Herðubreið 2006 – seismic project
Scientific report
Appendix: Station descriptions

Heidi Soosalu
Robert S. White

Bullard Laboratories
Department of Earth Sciences
University of Cambridge

September 2007

Herðubreið 2006 – seismic project

Abstract

Herðubreið area is located within the mid-Atlantic divergent plate boundary in north Iceland. The study area includes the subglacially formed mountains Herðubreið and Herðubreiðartögl and the volcanic system of Askja comprising a nested caldera volcano and a fissure swarm transecting it. A 10-km broad belt of persistent shallow seismicity occurs beneath Herðubreið and Herðubreiðartögl. As the stations of the permanent Icelandic seismic network are mainly tens of kilometres away from these mountains, a 20-station network of broadband Güralp 6TD seismometers was deployed and operated in the area during July–August 2006 in order to gather more detailed data on this activity. Also, an abundant dataset was gathered on a cluster of shallow seismicity in the SE part of the Askja volcano. A remarkable and unexpected discovery was the detection of lower-crustal seismicity, probably related to magma movements, within the Askja volcanic system and to the east of it. The recorded 47.3 GB dataset is excellent, with 97% recovery. Approximately 1800 local earthquakes were located, some 100 of which occurred in the lower crust at hitherto unknown depths of 15-25 km.

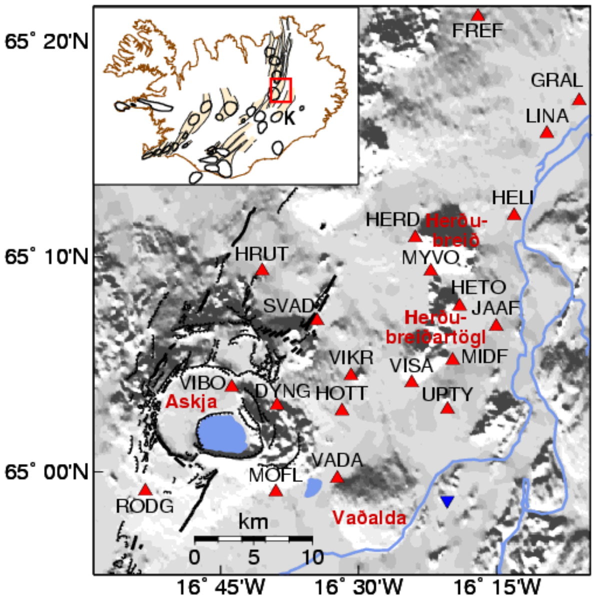

Figure 1. The location of the Herðubreið-Askja area in the Northern volcanic zone of Iceland. Red triangles are stations of the Herðubreið 2006 network and blue inverted triangles stations of the permanent seismic network run by the Icelandic Meteorological Office. Rivers and lakes are drawn in blue colour. The inset shows the neovolcanic zone of Iceland: the central volcanoes of the volcanic systems are circled and their fissure swarms shaded. K marks the volcanic system of Kverkfjöll.

Geological and seismic background

The mountains of Herðubreið and Herðubreiðartögl (see the upper cover photo) were formed as a result of subglacial eruptions during the last phases of the latest Ice Age. They are currently volcanically quiescent but are located between the active volcanic systems of Askja and Kverkfjöll at the north Iceland plate boundary (Fig. 1). Askja, which is included in the study area, is a prominent volcano massif with a nested caldera. The caldera lake of Askja was formed as a result of subsidence following a major eruption in 1875. The latest, minor eruption occurred in 1961. The extensive swarm of eruptive and tension fissures of Askja stretches to the NE and SW. Only a few such features can be found in the Herðubreið-Herðubreiðartögl area (Hjartardóttir, in prep.)

Despite the lack of surface features of faulting, the bedrock under Herðubreið and Herðubreiðartögl has long been known to be persistently seismically active, with earthquakes typically of magnitude < 3 (Einarsson 1991; IMO). The high level of seismicity and the fact that the permanent seismic stations maintained by the Icelandic Meteorological Office are mainly distant (i.e. several tens of kilometres away or more from the Herðubreið area), prompted us to carry out a pilot seismic study in August 2005. We deployed Güralp 6TD broadband sensors at five sites (DYNG, HELI, HERD, VIKR and UPTY, see Fig. 1) for three weeks, and detected over 200 earthquakes beneath and around Herðubreið during this short measuring period. This promising result convinced us that a more extensive survey would be worth conducting.

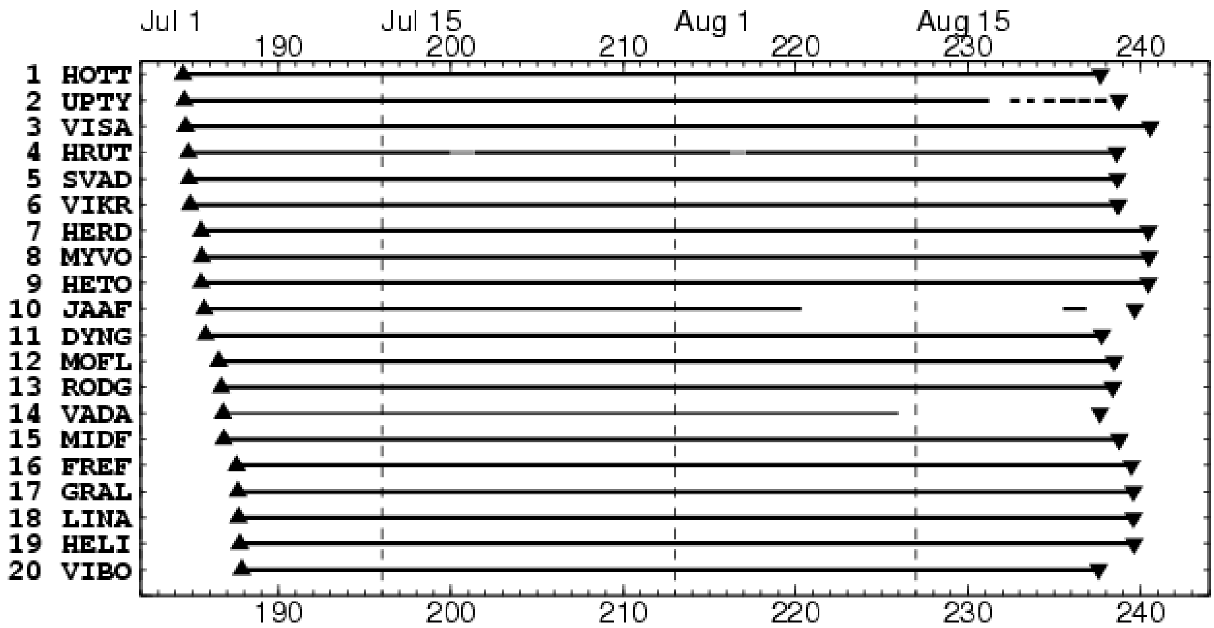

Figure 2. *The station operation chart. A triangle shows the installation time of a station and an inverted triangle the pick-up. Solid thick line shows the times when data were gathered at each station. Grey line shows times with patchy data (HRUT). Thinner line indicates data with a useless N component (VADA).*

The fieldwork during the Herðubreið 2006 seismic project

The field season is short in the northern Icelandic highland, which is at about 65°N and altitudes of 500-1200 metres a.s.l. Depending on the snow conditions of the preceding winter, the mountain roads around Askja are opened in late-June or early-July and they are accessible only by 4WD vehicles. Sometimes new snow covers the area again by late-August or early-September. There are two mountain huts within our field area, manned by rangers from late-June to the end of August.

We aimed to start the fieldwork as early as possible, once all the planned sites were accessible. We began the deployment on the 3rd July 2006 and finished it on the 6th July. The track to the last site at 1115 m altitude, VIBO (see Appendix), was only cleared from snow immediately before we drove there. The pick-up trip was done during 25th to 28th August 2007. If weather conditions are favourable, it would in principle be possible to run the stations longer into the autumn. However, as the field area is over 100 km away from inhabited areas, for safety reasons we restricted the end of the field season to be within the period when there were rangers at the huts so that they were aware of our locations and actions.

The seismic network consisted of twenty broadband Güralp 6TD seismometers. Ten of them were provided by SEIS-UK and another ten belong to Cambridge University. Each of them had an individual GPS clock and for a power source an 80 Ah battery together with a 20 W solar panel. The sites were chosen as a compromise between optimal coverage and the availability of mountain tracks for access. A station could be deployed typically within an hour. Most of the sensors were buried in a plastic bin bag in sand or pumice, depending on the local ground conditions. At two sites (HERD and SVAD) there were good exposures of flat pahoehoe lava, and the sensors were levelled directly on it, covered with a bucket with a cairn built around for protection. Despite higher long-wavelength background noise, these sites were very good, particularly at SVAD.

The sensors were aligned to grid north (N21E) and the sampling rate was set to 100 samples-per-second with the GPS clocks run in a continuous mode. The breakout box and the cable ends were placed in a plastic sandwich box with small holes made for the cables, which was either placed in the same bin bag with the battery or wrapped in a plastic bag and buried underground. The SEIS-UK instruments used firmware version .138 and the Cambridge instruments version .235 (see Appendix). The 3 or 4 Gb memory of the sensors was sufficient for the ~50-day long data gathering period, and no service trip was needed before the pick-up of the instruments. As the weather was turning cold during the pick-up trip and it had to be done relatively quickly, no downloading was done in the field, but was done at the first opportunity in the lab of the Science Institute in Reykjavík.

Table 1. The volume of data gathered

Site	°N	°W	Alt. (m)	Inst.	Pick-up	Operated (days)	Days of data	Recovery (%)	Raw data (MB)	Final mseed data (GB)
HOTT	65.04747	16.52984	717	3-Jul	25-Aug	53.24	53.24	100	?	2.4
UPTY	65.04866	16.33838	621	3-Jul	26-Aug	54.20	50.99	94	2735	2.8
VISA	65.06899	16.40368	640	3-Jul	28-Aug	56.01	56.01	100	3069	3.0
HRUT	65.15576	16.67442	704	3-Jul	26-Aug	53.88	~53.88	~100	2483	1.9
SVAD	65.11746	16.57499	680	3-Jul	26-Aug	53.87	53.87	100	2215	1.7
VIKR	65.07474	16.51347	718	3-Jul	26-Aug	53.85	53.85	100	?	3.4
HERD	65.18157	16.39730	688	4-Jul	28-Aug	54.99	54.99	100	2454	1.8
MYVO	65.15549	16.36895	636	4-Jul	28-Aug	54.96	54.96	100	2761	1.8
HETO	65.12871	16.31698	582	4-Jul	28-Aug	54.93	54.93	100	2597	1.7
JAAF	65.11278	16.25040	555	4-Jul	27-Aug	53.98	36.03	67	2977	2.0
DYNG	65.05192	16.64808	961	4-Jul	25-Aug	51.99	51.99	100	3071	2.8
MOFL	64.98449	16.64970	699	5-Jul	26-Aug	51.97	51.97	100	2849	2.8
RODG	64.98512	16.88638	1022	5-Jul	26-Aug	51.74	51.74	100	2438	2.0
VADA	64.99487	16.53813	673	5-Jul	25-Aug	50.89	~39.21	~77	?	1.5
MIDF	65.08676	16.32957	570	5-Jul	26-Aug	51.96	51.96	100	2742	2.8
FREF	65.35190	16.28353	531	6-Jul	27-Aug	51.93	51.93	100	2744	2.8
GRAL	65.28706	16.10030	477	6-Jul	27-Aug	52.94	52.94	100	2761	2.8
LINA	65.26202	16.15858	475	6-Jul	27-Aug	51.93	51.93	100	2749	2.8
HELI	65.19874	16.21843	489	6-Jul	27-Aug	51.92	51.92	100	2681	2.1
VIBO	65.06584	16.72938	1115	6-Jul	25-Aug	49.71	49.71	100	2817	2.4

Recorded Data

The data recovery was very good, totalling 96.9% (Fig. 2 and Table 1). The total amount of final data is 47.3 GB. We carried out the data downloading and conversion procedures following the detailed instructions provided by SEIS-UK (www.le.ac.uk/seis-uk/Manuals6T.htm). The data are stored in mseed format in the SEIS-UK archive, and also in the IRIS database with the temporary network code YT2006.

Seventeen sensors out of twenty operated completely correctly throughout the campaign. There were difficulties with downloading data from some of the sensors, but that was later achieved successfully either by the SEIS-UK staff or by Güralp, the manufacturer. The vertical component of the sensor at VADA had been accidentally set up 180° degrees wrong at Güralp: the first P-wave motion was recorded as up when it should have been down and vice versa. The north channel of this same seismometer was malfunctioning and produced no useful data. In mid-August this sensor stopped working altogether. The sensors at JAAF and UPTY had gaps in data towards the end of the period, probably due to battery or sensor problems or a combination of both. The sensor at HRUT worked well, but for some unknown reason its GPS clock jumped ahead one second some time during days 199–201 (18–20 July) and another second during days 216–217 (4–5 August), with patchy data around these jumps. However, the event picks are still useful, when corrected with -1, and later -2 seconds. Possibly these jumps can be corrected in the final version of data, but that has not been done yet at the time of writing this report. Some sites (GRAL, HELI, HOTT and LINA) located close to the main track suffered from occasional traffic noise.

The shipment arrived later than scheduled in Iceland, which left us with minimal time for huddle testing prior to the deployment trip. We only discovered after the pick-up that the newer software version v.235 on the Cambridge instruments caused the converted mseed data to be chopped into numerous short patches. Fortunately this could be fixed by later software provided by Güralp, and this problem has been corrected in the stored mseed data.

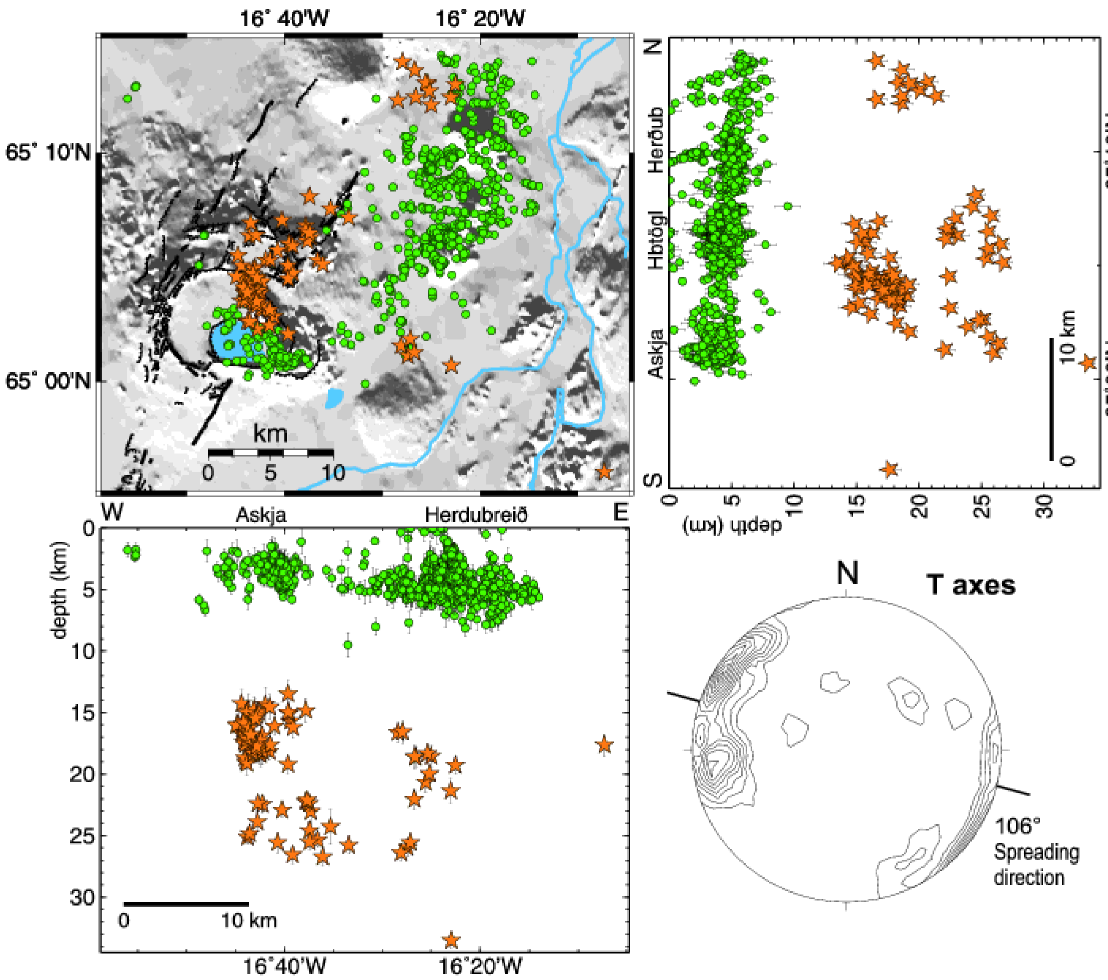

Figure 3. Epicentral and hypocentral distribution of the earthquakes during July–August 2006. Upper-crustal earthquakes are marked with green dots and lower-crustal earthquakes with orange stars. The stereographic projection shows the combination of tension axes of fault-plane solutions constructed for 52 upper-crustal earthquakes under Herðubreið and Herðubreiðartögl.

Preliminary results

As expected, we gathered a large dataset of local seismicity (Fig. 3). The magnitudes have not yet been determined for all the events, but comparison with detections by the national network indicates that they were all < 1.5 in magnitude. Approximately 1800 earthquakes were located, most of which lie within a ~10 km wide and ~30 km long belt beneath Herðubreið and Herðubreiðartögl. This activity is restricted to the upper crust and dips towards the NE, away from Askja and the active plate boundary. Most of the events occur towards the base of the seismogenic crust, from ~2 km down to ~8 km. The dominant cause of this seismicity appears to be plate boundary spreading, as the tension axes of the fault-plane solutions align along the spreading direction, N106E.

A prominent cluster of upper-crustal seismicity, down to ~5 km depth, occurs in the SE part of the Askja caldera system. The area of these earthquakes correlates with the sites of geothermal activity. A closer study of the nature of this activity will be made by Janet Key (new NERC PhD student starting in summer 2007). All the upper-crustal earthquakes, both at Herðubreið and at Askja have the typical appearance of tectonic, or volcano-tectonic, events, with a broad spectrum and impulsive P- and S-arrivals. They typically occur in swarms (Fig. 4).

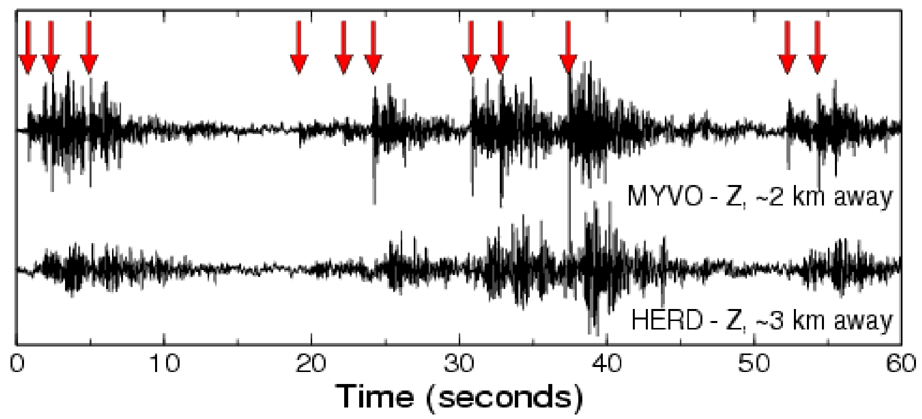

Figure 4. A sample of a high-frequency upper-crustal earthquake swarm at Herðubreið. Vertical component records of the closest stations, MYVO and HERD, are shown. Arrows mark P-wave arrivals of individual events. The seismograms are on the same scale and the data are bandpass filtered 2–15 Hz.

An unexpected and exciting discovery was the detection of deep, lower-crustal earthquakes, formerly unknown in this area (Fig. 5). We detected approximately 100 such events during July–August 2006. Retrospective examination of the database of the Icelandic Meteorological Office suggests that they have occurred at least since 2005. The lower-crustal earthquakes have distinctly different waveforms than the shallower events. They tend to occur in swarms, as does the upper-crustal seismicity, but their frequency content is much lower, typically restricted to around 3 Hz, with possibly some higher-frequency onsets at some sites.

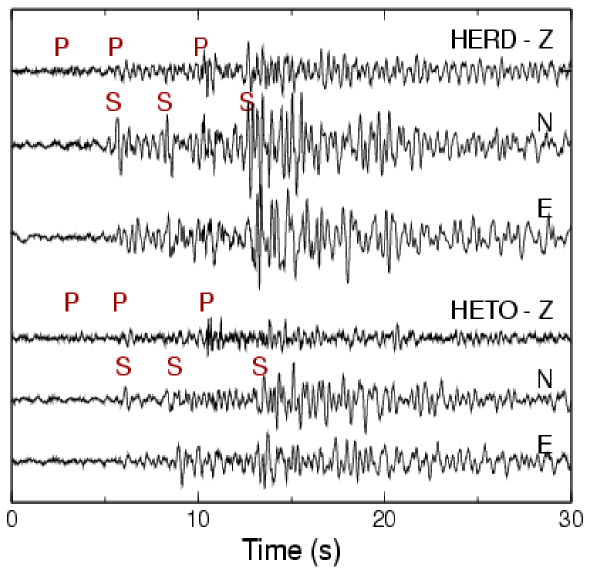

Figure 5. An example of a lower-crustal earthquake swarm, NW of Herðubreið and approximately at 20 km depth. Individual P- and S-wave arrivals are marked. All the seismograms are on the same scale and the data are high-pass filtered at 1 Hz.

The deep activity is very intriguing and sets constraints on rheological and temperature conditions within the lower crust of the north Iceland plate boundary. Our current understanding is that these events are related to magmatic movements within the neovolcanic zone. The crustal thickness in the Askja area is not precisely known, but is estimated from earlier work at Cambridge to be around 30 km (Darbyshire et al. 2000). It is possible that the deepest events, particularly the one located at 34 km depth, are occurring in the upper mantle rather than in near the base of the crust, but most are well within the lower-crust.

Presentations, publications and research in progress

Clare Knox (student at the University of Cambridge) and Heidi Soosalu examined the event cluster beneath Herðubreið and Herðubreiðartögl and the deep seismicity during 2006. The shallow seismic cluster beneath Askja is being analysed more thoroughly by another student during summer and autumn 2007. Janet Key, a NERC PhD student who has recently started at the University of Cambridge will use all the data we have recorded, and will incorporate new data from a similar deployment currently in the field in summer 2007. She will focus particularly on the lower-crustal seismicity and will apply waveform relocation and seismic tomographic techniques to improve the constraints from the seismicity. Its interpretation will be accompanied by theoretical modelling of these (globally) rare deep crustal events thought to be caused by melt movement in the lower crust.

First results of the Herðubreið 2006 campaign have been presented at several meetings:

Soosalu, H., C. Knox, R.S. White, P. Einarsson, S.S. Jakobsdóttir & Erik Sturkell (2007). Seismicity at the Askja volcano and its surroundings, north Iceland. Volcanic & Magmatic Studies Group, Winter Meeting, Oxford, U.K., 4-5 Jan, 2007, p. 27–28.

Knox, C. H. Soosalu, R.S. White & S.S. Jakobsdóttir (2007). Earthquakes at Herðubreið on the north Iceland plate boundary: tectonic or magmatic? Volcanic & Magmatic Studies Group, Winter Meeting, Oxford, U.K., 4-5 Jan, 2007, p. 55.

Soosalu, H. S.S. Jakobsdóttir, R.S. White, C. Knox & P. Einarsson (2007). Lower-crustal earthquakes at the divergent plate boundary of north Iceland near Askja. Geoscience Society of Iceland, Spring meeting 2007, p. 37.

Soosalu, H. R.S. White, C. Knox, S.S. Jakobsdóttir & P. Einarsson (2007). Discovery of lower-crustal earthquakes down to ~30 km depth near the Askja volcano in north Iceland. The 38th Nordic Seismology Seminar, Helsinki, Finland, 13-15 Jun, 2007. 2 pp.

Soosalu, H., R.S. White, C. Knox, P. Einarsson & S.S. Jakobsdóttir (2007). Waveforms of lower-crustal earthquakes near the Askja volcano at the north Iceland divergent plate boundary. European Seismological Commission workshop, Seismic phenomena associated with volcanic activity, Nesjavellir, Iceland, 9-16 Sep, 2007. 1 p.

A first manuscript on the lower crustal seismicity, to be submitted to Nature Geophysics, is currently under revision.

Acknowledgements

Ten of the seismometers were loaned from SEIS-UK. The SEIS-UK staff, Alex Brisbourne, David Hawthorn and Anna Horleston provided prompt and professional help during all the phases of the project. The rangers at the mountain huts of Dreki and Herðubreiðarlindir, Guðný, Hanna Kata, Hrafnhildur and Þórný, are thanked for their assistance, friendliness and hospitality during our stays in the field area. Erik Sturkell provided valuable logistical assistance and advice, and fed the fieldworkers with delicious dinners on the way out to and back from the highland. Nicholas Borner, Katherine Harland, Clare Knox, Andrew Lillington and Sarah White were good and skilful fieldworkers.

References

Darbyshire, F.A., R.S. White & K.F. Priestley (2000). Structure of the crust and uppermost mantle of Iceland from a combined seismic and gravity study. *Earth Planet. Sci. Lett.* **181**, 409-428.

Einarsson, P. (1991). Earthquakes and present-day tectonism in Iceland. *Tectonophysics* **189**, 261-279.

Hjartardóttir, Á.R. (in prep.). Fissures and fractures near the Askja volcano in the Northern rift zone of Iceland. MSc thesis, University of Iceland.

IMO. Icelandic Meteorological Office seismic database: www.vedur.is

Herðubreið 2006 – seismic project

Appendix: Detailed information on the seismograph stations of the Herðubreið network

1. **HOTT** – Höttur (65.04747 °N, 16.52984 °W, 717 m)
Installed 184 – 3.7. 10:48
Pick-up 237 – 25.8. 16:33
53.23958/53.23958 days of data, recovery 100 %
Sensor 6010 (Cambridge), grid north N21E, GPS G4193, firmware v.235
Ground: pumice, fine sand
Burial material: pumice, fine sand
Remarks: occasional traffic noise

2. **UPTY** – Upptyppingar (65.04866 °N, 16.33838 °W, 621 m**)** – re-occupied site from 2005
Installed 184 – 3.7. 12:33
Pick-up 238 – 26.8. 17:28
Data gaps 231 – 19.8. 05:38 to 232 – 20.8. 11:05; 232 – 20.8. 23:43 to 233 – 21.8. 10:25; 233 – 21.8. 20:55 to 234 – 22.8. 10:07; 235 – 23.8. 01:18 to 235 – 23.8. 08:11, 236 – 24.8. 06:34 to 236 – 24.8. 09:22; 237 – 25.8. 03:07 to 237 – 25.8. 07:52; 238 – 26.8. 01:02 to 238 – 26.8. 10:28
50.98749/54.20486 days of data, recovery 94.06 %
Sensor 6141 (SEIS-UK), grid north N21E, GPS G3767, firmware v.138
Ground: sand, pumice, lava blocks
Burial material: sand, pumice, lava blocks
Remarks: rather noisy data, surprising after better experience in 2005, possibly related to malfunctioning of the sensor

3. **VISA** – Vikursandur (65.06899 °N, 16.40368 °W, 640 m)
Installed 184 – 3.7. 14:03
Pick-up 240 – 28.8. 14:11
56.00555/56.00555 days of data, recovery 100 %
Sensor 6070 (SEIS-UK), grid north N21E, GPS G3846, firmware v.138
Ground: pumice, sand/fine sand, lava under
Burial material: bucket, pumice, sand

4. **HRUT** – Hrútur (65.15576 °N, 16.67442 °W, 704 m)
Installed 184 – 3.7. 17:58
Pick-up 238 – 26.8. 15:03
Patchy data 199 – 18.7. 23:48 to 201 – 20.7. 08:46; 216 – 4.8. 05:14 to 217 – 5.8. 02:03
~53.87847/53.87847 days of data, recovery ~100 %
Sensor 6305 (Cambridge), grid north N21E, GPS nn, firmware v.235
Ground: coarse and fine sand
Burial material: coarse and fine sand
Remarks: GPS jumped ahead a second twice for an unexplained reason,
first during the days 199–201 and later during the days 216–217,
data are usable, if corrected with **-**1 sec after the first jump and **-**2 sec after the second jump

5. **SVAD** – Svartadyngja (65.11746 °N, 16.57499 °W, 680 m)
Installed 184 – 3.7. 17:58
Pick-up 238 – 26.8. 15:51
53.86598/53.86598 days of data, recovery 100 %
Sensor 6359 (Cambridge), grid north N21E, GPS G4186, firmware v.235
Ground: levelled on flat lava

Burial material: bucket, cairn of lava blocks, sand

6. **VIKR** – Vikrafell (65.07474 °N, 16.51347 °W, 718 m) – re-occupied site from 2005
Installed 184 – 3.7. 20:44
Pick-up 238 – 26.8. 17:15
53.85486/53.85486 days of data, recovery 100 %
Sensor 6051 (SEIS-UK), grid north N21E, GPS G4155, firmware v.138
Ground: pumice, sand
Burial material: pumice, sand

7. **HERD** – Herðubreið (65.18157 °N, 16.39730 °W, 688 m) – re-occupied site from 2005
Installed 185 – 4.7. 11:47
Pick-up 240 – 28.8. 11:34
54.99097/54.99097 days of data, recovery 100 %
Sensor 6024 (Cambridge), grid north N21E, GPS G3801, firmware v.235
Ground: levelled on flat lava
Burial material: bucket, cairn of lava blocks, sand

8. **MYVO** – Mývatnsöræfi (65.15549 °N, 16.36895 °W, 636 m)
Installed 185 – 4.7. 13:11
Pick-up 240 – 28.8. 12:12
54.95902/54.95902 days of data, recovery 100 %
Sensor 6360 (Cambridge), grid north N21E, GPS G6455, firmware v.235
Ground: fine sand, lava slabs
Burial material: fine sand

9. **HETO** – Herðubreiðartögl (65.12871 °N, 16.31698 °W, 582 m)
Installed 185 – 4.7. 5:16
Pick-up 240 – 28.8. 13:34
54.92917/54.92917 days of data, recovery 100 %
Sensor 6150 (Cambridge), grid north N21E, GPS G4242, firmware v.235
Ground: sand, pumice, lava
Burial material: sand, pumice

10. **JAAF** – Jökulsá á fjöllum (65.11278 °N, 16.25040 °W, 555 m)
Installed 185 – 4.7. 16:44
Pick-up 239 – 27.8. 16:20
36.02848/53.98334 days of data, recovery 66.74 %
Sensor 6128 (SEIS-UK), grid north N21E, GPS G3873, firmware v.138
Ground: sand, pumice, lava blocks
Burial material: sand, pumice
Remarks: noisy site

11. **DYNG** – Dyngja (65.05192 °N, 16.64808 °W, 961 m)
Installed 185 – 4.7. 18:22
Pick-up 237 – 25.8. 18:05
51.98819/51.98819 days of data, recovery 100 %
Sensor 6191 (SEIS-UK), grid north N21E, GPS G3839, firmware v.138
Ground: vault with concrete bottom, built on a hyaloclastite ridge
Burial material: vault

12. **MOFL** – Móflöt (64.98449 °N, 16.64970 °W, 699 m)
Installed 186 – 5.7. 12:18
Pick-up 238 – 26.8. 11:42
51.97500/51.97500 days of data, recovery 100 %
Sensor 6071 (SEIS-UK), grid north N21E, GPS G3810, firmware v.138
Ground: sand, on the flank of hyaloclastite bank
Burial material: sand, lava/hyaloclastite blocks
Remarks: high-frequency noise from a river close by, sometimes electric noise

13. **RODG** – Roðgúll (64.98512 °N, 16.88638°W, 1022 m)
Installed 186 – 5.7. 16:09
Pick-up 238 – 26.8. 10:01
51.74444/51.74444 days of data, recovery 100 %
Sensor 6173 (Cambridge), grid north N21E, GPS G4208, firmware v.235
Ground: sand, ash, lava blocks
Burial material: sand, ash, lava blocks

14. **VADA** – Vaðalda (64.99487 °N, 16.53813 °W, 673 m)
Installed 186 – 5.7. 18:13
Pick-up 237 – 25.8. 15:30
Data gap 225 – 13.8. 23:12 to 237 – 25.8. 15:30
39.20764/50.88680 days of data, recovery 100 %
Sensor 6096 (Cambridge), grid north N21E, GPS G4269, firmware v.235
Ground: sand, small pumice, lava blocks
Burial material: sand, small pumice, lava blocks
Remarks: vertical component 180° wrong (UP is DOWN and DOWN is UP), north component useless

15. **MIDF** – Miðfell (65.08676 °N, 16.32957 °W, 570 m)
Installed 186 – 5.7. 19:48
Pick-up 238 – 26.8. 18:45
51.95625/51.95625 days of data, recovery 100 %
Sensor 6023 (SEIS-UK), grid north N21E, GPS G2121, firmware v.138
Ground: sand, pumice, lava slabs
Burial material: sand, pumice, lava slabs

16. **FREF** – Fremstafell (65.35190 °N, 16.28353 °W, 531 m)
Installed 187 – 6.7. 13:35
Pick-up 239 – 27.8. 11:49
51.92639/51.92639 days of data, recovery 100 %
Sensor 6158 (SEIS-UK), grid north N21E, GPS G3841, firmware v.138
Ground: sandy soil
Burial material: sandy soil, pebbles

17. **GRAL** – Grafarlönd (65.28706 °N, 16.10030 °W, 477 m)
Installed 187 – 6.7. 15:37
Pick-up 239 – 27.8. 14:13
51.94167/51.94167 days of data, recovery 100 %
Sensor 6351 (SEIS-UK), grid north N21E, GPS G4136, firmware v.138
Ground: sand, pebbles
Burial material: sand, pebbles
Remarks: occasional traffic noise

18. **LINA** – Lindahraun (65.26202 °N, 16.15858 °W, 475 m)
Installed 187 – 6.7. 16:35
Pick-up 239 – 27.8. 14:55
51.93056/51.93056 days of data, recovery 100 %
Sensor 6038 (SEIS-UK), grid north N21E, GPS G3822, firmware v.138
Ground: sand, lava
Burial material: sand, lava blocks
Remarks: occasional traffic noise

19. **HELI** – Herðubreiðarlindir (65.19874 °N, 16.21843 °W, 489 m) – re-occupied site from 2005
Installed 187 – 6.7. 17:38
Pick-up 239 – 27.8. 15:44
51.92084/51.92084 days of data, recovery 100 %
Sensor 6026 (Cambridge), grid north N21E, GPS G4187, firmware v.235
Ground: sand, pebbles, riverbed material
Burial material: sand, pebbles
Remarks: occasional traffic noise

20. **VIBO** – Vikraborgir (65.06584 °N, 16.72938 °W, 1115 m)
Installed 187 – 6.7. 20:29
Pick-up 237 – 25.8. 13:34
49.71181/49.71181 days of data, recovery 100 %
Sensor 6355 (Cambridge), grid north N21E, GPS G4157, firmware v.235
Ground: scoria
Burial material: scoria
Remarks: often long reverberations because of the porous material