



3D fracture zon network in the crystalline geothermal reservoir of Soutz-sous-Forêts (Upper Rhine Graben, France)

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The Soutz experimental geothermal site is located in the French part of the Upper Rhine Graben, nearby its western regional boundary fault. The structure of the granite reservoir is constituted by both a nearly vertical major fracture zone network, connected to a dense network of small-scale fractures. Fracture zones are complex brecciated and fractured zones having irregular shape. The permeability of these fracture zones could be enhanced by hydraulic/chemical stimulations. They constitute the major pathways and their characterization is of prime importance for the reservoir knowledge.

Based on borehole data of the Soutz geothermal site, 39 fracture zones have been characterized in six wells between 1400 and 5000m depth. The direction of the major set of fracture zone is $N160^{\circ}E \pm 10^{\circ}$ with high dip westward and eastward. These fracture zones are spatially concentrated in three clusters with depth. The upper cluster at 1800-2000m TVD (True Vertical Depth) is highly naturally permeable and mainly dipping to the East. At 3000-3400m TVD, the intermediate cluster constitutes a dense network developed in an altered matrix and constituted the upper reservoir. In the lower part of the wells, the deeper cluster appears as a fractured reservoir corresponding to isolated discrete faults developed within a low permeable matrix at about 4500-5000m TVD. In the two deep clusters, fracture zones are mainly dipping to the West.

The geometry of these fracture zones has been integrated in a 3D model, in addition with the location of induced microseismicity as well as structures derived from vertical seismic profile (VSP) data interpretation. This 3D representation allows correlating geophysical and geological data in order to illustrate the complexity of 3D fracture network in crystalline rocks characterized at borehole scale (meter) and extended in 3D at reservoir scale (kilometer).