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Geothermal, structural and petrophysical characteristics of Buntsandstein sandstone reservoir in the Upper Rhine Graben

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Petrophysical measurements, including porosity, permeability, thermal conductivity and P-waves velocity, were performed on cores of EPS1 borehole (Soultz-sous-Forêts, Upper Rhine Graben, France) in order to characterise Buntsandstein sandstone (lower Triassic) reservoir properties. Temperature gradient analysis, made from (1) thermal conductivity measurements performed on cores and (2) a temperature profile, suggest that fluid flow occurs locally in the reservoir. Petrophysical measurements and structural analysis of flow zones suggest that they are controlled first by a macroscopic network: with two major fault zones, and second by a matrix network: formed by sedimentary or diagenetic processes within two distinguishable facies: the Playa-lake and Fluvio-aeolian marginal erg facies. In order to validate the previous proposed methodology and reservoir model, we propose to simulate fluid flow in the Buntsandstein reservoir, thanks to TOUGH2 software, especially by copying temperature profile from static reservoir model. This model integrates, with horizontal layers, the lithostratigraphic context described from cores observation, and with vertical layers, two faults corresponding to the Soultz-sous-Forêts horst boundary. Petrophysical characteristics are integrated thanks to previous measurements. Two cases are tested. In the first, the temperature profile is determined in a model in which there is no fluid circulation between faults; heat transfer is governed only by conduction. In the second, the temperature profile is determined in a model in which there is flow circulation between faults. In the first case, same overpressures (10 bars) are applied at the base of both faults, whereas in the second case, two different pressures are applied (5 and 10 bars). In one hand, temperature profile obtained in the first case show an opposite global trend to those measured in the borehole. In the other hand, temperature profile obtained in the second case indicates a global trend similar to those measured in the borehole. In the last case, fluid circulation occurs in faults zones and in three lithostratigraphic levels, previously identified as fluid circulation zones in the reservoir. The differential pressure between faults, driving to the fluid flow inside the rock formation, could be explained by a tilt of the horst, as what was noticed at Soultz-sous-Forêts. Data obtained from thermal gradients analysis are associated to those obtained from different outcrops analysis. Two 3D conceptual bloc models have been built for the Buntsandstein sandstones reservoir of the Upper Rhine Graben: the first integrated solely fracturation of the reservoir, whereas the second takes into account data of fracturation, sedimentology and fluid flow. These models appear as new kind of data important for future exploration and exploitation of the reservoir.