# Characterization of Crustal Fault Zones as geothermal power systems: a multidisciplinary approach

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As potential geothermal reservoirs, crustal fault zones remain largely unexplored and unexploited. The aim of this work is to understand the potential of these naturally permeable area, with the example of the Pontgibaud crustal Fault Zone (PFZ), a crustal scale fault in the French Massif Central. The PFZ has been well studied in the last few years (Bellanger et al., 2017). Electrical conductivity anomalies have been identified (Ars et al., 2019) and a positive temperature anomaly has been estimated (150°C at a depth of 2.5 km, Duwiquet et al., 2019). These results highlighted that vertical crustal fault zones could concentrate the highest temperature anomalies at shallow depths. However, these results did not characterize the capacity of the system to allow fluids to circulate at different scales, and the numerical models did not consider 3D effects and interactions between fluids, deformation and temperature. New 2D (thin-section) and 3D (X-ray micro-tomography) observations point to well-defined spatial propagation of fractures and voids at different scales (2.5 µm to 2 mm). This architecture at different scales appears to be arranged in a way to facilitate fluid flow (Bejan and Lorente, 2011). We performed 3D numerical modeling where permeability, stress intensity, and stress direction relative to the deformation zone were varied systematically. In accordance with 2D results, the 3D results show three different convective patterns (finger-like, blob-like and double-like). These results also show that the deformation zones are at an angle of 30° and 70° to the stress direction will have the most intense temperature anomalies at the shallowest depths. Finally, large scale (at the scale of the PFZ) 3D numerical modeling of Thermal (T) Hydraulic (H) and Mechanical (M) behaviours has been performed. The comparison with field data is used to characterize the spatial geometry of the 150°C isotherm.

**Key words :** Crustal Fault Zones, High temperature geothermal system, Constructale theory, 3D THM Numerical modelling, Pontgibaud, French Massif Central

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Merci de ne rien inscrire dans cette zone et ne pas modifier les marges des pieds de page et entêtes.