Advanced 3D modeling to shed light on thermal convection in fault zones with varying thicknesses

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Résumé

Fault zones exhibit variable geometry, a feature that remains inadequately explored, particularly with regard to the impact of thickness variation on fluid flow. Upon analyzing the critical Rayleigh number, we examine 3D thermal-hydraulic (TH) dynamical models through a benchmark experiment, which incorporates a fault zone with thickness variations corresponding to coherent orders of magnitude. The findings emphasize an area of interest where vigorous convection drives fluid flow, resulting in a temperature increase to 150∘C at a shallow depth of 2.7 km in the thickest sections of the fault zone. Moreover, by considering various tectonic regimes (compressional, extensional, and strike-slip) within the 3D thermal-hydraulic-mechanical (THM) models and comparing them to the benchmark experiment, we observe alterations in fluid pressure induced by poroelastic forces acting on fluid flow within the area of interest. These tectonic-induced pressure changes influence the thermal distribution of the region and the intensity of temperature anomalies. Outcomes of this study emphasize the impact of poroelasticity-driven forces on transfer processes and highlight the importance of addressing fault geometry as a crucial parameter in future investigations of fluid flow in fractured systems. Such research has relevant applications in geothermal energy, CO2 storage, and mineral deposits.

Mots-Clés: Fault Zones, High, Temperature geothermal system, Geometry impact, 3D Dynamic numerical modeling

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