A large-scale seismological experiment to study magmatic processes beneath the Eifel region

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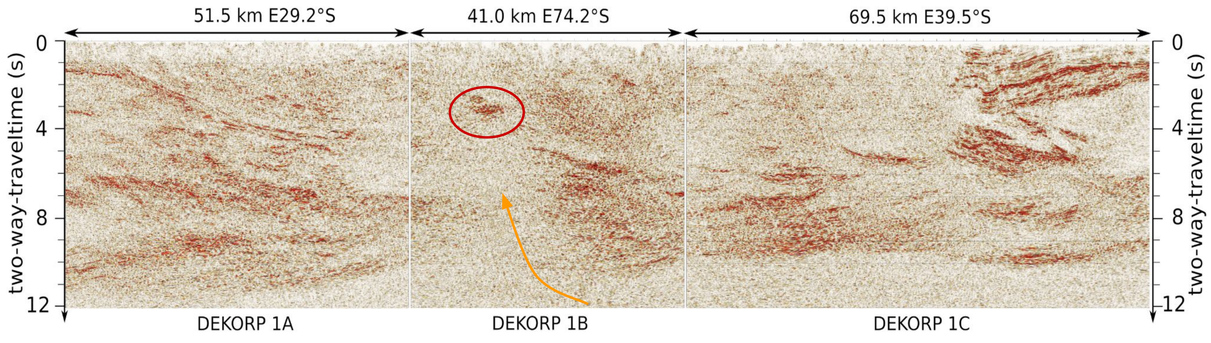
Background

Eifel Quaternary Volcanic Fields are an outstanding example of distributed, volcanic fields in an intracontinental setting. Highlights comprise

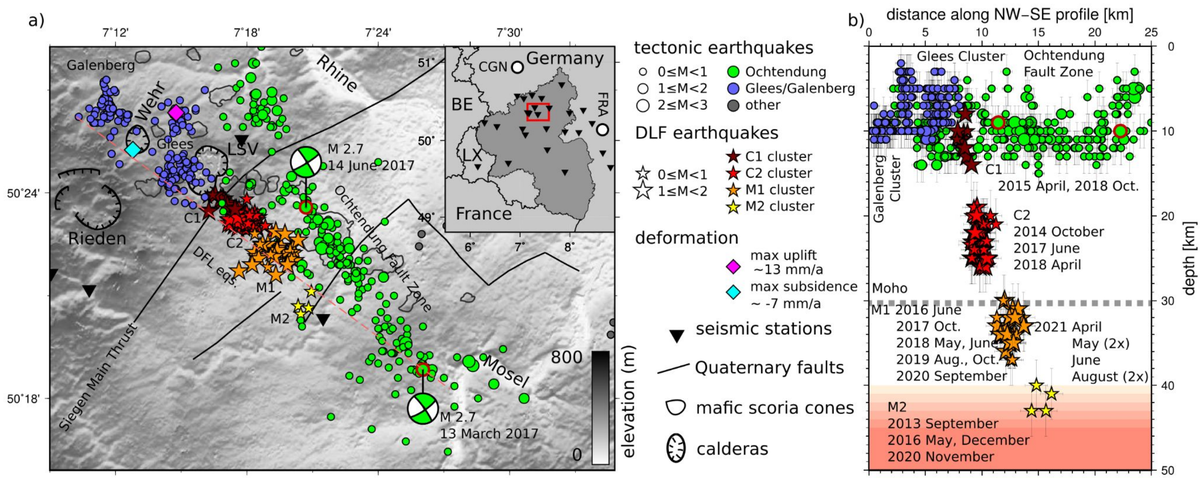
- Hundreds of cinder cones and maars disrtributed over two volcanic fields
- Episodic activity with cycles > 100 ka in both fields, last eruptions 12 ka ago
- 3 large, phonolitic centres in the East Eifel field, where the Laacher See eruption (LSV, 13 ka) had an explosivity index VEI=6
- Shallow crustal reservoir of the LSV was active / hot during the last 30 ka
- Massive degassing of mantle CO2 (mineral water and production)
- Ongoing regional uplift today (GNSS and InSAR) driven by upper mantle
- A transcrustal magmatic system that covers large regions of > 100 km

Crustal structure beneath the Rhenish Massif



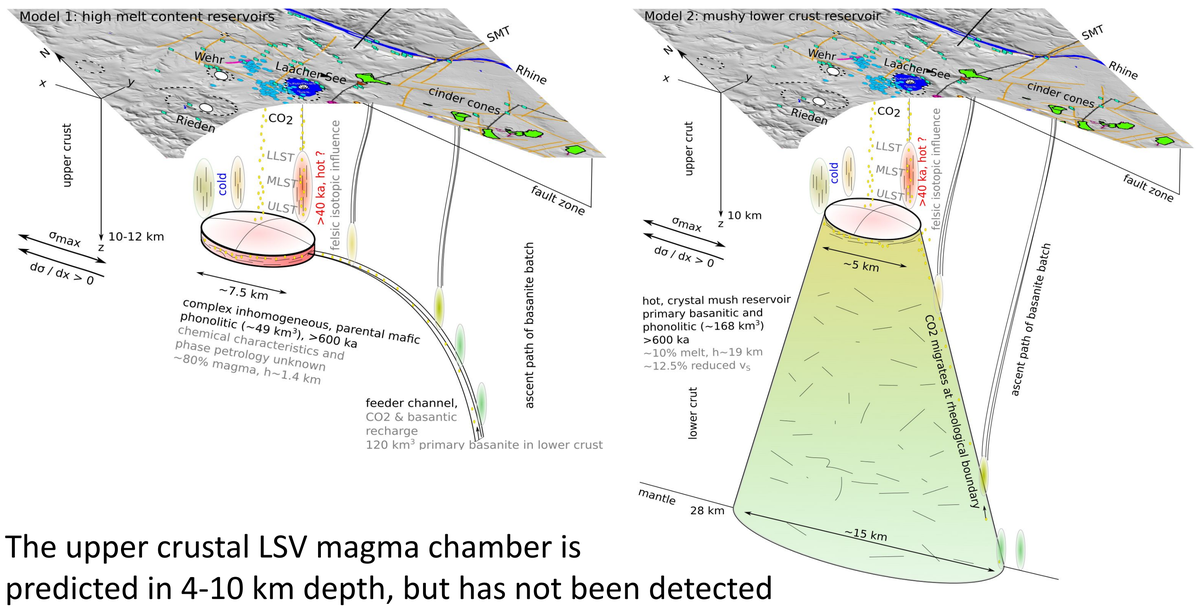
Reprocessed reflection seismic profiles (DEKORP 1, 1987) crossing the West Eifel at the Kelberg magnetic anomaly. Beneath Kelberg a bright spot is resolved (old reservoir). The youngest maar (Ulmen) is at the center of the profile. The transparent zone beneath Kelberg indicates a hot region and presence of melts (mush reservoir?)

Deep Low-Frequency (DLF) Earthquakes



Volcanic DLF earthquakes are observed since 2013, where more than 50% of the total moment release occurred in 2021, and 25% during a swarm in November 2021. DLFs indicate a channel which is used for CO2 transport from the mantle to the LSV. Shallower weak high-frequency earthquake swarm (Glees/Galenberg, blue circles) occurred in 2018-2020 above the DLF channel

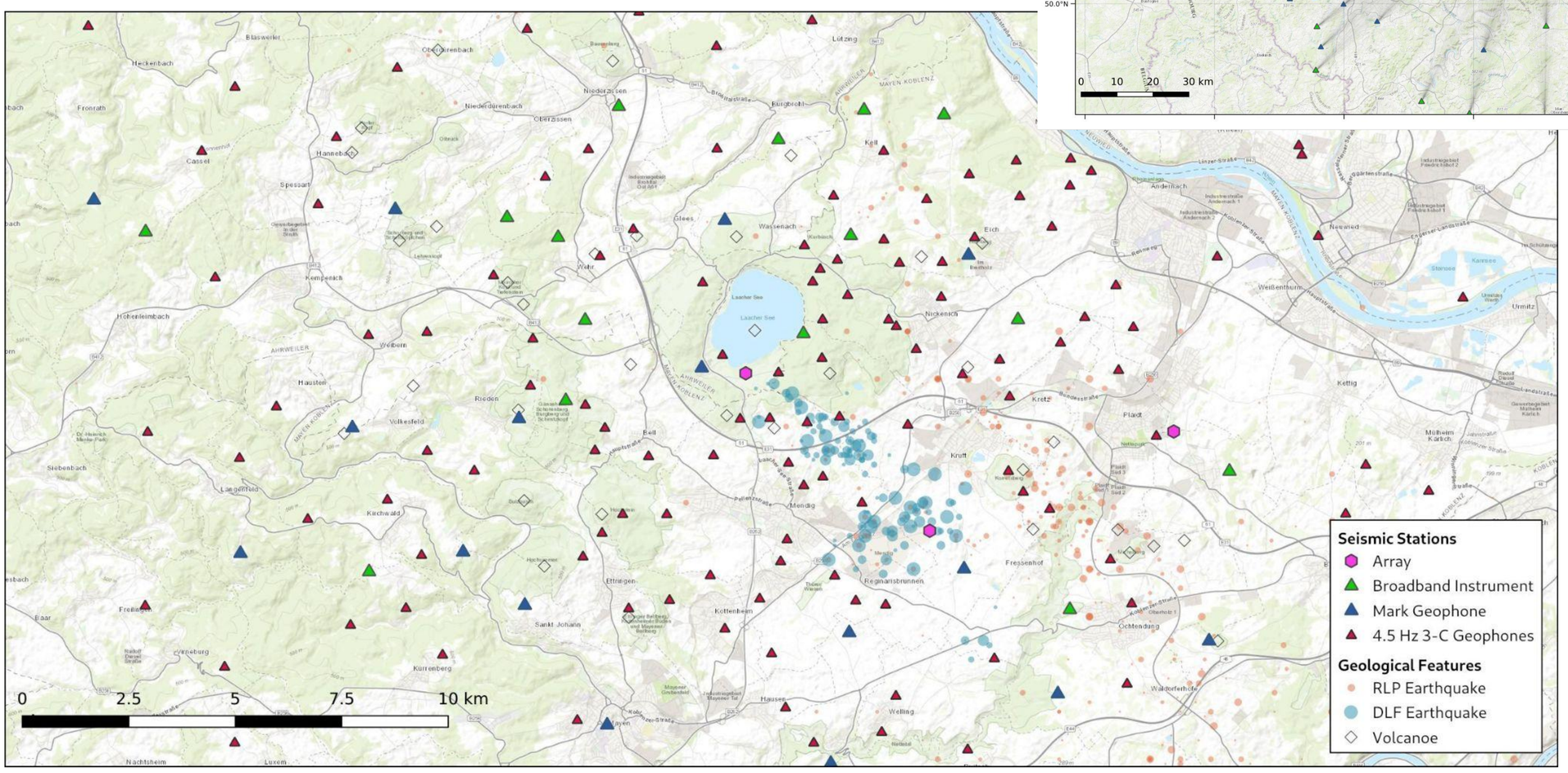
Challenge: Imaging volcanic structures



The upper crustal LSV magma chamber is predicted in 4-10 km depth, but has not been detected with geophysical data so far. The sketches show two hypothetical models how the reservoir system may look. A dense seismic network and novel analysis methods are needed to distinguish between both models

The Eifel Large-N Experiment

The main objective is to better image and characterise the transcrustal magmatic system beneath the East and West Eifel volcanic fields, and to understand the relation to tectonic, crustal and mantle features. It is the first large-N experiment at a volcanic field in Central Europe, and the first time that the transcrustal magmatic system of the Eifel is studied with high-frequency, high-resolution seismology. Results will help to assess the volcanic hazard and will additionally contribute to seismic hazard and geothermal exploitation



Layout of the large-N experiment and background information.

Upper right: ***Total of ~330 stations*** *will be deployed for 1 year, comprising 4.5 Hz 3C geohones, short-period Mark 3D and broadband seismometers.. Some stations will be moved after 6 month to realise long-dfistance profile measurements. Ray coverage is optimal in the region of the LSV.*

Lower left: Zoom of the planned network in the region of the LSV (East Eifel). DLF, tectonic earthquakes and volcanoes are indicated (see legend).

Project Partners

Geologischer Dienst Nordrhein-Westfalen – Landesbetrieb –

Johannes Gutenberg Universität Mainz

Universität Potsdam

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