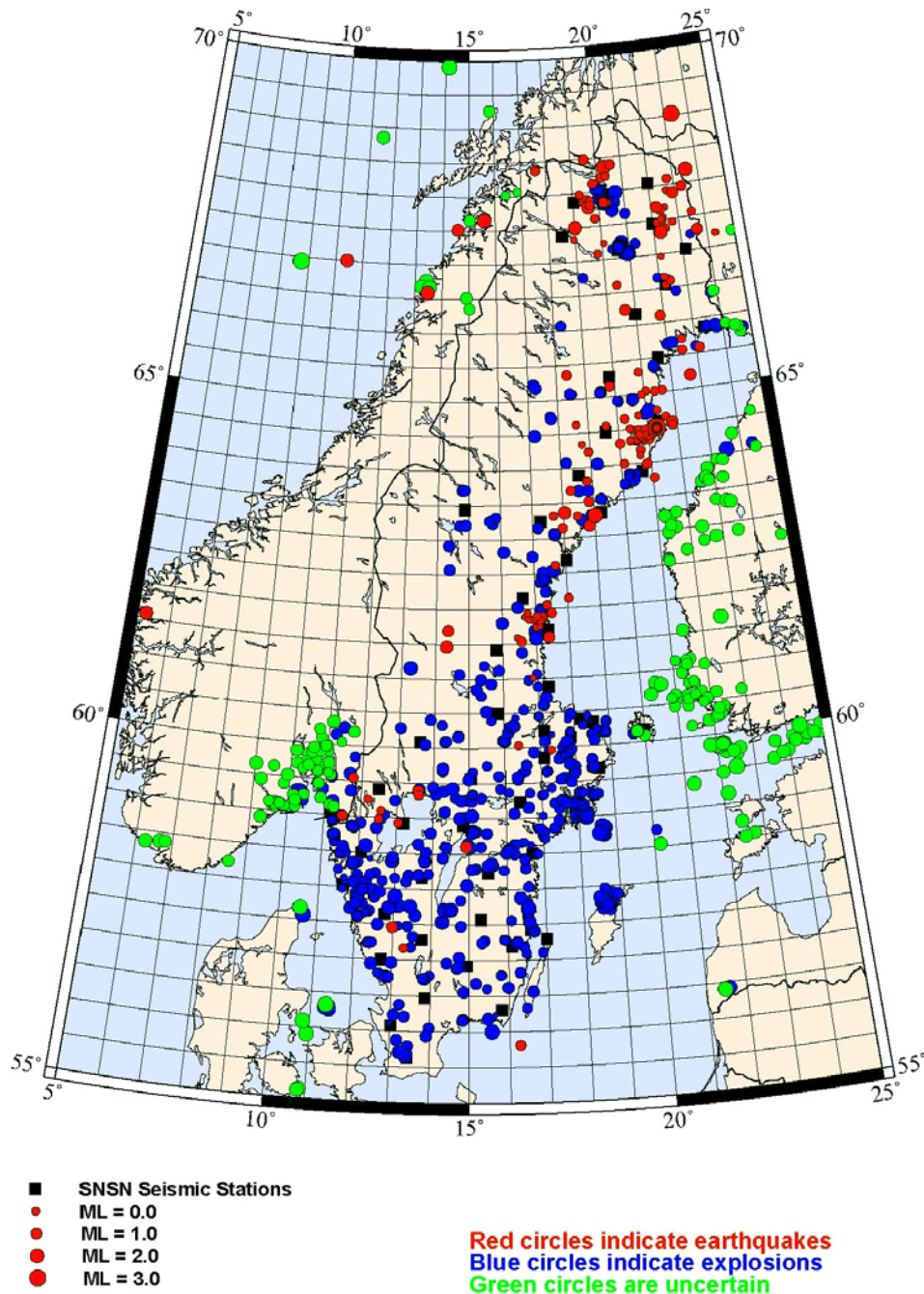


Figure 3-1. Recorded events including explosions in the SNSN network during the period April through June 2010.

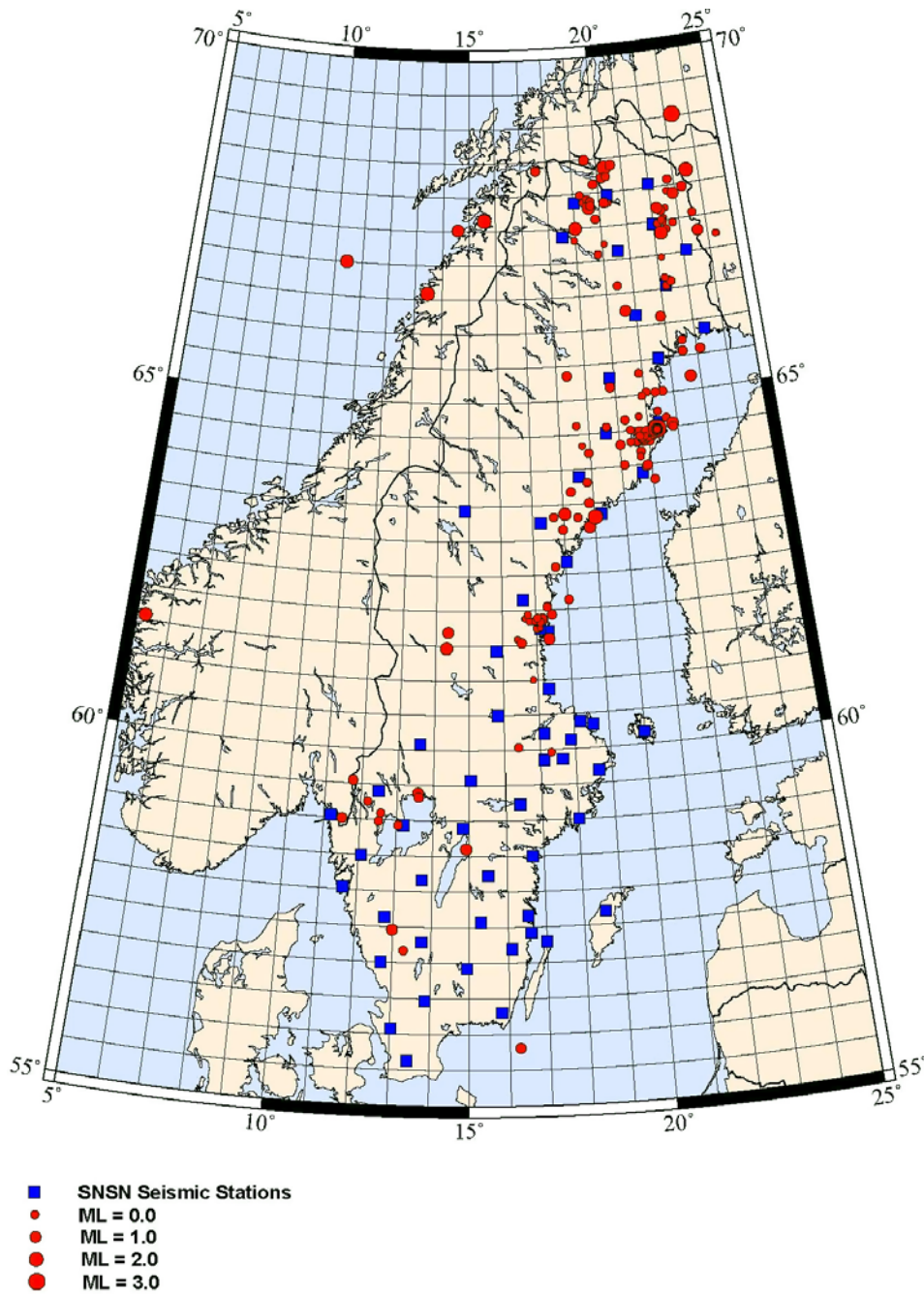


Figure 3-2. Earthquake activity in Sweden during April through June 2010.

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 39 events were located whereof one had a magnitude of $M_L=2.9$ located in Norway, 180 km NE of Kiruna. One earthquake with a magnitude of $M_L=2.0$ was located 55 km north of Kiruna. Additional 3 earthquakes had magnitudes between $M_L=1.1$ and $M_L=1.8$. The depth range of the events varies between 0.1 and 36.4 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
20100403	004303.6	65.035	21.061	7,224.8	1,747.2	3.0	0.1
20100403	121158.1	61.869	17.197	6,862.4	1,573.1	8.2	1.1
20100404	041035.1	64.580	19.594	7,169.2	1,681.3	26.0	0.1
20100404	043251.6	64.627	18.593	7,171.9	1,633.1	28.5	-0.2
20100405	042435.1	64.693	20.720	7,185.5	1,734.2	26.8	-0.3
20100405	164042.9	67.672	22.522	7,523.9	1,784.3	3.0	-0.5
20100407	222710.2	61.588	16.428	6,830.5	1,532.9	3.0	-0.4
20100408	004713.1	61.584	17.381	6,830.9	1,583.5	25.5	1.2
20100408	211051.8	67.978	19.268	7,546.7	1,644.7	5.6	-0.2
20100408	223023.8	57.167	13.287	6,340.7	1,347.5	18.9	0.2
20100409	122946.6	67.242	20.062	7,466.8	1,683.5	6.4	-0.7
20100410	071351.9	68.352	20.318	7,591.1	1,685.6	2.2	2.0
20100410	123401.9	67.866	19.394	7,534.6	1,650.7	5.2	0.1
20100410	213140.5	68.086	22.753	7,571.0	1,788.8	8.9	0.2
20100411	070212.6	61.888	16.701	6,864.1	1,546.9	16.7	-0.3
20100413	013413.9	67.495	19.016	7,492.3	1,637.0	10.1	1.8
20100414	033119.4	64.341	20.814	7,146.6	1,741.7	18.1	0.5
20100415	065007.9	64.310	20.021	7,140.4	1,703.7	3.0	0.4
20100417	082849.7	64.482	20.584	7,161.5	1,729.5	21.3	-0.2
20100418	014819.3	63.774	21.053	7,084.6	1,758.4	7.7	0.2
20100418	015823.1	67.321	18.951	7,472.7	1,635.2	7.7	-0.4
20100418	022059.2	68.205	20.177	7,574.3	1,681.0	0.1	0.5
20100418	214631.7	66.613	20.415	7,398.0	1,704.0	4.2	0.1
20100420	002813.8	65.153	19.832	7,233.7	1,688.6	21.3	0.6
20100422	123303.6	66.541	22.207	7,397.0	1,783.9	13.7	-0.1
20100423	011405.8	66.963	22.160	7,443.6	1,777.1	36.4	-0.6
20100423	013850.2	63.961	20.802	7,104.3	1,744.5	19.6	-0.1
20100423	050922.7	64.335	21.007	7,146.7	1,751.1	21.8	0.5
20100424	034738.6	61.850	16.820	6,859.9	1,553.3	3.7	-0.2
20100424	100702.4	64.325	20.797	7,144.8	1,741.1	29.2	-0.0
20100425	131715.0	64.639	21.642	7,183.1	1,778.6	8.9	0.0
20100426	233621.5	64.440	21.363	7,159.8	1,767.2	20.3	-0.2
20100427	211159.7	63.307	18.460	7,024.6	1,632.9	17.3	0.2
20100428	031638.1	69.027	23.300	7,677.9	1,798.7	0.1	2.9
20100428	115559.4	63.985	20.868	7,107.3	1,747.5	0.7	0.5
20100428	202900.5	65.027	21.615	7,226.1	1,773.3	16.6	0.4
20100429	062621.9	63.801	18.830	7,080.5	1,648.9	31.0	0.2
20100430	012825.7	61.935	17.497	6,870.2	1,588.6	4.8	0.4
20100430	161100.0	64.331	20.585	7,144.7	1,730.8	3.0	0.4

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 60 events were located by the network whereof three with magnitudes of $M_L=2.0$. One was located in Finland, 108 km north of Pajala and two of them were located in Norway, 198 km west of Kiruna and the other 205 km west of Arjeplog. One earthquake with a magnitude of $M_L=1.6$ was located 25 km south of Skellefteå. Additional 14 events had magnitudes equal or above $M_L=1.0$. The depth range of the events varies between 0.1 and 31.9 km.

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 60 events were located whereof one had a magnitude of $M_L=3.5$ located 31 km SE of Skellefteå. One foreshock with magnitude $M_L=0.3$ and 10 aftershocks with magnitudes between $M_L=-0.1$ and $M_L=0.7$ were located. One earthquake with magnitude $M_L=2.3$ was located 14 km east of Örnsköldsvik. Additional 7 earthquakes had magnitudes equal to or above $M_L=1.0$. The depth range of the events varies between 0.1 and 28.7 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
20100501	013845.6	67.834	20.350	7,533.6	1,691.1	19.6	-0.4
20100501	075031.1	64.335	20.575	7,145.1	1,730.3	12.3	0.0
20100502	013704.3	63.366	18.046	7,030.4	1,611.9	6.7	1.6
20100502	073145.7	64.016	20.104	7,108.0	1,709.9	4.3	0.2
20100503	133733.1	67.452	22.753	7,500.7	1,796.7	19.8	-0.1
20100504	004517.5	67.917	22.674	7,551.8	1,787.6	18.9	-0.3
20100504	071223.6	68.367	17.588	7,587.0	1,573.2	8.6	0.6
20100505	141945.6	64.387	20.810	7,151.8	1,741.1	8.8	1.4
20100506	212043.7	64.544	21.838	7,173.4	1,788.9	9.3	1.4
20100507	172622.2	61.742	17.034	6,848.1	1,564.8	7.4	0.1
20100507	175408.0	61.569	05.248	6,873.7	0,940.7	0.1	1.8
20100509	003205.9	61.939	16.762	6,869.7	1,550.1	3.9	-0.3
20100509	152130.5	68.224	20.358	7,577.1	1,688.3	19.6	0.1
20100510	021604.0	62.064	17.375	6,884.4	1,581.9	17.3	-0.1
20100510	044007.7	66.626	22.328	7,406.9	1,788.3	2.4	-0.4
20100510	044019.5	66.636	22.295	7,407.9	1,786.7	1.2	-0.3
20100510	084131.4	66.602	22.399	7,404.6	1,791.7	3.8	0.1
20100510	084313.1	67.701	22.248	7,525.9	1,772.4	21.0	-0.4
20100510	124341.5	64.511	20.391	7,164.1	1,720.0	12.1	-0.1
20100510	181903.4	68.187	23.537	7,586.0	1,819.9	3.2	2.0
20100511	020047.9	65.354	18.364	7,252.5	1,618.9	18.2	0.5
20100511	021351.8	67.954	23.276	7,558.9	1,812.2	14.2	0.6
20100512	002500.0	67.528	22.418	7,507.5	1,781.6	8.0	-0.4
20100513	012046.7	67.097	19.800	7,450.0	1,673.3	16.9	-0.1
20100514	104258.9	67.912	19.540	7,540.0	1,656.6	8.6	-0.0
20100514	195107.2	68.124	19.821	7,564.4	1,666.8	5.0	0.4
20100514	202842.4	65.579	23.108	7,294.6	1,836.3	4.8	0.5
20100515	142237.2	67.463	22.172	7,499.2	1,771.9	0.7	-0.2
20100516	113446.3	67.611	19.813	7,507.2	1,670.2	18.3	0.2
20100516	134125.1	67.368	22.467	7,489.9	1,785.6	2.7	-0.1
20100516	234858.4	63.141	17.961	7,005.2	1,608.5	13.2	0.4
20100517	221657.2	65.200	22.658	7,250.3	1,820.2	2.8	1.3
20100518	015326.3	59.388	13.571	6,587.4	1,372.9	1.6	1.1
20100518	204539.6	64.538	21.214	7,170.1	1,759.1	17.1	1.2
20100519	055337.2	61.693	14.365	6,842.8	1,423.6	3.8	1.1
20100519	064150.5	66.664	22.185	7,410.5	1,781.5	4.5	-0.3
20100519	074916.3	67.702	22.239	7,526.0	1,772.0	16.2	-0.7
20100520	091105.0	64.478	20.707	7,161.4	1,735.4	27.1	0.6
20100521	104331.5	61.464	14.323	6,817.4	1,420.8	2.6	1.6
20100521	234625.4	67.290	23.645	7,487.2	1,837.0	11.3	1.1
20100523	201438.2	67.518	14.566	7,491.8	1,447.0	20.2	1.4
20100524	210502.1	67.653	15.563	7,506.3	1,489.6	0.1	2.0
20100526	030057.7	64.405	20.996	7,154.5	1,749.9	24.8	1.0
20100526	090157.7	66.107	21.859	7,347.2	1,773.2	2.4	0.7
20100526	120701.8	58.603	14.915	6,498.1	1,448.1	3	1.2
20100527	092457.9	64.189	20.691	7,129.2	1,737.1	2.9	0.3
20100527	225922.3	64.987	20.896	7,218.8	1,739.9	17.9	-0.1
20100528	203250.0	61.010	16.867	6,766.4	1,557.3	0.1	-0.6
20100529	014706.5	67.478	22.386	7,501.8	1,780.8	3.0	-0.1
20100529	030209.4	67.787	19.584	7,526.2	1,659.2	1.1	1.8
20100530	043410.7	64.742	21.371	7,193.4	1,764.7	6.3	-0.1
20100530	050741.7	68.490	19.543	7,604.3	1,652.8	13.9	0.8
20100530	053212.0	59.962	17.314	6,650.1	1,584.1	1.1	-0.2
20100530	060020.7	67.005	10.425	7,444.3	1,265.5	0.1	1.7
20100530	082939.1	65.572	22.484	7,290.6	1,807.7	2.4	0.4
20100530	092217.0	64.501	21.846	7,168.7	1,789.8	23.0	0.2
20100530	110952.3	59.096	12.560	6,557.2	1,313.9	31.9	0.1
20100530	113644.8	64.398	21.170	7,154.4	1,758.3	10.7	-0.4
20100530	160619.9	59.253	12.185	6,575.8	1,293.4	19.4	0.1
20100531	062319.4	66.593	13.467	7,390.1	1,396.2	0.1	2.0

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
20100601	192930.7	62.137	18.036	6,893.5	1,616.2	19.2	0.2
20100601	214142.4	64.471	20.940	7,161.6	1,746.7	7.9	0.7
20100603	035054.8	58.933	13.047	6,537.9	1,341.0	18.4	0.2
20100603	043000.7	61.879	17.186	6,863.5	1,572.5	4.2	0.5
20100603	192152.1	58.979	12.510	6,544.3	1,310.4	18.6	0.3
20100604	053533.3	67.844	20.185	7,534.2	1,684.1	1.3	0.5
20100604	131559.2	67.878	19.660	7,536.5	1,661.8	1.4	0.0
20100604	132402.3	62.611	17.670	6,945.7	1,595.6	3.0	0.2
20100606	135221.0	64.663	20.246	7,180.4	1,711.8	5.3	0.2
20100610	010954.1	63.325	17.683	7,025.2	1,593.9	12.0	0.3
20100610	160017.8	61.844	16.990	6,859.4	1,562.2	20.7	0.1
20100610	222653.0	63.161	18.822	7,009.1	1,651.8	6.0	1.2
20100611	065648.6	65.732	22.512	7,308.6	1,807.0	15.1	0.2
20100611	132655.3	65.021	21.366	7,224.4	1,761.7	26.1	0.2
20100611	182005.3	67.871	22.904	7,547.8	1,797.8	0.1	1.1
20100612	094433.8	61.849	16.986	6,860.0	1,562.0	1.6	-0.2
20100613	134540.0	64.379	20.770	7,150.7	1,739.3	25.4	-0.2
20100614	112224.4	65.319	20.871	7,255.6	1,735.8	22.2	0.1
20100614	182143.8	61.745	17.130	6,848.6	1,569.8	5.9	-0.8
20100615	202812.4	64.492	21.304	7,165.4	1,763.9	25.1	0.3
20100615	203051.0	64.493	21.298	7,165.5	1,763.6	24.8	3.5
20100615	203639.7	64.465	21.284	7,162.3	1,763.2	18.5	0.7
20100615	205944.3	64.494	21.300	7,165.6	1,763.7	25.0	0.1
20100615	211214.7	64.491	21.283	7,165.1	1,762.9	23.7	1.0
20100615	211932.7	64.499	21.344	7,166.4	1,765.8	26.6	-0.1
20100615	215934.5	64.482	21.309	7,164.2	1,764.2	25.3	-0.0
20100615	222640.2	64.495	21.311	7,165.8	1,764.2	24.6	0.0
20100615	233904.8	64.488	21.317	7,165.0	1,764.5	24.8	-0.0
20100616	015432.4	64.492	21.303	7,165.3	1,763.9	25.4	0.4
20100616	044702.0	64.493	21.307	7,165.5	1,764.1	24.6	0.1
20100616	050740.1	64.483	21.308	7,164.4	1,764.2	23.9	0.2
20100616	074704.1	59.545	11.752	6,609.7	1,270.7	18.7	0.5
20100616	101907.5	57.456	12.981	6,373.6	1,330.3	12.1	1.1
20100616	113700.7	64.335	20.369	7,144.3	1,720.3	19.1	-0.1
20100618	144352.4	64.225	18.948	7,128.0	1,652.3	18.1	0.2
20100619	041433.9	67.817	19.645	7,529.6	1,661.6	1.8	0.2
20100619	060157.5	61.829	17.132	6,857.9	1,569.7	0.1	-0.2
20100619	233747.6	63.301	19.024	7,025.2	1,661.2	2.3	2.3
20100620	132325.7	61.892	17.044	6,864.8	1,565.0	23.5	-0.2
20100621	125840.3	64.476	21.295	7,163.5	1,763.6	20.6	-0.3
20100621	173916.1	68.389	20.571	7,596.0	1,695.7	9.8	0.5
20100622	040401.3	67.206	24.298	7,481.6	1,866.2	16.9	-0.5
20100622	062716.0	67.502	22.330	7,504.2	1,778.1	5.3	-0.3
20100624	133146.3	59.329	13.598	6,580.7	1,374.2	13.5	0.5
20100624	162442.9	67.646	22.333	7,520.2	1,776.6	3.0	0.5
20100625	091257.5	60.039	16.386	6,657.8	1,532.2	5.1	0.0
20100625	155934.2	55.808	16.264	6,186.6	1,528.6	8.0	0.7
20100625	161623.8	64.335	18.739	7,139.8	1,641.6	28.7	-0.5
20100626	021713.6	64.407	20.863	7,154.2	1,743.5	18.1	-0.5
20100626	090427.3	62.047	17.355	6,882.4	1,580.9	11.6	0.2
20100626	093951.2	67.319	22.253	7,483.5	1,777.0	5.9	1.7
20100627	100517.0	64.414	20.701	7,154.4	1,735.7	20.7	-0.2
20100627	193312.6	67.691	22.200	7,524.6	1,770.4	21.5	1.1
20100628	013215.7	64.116	20.659	7,121.0	1,736.2	16.7	-0.3
20100628	040708.0	59.002	11.503	6,550.2	1,252.7	15.8	0.8
20100629	071612.5	63.680	18.285	7,065.8	1,622.5	3.0	0.4
20100630	010334.1	66.240	20.620	7,357.1	1,716.2	8.4	1.0
20100630	033429.2	63.505	18.853	7,047.6	1,651.5	21.5	0.5
20100630	060322.1	61.535	16.555	6,824.7	1,539.7	13.2	0.5
20100630	130924.4	67.560	23.538	7,516.5	1,828.6	0.1	0.0