Scientific Report for NERC GEF Loan 857
Tracking melt injection under the Mid-Atlantic Rift near Askja, central Iceland

Janet Key, Tim Greenfield and Robert White
Bullard Laboratories, University of Cambridge

October 2011

Abstract

Despite the challenging sub-Arctic conditions, we have run a continuous year-round network at Askja since 2008. Thanks to experience gained over successive years, modifications to the network have allowed the number of stations that operate through the winter to increase. This has allowed extensive monitoring of the highly unusual lower crustal earthquakes beneath Askja, which are thought to be caused by melt moving into the lower crust from the mantle and has shown that they are a persistent ongoing feature. Travel time tomography has been completed showing a low velocity body beneath the caldera thought to be the magma chamber. The Askja network forms part of a larger network along the length of the Northern Volcanic Zone of Iceland, which will be used to constrain the structure of the entire rift.

1 Background

The Askja volcanic system is one of five volcanic systems that make up the Northern Volcanic Zone (NVZ) in Iceland, a section of the mid-Atlantic plate boundary extending from the Vatnajökull glacier to the north coast (Figure 1). The last major rifting episode was 1874–1876, but since then there have been several small effusive eruptions at Askja central volcano, most recently in 1961. Geodetic measurements show deflation since at least 1983 at an exponentially decaying rate (Sturkell et al., 2006). The majority of this deformation can be explained by a deflating magma chamber at 3 km depth, centred beneath the main Askja caldera (Sturkell et al., 2006). However, Rymer et al (2010) observed a net gravity increase between 2007 and 2009, suggesting that magma may now be accumulating at a shallow level beneath the caldera. The crustal thickness in this area is not well defined, but is estimated from regional seismic studies to be approximately 30 km (Darbyshire et al., 2000).

Askja is a region of persistent seismicity with local magnitudes less than 3 (Jakobsdottir, 2008). The University of Cambridge has deployed seismic networks in the Askja region since 2005 to record the local seismicity, as the small magnitude events are not observed by the majority of the Icelandic national network (SIL) stations. A successful three week, five station pilot study in 2005 was followed in 2006 and 2007 with two-month long summer deployments, each using more than twenty 3 or 4 GB Güralp 6TDs (Soosalu and White, 2007; Key et al., 2008). The earthquakes recorded during these deployments mostly occurred in the upper 8 km of the crust (?), typical of Icelandic rift zones. Unexpectedly we also discovered lower crustal earthquakes at depths of 12–34 km, where it should be too hot and ductile for earthquakes to occur (?). Using experience gained from a trial five station network run over winter 2007/2008, fifteen 16 GB 6TDs on Loan 857 were installed around Askja in July 2008. These 15 instruments originally on Loan 857 were then included in a fresh application to borrow an additional ten 16 GB 6TDs (NERC GEF Loan 914) and were kept operating continuously in the field as part of Loan 914. A further extension was agreed with Alex Brisbourne of SEISUK in August 2011. This report is intended as a follow up to the Interim Report for Loan 857 (Key and White, 2009) with a summary of findings to date. As we are continuing our fruitful work in this region, a final report encompassing the data recovered from all of the Askja and NVZ related loans will be submitted once the project is complete.

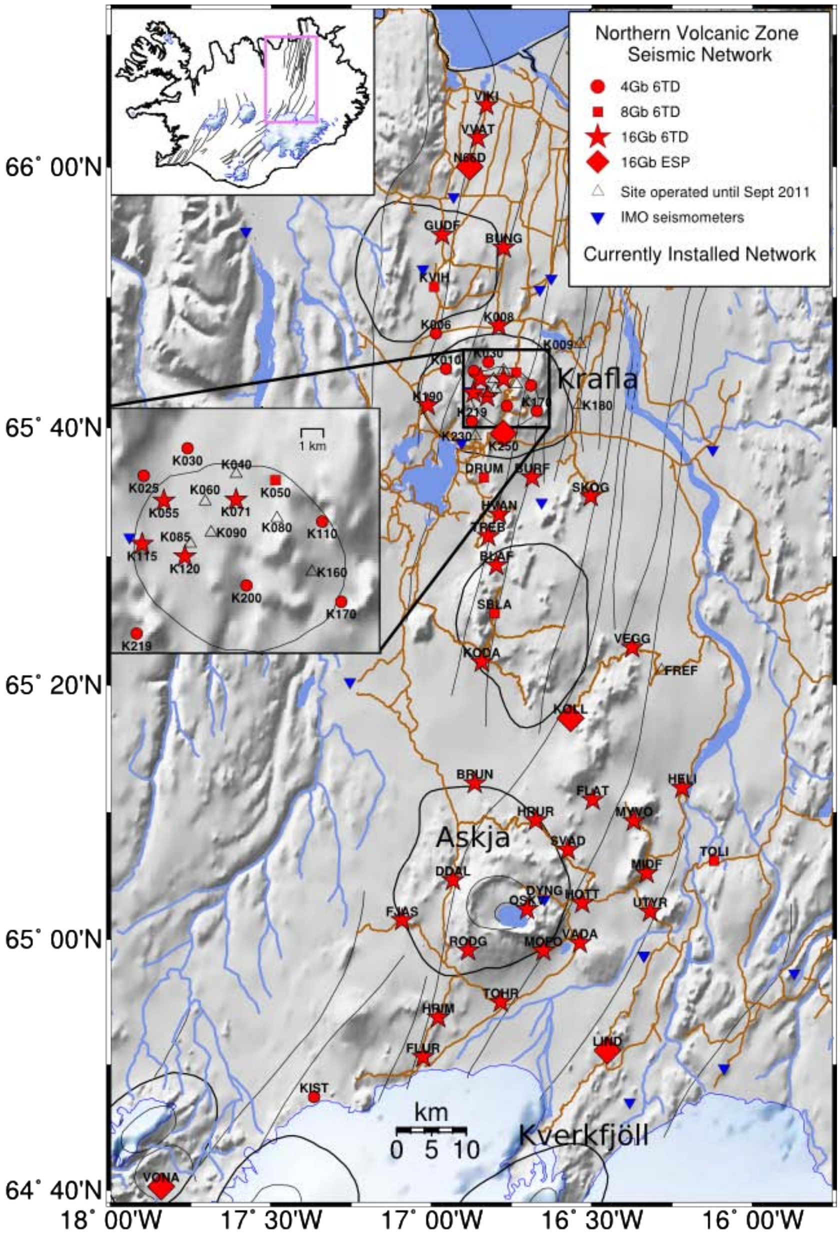

Figure 1: Current seismic network installed around Northern Volcanic Zone of Iceland. Volcanic systems and their central volcanoes outlined in black; roads are brown; rivers, lakes and sea shaded blue; ice caps shaded white with blue outline. Three central volcanoes (which all share their names with their volcanic systems) are labelled: Askja, Krafla and Kverkfjöll. Mid left inset shows zoom of Krafla area where station spacing is smaller. Top left inset shows volcanic systems and ice caps of Iceland (same colours as main figure), pink box outlines NVZ region displayed in main figure.

2 Fieldwork procedure

The field season in the Askja area is limited to summer and early autumn, due to the high latitude of 65°N and altitudes of 500–1200 m a.s.l. Depending on snow conditions, the mountain roads open in late-June and are closed in early-September and are accessible only by 4WD vehicles. There are two mountain huts in the field area, staffed by rangers in the summer months. As the field area is over 100 km from inhabited areas, for safety reasons we restrict our fieldwork to periods when rangers are present and aware of our locations.

2.1 Network summary

The Askja network has been operating continuously since July 2008, initially using the 15 instruments on Loan 857 and supplemented with several 4GB 6TDs owned by University of Cambridge (Figure 2). There were teething problems with the brand new instruments which are detailed in Key and White (2009). The

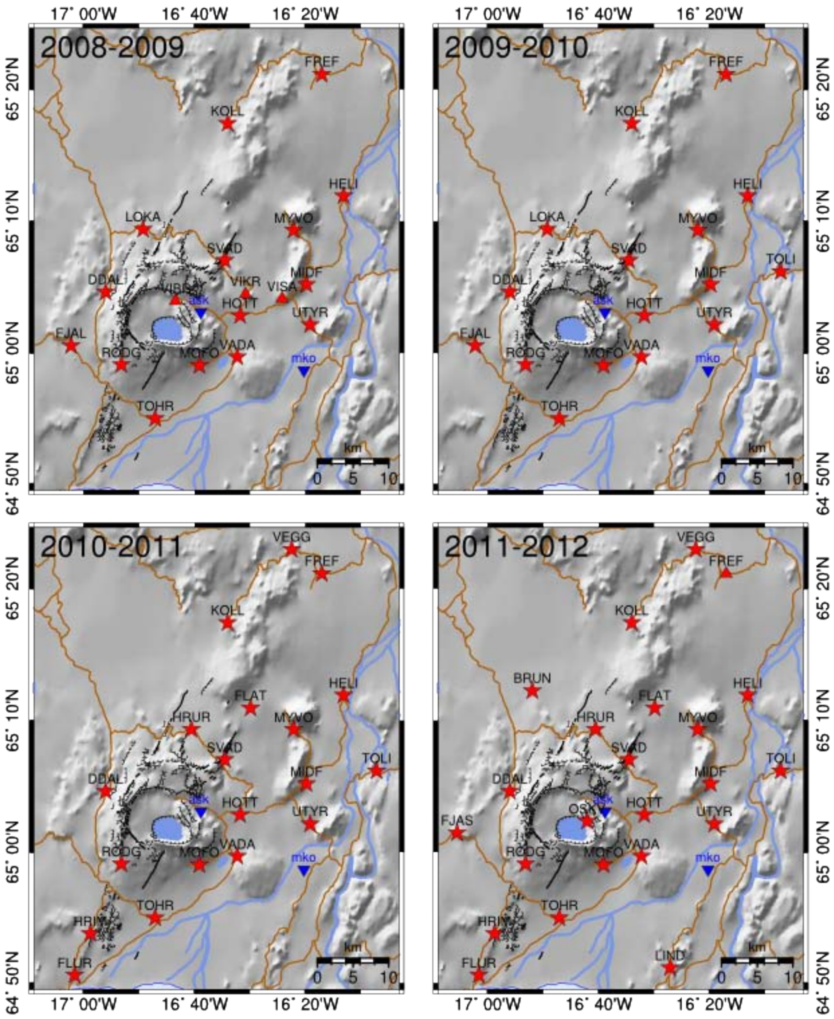

Figure 2: The Askja network through time: red stars are winter stations, red triangles are summer only stations, inverted blue triangles are IMO seismometers. Mapped faults and fissures are black; roads are brown; rivers and lakes shaded blue.

network was serviced in July 2009 and the station TOLI was installed. The network was serviced again in both July and August 2010, when new stations were set up at FLAT, FLUR, HRIM, HRUR and VEGG thanks to the removal of the stations LOKA and FJAL as well as additional instruments from Loan 914 (Figure 2). In July 2011 the stations BRUN, FJAS, LIND and OSKV were added to the Askja network using new seismometers purchased on a successful NERC grant application, and the station FREF was removed (Figure 2). Since 2009 a second University of Cambridge network using SEISUK seismometers was set up around Krafla, another volcano on the NVZ. In 2010 more stations were added north and south of Krafla, which when combined with the Askja network creates a much larger network along the length of the NVZ (Figure 1). This NVZ network had 65 stations for the summer of 2011, but was reduced to 55 stations in September 2011 after ten 8 GB instruments were returned to SEISUK.

2.2 Typical station set up

The seismometer is placed inside a plastic bin bag for protection then buried and levelled in sand, soil, pumice or scoria depending on local ground conditions (Figure 3). The top of the sensor is typically 30–40 cm below the surface. At sites SVAD and HRUR there are good exposures of flat pahoehoe lava, and the sensors were levelled directly on it, covered with a bucket and a cairn built over that for protection (Figure 3). Each 6TD uses typically two 115 Ah batteries (or different size batteries giving minimum 200 Ah total) recharged by 80–120 W total solar panels. The large number of solar panels per instrument is necessary to make the most of the limited daylight in the winter months in this sub-Arctic location. The solar panels are set near-vertical to catch the sun when it is low to the horizon and also to help snow slide off. To prevent panels being covered in snow they are mounted on wooden stands. Originally we used a bench design, weighed down with lava boulders (Figure 3), but this was prone to collapse.

We now favour an A-frame design (Figure 3), which we have found to be more sturdy and easily allows panels to be mounted even higher off the ground. Batteries are buried in pits, that are covered over with plastic sheeting to protect from water. We used to line the battery pits with styrofoam but subsequent experiment has shown that the this makes no difference to battery survival so we no longer use it. The GPS clocks are mounted as high as possible on sticks or on the panel stands as the snow can block the signal. Finally, we used to bury the firewire cable and breakout box in a sealed plastic bag, but due to imperfect sealing this could result in the breakout boxes sitting in a puddle of water during the spring thaw, leading to some failures. We now mount the breakout box and firewire cable on a short wooden stick, which is then covered over with a bin bag (Figure 3). Wind turbines were trialled as additional power source at two of the Askja sites in winter 2010/2011 (Figure 3), but both turbines were found to be broken upon service in 2011 and were removed. An alternative design of wind turbine is being trialled at one site over winter 2011/2012.

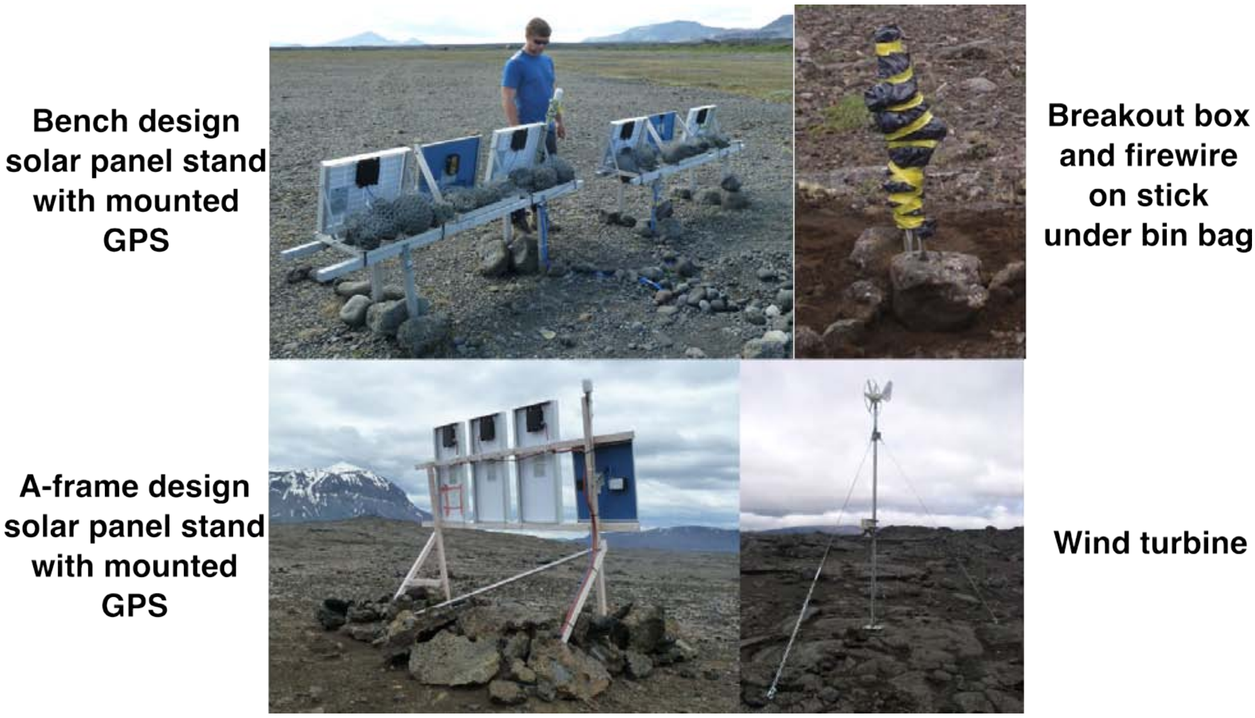

Figure 3: Photos to show example site set constructions.

All the instruments used a sampling rate of 100 sps for summer 2008, which was reduced to 50 sps for the winter to give enough disk space to last at least 10 months. The 50 sps sampling rate was used for all stations (with the exception of TOLI which was mistakenly run at 100 sps for winter 2009/2010) until summer 2011, when the sampling rate was increased back up to 100 sps for all instruments. This higher sampling rate was used because there was a possibility of setting off active sources which have a higher frequency content than the earthquakes. Over winter 2011/2012 the 16 GB instruments have been left at 100 sps, while the 8 and 4 GB instruments were reduced to 50 sps. To ensure that the data recorded is from the same time period for all instruments, they have all been left in write-once mode for winter 2011/2012.

During each service run, data was downloaded to Lacie disks. At each site any necessary repair work was carried out and if the masses on any component had exceeded ∼50% of their operating range, it was dug up and re-levelled. Each evening, data was copied from the Lacie disks onto portable hard drives in GCF format, then converted to miniseed and QC'd to ensure there were no problems that we needed to fix while in the field. Since 2009 the seismometers have been very reliable.

3 Data coverage

The average amount of data downloaded from instruments that have been run through the winter from the end of August to the start of July is 8.5 GB. The average data accumulation rate for instruments run at 50 sps is 0.8 GB/month and 1.5 GB/month for those run at 100 sps but the maximum data accumulation rate at 100 sps was 1.8 GB/month. This provides support for the decision to use a 50 sps sampling rate in the winter, because with this we could be certain of recording continuous data from all stations, whereas 100 sps could have exceeded the data capacity of the sensors at some sites. The data recovery rates in miniseed format were 100%, 99% and 99% for summer 2008, summer 2010 and summer 2011 respectively. This is much higher than the 89% for both winter 2008/2009 and winter 2009/2010 and 93% for winter 2010/2011. This is because there are usually data gaps caused by insufficient power on some of the stations, typically in the months of March, April and May (Figure 4). The lack of power is most likely due to a combination of limited winter daylight and snow/ice cover preventing the solar panels from recharging the batteries to a sufficiently high voltage to power the sensor. This is consistent with the observation that instruments tend to operate during the day and power off overnight at either side of a data gap. However, it is not clear what else affects whether or not a station runs continuously as stations in similar settings performed very differently. Four stations: DDAL, MOFO, VADA and RODG have had gaps every winter (Figure 4), therefore during the September 2011 service an extra battery was added to each of these sites. The modifications we have made to the network building on experience gained from each successive winter deployment has allowed a greater number of stations to run completely continuously each year.

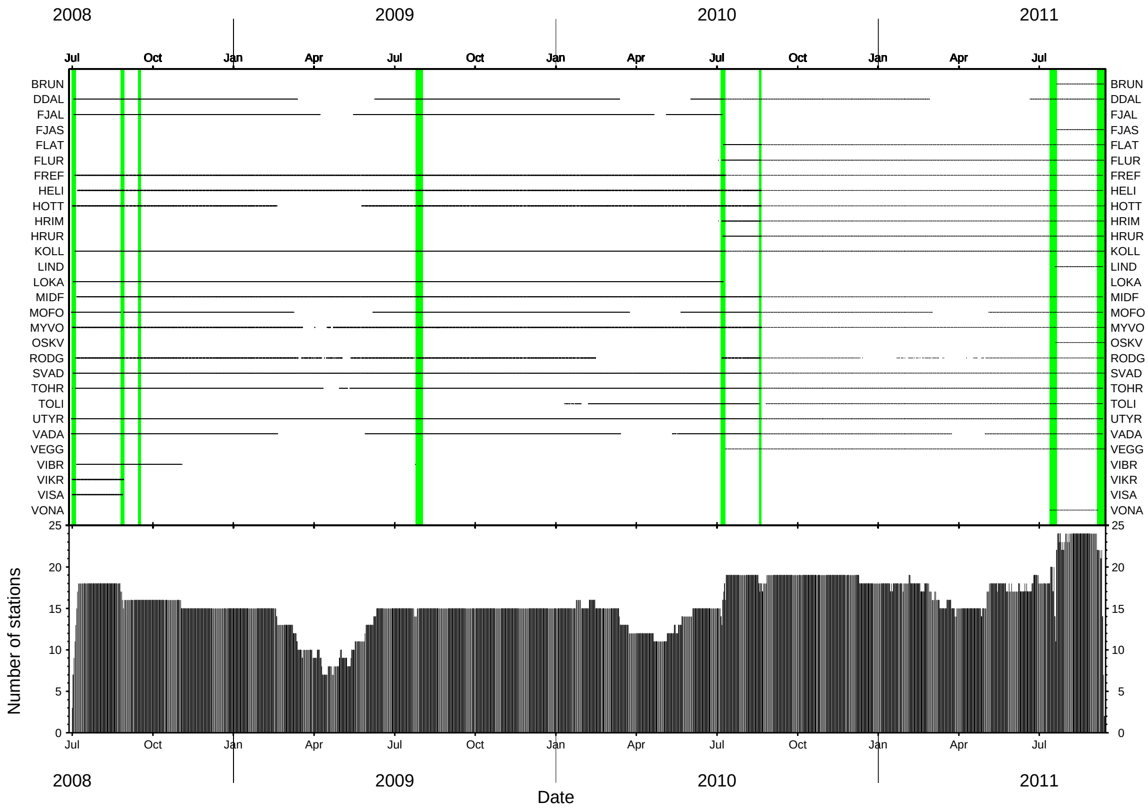

Figure 4: Station durations, top shows when each stations is operational, bottom shows total number of stations active. Green lines show servicing periods. The month-labelled tick marks show the start of each quarter year.

Other than power failures the main problems were related to GPS timing issues. Problems found in data collected before July 2009 are listed in Key and White (2009), anything since then is detailed here. A re-occurrence of the rapidly oscillating offset and drift values like that observed on RODG and MYVO in 2008 and 2009 respectively (Key and White, 2009), occurred again at RODG from 21st January-14th February 2010, despite being a different GPS unit to the one that had the problem in 2008. This suggests the cause could be a site-effect as Guralp have been unable to reproduce it in laboratory testing. A different problem affected RODG between 14th February 2010 and the July service, when the instrument failed to write any velocity streams to its memory, despite the GPS data suggesting that it was powered on. After power-cycling the sensor it began to behave normally and has continued to do so to date, but Guralp could provide no explanation for why this behaviour started.

Due to the remote location of the network the background seismic noise level is very low making the seismic data gathered here high quality (Figure 5). This has allowed detection and picking of very small magnitude events that it would not be possible to observe in other locations.

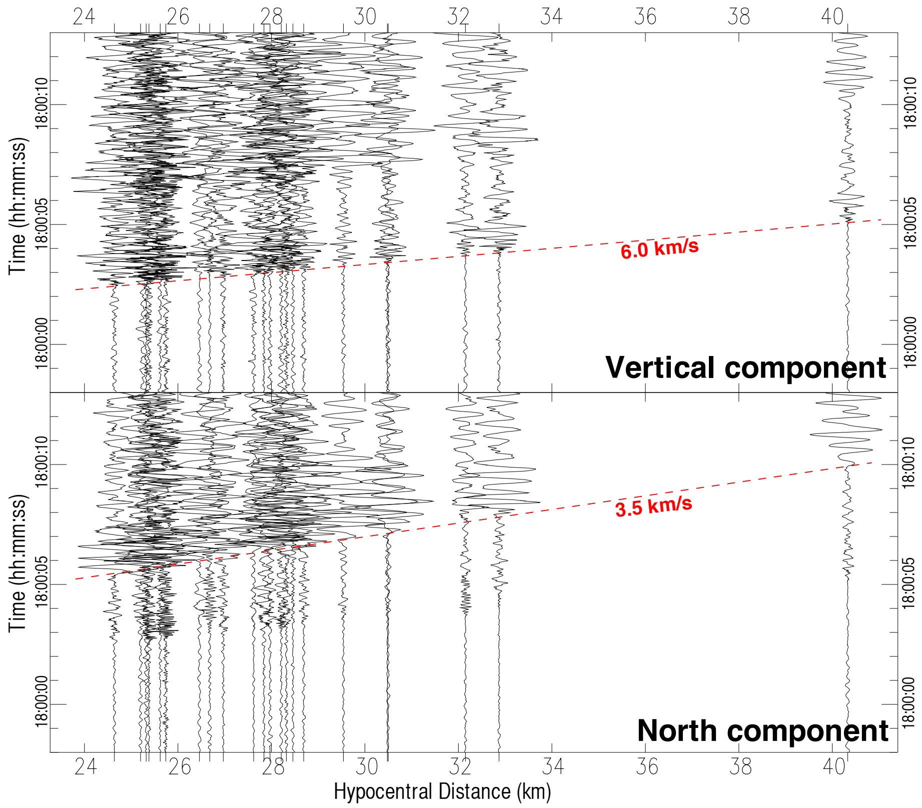

Figure 5: Record sections of a lower crustal earthquake (M_L 1.7) located at 24 km depth just to the north east of Askja caldera to show typical data quality. Top is vertical components showing P-wave propagating at 6 km/s, bottom is north components showing S-wave propagating at 3.5 km/s.

4 Processing

When back in the UK the GCF was converted to miniseed with fully populated headers, which will be archived at IRIS. The miniseed was then converted to SAC format for use with SAC seismic processing software (Goldstein et al., 2003) and to DAT format for use with the CMM automatic detection and location software developed in-house (?). CMM is an excellent technique to create a catalogue of earthquakes in different locations, but to reveal fine structure earthquakes must also be picked by hand. Picks were made either in SAC or using the Phase Pick (PPICK) software (?), developed in-house to make use of CMM output. The picks were located using HYPOINVERSE-2000 (Klein, 2002) and in some cases relatively-relocated using HYPODD (Waldhauser, 2001). VELEST was used to derive local velocity models for Upptyppingar and Askja. Fault plane solutions were determined using FPFIT (Reasenberg and Oppenheimer, 1985) or FMINV (?), another in-house program for use with CMM output.

5 Preliminary results and ongoing research

5.1 Upper-crustal Askja region earthquakes

The most common local earthquakes in the Askja region are the upper-crustal events around Herðubreið and Herðubreiðatögl as well as in the south east corner of the Askja caldera (Figure 6). These shallow earthquakes have been the focus of a number of Cambridge MSci Masters projects (see Section 6) and are briefly discussed in ?. They are thought to have a tectonic origin and their sharp lower cut-off delineates the brittle-ductile transition. A current MSci is looking at several swarms of these events that occurred in 2009 which show strong SW-NE lineation and could provide insight into how the plate spreading is partitioned locally.

5.2 Lower-crustal Askja region earthquakes

Several papers have been published discussing the unusual lower crustal earthquakes (???). The key conclusion is that they are generated by melt intrusion from the mantle. As there are three distinct clusters (Figure 6) melt must be simultaneously supplied to the crust at three separate locations within

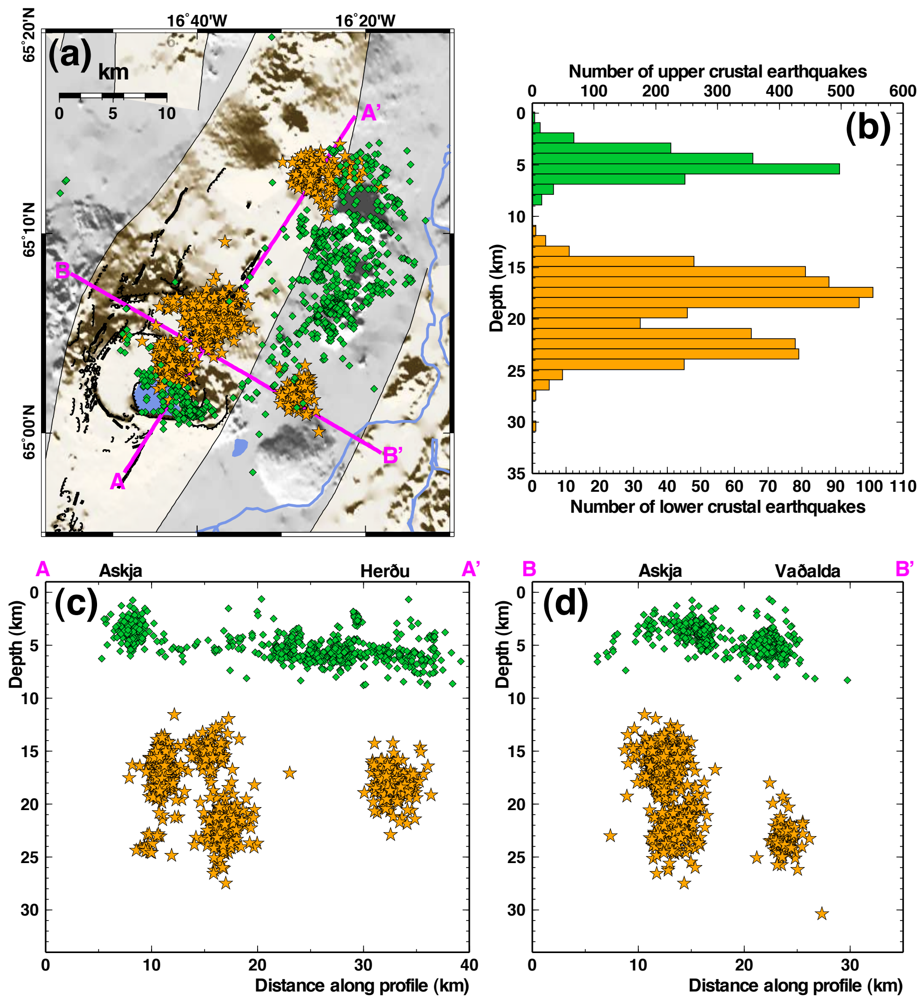

Figure 6: a) Map of all well located (RMS $<$ 0.2s, locations errors $<$ 1.0 km and gap of $<$ 180°) handpicked earthquakes in Askja region picked to date. Green diamonds are upper crustal earthquakes and yellow stars lower crustal earthquakes. Cross sections along lines A-A' and B-B' are shown in (c) and (d) respectively, including all earthquakes $<$ 10 km from each line. (b) Histogram of depth distribution following same colour scheme as map.

a single spreading segment. High local Vp/Vs ratios support the presence of melt in the lower crust. The continuous monitoring made possible by Loan 857 has shown that while on short time scales the earthquakes are quite episodic and occur in short swarms of several events, on longer time scales they are persistent, with some lower crustal earthquakes occurring every week for the entire monitoring period. Assuming they have been occurring at similar rates since they were first observed, melt has been gradually accumulating in the lower crust of Askja for at least six years.

5.3 Upptyppingar earthquakes

In 2007/2008 there was an intense swarm of seismicity beneath Upptyppingar, a hyaloclastite ridge in the Kverkfjöll volcanic system, 20 km east of Askja. The seismicity is thought to have been caused by a dyke injection at 15 - 25 km depth (Jakobsdóttir et al., 2008; **?**; **?**), one of the aims of Loan 857 was to monitor the development of the intrusion. A tight cluster of upper-crustal seismicity began in 2008 in a location where seismicity had not previously been observed, which are thought to be a response to the stress field caused by the deeper melt injection.

5.4 Tomography

All three event types described above have been used as sources in a tomographic inversion to determine the 3D velocity structure of Askja central volcano (**?**). The best located and well constrained earthquakes were selected to give a catalogue of ~1000 events recorded between 2007–2009. An ellipsoidal low-velocity region was imaged beneath the caldera at 6 to 9 km depth which is interpreted as a magma chamber, along with possible dyke and sill systems which connect to it from greater depths. Additional earthquakes from 2010 and 2011 when the station coverage was improved are now being added to the inversion to provide extra constraints.

5.5 Regional earthquake studies

A new PhD student, Tim Greenfield, has started in October 2011 and will use both regional earthquakes and active sources to probe the lower crust along the entire NVZ. Using various techniques such as seismic refraction, receiver function analysis and tomography he will image the structure of the rift. Early results determined during a Cambridge MSci Masters project (**?**) using the 2010 NVZ network with events from the Tjörnes Fracture Zone and beneath the Vatnajökull icecap, show the possibility of confirming a high velocity zone beneath Krafla and attenuation of high frequencies as the rays pass through volcanic centres, possibly due to the presence of melt.

6 Publications

6.1 International Reviewed Publications

Soosalu, H., J. Key, R.S. White, C. Knox, P. Einarsson, and S.S. Jakobsdóttir (2010). Lower-crustal earthquakes caused by magma movement beneath Askja volcano on the north Iceland rift. *Bulletin of Volcanology*, **72**, 55–62.

Martens, H.R., R.S. White, J. Key, J. Drew, H. Soosalu, S. Jakobsdóttir (2010). Dense seismic network provides new insight into the 2007 Upptyppingar dyke intrusion. *Jökull*, **60**,47–66.

Key, J., R.S. White, H. Soosalu, S.S. Jakobsdóttir (2011). Multiple melt injection along a spreading segment at Askja, Iceland. *Geophysical Research Letters*, **38**, L05301.

Key, J., R.S. White, H. Soosalu, S.S. Jakobsdóttir (2011). Correction to "Multiple melt injection along a spreading segment at Askja, Iceland". *Geophysical Research Letters*, **38**, L10308.

White, R.S., J. Drew, H. Martens, J. Key, H. Soosalu and S.S. Jakobsdóttir (2011). Dynamics of dyke intrusion in the mid-crust of Iceland. *Earth and Planetary Science Letters*, **304**, 300–312.

6.2 Conference presentations

Total of 15 national and international conference presentations, full list on SEIS-UK website.

6.3 PhD, MPhil and MSci Theses

Drew, J. (2010) Coalescence microseismic mapping: an imaging method for the detection and location of seismic events. University of Cambridge PhD Thesis.

Martens, H.R. (2010) Microseismic Evidence for Active Dyke Emplacement in Iceland's Northern Volcanic Zone. University of Cambridge MPhil Thesis.

Eilon, Z. (2010) Investigation of crustal earthquakes near Upptyppingar, Iceland. University of Cambridge Masters Thesis.

Turner, M. (2010) Shallow Level Seismicity Around Herðubreið, Northern Iceland. University of Cambridge Masters Thesis.

Greenfield, T. (2011) Microseismicity of the Krafla Volcanic System, Iceland. University of Cambridge Masters Thesis.

Key, J. (2011) Tracking Melt with Lower Crustal Earthquakes at Askja, Iceland. University of Cambridge PhD Thesis.

Mitchell, M. (2011) 3-D Tomographic Inversion of Local Microseismic Events to Image the Askja Magma Chamber, Iceland. University of Cambridge MPhil Thesis.

6.4 Papers in preparation

Additional papers include a tomography-based paper from Michael Mitchell and a more detailed lower crustal earthquakes paper from Janet Key (now PostDoc). Tim Greenfield is expected to publish several papers during the course of his PhD.

References not listed in Section 6: Publications

Darbyshire, F., R. White, and K. Priestley (2000). Structure of the crust and uppermost mantle of iceland from a combined seismic and gravity study. *Earth and Planetary Science Letters* **181**(3), 409–428.

Goldstein, P., D. Dodge, M. Firpo, and L. Milner (2003). Signal processing and analysis tools for seismologists and engineers. *Invited contribution to The IASPEI International Handbook of Earthquake and Engineering Seismology,* Edited by W.H.K. Lee, H. Kanamori, P.C. Jennings, and C. Kisslinger, Academic Press, London.

Jakobsdóttir, S., M. Roberts, G. Gudmundsson, H. Geirsson, and R. Slunga (2008). Earthquake swarms at upptyppingar, north-east iceland: A sign of magma intrusion? *Studia Geophysica et Geodaetica* **52**(4), 513–528.

Jakobsdottir, S. S. (2008). Seismicity in iceland: 1994-2007. *Jokull* **58**, 75–100.

Key, J., H. Soosalu, and R. White (2008). Askja 2007 seismic project, scientific report. Technical report, Bullard Laboratories, University of Cambridge.

Key, J. and R. White (2009). Interim Report for Extension to GEF Loan 857. Technical report, Bullard Laboratories, University of Cambridge.

Klein, F.W. (2002) User's Guide to HYPOINVERSE-2000 a Fortran Program to Solve for Earthquake Locations and Magnitudes. *U.S. Geological Survey Open File Report 02-171*.

Reasenberg, P.A. and D. Oppenheimer (1985) FPFIT, FPPLOT and FPPAGE: Fortran computer programs for calculating and displaying earthquake fault-plane solutions. *U.S. Geological Survey Open File Report 85-739*.

Rymer, H., C. Locke, B. G. Ófeigsson, P. Einarsson and E. Sturkell (2010). New mass increase beneath Askja Volcano, Iceland - a precursor to renewed activity? *Terra Nova*, **22**(4), 309-313, doi: 10.1111/j.1365.3121.2010.00948.x.

Soosalu, H. and R. White (2007, October). Herðubreið 2006 - seismic project, scientific and technical report. Technical report, Bullard Laboratories, University of Cambridge.

Sturkell, E., F. Sigmundsson, and R. Slunga (2006). 1983–2003 decaying rate of deflation at askja caldera: Pressure decrease in an extensive magma plumbing system at a spreading plate boundary. *Bulletin of Volcanology* **68**(7), 727–735.

Waldhauser, F. (2001) HypoDD: A computer program to compute double-difference hypocentre locations. *U.S. Geological Survey Open File Report 01-113*.

7 Appendix

Table 1: Summary of Askja stations 2008-present including locations, instrument details and power source, T in panels column indicates windturbine as additional power source

Name	Lat. (N)	Long. (W)	Alt. (m)	Installed	Sensor Serial	Size (GB)	Sample Rate	Panels (Total W)	Batteries (Total Ah)
BRUN	65°16.87	16°51.96	536	21/07/11-12/09/11	6D73	16	100	50	230
				12/09/11-present	"	"	"	90	"
DDAL	65°04.64	16°56.00	801	03/07/08-26/08/08	6132	16	100	120	240
				26/08/08-20/07/11	"	"	50	"	"
				20/07/11-12/09/11	"	"	100	"	"
				12/09/11-present	"	"	"	"	355
FJAL	65°00.57	17°02.26	837	03/07/08-26/08/08	6177	16	100	120	240
				26/08/08-07/07/10	"	"	50	"	"
FJAS	65°01.48	17°05.53	798	21/07/11-12/09/11	6D79	16	100	80	115
				12/09/11-present	"	"	"	110	230
FLAT	65°10.97	16°29.88	728	09/07/10-21/08/10	6041	16	50	80	230
				21/08/10-19/07/11	"	"	"	110	"
				19/07/11-present	"	"	100	"	"
FLUR	64°50.61	17°01.61	838	07/07/10-19/08/10	6145	16	50	60	230
				19/08/10-20/07/11	"	"	"	120	"
				20/07/11-present	"	"	100	"	"
FREF	65°21.11	16°17.01	533	04/07/08-27/08/08	6153	16	100	60	320
				27/08/08-11/07/10	"	"	50	120	"
				11/07/10-17/07/11	"	"	"	100	"
				17/07/11-11/09/11	"	"	100	"	"
HELI	65°11.92	16°13.11	491	07/07/08-30/08/08	6166	16	100	20	280
				30/08/08-06/07/10	"	"	50	120	135
				06/07/10-20/08/10	"	"	"	80	"
				20/08/10-19/07/11	"	"	"	120	"
				19/07/11-present	"	"	100	"	"
HOTT	65°02.85	16°31.79	718	01/07/08-29/08/08	6135	16	100	60	120
				29/08/08-20/07/11	"	"	50	120	240
				20/07/11-present	"	"	100	"	"
HRIM	64°53.78	16°58.75	849	07/07/10-19/08/10	6575	16	50	60	230
				19/08/10-20/07/11	"	"	"	120	"
				20/07/11-present	"	"	100	"	"
HRUR	65°09.35	16°40.53	697	08/07/10-20/08/10	6177	16	50	80	240
				20/08/10-20/07/11	"	"	"	120	"
				20/07/11-present	"	"	100	"	"
KIST	64°47.45	17°21.99	1145	12/09/11-present	6360	4	50	60	320
KOLL	65°17.41	16°34.04	593	04/07/08-27/08/08	6200	16	100	60	240
				27/08/08-11/07/10	"	"	"	120	"
				11/07/10-17/07/11	"	"	"	100	"
				17/07/11-present	36797	16	"	"	355
LOKA	65°09.42	16°49.23	734	02/07/08-26/08/08	6041	16	100	60	240
				26/08/08-08/07/10	"	"	50	120	"
LIND	64°51.17	16°27.14	726	19/07/11-11/09/11	36794	16	100	90	345
				11/09/11-present	"	"	"	110	"
MIDF	65°05.21	16°19.78	572	06/07/08-29/08/08	6026	4	100	20	160
				29/08/08-15/09/08	"	"	50	100	280
				15/09/08-06/07/10	6212	16	"	"	"
				06/07/10-19/07/11	"	"	"	"	200
				19/07/11-present	"	"	100	"	"
MOFO	64°59.06	16°39.07	702	30/06/08-26/08/08	6212	16	100	20	120
				28/08/08-20/07/11	6117	16	50	120	240
				20/07/11-11/09/11	"	"	100	"	"
				11/09/11-present	"	"	"	"	355
MYVO	65°09.33	16°22.14	639	01/07/08-30/08/08	6106	4	50	60	120
				30/08/08-08/07/10	6075	16	50	120	240
				08/07/10-19/07/11	"	"	"	60 + T	"
				19/07/11-13/09/11	"	"	100	80	"
				13/09/11-present	"	"	"	100	"
OSKV	65°02.36	16°42.10	1209	20/07/11-13/09/11	6D76	16	100	100	150
				13/09/11-present	"	"	"	"	300
RODG	64°59.11	16°53.18	1022	05/07/08-28/08/08	6205	16	100	60	240
				28/08/08-26/07/09	"	"	50	"	"
				26/07/09-19/08/10	"	"	"	100	"
				19/08/10-20/07/11	"	"	"	120	"
				20/07/11-12/09/11	"	"	100	"	"
				12/09/11-present	"	"	"	"	355
SVAD	65°07.05	16°34.50	680	02/07/08-26/08/08	6128	16	100	60	240
				26/08/08-20/07/11	"	"	50	120	"
				20/07/11-present	"	"	100	"	"

Continued on next page

Table 1 – continued from previous page

Name	Lat. (N)	Long. (W)	Alt. (m)	Installed	Sensor Serial	Size (GB)	Sample Rate	Panels (Total W)	Batteries (Total Ah)
TOHR	64°54.99	16°47.08	715	05/07/08-28/08/08	6116	16	100	120	240
				28/08/08-20/07/11	"	"	50	"	"
				20/07/11-present	"	"	100	"	"
TOLI	65°06.20	16°07.17	537	27/07/09-06/07/10	6025	8	100	80	230
				06/07/10-18/08/10	"	"	50	"	"
				18/08/10-19/07/11	"	"	"	110	"
				19/07/11-present	"	"	100	"	"
UTYR	65°02.16	16°19.12	623	30/06/08-29/08/08	6087	16	100	60	240
				29/08/08-19/07/11	"	"	50	120	"
				19/07/11-present	"	"	100	"	"
VADA	64°59.69	16°32.29	673	30/06/08-28/08/08	6038	16	100	20	120
				28/08/08-06/07/10	"	"	50	120	240
				06/07/10-20/07/11	"	"	"	120 + T	"
				20/07/11-11/09/11	"	"	100	120	"
				11/09/11-present	"	"	"	120 + T	355
VEGG	65°22.92	16°22.48	507	11/07/10-17/07/11	6163	16	50	80	230
				17/07/11-present	"	"	100	"	"
VIBR	65°03.97	16°43.94	1110	06/07/08-29/08/08	6305	4	100	20	80
				29/08/08-25/07/09	"	"	50	None	280
VIKR	65°04.48	16°30.81	718	01/07/08-28/08/08	6360	4	100	20	80
VISA	65°04.14	16°24.22	640	01/07/08-27/08/08	6359	4	100	20	120
VONA	64°40.28	17°50.57	949	13/07/11-05/09/11	36796	16	100	100	230
VONS	64°40.41	17°45.29	952	05/09/11-present	36796	16	100	100	255