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Characteristics of a fault zone in Triassic Lower Bunter as an outcrop analogue of a potential geothermal reservoir of the Upper Rhine Graben.

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Fault zones have great effects on crustal fluid flow because they enhance or impede the permeability of the rock. In a common view fault zones consist of a central core zone and a surrounding damage zone. In clastic reservoirs, fault zones permit a high sealing capacity, because the permeability decreases with fault related processes as cataclasis, juxtaposition of different layers, or the formation of deformation bands rather than fractures. To increase the predictability of fluid flow conditions across and within fault zones we analyze their infrastructures in outcrop analogues.
Here we present results for a fault zone in the Triassic Lower Bunter of the Upper Rhine Graben in France. The outcrop at Cleebourg exposes the damage zone of the footwall and a clearly developed fault core of a NNW-SSE-striking fault. We measure fault zone width and orientation. In the damage zone we note for every fracture its position, orientation, aperture, length and connectivity. We also describe the general formation of the core zone with e.g. deformation bands, slip zones and lithological content. Secondly we take representative rock samples to obtain Young′s modulus, compressive and tensile strengths in the laboratory. Since fractures reduce the stiffness of in situ rock masses we use an inverse correlation of the number of discontinuities to calculate effective (in situ) Young's moduli to investigate the variation of mechanical properties in fault zones. In addition we determine the rebound hardness, which correlates with the compressive strength measured in the laboratory, with a "Schmidt-Hammer" in the field because this allows detailed maps of mechanical property variations within fault zones.
We observed increasing fracture frequency, apertures and connectivity but decreasing fracture lengths towards the major slip surface where the reservoir permeability may thus be higher, the effective Young′s modulus lower. Similarly the "Schmidt-Hammer" measurements show that the rebound hardness, or the compressive strength, respectively, decreases near the fault core. The core zone can be divided into a central and a distal part with different deformation characteristics. The distal part combines characteristics from the central core zone and the damage zone and contains the highest fracture frequency. But since there occur also deformation bands the permeability is presumably lower than in the damage zone. In contrast, the most common features in the central fault core are slip surfaces, deformation bands and host rock lenses. We conclude that damage zones in Triassic sandstones may increase fluid flow and are potential drilling targets for geothermal projects. Because the fracture connectivity is low hydraulic stimulations may be needed to get a hydraulically active fracture network.
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