EGU2020-10569

Seismic and geodetic response to crustal deformation in Krísuvík volcanic system, southwest Iceland

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Disclaimer: Ongoing research.
Results pending due delay in funding following COVID-19 outbreak

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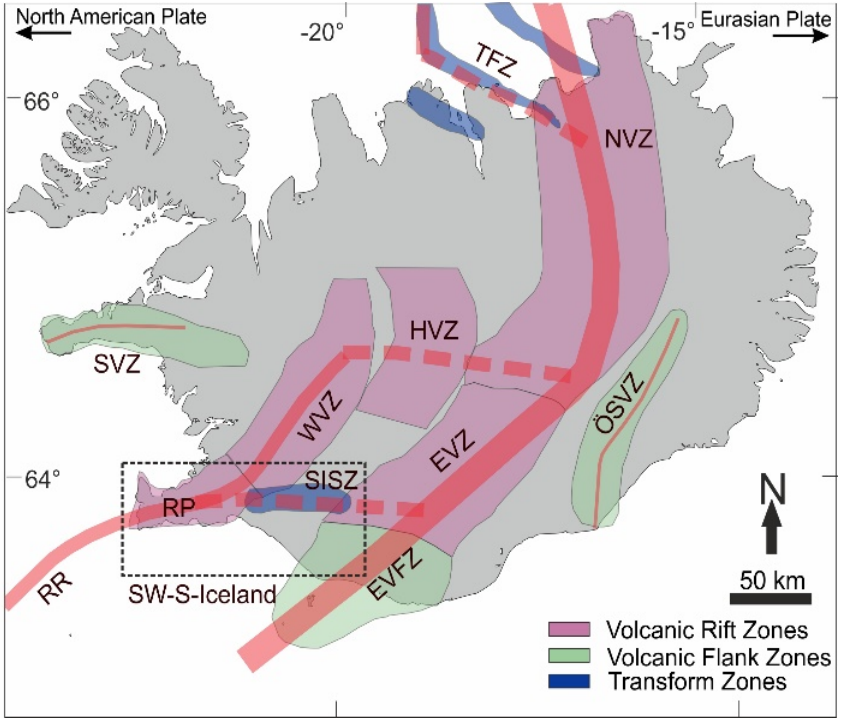
Tectonic backdrop of Southwest- and South-Iceland (SW-S-Iceland)



Modified after Sigmundsson et al. (2018)

- Icelandic plate boundary is the aerial extension of Mid-Atlantic Ridge (MAR).
- Complexity due to interaction with Icelandic hotspot
- Spreading, volcanic zones offset by transform zones
- 18-19 mm/yr spreading (NUVEL-1A)

The red solid and dashed lines depict the approximate structure of the plate boundary.

The black dashed box includes the study areas – Reykjanes Peninsula (RP) and South Iceland Seismic zone (SISZ).

Other abbreviations: TFZ=Tjörnes Fracture zone; NVZ=Northern Volcanic Zone; ÖSVZ=Öræfajökull-Snæfell Volcanic Zone; EVZ=Eastern Volcanic Zone; WVZ=Western Volcanic Zone; HVZ= Hofsjökull Volcanic Zone; EVFZ=Eastern Volcanic Flank Zone; SVZ=Snæfellsnes Volcanic Zone; RR=Reykjanes Ridge.

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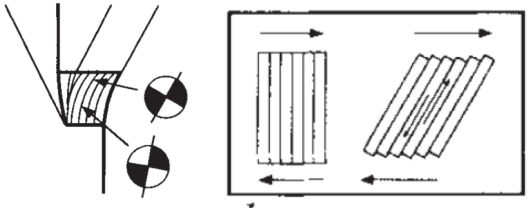
Faulting in South Iceland; volcanic and seismic interactions

Ref: Wetzel et al., 1993

Bookshelf-type faulting

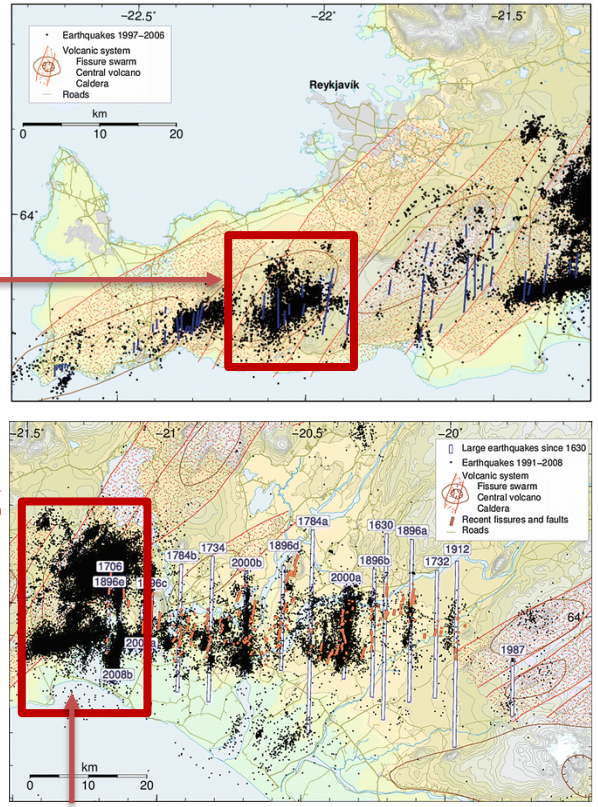


RP

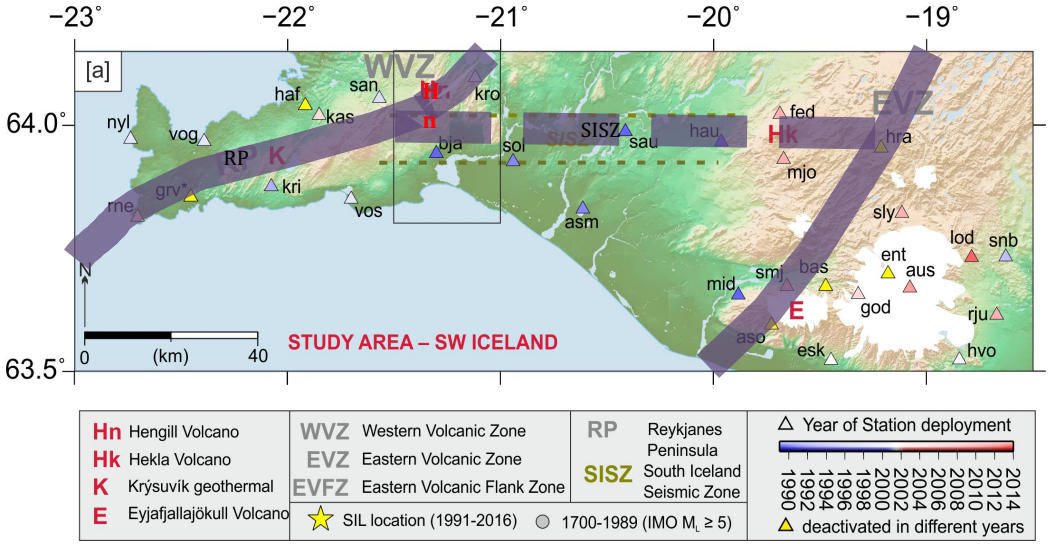
Krísuvík

SISZ

Hengill volcano + western SISZ



Ref: Einarsson, 2015



Ref: Parameswaran et al., 2020a; Revision under review

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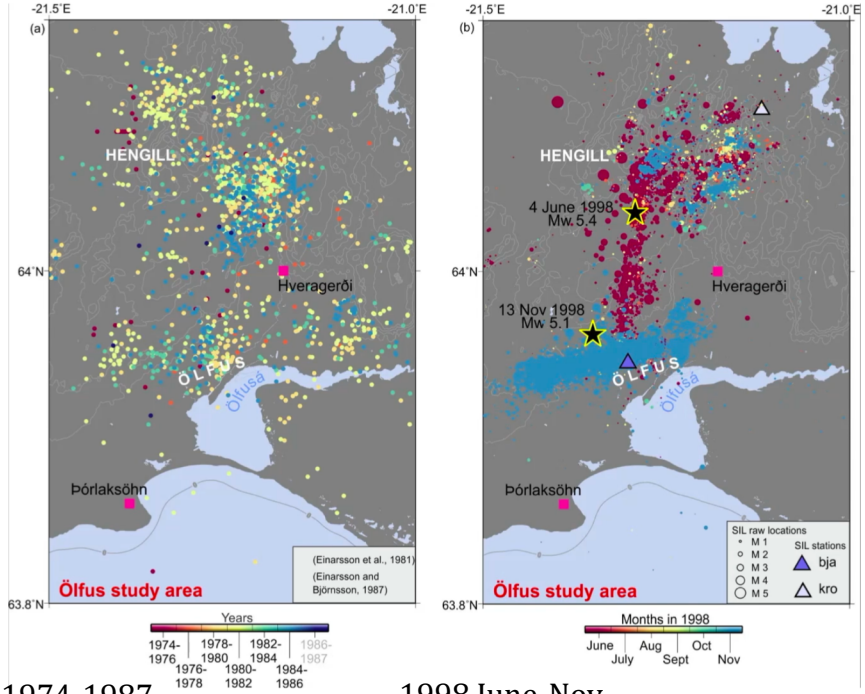
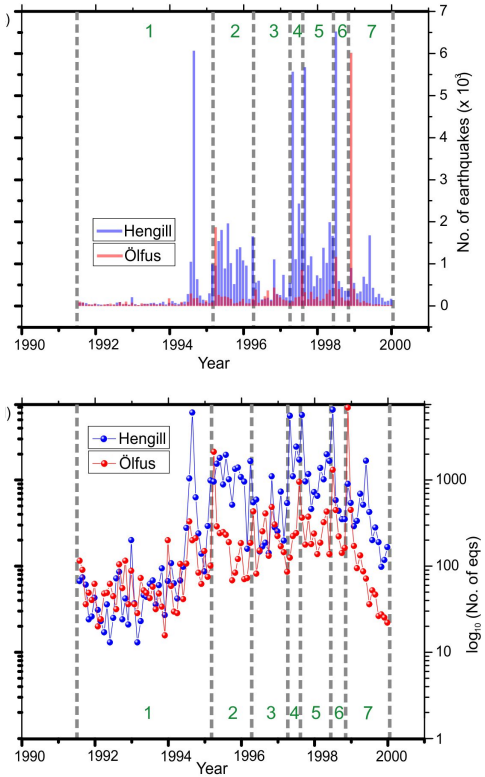
Example: Hengill – SISZ (Hjalli-Ölfus area) interaction

Ref: Parameswaran et al., 2020a; Revision under review



1974-1987 1998 June-Nov



Events from July 1991 to December 1999.

Interaction possibly due to an inflation episode in Hengill from 1994-1998 (e.g., Feigl et al, 2000)

Is the Ölfus region a transition between the RP, SISZ, and WVZ?

See more at:
EGU2020 SM6.5/GMPV/NH2
Thursday 7th May 16:45 - 18:15 (CET)

EGU2020-8521
(Interseismic stress field variations in Hjalli-Ölfus, SW Iceland)

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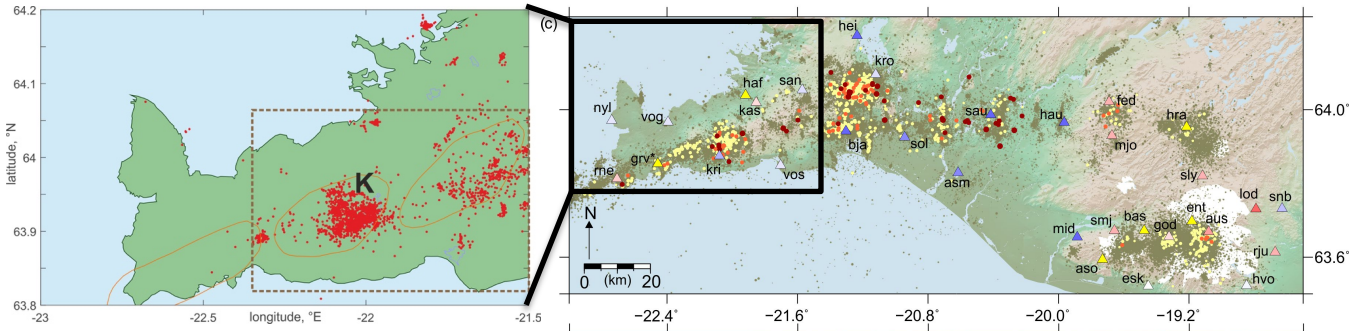
Comments, questions, and ongoing research

EGU2020-8521
SM 6.5

- Seismic analysis and stress inversions in Ölfus indicate spatio-temporal variations in stress-field.

- Is there a similar volcano-lowland interaction in South Iceland? – Krísuvík (Reykjanes Peninsula)
- Krísuvík – Transtensional rift/transform zone: 'Bookshelf' faulting
- Seismic analysis using data from 2007-2016 (with Bjarnason and team) **ongoing** Methodology in #8521
- Geodetic analysis using data from T117 and T034 track of TerraSAR-X from 2009-2019 (with Freysteinn Sigmundsson and team) **ongoing** Preliminary results



Ref: Parameswaran et al., 2020b; in preparation

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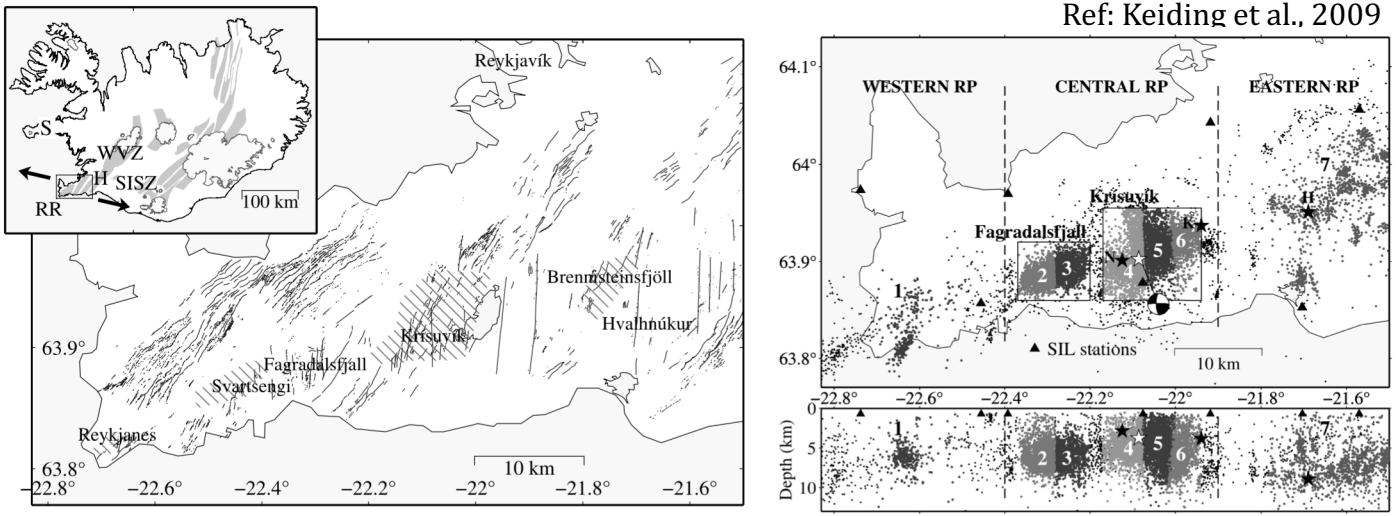
Overview of the Reykjanes Peninsula (RP)

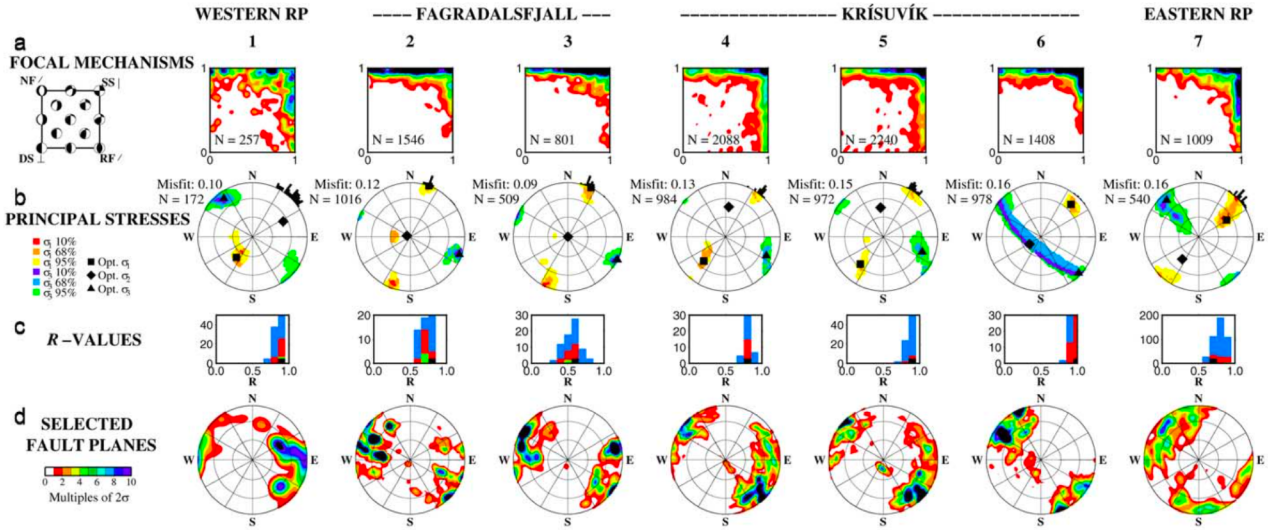
Ref: Keiding et al., 2009



- The oblique boundary exhibits left-lateral and extensional faulting (Clifton and Kattenhorn, 2006).
- Seismically active centres: Reykjanes, Svartsengi, Fagradalsfjall, Krísuvík, and Brennisteinsfjöll.
- Fissure swarms: Reykjanes, Krísuvík, and Brennisteinsfjöll.
- Krísuvík geothermal system has hosted inflation/deflation episodes, fissure swarms, and consequent seismic sequences.

Seismic stress inversion from 1997-2006 over the length of RP

Ref: Keiding et al., 2009



- Stable directions of σ_3, and greatest compressive horizontal stress (Shmax)
- Western RP has an extensional stress state, with some obliquity toward strike slip.
- Fagradalsfjall area has a stress state that appears to be both strike slip and extensional.
- The eastern Fagradalsfjall area has a stress state that is mostly strike slip.
- Eastern RP has an oblique strike-slip stress state, with relatively large confidence regions.
- Krísuvík area has oblique strike-slip stress states, with the optimal σ_1 plunging around 30° toward SW.

Ongoing (Results pending):

Variation of stress field in Krísuvík using spatial and temporal grids (2007-2016).

Methodology in EGU2020-8521

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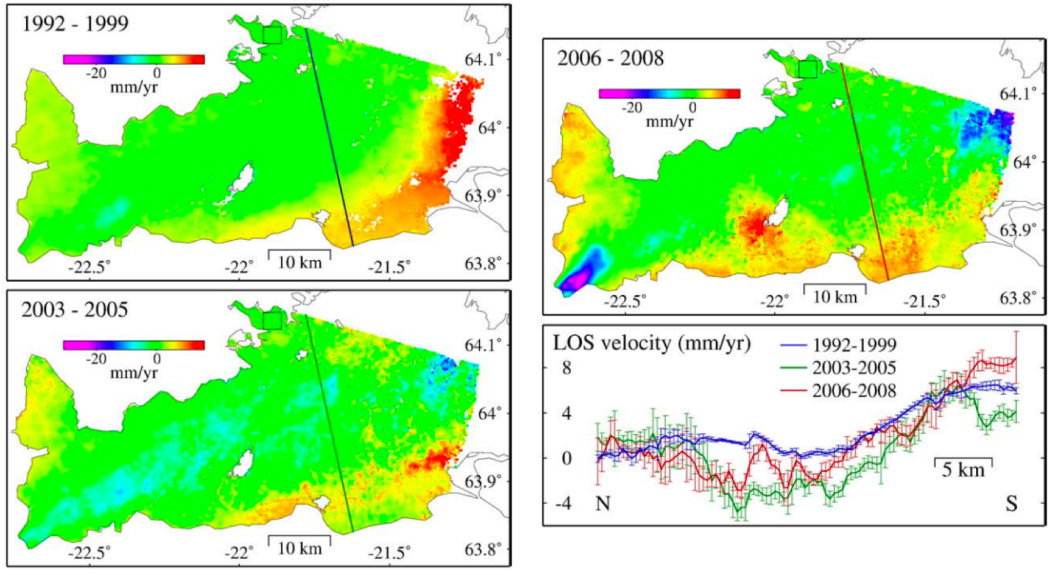
Geodetic measurements of deformation in RP (InSAR)

Ref: Keiding et al., 2010

- Residual mean LOS fields generated using Envisat images indicate eastward velocities across the plate boundary.
- They also indicate a slight uplift to the SE part of the peninsula in all three time-periods.



- Mild subsidence in Svartsengi from 2003-2005; possibly related to regional subsidence along the central plate boundary zone.
- Marked subsidence in Reykjanes from 2006-2008 due to geothermal fluid extraction.
- Inflation signal in Krísuvík from 2006-2008; either due to geothermal overpressure or slow magmatic intrusion.

Ongoing (preliminary results):
StaMPs analysis of TerraSAR-X data from 2009-2019

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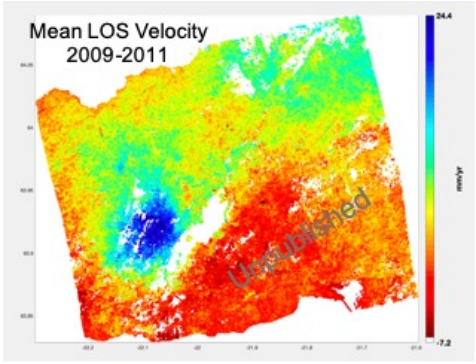
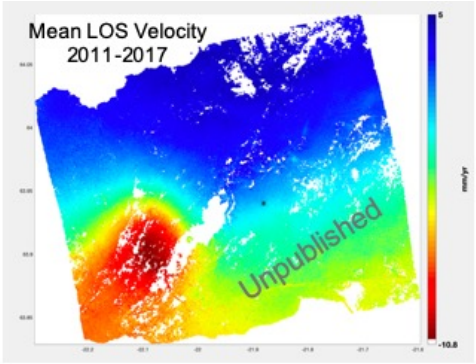
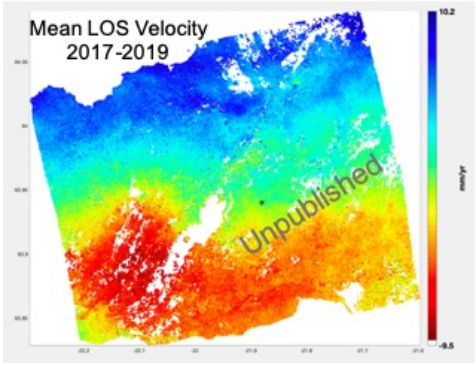
Preliminary analysis of TerraSAR-X data from Krísuvík (2009-2019)

- Subsidence: high-wavelength colours
- Inflation: low-wavelength colours
- 2009-2011 shows a period of inflation followed by deflation.
- The inflation is a continuation from 2008 as described in Keiding et al. (2010).
- It is also coincident with large seismic swarm in February 2011, with the largest event to be recorded was M4.2 (Michalczewska et al., 2012: AGU 2012, V33A-2843)







TerraSAR-X data were provided by the German Aerospace Center (DLR), through the Icelandic Volcanoes Supersite project, supported by the Committee on Earth Observing Satellites (CEOS).

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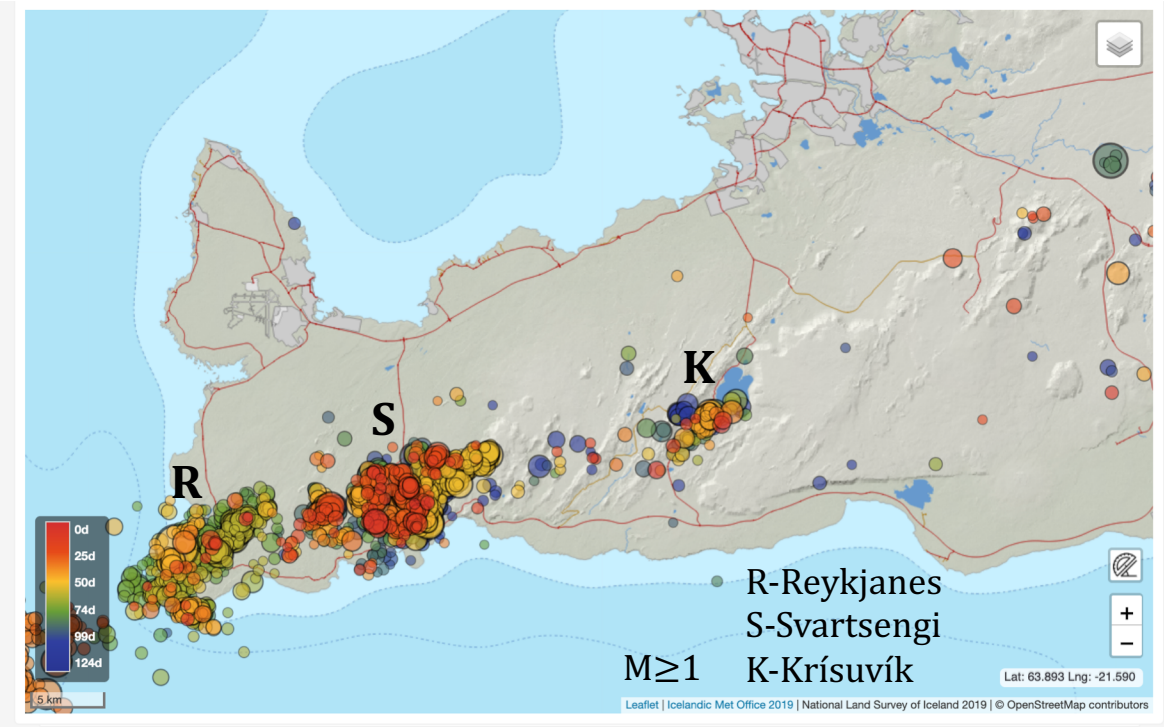
In recent news...

- Heightened seismicity and crustal uplift (up to 8 cm till date) recorded near Svartsengi geothermal system.
- Activity started in January 2020 near Grindavík close to Svartsengi.
- Migration of seismicity to Reykjanes in March 2020, and back to Svartsengi in April 2020.
- Current hypothesis: magma movement at 8-13 km depth



Courtesy: Icelandic Meteorological Office (IMO); www.vedur.is

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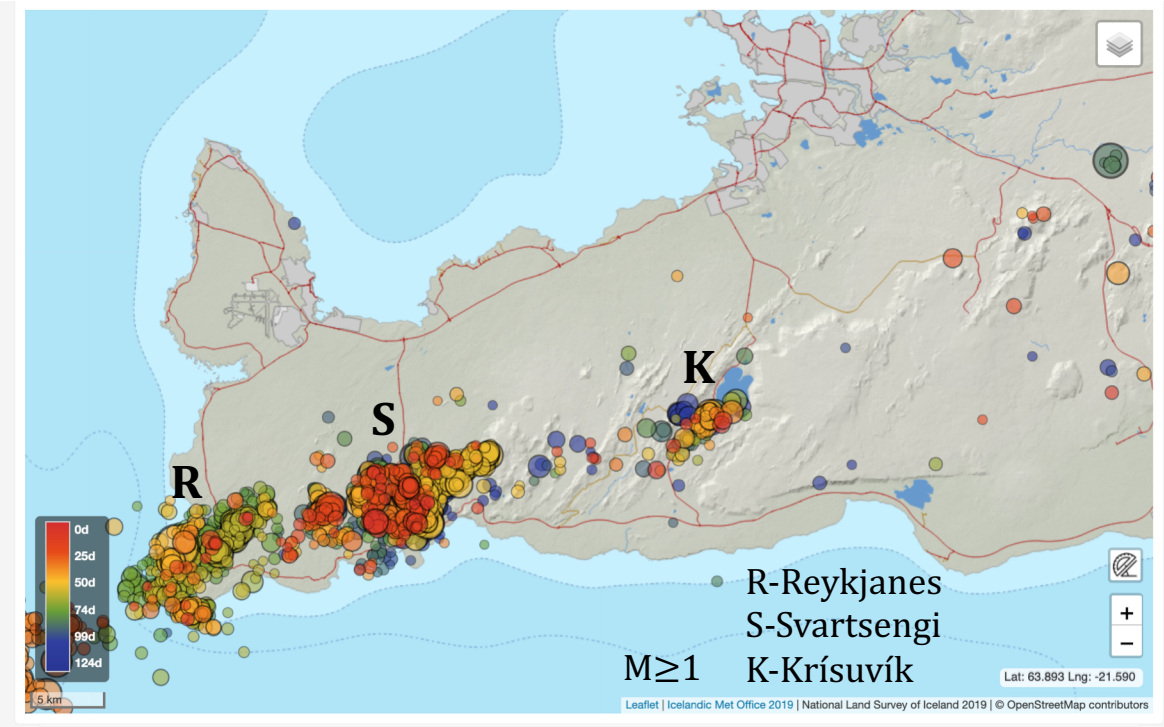
Therefore, in light of recent productivity in RP, and the symbiotic relationship between crustal deformation and seismicity in Krísuvík, the following studies are underway:

- Seismic relocations
- stress inversions
- focal mechanism analysis
- crustal deformation (InSAR)
- Modeling deformation related seismicity

We look forward to your comments and suggestions on this ongoing study!



Courtesy: Icelandic Meteorological Office (IMO); www.vedur.is