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3D features of delayed thermal convection in fault zones: consequences for deep fluid processes in the Tiberias Basin, Jordan Rift Valley

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It has been shown that thermal convection in faults can also occur for subcritical Rayleigh conditions. This type of convection develops after a certain period and is referred to as “delayed convection” (Murphy, 1979). The delay in the onset is due to the heat exchange between the damage zone and the surrounding units that adds a thermal buffer along the fault walls. Few numerical studies investigated delayed thermal convection in fractured zones, despite it has the potential to transport energy and minerals over large spatial scales (Tournier, 2000).
Here 3D numerical simulations of thermally driven flow in faults are presented in order to investigate the impact of delayed convection on deep fluid processes at basin-scale. The Tiberias Basin (TB), in the Jordan Rift Valley, serves as study area. The TB is characterized by upsurge of deep-seated hot waters along the faulted shores of Lake Tiberias and high temperature gradient that can locally reach 46 °C/km, as in the Lower Yarmouk Gorge (LYG). 3D simulations show that buoyant flow ascend in permeable faults which hydraulic conductivity is estimated to vary between 30 m/yr and 140 m/yr. Delayed convection starts respectively at 46 and 200 kyrs and generate temperature anomalies in agreement with observations. It turned out that delayed convective cells are transient. Cellular patterns that initially develop in permeable units surrounding the faults can trigger convection also within the fault plane. The combination of these two convective modes lead to helicoidal-like flow patterns. This complex flow can explain the location of springs along different fault traces of the TB. Besides being of importance for understanding the hydrogeological processes of the TB (Magri et al., 2015), the presented simulations provide a scenario illustrating fault-induced 3D cells that could develop in any geothermal system.

References

Magri, F., Inbar, N., Siebert, C., Rosenthal, E., Guttman, J., Möller, P., 2015. Transient simulations of large-scale hydrogeological processes causing temperature and salinity anomalies in the Tiberias Basin. Journal of Hydrology, 520(0), 342-355.
Murphy, H.D., 1979. Convective instabilities in vertical fractures and faults. Journal of Geophysical Research: Solid Earth, 84(B11), 6121-6130.
Tournier, C., Genthon, P., Rabinowicz, M., 2000. The onset of natural convection in vertical fault planes: consequences for the thermal regime in crystalline basementsand for heat recovery experiments. Geophysical Journal International, 140(3), 500-508.