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Seismic imaging of crustal fault systems

CharLotte Krawczyk[1,2]
[1]GFZ German Research Centre for Geosciences, Potsdam, Germany (lotte@gfz-potsdam.de)
[2]Institute for Applied Geosciences, TU Berlin, Berlin, Germany

The construction of geodynamic and reservoir models requires - as many other applications - the knowledge of fault signatures and fracture systems. In general, structural images of the subsurface rely on sampling and experiment design, wavefield components retrieved, as well as coherence and focusing potential of the data recorded in different geological settings. Nonetheless, direct geophysical images of especially sub-/vertical or inactive faults are still hampered by fracture complexity and associated diffuse wavefields. Furthermore, back-tracing weak signals to their originating location remains one of the challenges for high-resolution imaging. While petrophysical and mechanical rock properties characterize the hosting material as such, they can provide at the same time assistance in fault or horizon tracking, respectively, and may allow pattern identification, for instance by machine learning tools.

In the overview presented, we will discuss different examples from recent active and passive seismic surveys covering both sedimentary and hardrock environments using either dense or sparse seismic and fibre-optic arrays. These experiments are adapted to investigation depths between some km and only few 10s of metres scale, encompassing geodynamic, geothermal, hazard and critical zone investigations. Thereby, the wide applicability of seismic methods for imaging and characterizing distinct horizons, transitional zones, and fault systems is emphasized.