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Fault zone characterization using P- and S-waves

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Although deep fault zones have high potential for geothermal energy extraction, their real usability depends on complex lithological and tectonic factors. Therefore a detailed fault zone exploration using P- and S-wave reflection seismic data is required.

P- and S-wave reflection seismic surveys were carried out along and across the eastern border of the Leinetal Graben in Lower Saxony, Germany, to analyse the structural setting, different reflection characteristics and possible anisotropic effects.
In both directions the P-wave reflection seismic measurements show a detailed and complex structure. This structure was developed during several tectonic phases and comprises both steeply- and shallowly-dipping faults. In a profile perpendicular to the graben, a strong P-wave reflector is interpreted as shallowly west-dipping fault that is traceable from the surface down to 500 m depth. It is also detectable along the graben. In contrast, the S-waves show different reflection characteristics: There is no indication of the strong P-wave reflector in the S-wave reflection seismic measurements - neither across nor along the graben. Only diffuse S-wave reflections are observable in this region. Due to the higher resolution of S-waves in the near-surface area it is possible to map structures which cannot be detected in P-wave reflection seismic, e.g the thinning of the uppermost Jurassic layer towards the south.

In the next step a petrophysical analysis will be conducted by using seismic FD modelling to a) determine the cause (lithological, structural, or a combination of both) of the different reflection characteristics of P- and S-waves, b) characterize the fault zone, as well as c) analyse the influence of different fault zone properties on the seismic wave field.

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