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Prediction of matrix reservoir properties in fault zones and weathered layers for deep EGS in basement rocks using outcropping analogs.

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Geothermal prospects for electricity production target fluids at temperatures at 150°C and higher. In extensional related fault zones reservoirs, like in the West European Rift system (WER), these temperatures are reached in the basement of the basins. It is composed mostly crystalline or metamorphic rocks emplaced during the Hercynian orogeny covered by pre and syn-rift sediments. In these type of rocks, the reservoir properties are controlled by 1) the fault and fracture system that creates a permeable network if well connected and 2) the mineral alteration that could enhance the primary porosity and permeability of the rock matrix in the fault zones and/or the weathered layer at the basement/sediment unconformity.
In order to estimate the potential reservoir properties of these rocks before the drilling phase of different geothermal prospects in the WER, the different facies of the basement rocks have been sampled on the shoulders of the rift. Three outcropping areas have been studied: The Northern Vosges as analogous rocks of the central part of the Upper Rhine Graben basement, the SE border of the French Massif Central for the Valence trench (Rhone Valley) and each side of the Limagne graben shoulders for the Riom trench. Hand samples have been kept in the weathered layers, the fault cores, the damaged zones and the unaltered protolith with the aim to characterize the reservoir properties evolution regarding the different rocks types. On these samples, gas permeability, skeletal and bulk density, water and Mercury porosity, P-waves velocity and thermal conductivity measurements were performed.
This study shows that the different rock facies can be classified in three groups regarding their alterability and its consequence on the reservoir properties of the rock matrix: 1) The granitic and granodioritic bodies but also the orthoderived gneiss that expose commonly fault cores with gouge and breccias, and wheathered layers with porosity up to 20-25 % and permeability up to 100 mD; and up to 8 % porosity in the fractured damaged zones; 2) The schistes and paraderived gneisses with the same porosity evolution but with less maximum permeability (10 mD) du to the influence of the schistosity and 3) the metamorphosed rocks with volcanic origin and dioritic bodies with porosity mostly controlled by the fracture network and only small amount of mineral alteration (3% porosity and 0.2 mD matrix permeability).