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Uppsetning Þennslumæla til Vöktunar á Jaðskorpuhreifingum undir Kötlu

Rannsóknaráðstefna Vegagerðarinnar 2015, 30. október

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Background:
Borehole strainmeters in Iceland

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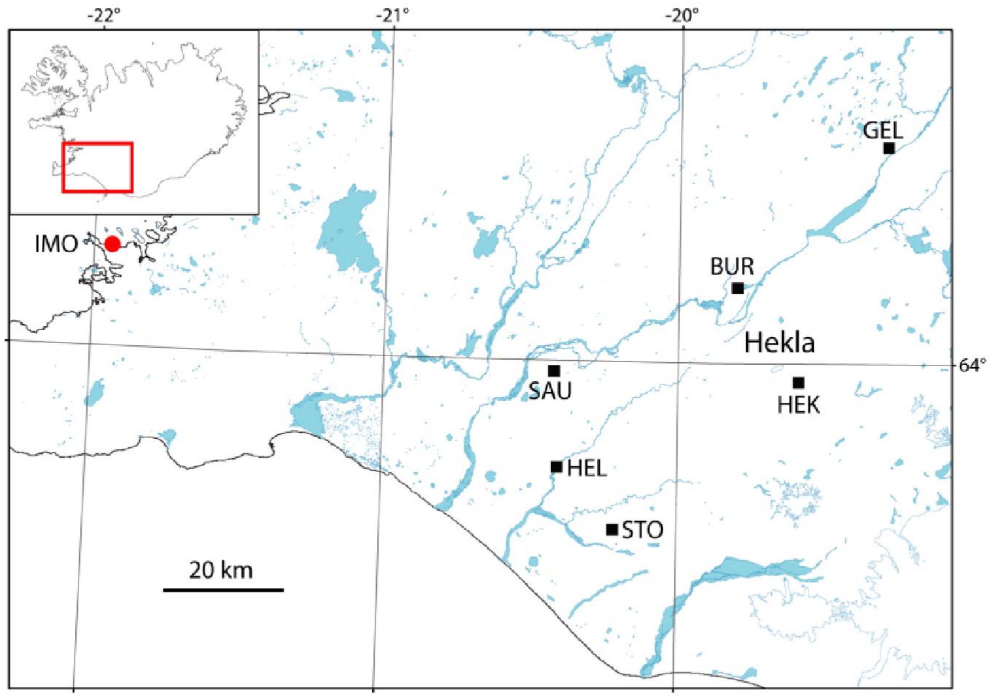
- Six volumetric strainmeters in use in southern Iceland since 1979.
- The network was established in collaboration with the Carnegie Institution of Science, Washington D.C.
- Goal: To observe regional-scale crustal deformation caused by strong earthquakes.



In early 2015, four stations were operational (BUR, HEK, HEL, & STO)

Background: Borehole depths

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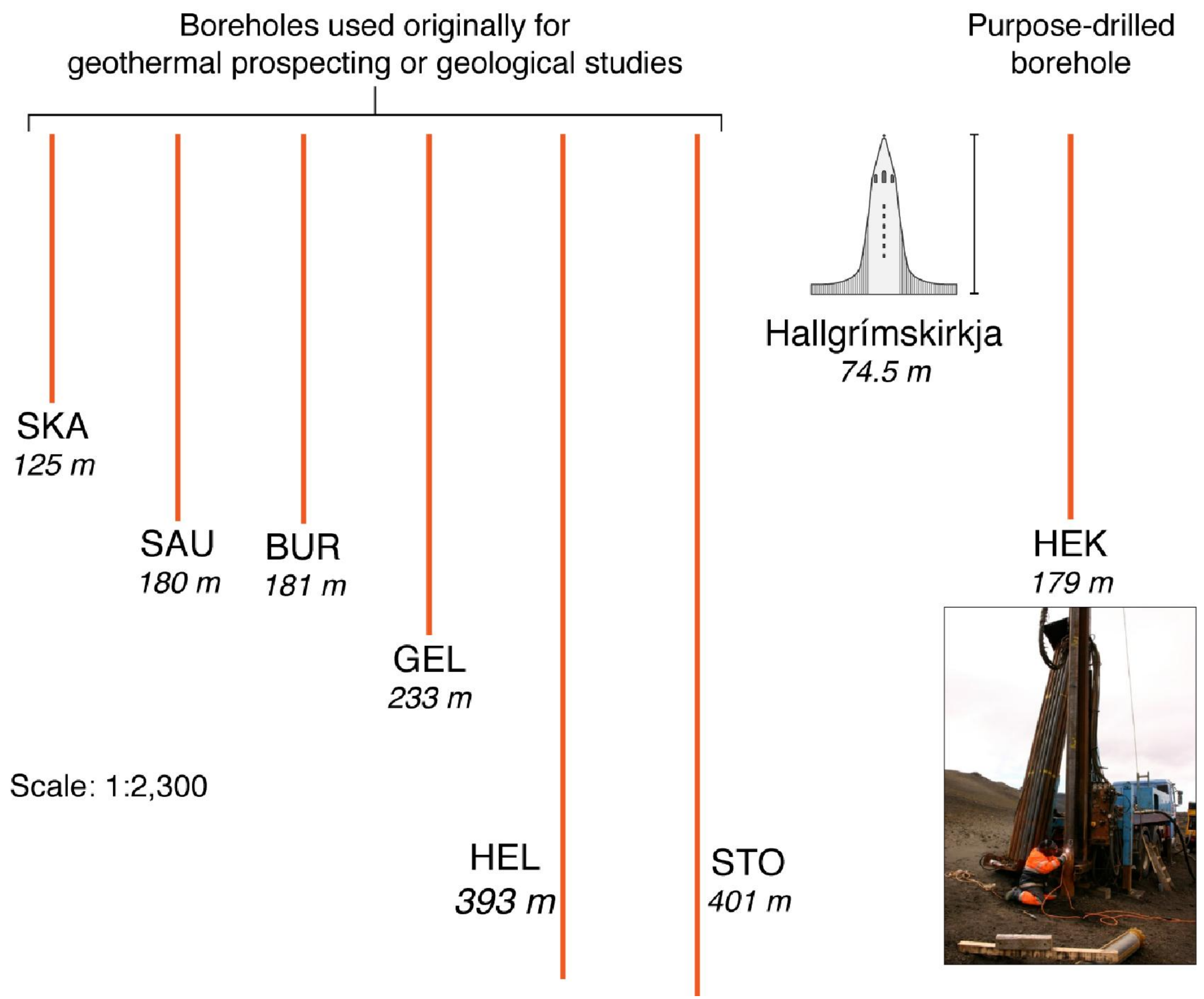
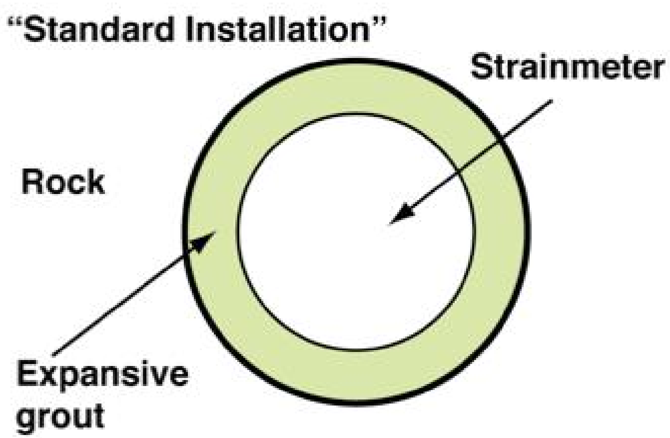


Background:
Single-component strainmeter

- Essentially an oil-lined steel tube, 3–6 m in length and 7–15 cm in diameter.
- Expansive grout used to ‘connect’ the strainmeter to the surrounding rock.



Background: Borehole strainmeters

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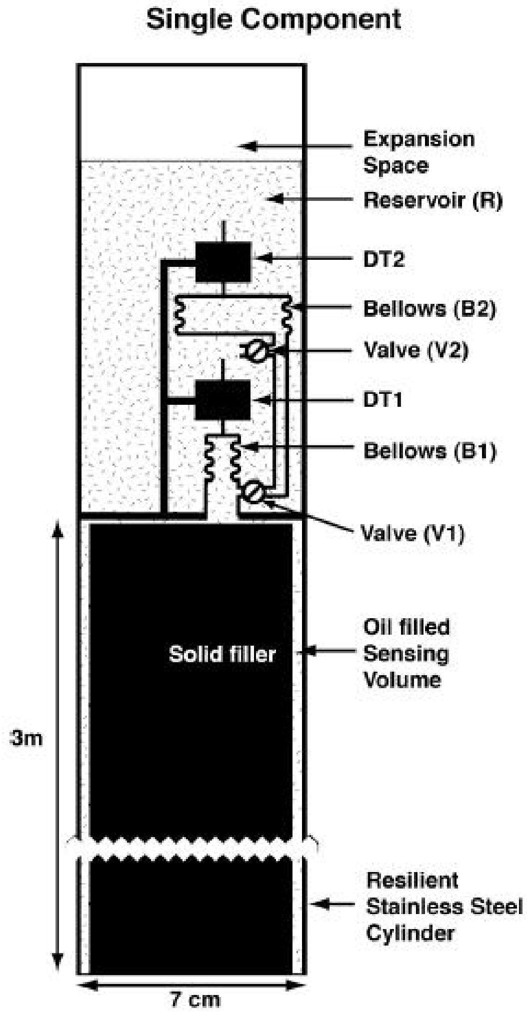
- Compressive strain causes silicon oil to be expelled from the sensing volume via a narrow tube to an expansion space.
- Oil from the sensing volume passes through two bellows (B1 & B2); electromagnetic transducers (DT1 & DT2) are used to measure the movement of these bellows.



Application to volcano monitoring

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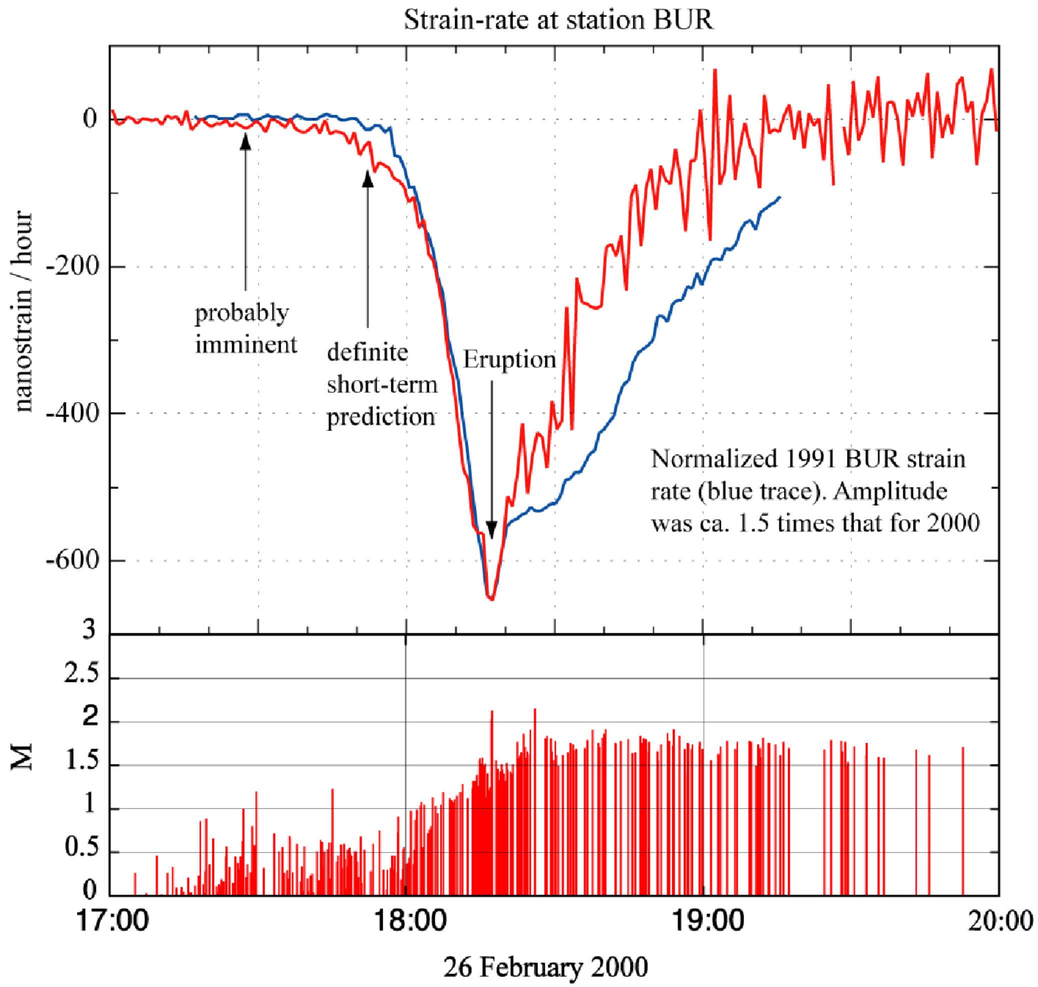
- The monitoring network has proved essential for monitoring volcanic eruptions of Hekla.
- Strain pulses registered at Búrfell (BUR) tens of minutes before the 1991 and 2000 eruptions of Hekla enabled public warnings to be issued before each eruption began.



Exceptionally sensitive instruments

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- Over short intervals, volumetric strainmeters can resolve strain changes as small as 0.002 mm km^{-1} (i.e. $\sim 10^{-11}$).
- This makes them ideal for measuring crustal deformation over periods ranging from minutes to months.
- The frequency response and dynamic range of borehole strainmeters is unsurpassed.

Recurrence interval of ash-producing Katla eruptions since 1179 AD

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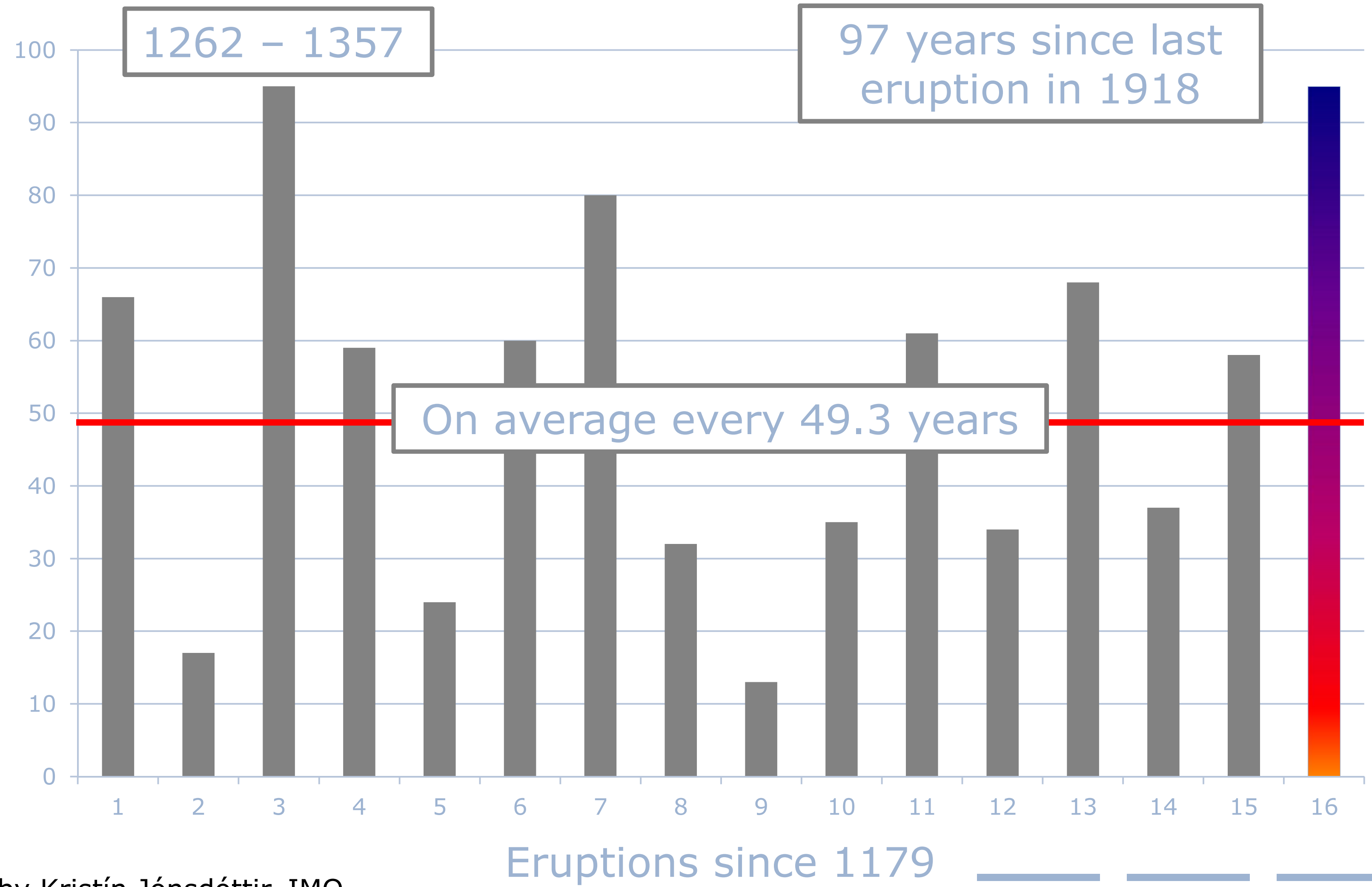

Prepared by Kristín Jónsdóttir, IMO

Location of new Katla strainmeter

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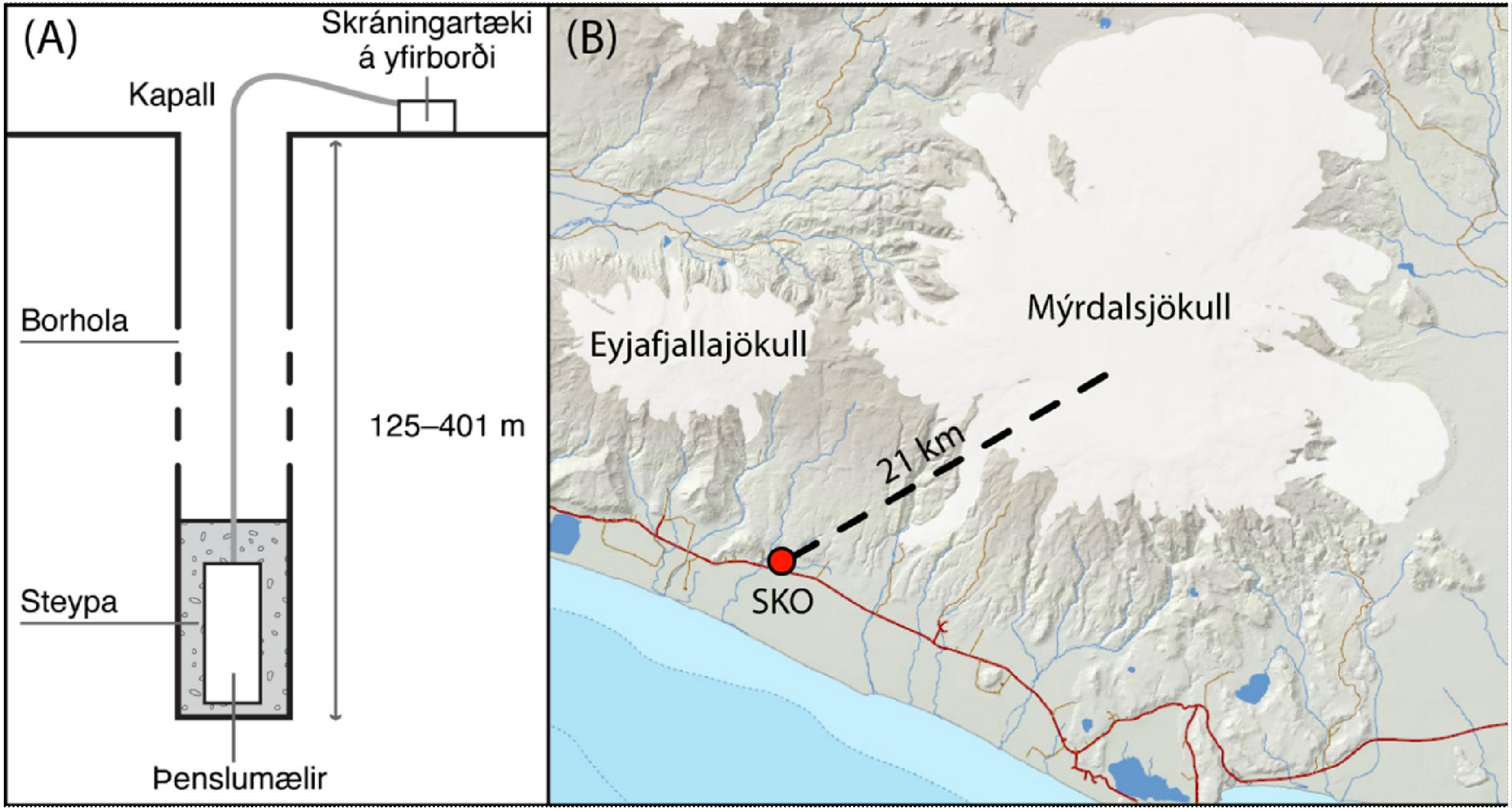

Borehole YS-01, Eystri-Skógar

Aerial photograph of Skógar museum, showing the distance from the transport museum (samgöngusafn) to borehole YS-01.

Borehole YS-01, Eystri-Skógar

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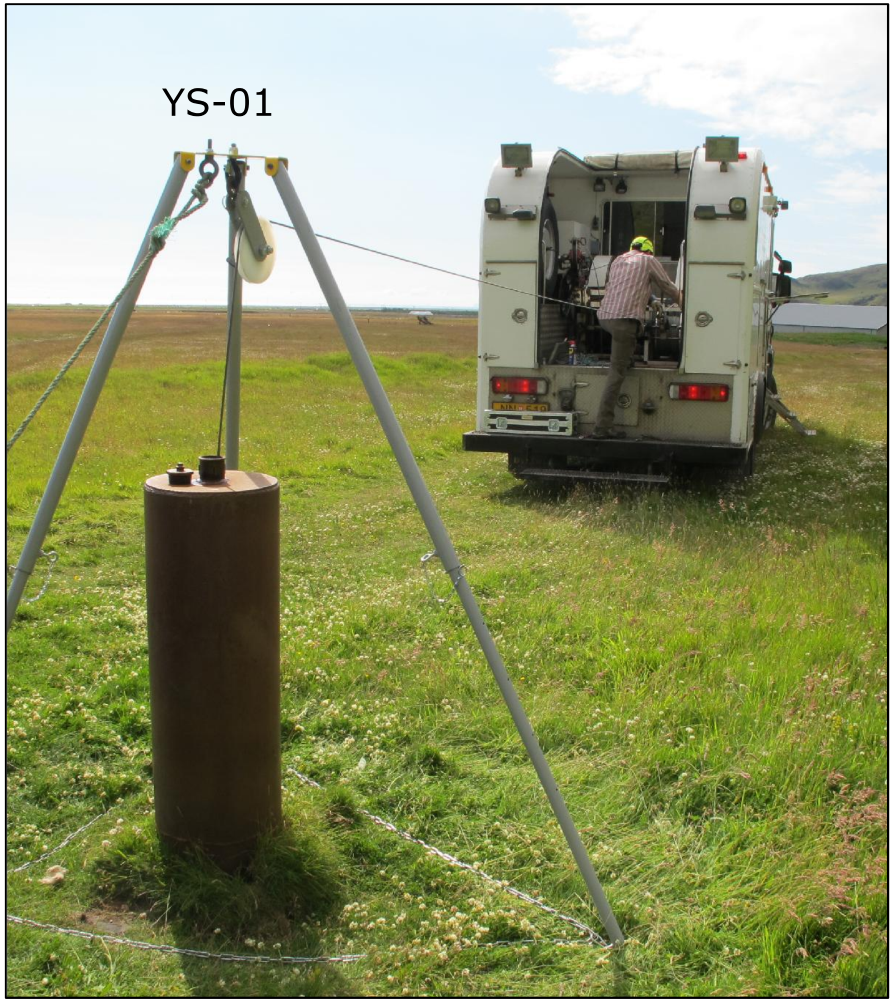
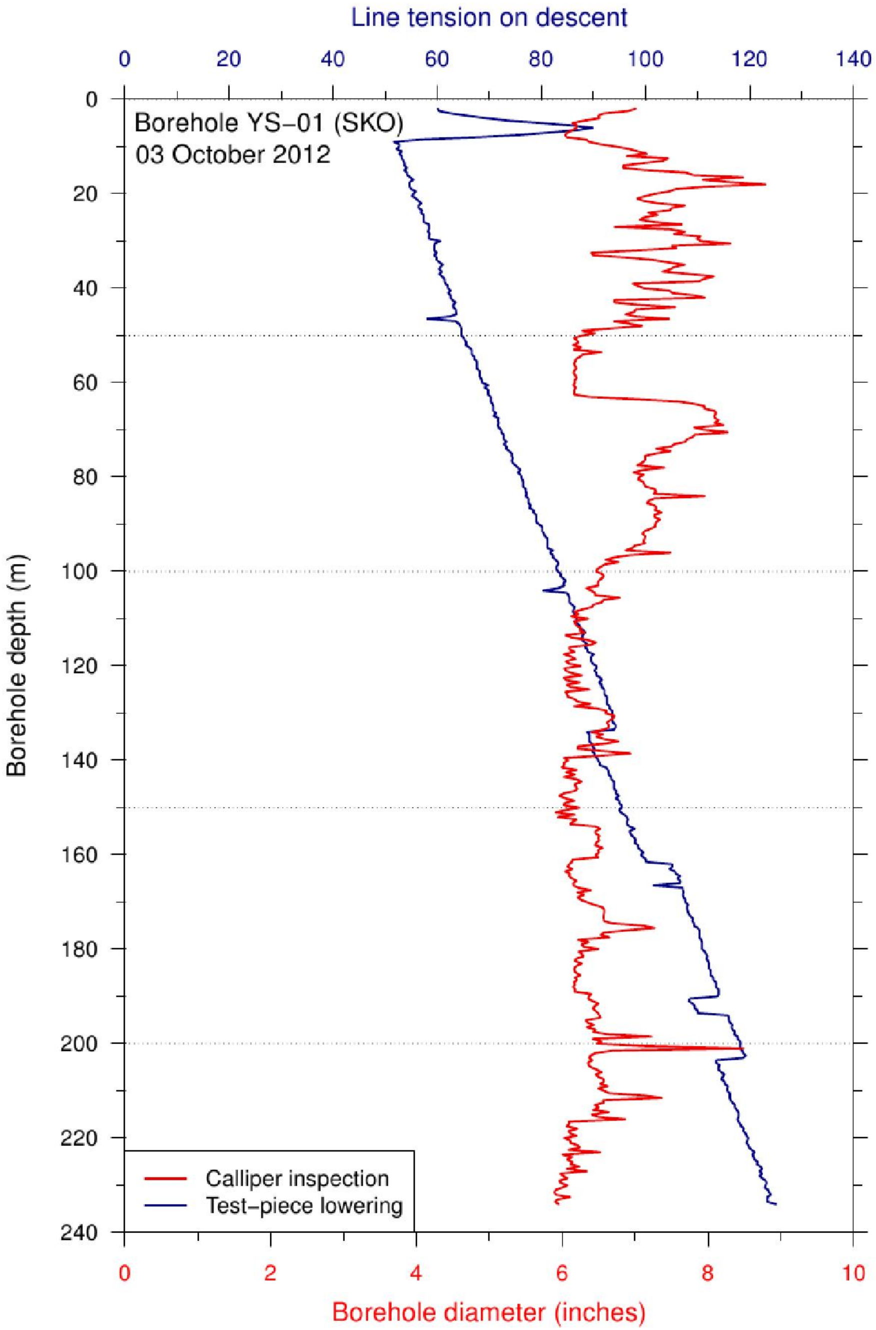
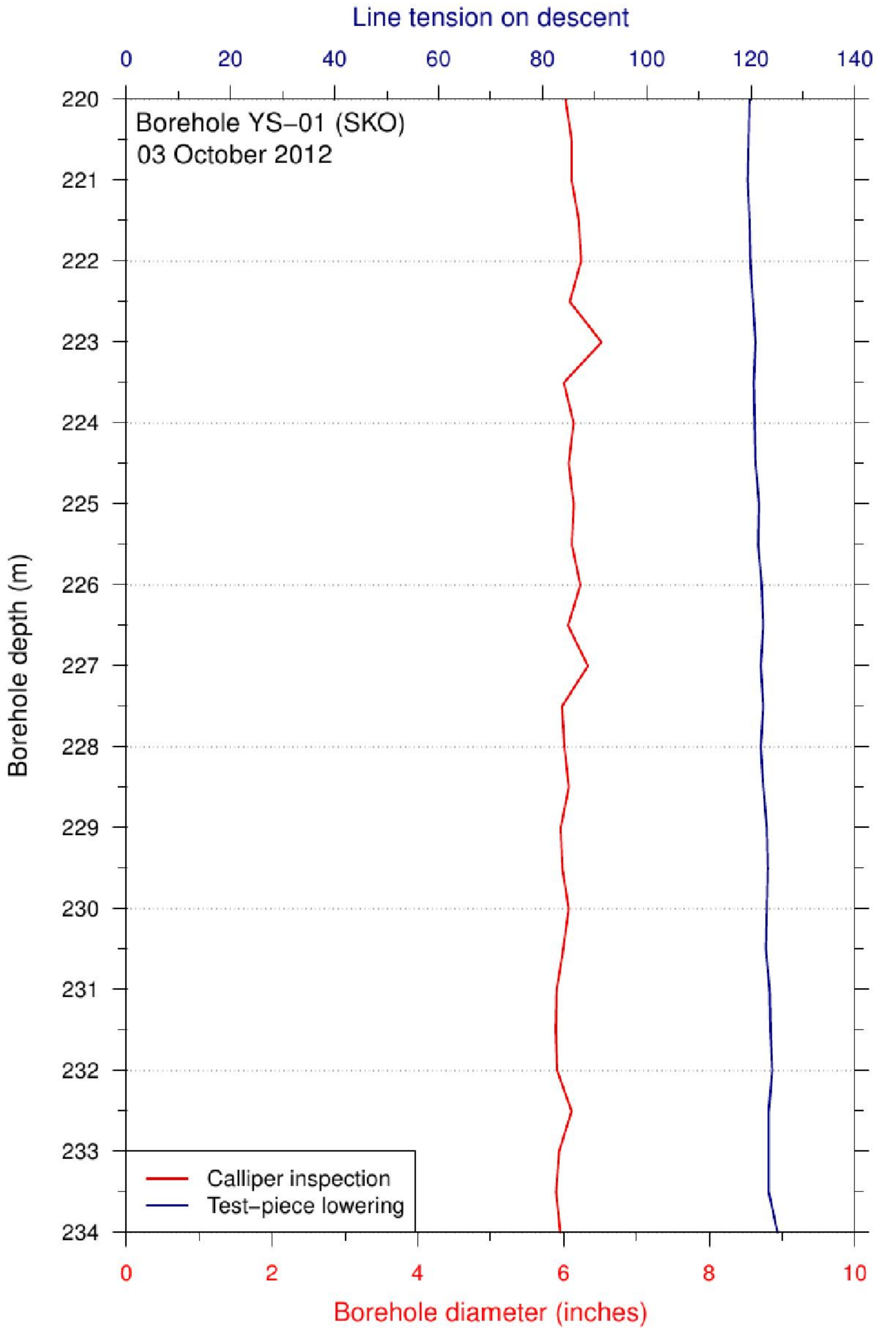
Westward ground view from borehole YS-01 to the Skógar museum. July 2012.

Borehole inspection by ÍSOR
Video footage and calliper measurements





Line tension on descent
0
20
40
60
80
100
120
140
Borehole YS−01 (SKO)
03 October 2012
Borehole depth (m)
0
20
40
60
80
100
120
140
160
180
200
220
240
Calliper inspection
Test−piece lowering
0
2
4
6
8
10
Borehole diameter (inches)



Line tension on descent
0
20
40
60
80
100
120
140
Borehole YS−01 (SKO)
03 October 2012
Borehole depth (m)
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
Calliper inspection
Test−piece lowering
0
2
4
6
8
10
Borehole diameter (inches)

Preparation of the surface enclosure

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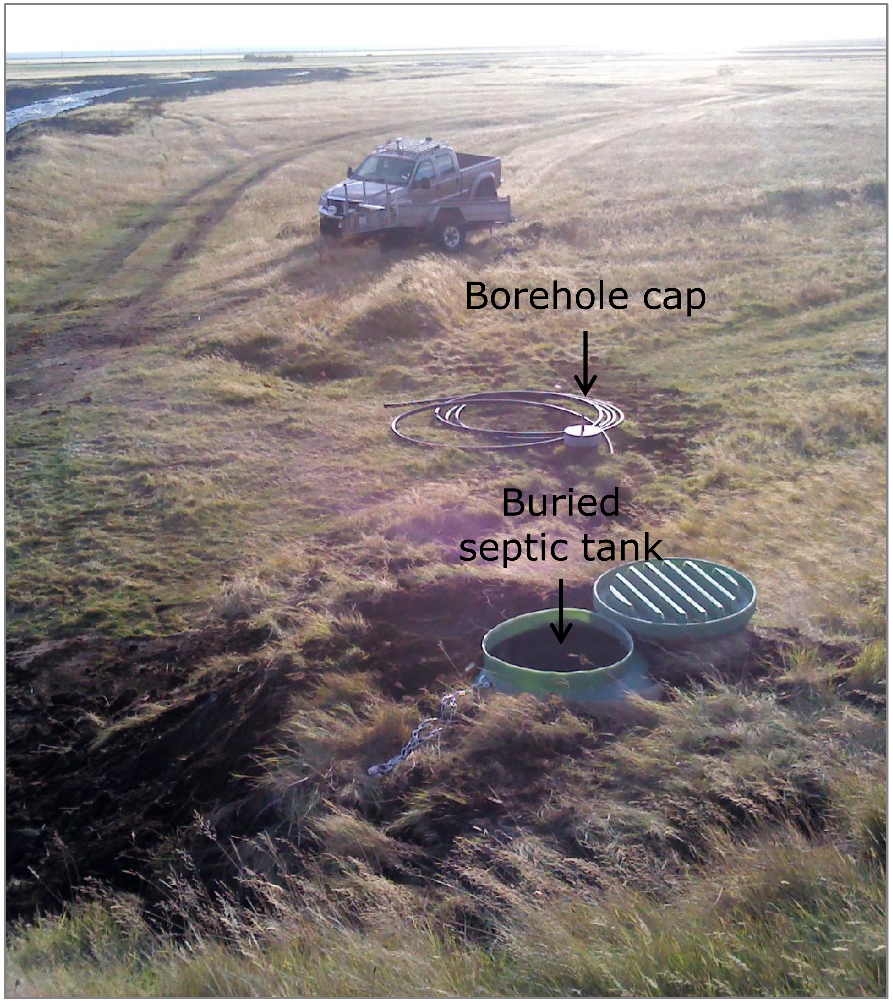

Layout inside strain station SKO

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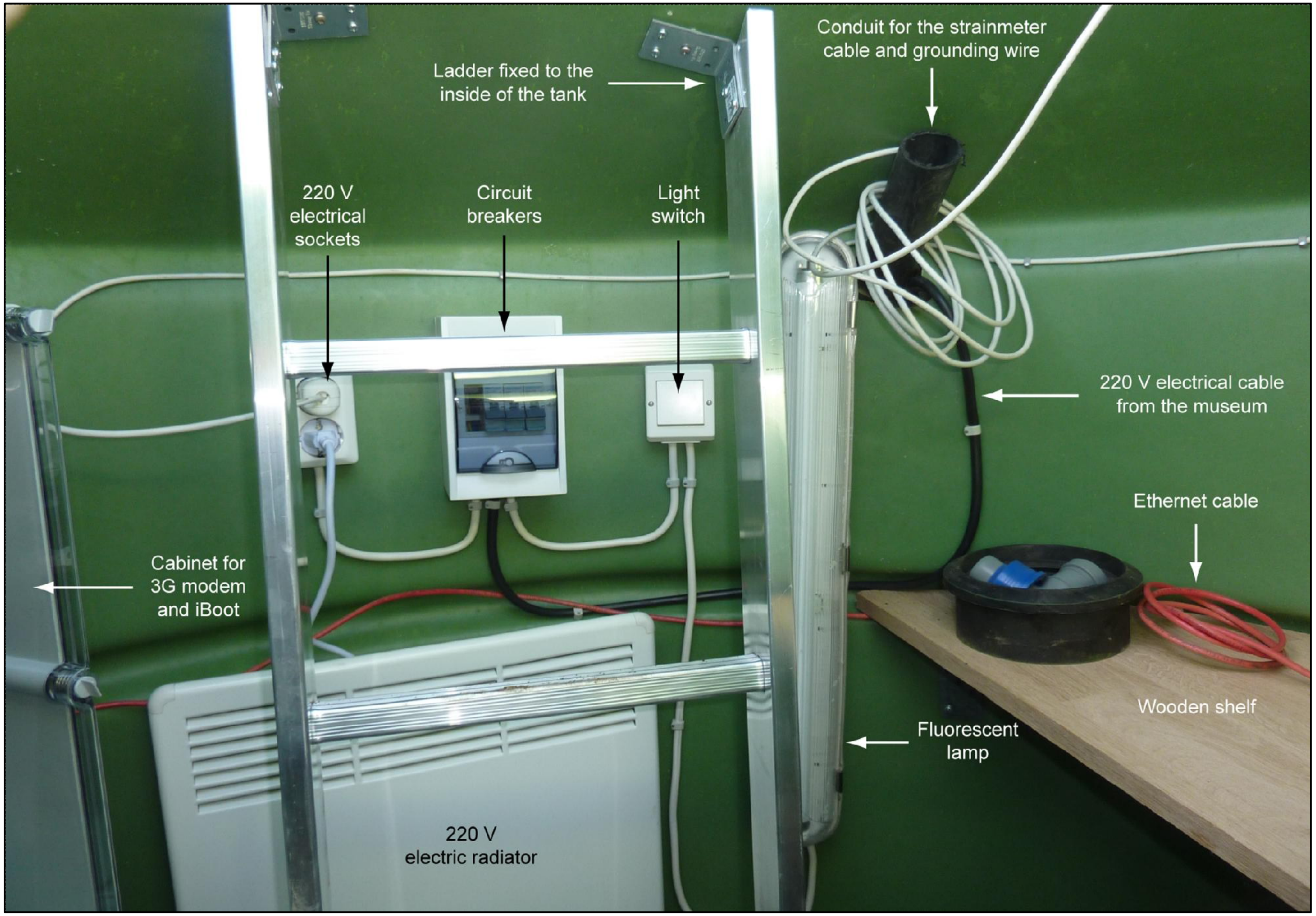

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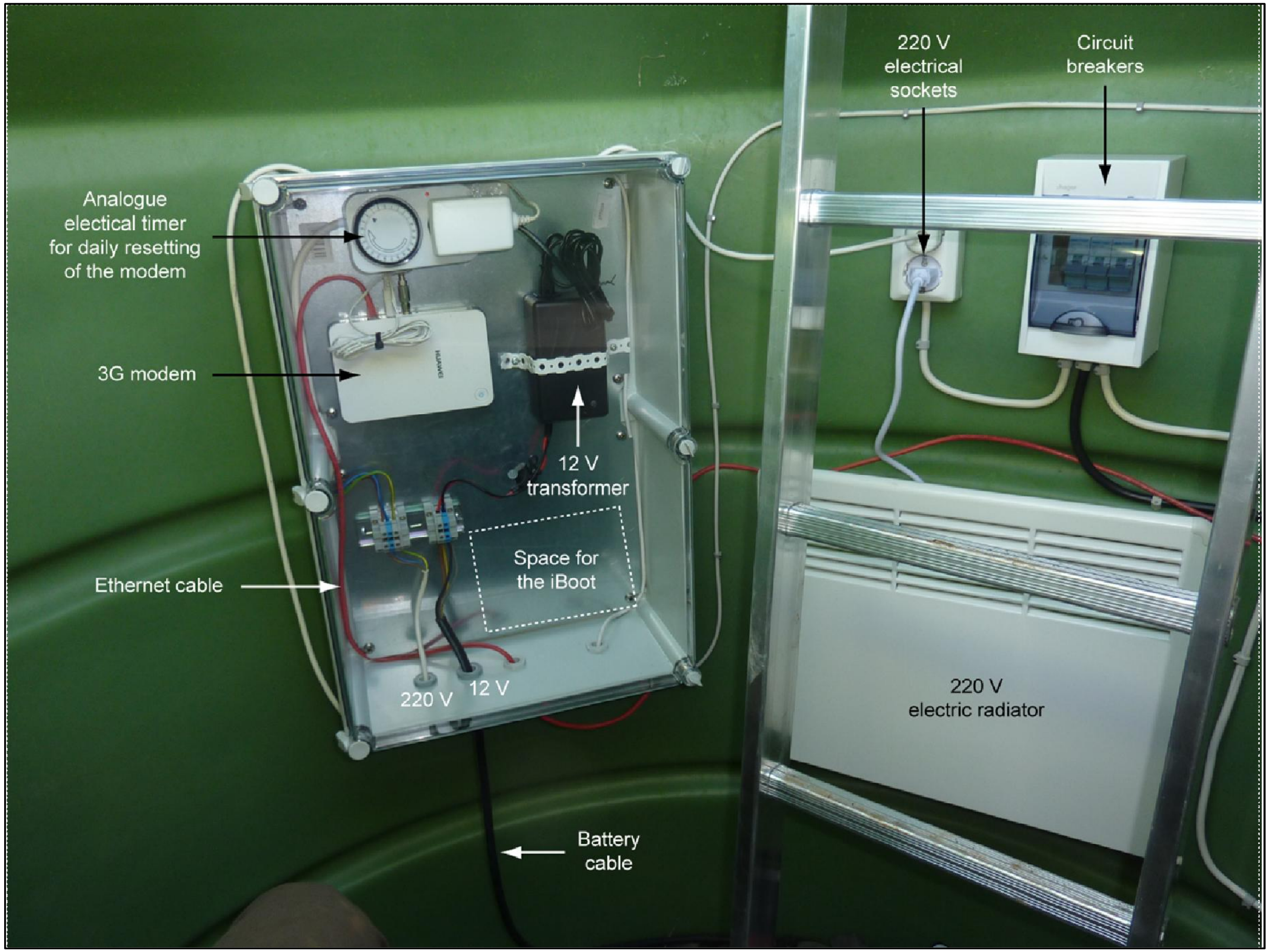

Installation day: 24 June 2015

Empty bailer about to be lowered down the borehole for testing purposes…

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Installation day: 24 June 2015

Electrical cable connected to the strainmeter, ready for the instrument to be lowered into the borehole

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Grout mixed next to borehole and then poured into the bailer


Strainmeter about to be lowered down the borehole

Detection of earthquakes confirms good connection to local bedrock

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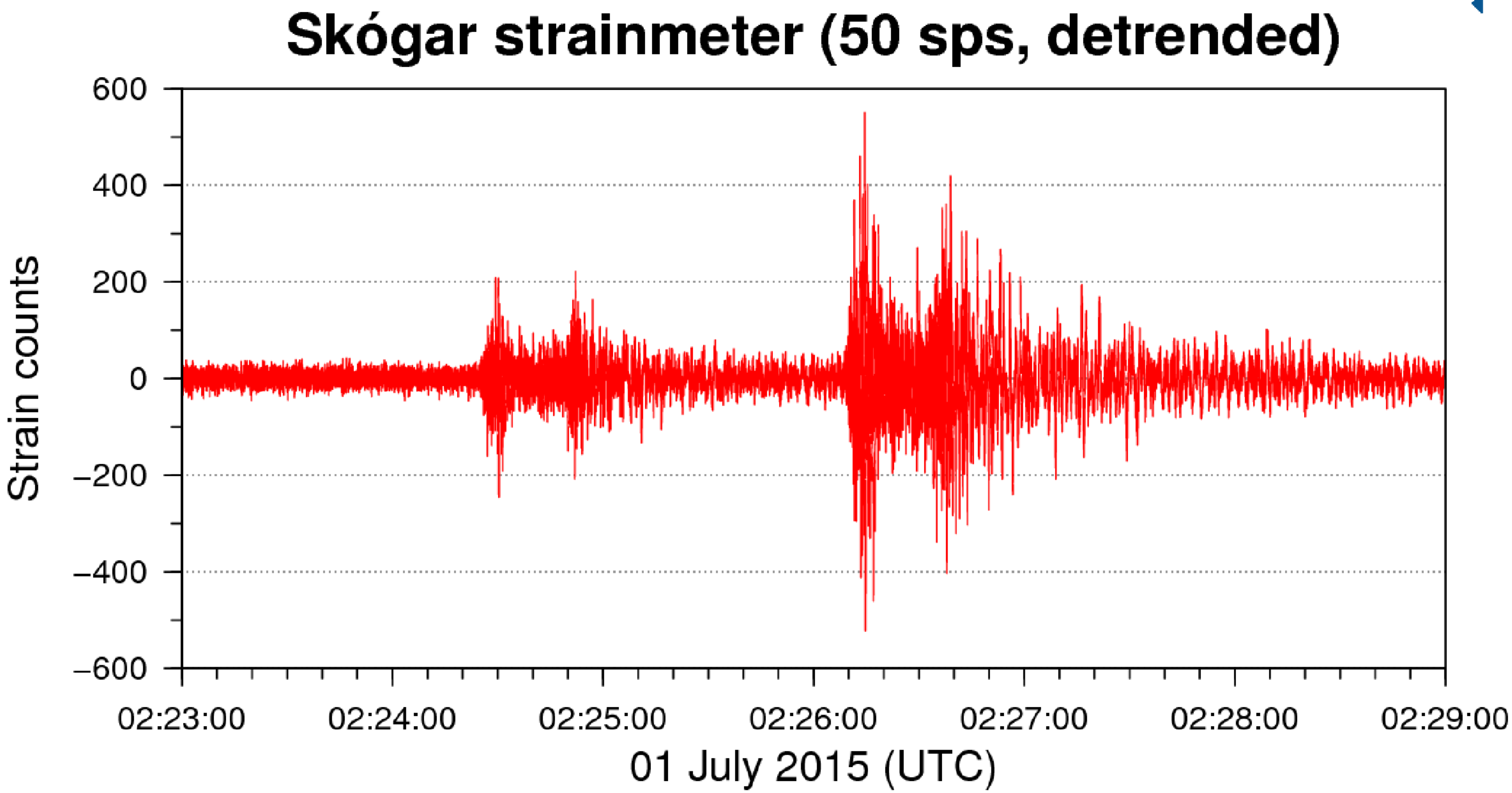

Summary and next steps

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- Strainmeter SKO was installed successfully on 24 June 2015 at a depth of ~222 m.
- Strain signals from the station show that a solid connection between the instrument and the surrounding rock.
- Near-real-time strain data from SKO, together with other geophysical measurements, can be used to monitor signs of volcanic unrest, particularly the onset of an eruption.
- In 2016, strain data from SKO will be made available to the public via the Veðurstofan web-site.
- A second strainmeter has been made by the Carnegie Institution for use around Katla; work is underway on securing funding for the installation work.

Time-lapse video of the installation work

Play video...