Data report

Seismicity in Iceland during 2001

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Abstract — *Over 14,000 earthquakes were located in 2001 by the SIL seismic system. During the first half of the year the majority of the located earthquakes were aftershocks of the magnitude 6.6 earthquakes of June 2000. The Mýrdalsjökull region was more seismically active than usual in the first half of the year and the Reykjanes ridge was fairly active in the latter half of the year. Many small earthquake swarms occurred as well, the two largest along the Tjörnes Fracture Zone, offshore northern Iceland. The larger of these swarms originated in Öxarfjörður with a total number of earthquakes greatly exceeding previous swarms in the area, recorded by the SIL system. Five stations were added to the SIL network and one station was dismantled. At the end of the year 42 seismic stations comprised the SIL network.*

INTRODUCTION

The SIL seismic system is a network of 3-component digital seismic stations and a data processing system (Jakobsdóttir *et al.*, 2002). In 1990 eight stations were installed in the South Iceland Lowlands. The number has since gradually increased to 42 in 2001 (Figure 1). The stations are concentrated along the seismic zones and rift zones through Iceland. Since its installment the system has recorded nearly 200,000 events (May, 2003). The density of the SIL network varies between areas, producing varying detection levels. In some areas, for example the Reykjanes peninsula and the South Iceland Lowlands, the detection threshold is about 0. In other areas, such as the highlands, the stations are more widely spaced and only earthquakes greater than 1.5 may be detected.

At the beginning of 2001, a total of 38 stations were operating within the SIL network (Figure 1). Three stations were installed late in the year 2000, but were not fully operational until 2001. These stations are; Vestmannaeyjar (ves), offshore southern Iceland, and Flatey (fla) and Brettingsstaðir (bre) in the north. Other stations added during the year were Grímsfjall (grf) on the Vatnajökull ice cap and Eystri Skógar (esk), southwest of the Mýrdalsjökull glacier. The Hafnarfjörður (haf) station in southwest Iceland was dismantled due to increasing traffic in the area. Thus a total of 42 stations comprised the SIL network at the end of the year 2001 (Figure 1).

TJÖRNES FRACTURE ZONE

The largest earthquake swarms in 2001 occurred within the Tjörnes Fracture Zone, offshore northern Iceland (Figures 1 and 2). The Tjörnes Fracture Zone is a transform fault zone connecting the rift zone in north Iceland with that of the Kolbeinsey Ridge. Most of the seismicity in north Iceland is associated with this zone (Rögnvaldssson *et al.*, 1998). In September and October 2001 an earthquake swarm occurred in Öxarfjörður with over 2000 earthquakes. This is the largest swarm that has been recorded in the Öxarfjörður area by the SIL system since it was expanded in 1994 to cover the northern rift zone (Figure 3). As the swarm progressed the seismicity migrated to the southwest.

In December another large swarm was located within the Tjörnes Fracture Zone, north of Eyjafjörður (Figures 1 and 2). Over 1200 earthquakes were located.

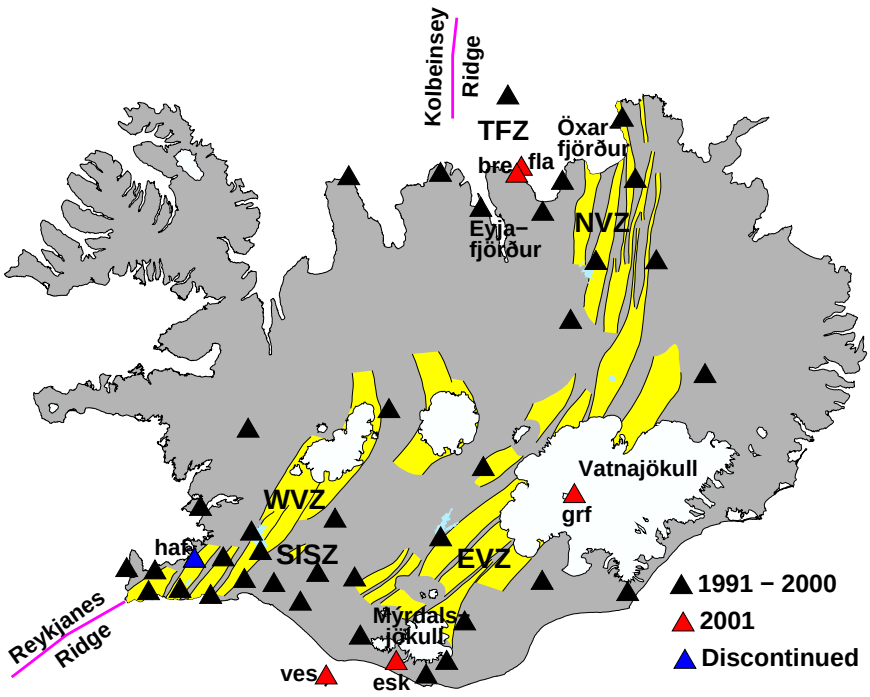

Figure 1. The map shows the SIL seismic station network. The main tectonic featues of Iceland are also shown: The Tjörnes Fracture Zone (TFZ), the Northern Volcanic Zone (NVZ), the Eastern Volcanic Zone (EVZ), the Western Volcanic Zone (WVZ) and the South Iceland Seismic Zone (SISZ). – *SIL jarðskjálftamælanetið ásamt gos- og brotabeltum landsins. Tjörnesbrotabeltið (TFZ), nyrðra gosbeltið (NVZ), eystra gosbeltið (EVZ), vestara gosbeltið (WVZ) og Suðurlandsbrotabeltið (SISZ).*

MÝRDALSJÖKULL

Seismic activity beneath the Mýrdalsjökull glacier is concentrated in two areas, within the Katla caldera and in the currently more active Goðabunga area, in the western part of the glacier. The seismicity under Goðabunga has followed a seasonal pattern during the last decades (Figure 4). The number of earthquakes in the latter half of the year is many times higher than in the first half. Two factors are likely involved, the decreased load of the ice and the increased pore pressure in the crust beneath the glacier. Einarsson and Brandsdóttir (2000) argued that the pore pressure is the more influential factor, causing fluctuations in the brittle crust beneath the glacier.

In July of 1999 a minor magmatic event (Einarsson, 2000) resulted in a small jökulhlaup in the river Jökulsá á Sólheimasandi, southwest of the Mýrdalsjökull glacier. A new cauldron was formed and other known cauldrons in the glacier increased in size (Guðmundsson *et al.*, 2000).

Changes have occurred in seismicity in the Goðabunga area over the last semesters. The activity in 2000 continued into the year 2001 and did not decrease until a few months later. The activity increased again in August but at the end of the year it continued with the same intensity the following months.

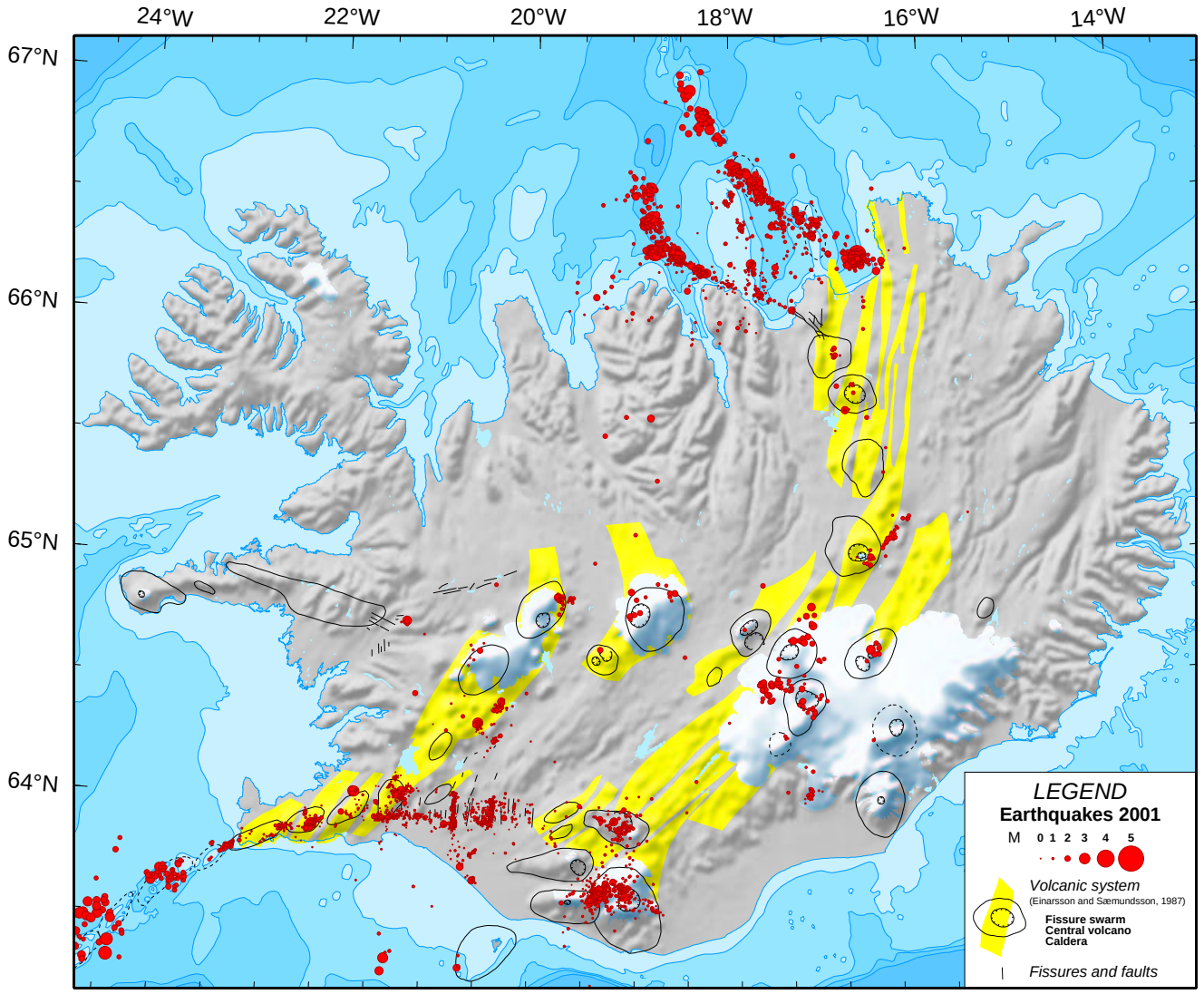

Figure 2. Earthquake epicenters (red dots) recorded by the SIL seismic system during 2001. – *Jarðskjálftar (rauðir punktar) mældir með SIL kerfinu árið 2001.*

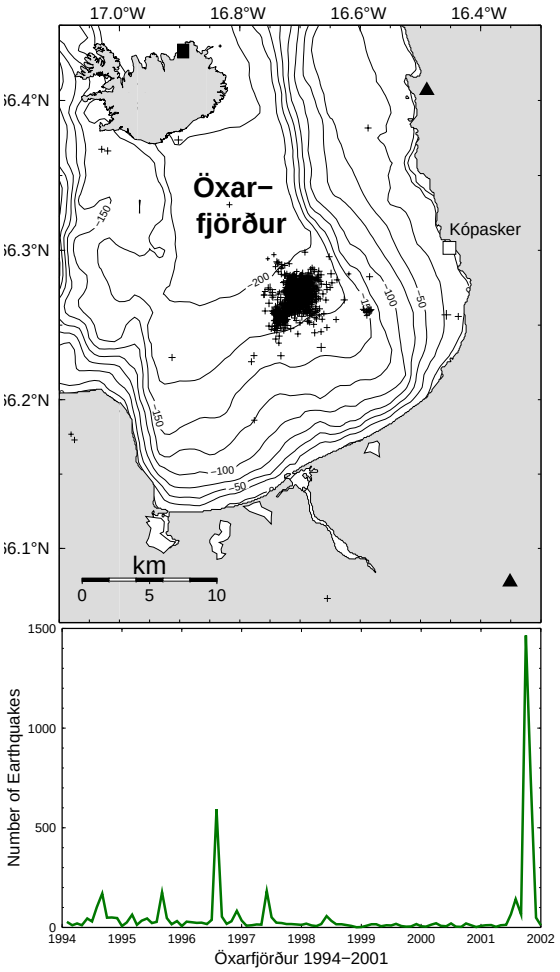

Figure 3. Earthquake epicenters in the Öxarfjörður region during September and October 2001 and number of earthquakes per month from 1994 to 2001. – *Staðsetningar jarðskjálfta í hrinu í Öxarfirði í september og október 2001. Neðri myndin sýnir mánaðarlegan fjölda jarðskjálfta frá 1994 til 2001.*

SOUTH ICELAND

A great number of small aftershocks was located in 2001 along the faults of the June 2000 earthquakes in the South Iceland Lowlands. Nearly 2000 aftershocks of the June 17 mainshock (M_s = 6.6) were located. Over 2500 aftershocks of the June 21 mainshock (M_s = 6.6) were located (Figure 5). Earthquake swarms were especially frequent along the fault of the June 21 mainshock. The majority of earthquakes was small with magnitudes less than 1. The activity has been gradually decreasing.

The Reykjanes ridge (Figures 1 and 2) was fairly active during the year. In the fall a few earthquake swarms were located 30 km off Reykjanes peninsula. In the last days of December around 30 earthquakes were located about 65 km off Reykjanes peninsula.

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ÁGRIP

Jarðskjálftavirkni á Íslandi árið 2001

Rúmlega 14.000 jarðskjálftar mældust árið 2001 með SIL jarðskjálftakerfi Veðurstofu Íslands. Stærstu jarðskjálftahrinurnar voru norðan við land, í Tjörnesbrotabeltinu. Fyrri hrinan hófst um miðjan september í Öxarfirðinum, þar sem yfir 2000 skjálftar voru staðsettir. Seinni hrinan var í desember fyrir mynni Eyjafjarðar og mældust þar rúmlega 1200 skjálftar. Mikið var um smáskjálfta, flestir innan við stærð 1, á sprungunum tveimur í Holtum og við Hestvatn, þar sem 17. og 21. júní 2000 stórskjálftarnir áttu upptök sín. Nærri 2000 eftirskjálftar mældust á Holtasprungunni og yfir 2500 á Hestvatnssprungunni. Smáskjálftahrinur voru tíðar, sérstaklega á Hestvatnssprungunni. Virkni á sprungunum fer hægt minnkandi.

Jarðskjálftavirkni undir Mýrdalsjökli var nokkur fyrstu mánuði ársins, en yfirleitt minnkar virknin þá. Um haustið jókst svo virkni aftur eins og vanalegt er,

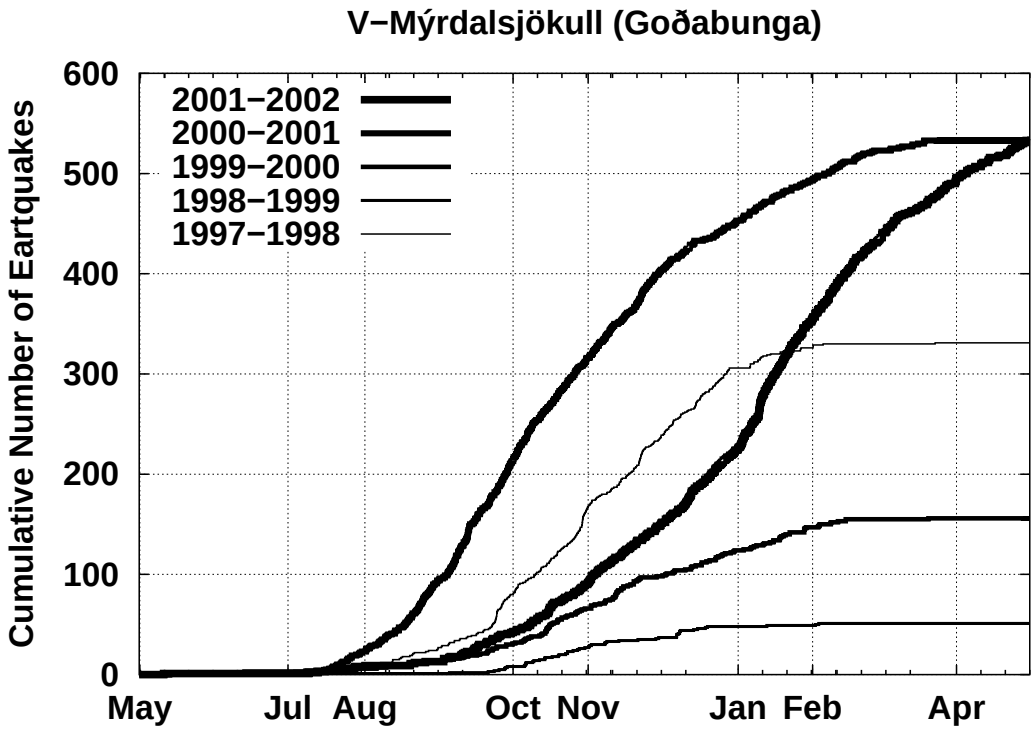

Figure 4. Cumulative number of M > 1.5 earthquakes beneath Goðabunga, western Mýrdalsjökull, from May to April in the years 1997 to 2002. – *Uppsafnaður fjöldi M > 1,5 jarðskjálfta undir vestanverðum Mýrdalsjökli, frá maí til apríl, 1997 til 2002.*

en í stað þess að minnka eða hætta um áramótin 2001–2002 hélt hún áfram af sama krafti næstu mánuði.

Nokkur virkni var á Reykjaneshrygg á árinu. Um haustið voru nokkrar smáhrinur við Geirfugladrang og síðustu daga desembermánaðar mældust um 30 jarðskjálftar við Eldeyjarboða.

Í byrjun árs 2001 voru 38 stöðvar í SIL netinu og uppsetning 3ja nýrra stöðva langt komin. Þessar stöðvar voru Vestmannaeyjar (ves) sem komst inn í netið um áramótin og tvær stöðvar við Skjálfanda, Flatey (fla) og Brettingsstaðir (bre) á Flateyjardal, sem fóru í gang í byrjun febrúar. Stöð á Grímsfjalli (grf) komst í gagnið í byrjun maí og ný stöð við Mýrdalsjökul, að Eystri Skógum (esk), var sett upp í október. Stöðin í Hafnarfirði (haf) var tekin niður vegna truflana, þar sem byggðin var komin að stöðinni. Í lok árs 2001 voru 42 stöðvar í SIL skjálftanetinu.

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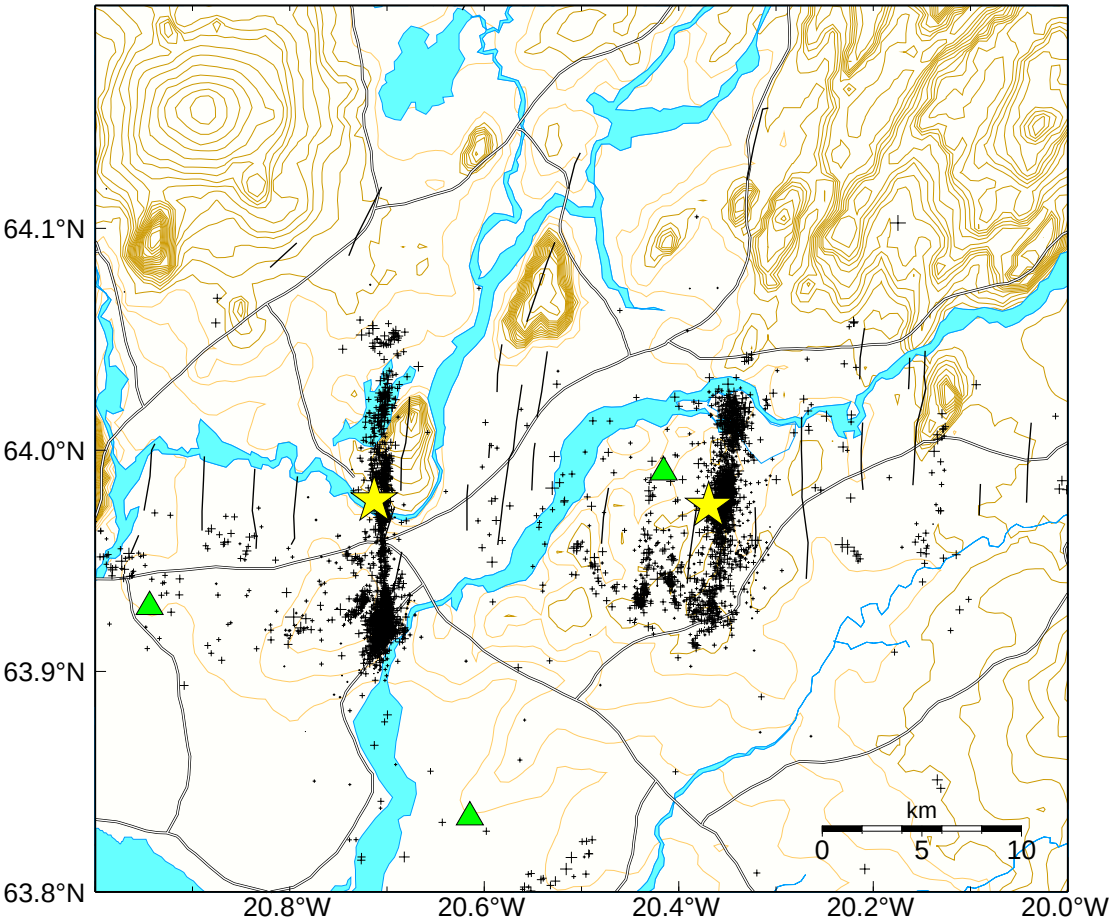

Figure 5. Earthquake epicenters, black crosses, in the area of the June 2000 mainshocks. The epicenters of the mainshocks are shown as yellow stars. The June 17 mainshock is east of the June 21 mainshock. SIL stations in the area are represented by green triangles. – *Jarðskjálftar, svartir krossar, á svæði aðalskjálftanna frá júní 2000, en staðsetning þeirra er sýnd með gulum stjörnum. SIL stöðvar eru táknaðar með grænum þríhyrningum.*

(map). *In* Þ. I. Sigfússon (editor), *Í hlutarins eðli*. Festschrift for Þorbjörn Sigurgeirsson, Menningarsjóður, Reykjavík.

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