Swarm seismicity illuminates stress transfer prior to the 2021 Fagradalsfjall eruption, Iceland

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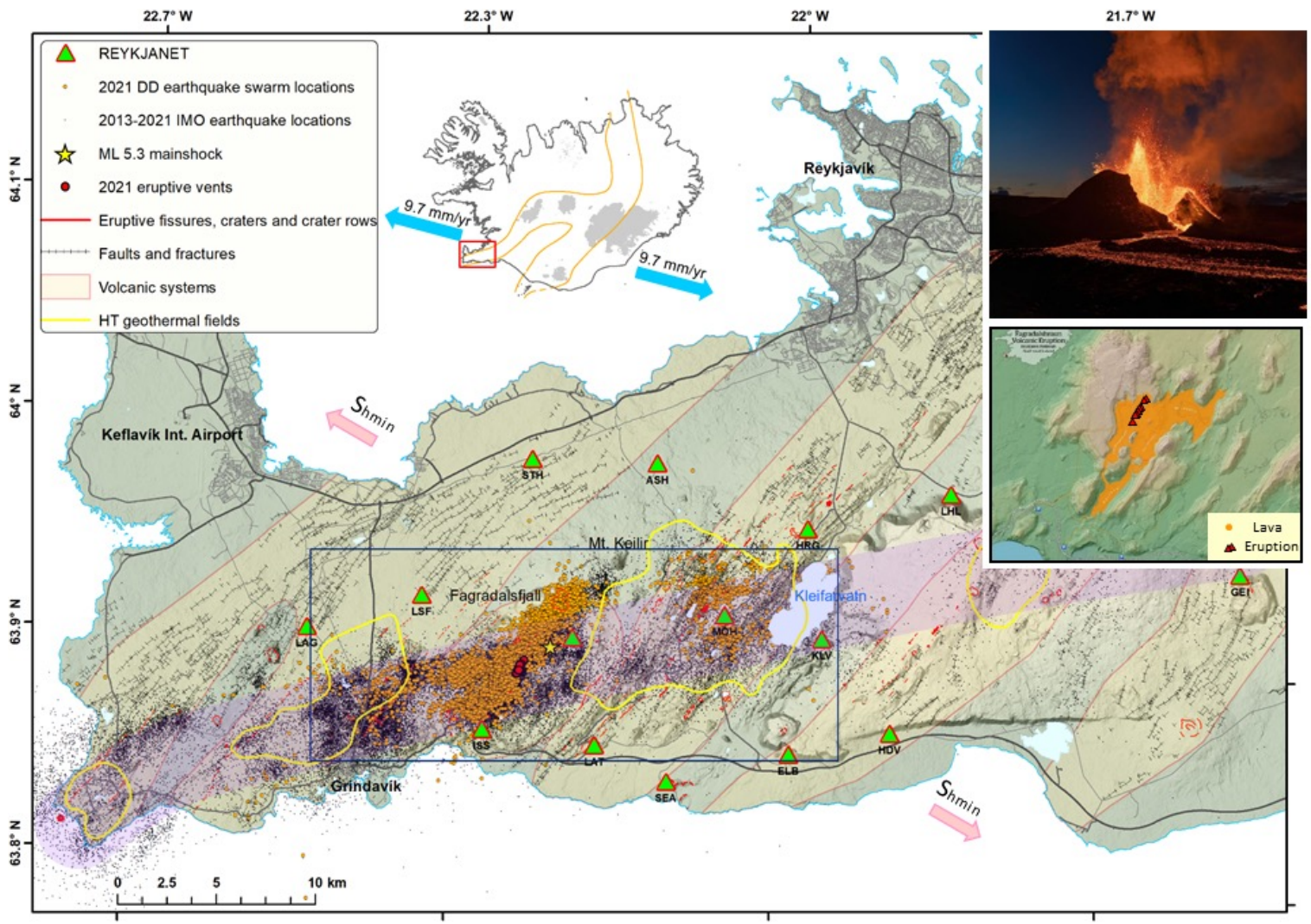
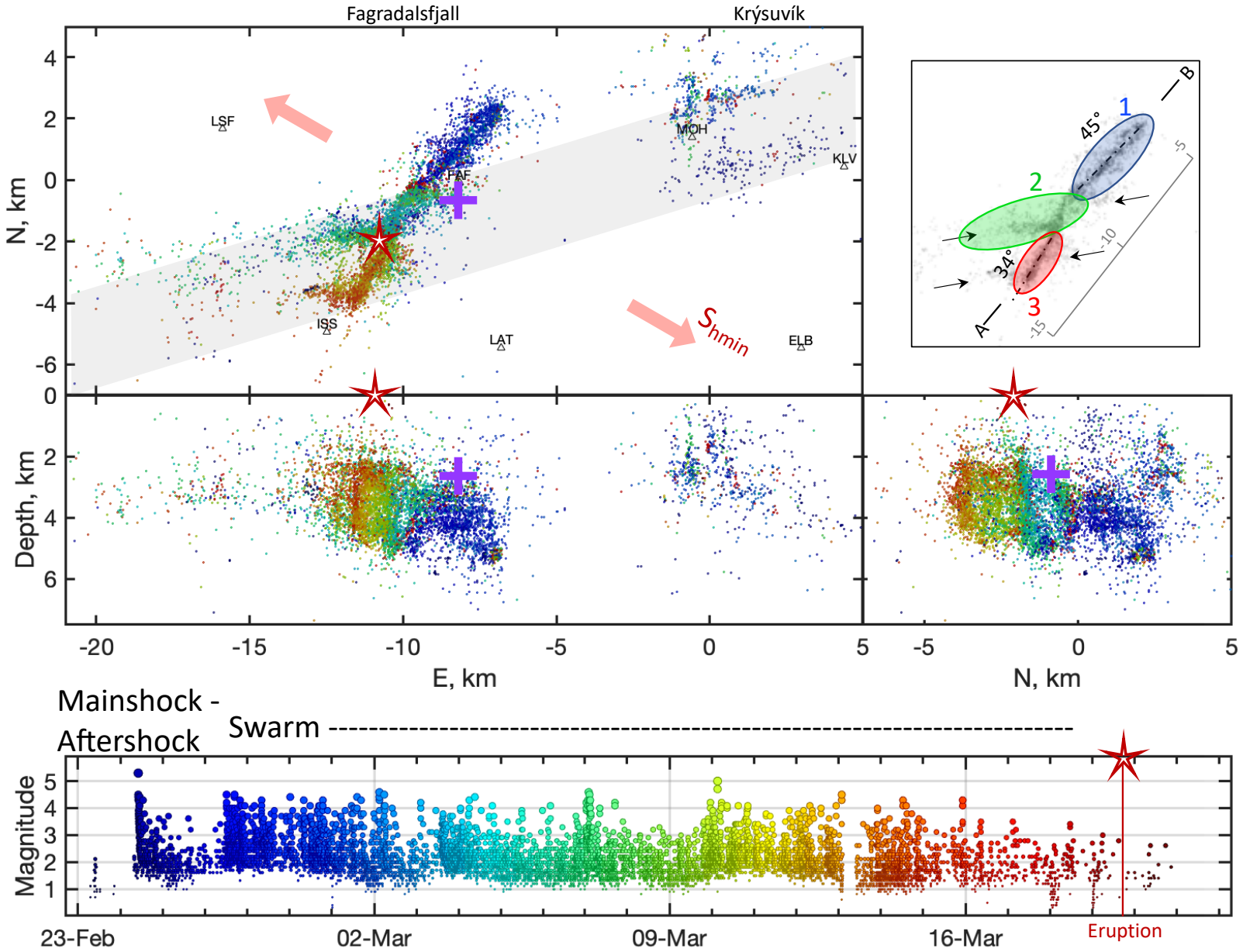
ÍSOR ÍSLENSKAR ORKURANNSÓKNIR



Data: Reykjanet seismic network
- 15 broadband online stations
- operated by Czech Academy of Science, Iceland GeoSurvey and Icelandic Meteorological Office

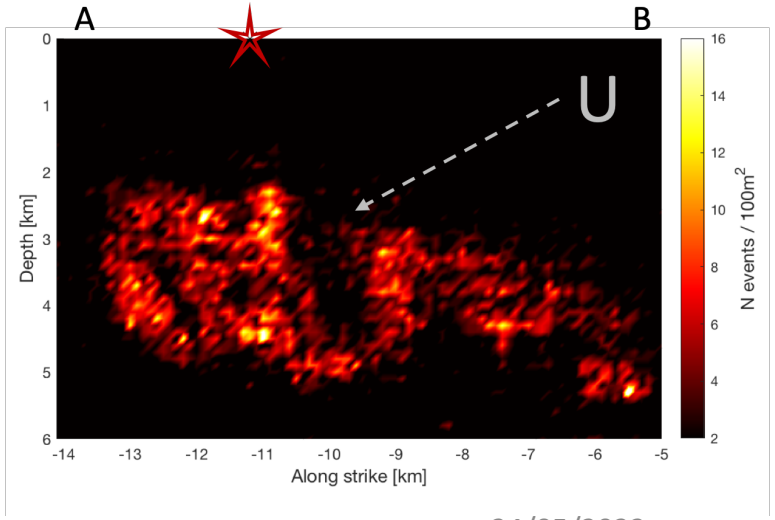
HypoDD relocations based on combined attomatic and manual picks and cross-corelation differential times



Three segments
1: dyke related
2: rift zone
3: dyke related

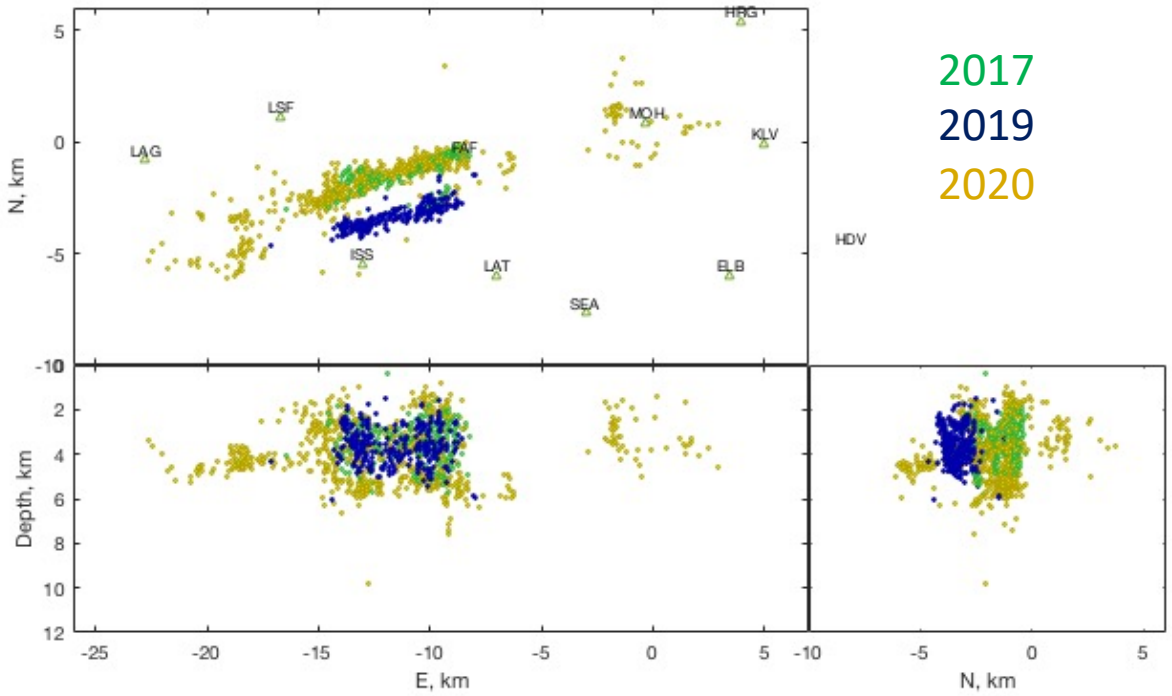
24-February mainshock

19-March eruption

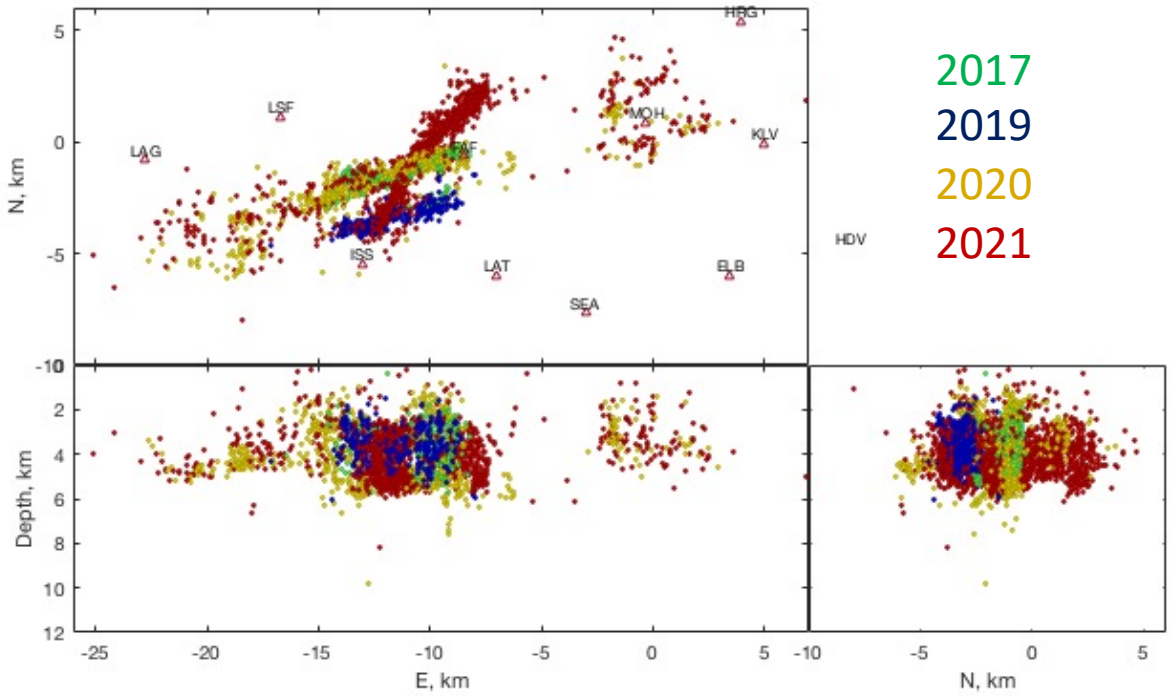


Relation to previous swarms

The swarms 2017, 2019, 2020 – along the rift zone

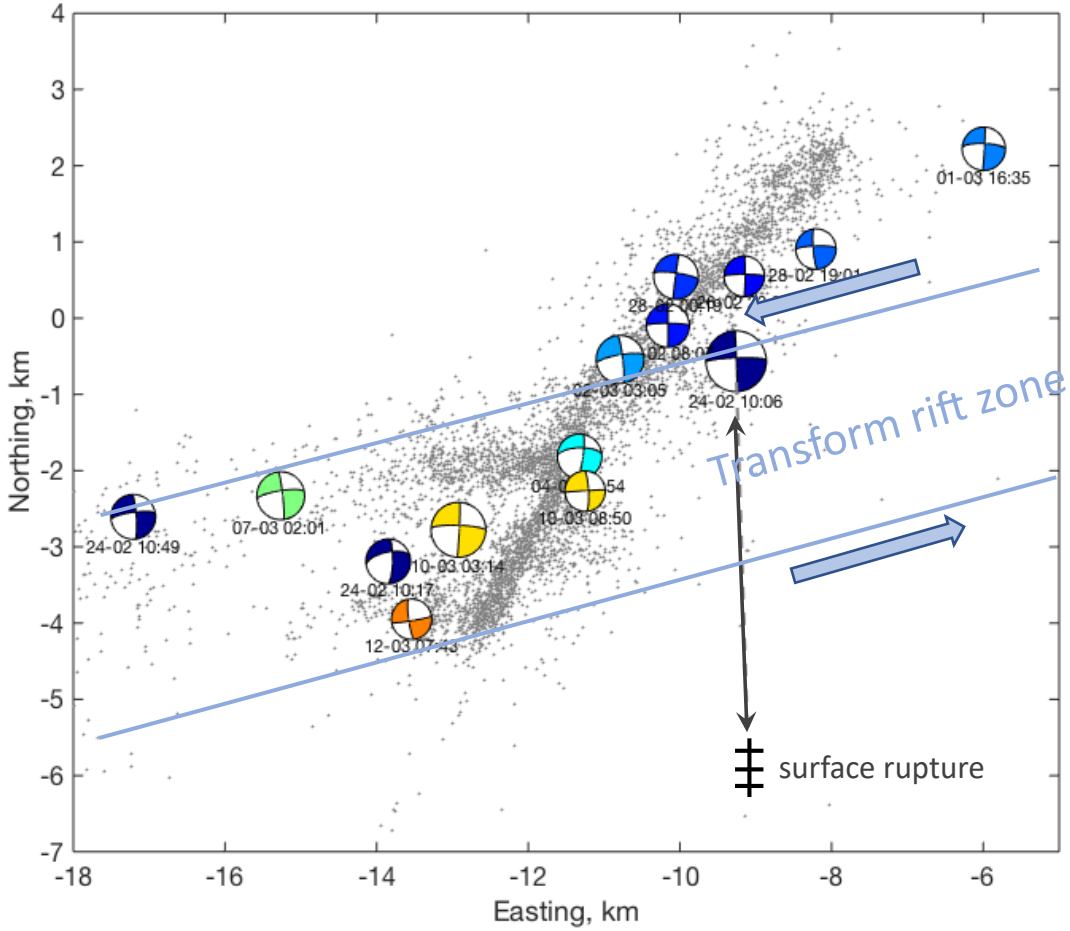


2021 – main cluster intersects the rift zone clusters

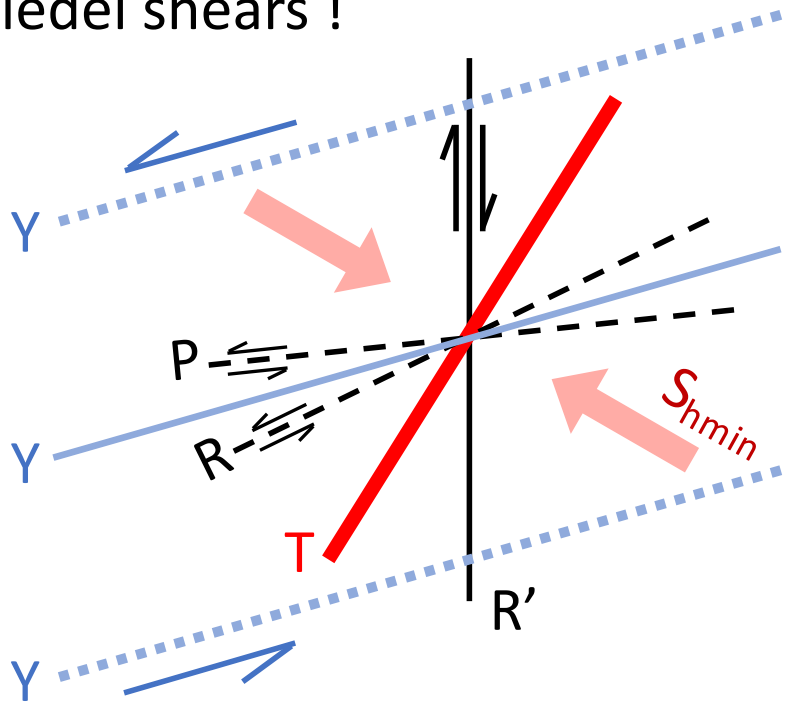


1. Seismotectonics

Focal mechanisms, M_L > 4.5: Prevailing strike-slips with N-S fault plane – Why?

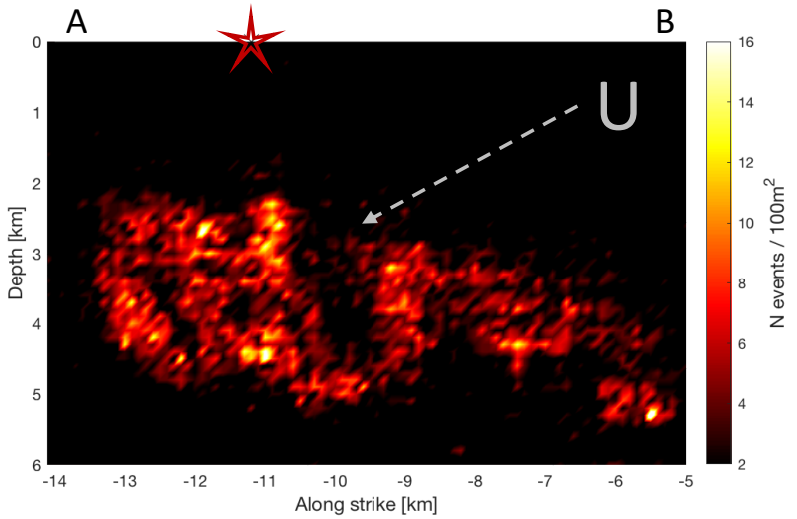


Riedel shears !

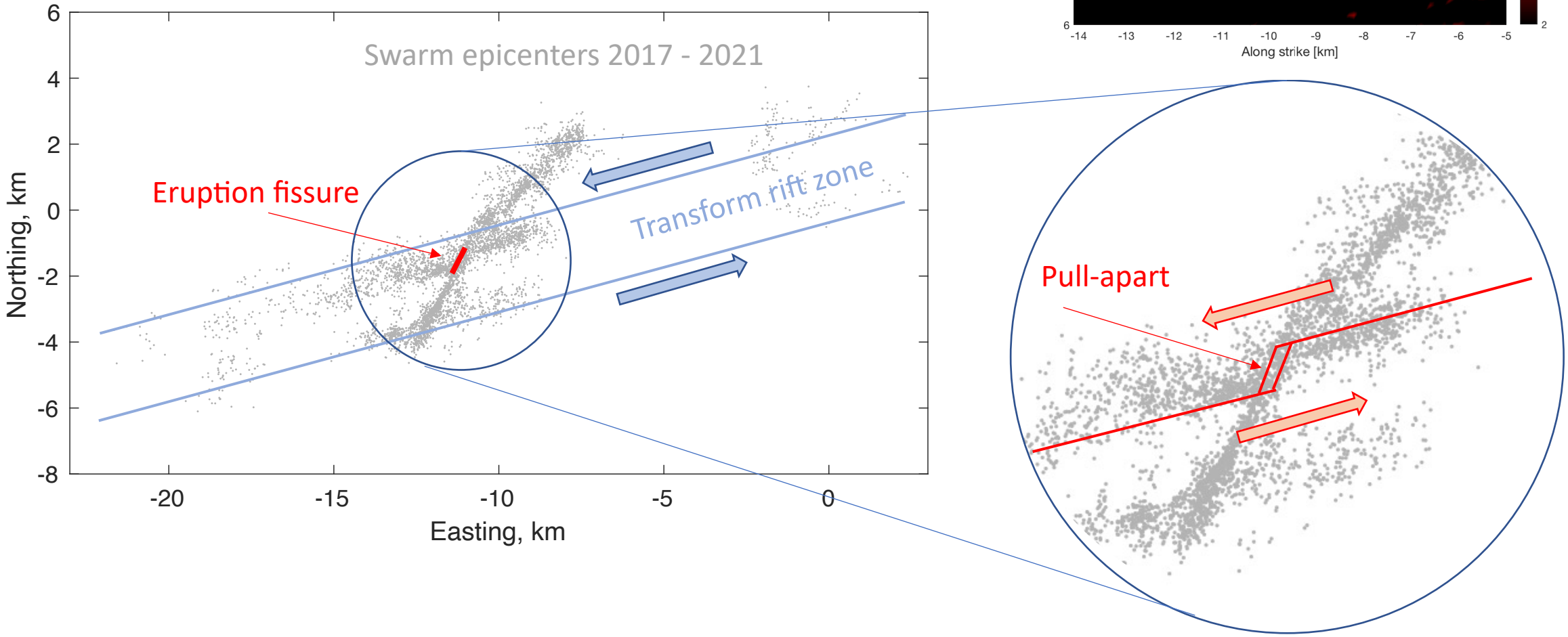


T – tensile fracture, azimuth 32° controlled by the stress field;
Y – direction 72° of the transform zone shear;
R, P – synthetic shears associated with nodal planes;
R' – antithetic shear associated with the north-south trending fault plane of the focal mechanisms.

2. Weakened crust due to extension at the eruption site



Stepover along the rift zone

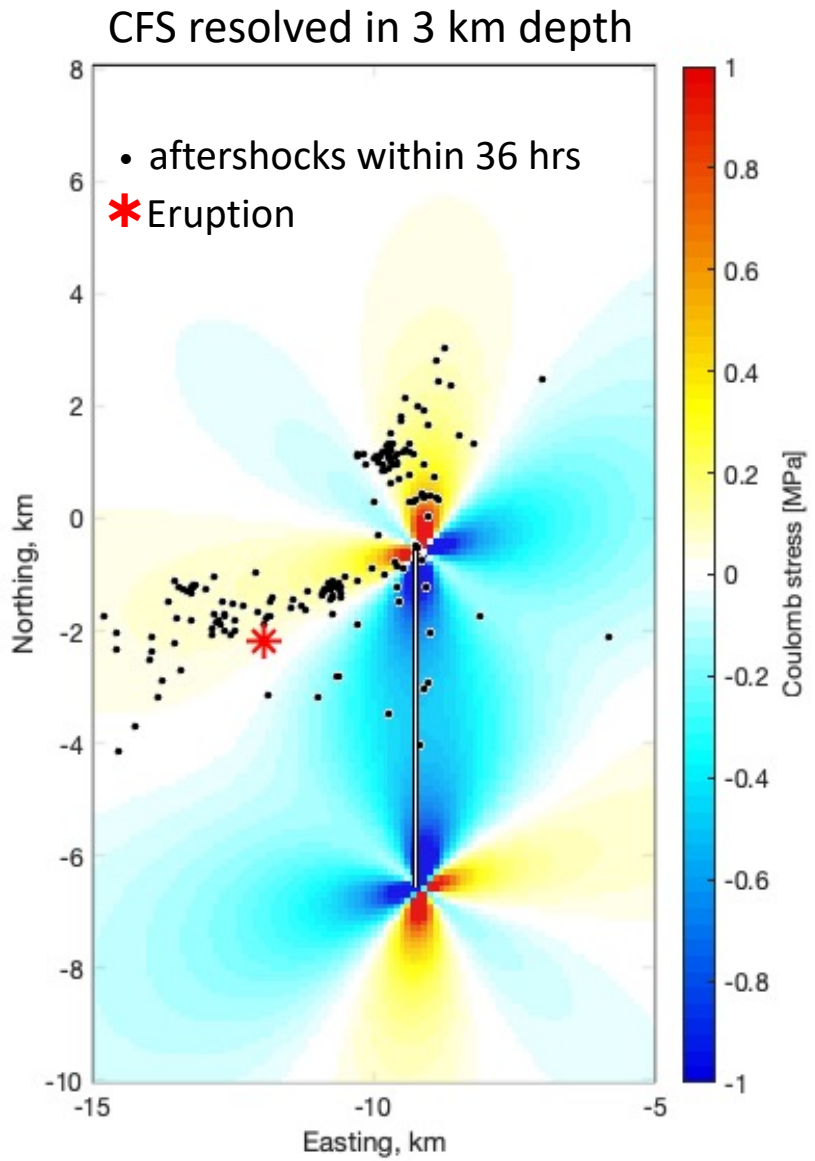


3. Stress change due to the M_L 5.3 mainshock

24-February 2022 mainshock
- N-S vertical plane, 7 km long, 0 - 6 km depth
- Slip 0.1 m

Receiver faults: N-S vertical

=>
Mainshock could have triggered:
- Aftershocks along the rift zone
- First events of the swarm



Scenario of the Fagradalsfjall swarm and eruption

1. Long-term extension in the stepover
2. February 2021 – formation of the the NE-SW dyke
3. 24-Feb 10:06 – Mw 5.3 earthquake,

   triggered aftershocks and the swarm
4. 24-Feb – 25 Feb – aftershocks along the rift zone
5. 24 Feb evening - first events of the swarm
6. March – swarm migrating south, then back
7. 19 March – eruption in the weakened zone