



Hydrothermal alteration investigation of selected rock samples from the Odenwald area, Germany: a contribution towards the site selection for the GeoLaB underground infrastructure

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1) Research background

- Sustainable geothermal use of the crystalline bedrock for the energy transition requires scientific investigations in an underground laboratory.
- The Oetzberg fault with the resulting shear zone and the occurrence of fractured permeable crystalline rocks make the Odenwald a unique location to realize the GeoLaB infrastructure.
- As a holistic research platform, GeoLaB (a Helmholtz initiative) offers cutting-edge research beyond geothermal energy and creates synergies for the development of geotechnologies economically relevant today. The mineral investigation targets to detect **hydrothermal alteration in fractured crystalline rocks**.

2) Sampling area, Odenwald

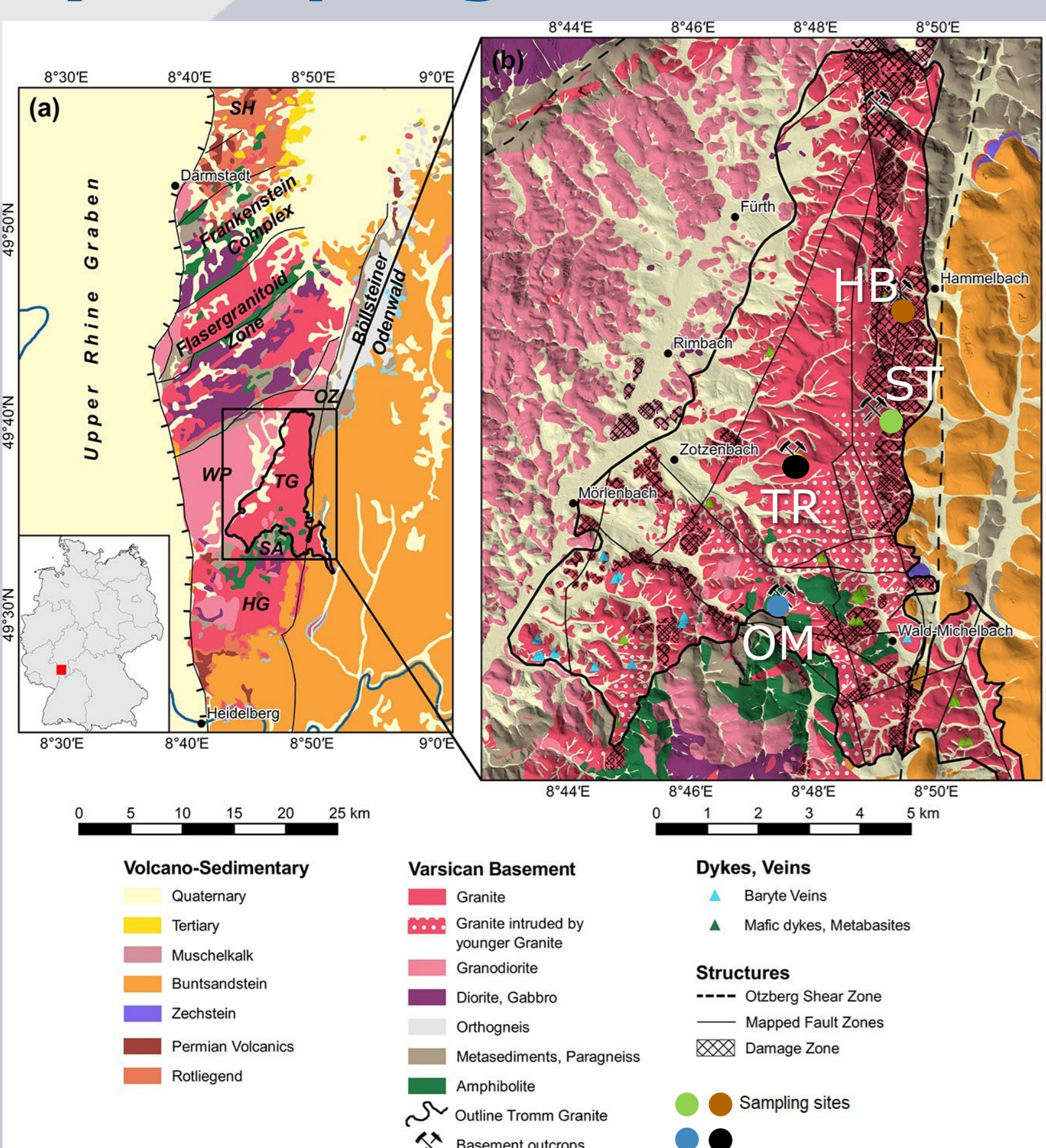
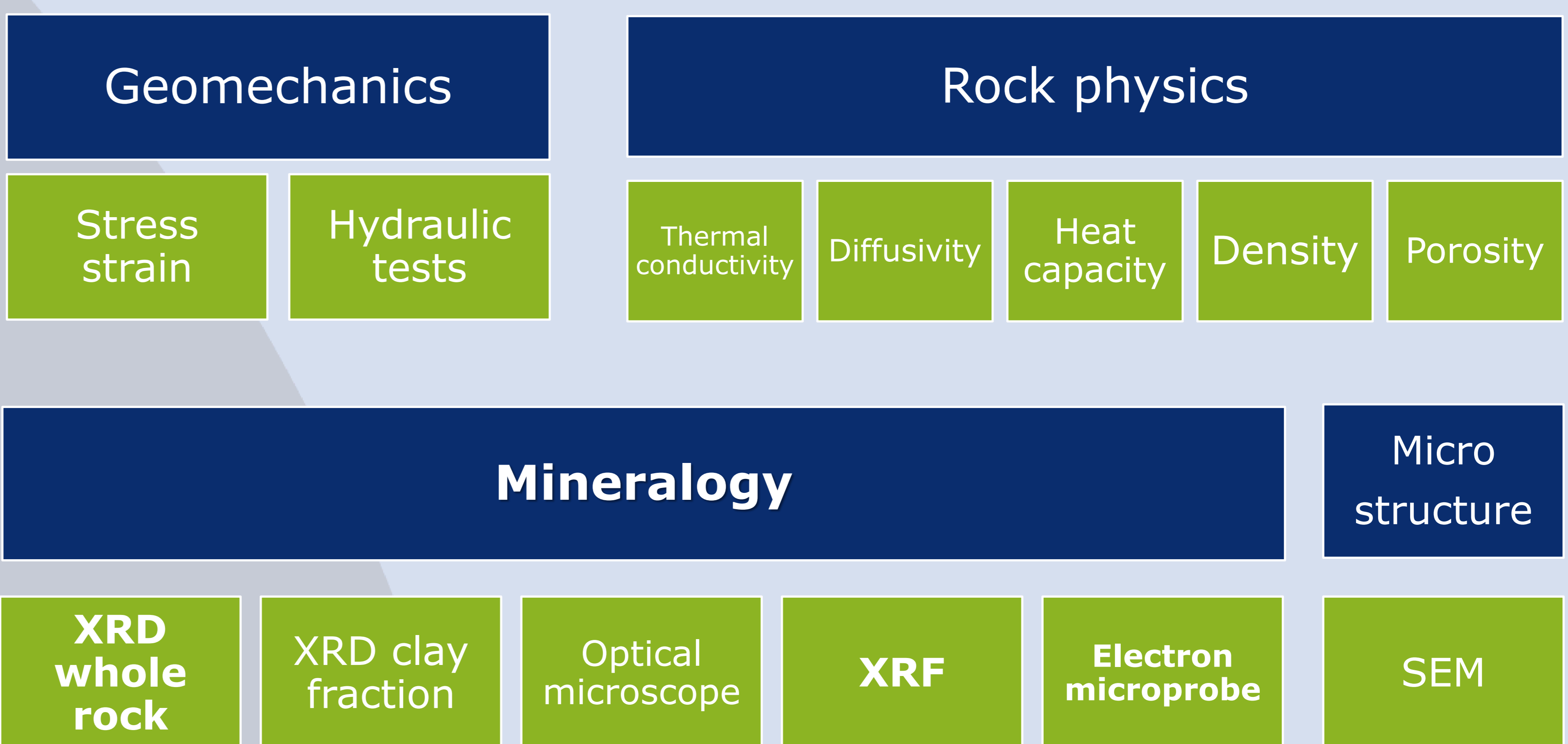


Figure 1. Fieldwork area in the Tromm Odenwald with the lithologies and the sampling locations. Modified after Frey et al. (2022).

3) Experimental workflow GeoLaB



4) Geochemistry results

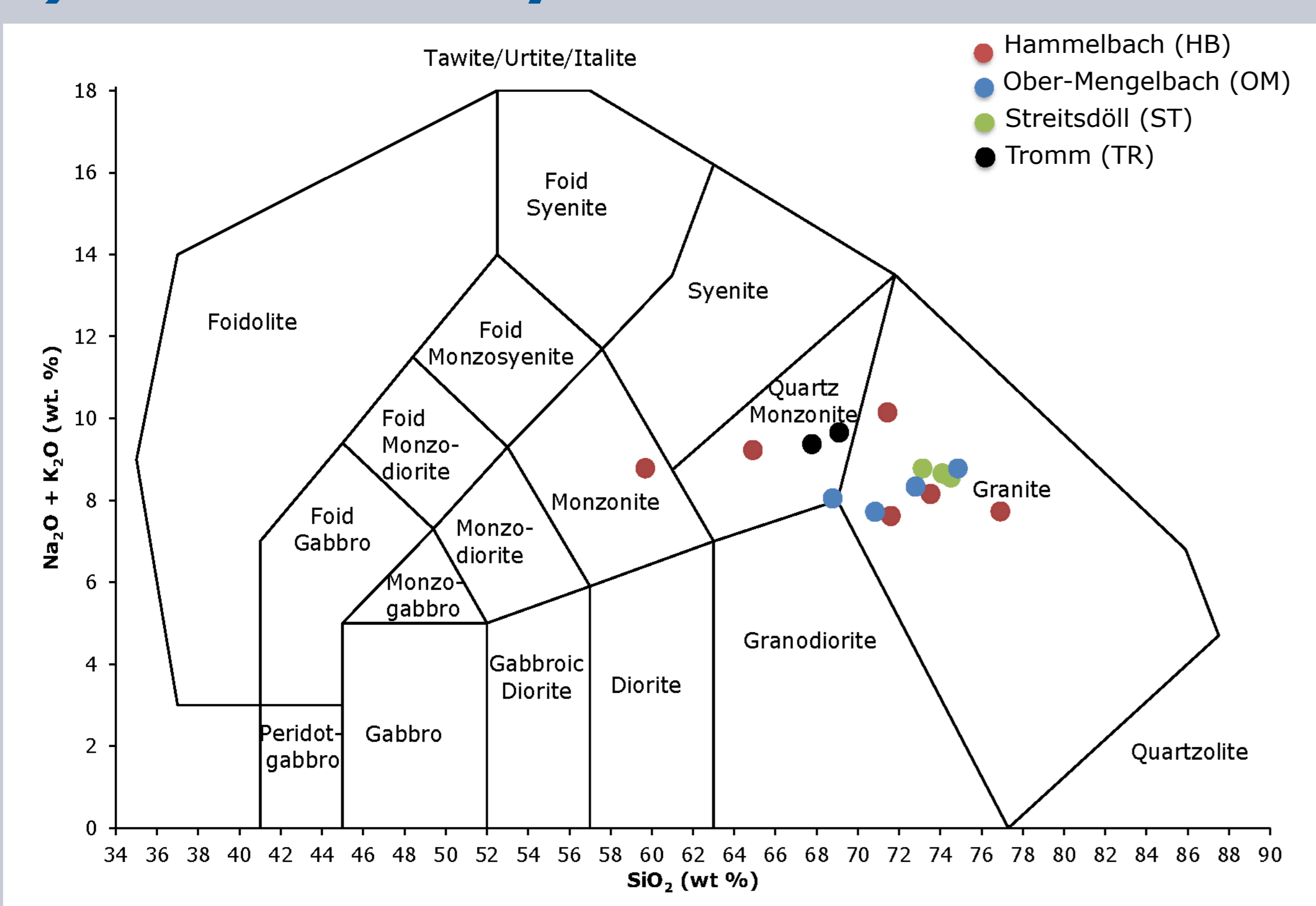


Figure 2. Total SiO₂ versus the sum of Na₂O and K₂O after le Bas et al. (1986). The analysed samples have a geochemical signature ranging from granite to monzonite. This classification was confirmed with the XRD measured which revealed a granite mineral assemblage mostly with quartz, plagioclase and mica (biotite-muscovite).

5) Electron microprobe results

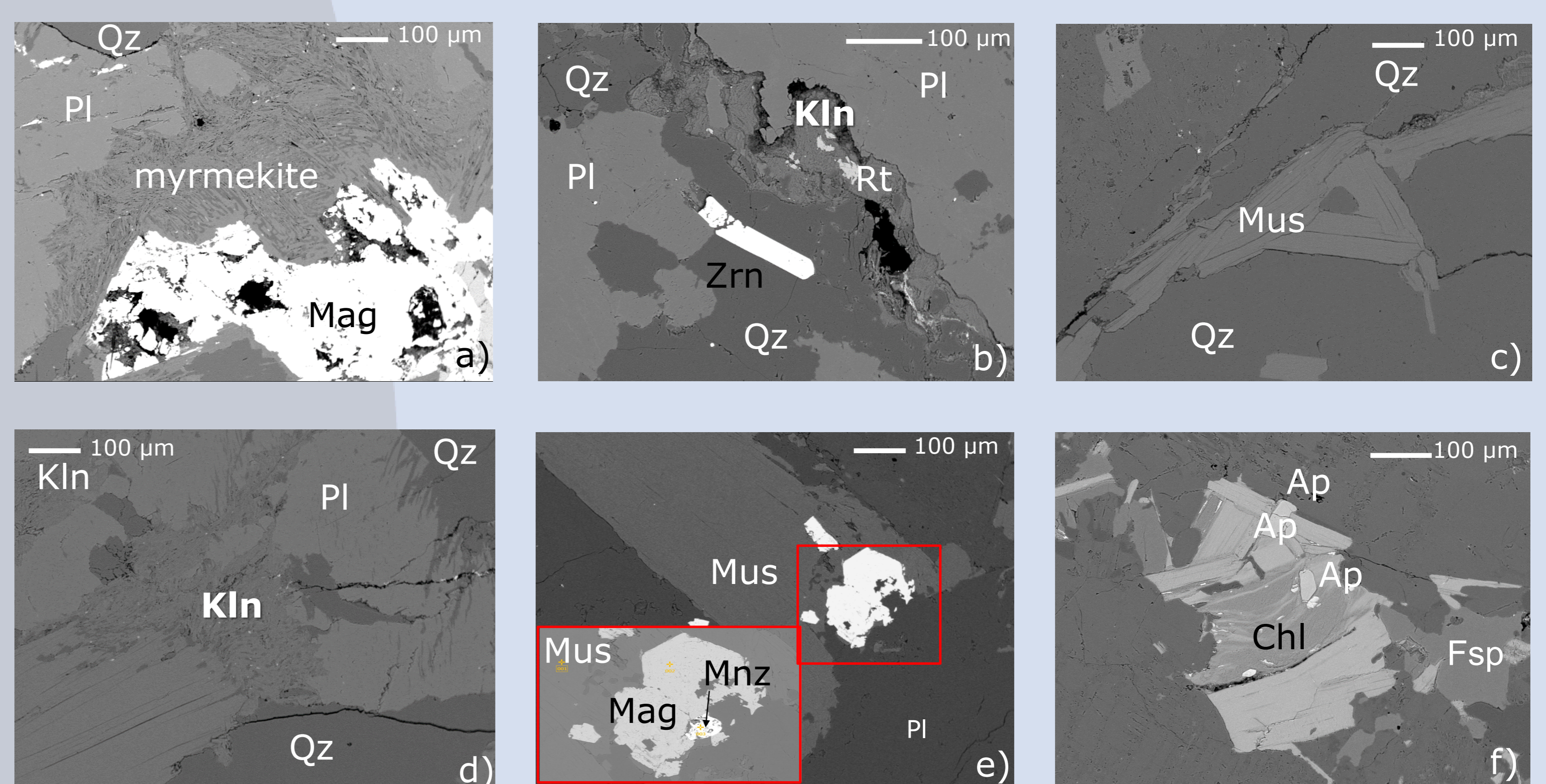


Figure 3. A selection of SE (Secondary Electron) images acquired with the electron microprobe. a) ST001: myrmekite structures, i.e. inclusion of quartz (Qz) in plagioclase (Pl) indicating tectonic induced metasomatism. The structures follow the magnetite (Mag) rims. b) HB002: well formed zircon (Zrn) embedded in quartz (Qz). Kaolinite (Kln) occurring in the fracture indicate the occurrence of hydrothermal alteration. Rutile (Rt) is an accessory phase. c) ST002: a triangular muscovite (Mus) embedded in quartz (Qz). d) ST002: small kaolinite (Kln) grains likely formed from the alteration of plagioclase (Pl). e) ST002: muscovite (Mus) grain including magnetite (Mag) and monazite (Mnz). The latter offers the possibility to perform in-situ geochemical dating and investigate REEs concentration. f) OM001: Chlorite (Chl) with large apatite (Ap) grains.

6) Outlook

- Pilot seismic campaign: the first seismic survey was carried out in September 2024.
- Potential geophysics: on-going.
- Exploration drilling: start planned for the beginning of 2025. Cores will be sampled.

Acknowledgements

Gabriela Schubert and Lukas Seib (Technische Universität Darmstadt)

References

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Frey, M., Bossennec, C., Seib, L., Bär, K., Schill, E., & Sass, I. (2022). Interdisciplinary fracture network characterization in the crystalline basement: a case study from the Southern Odenwald, SW Germany. *Solid Earth*, 13(6), 935-955



Figure 4. GFZ Vibrottruck deployed during the recent pilot seismic campaign.