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Modes of free convective flow in fractured-porous rock

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Abstract The effect of regular orthogonal fracture networks on density dependent free convection is investigated by numerical simulations. Discrete orthogonal fracture networks of different fracture spacing are systematically added to the Horton-Rogers-Lapwood (HRL) problem for free-convective flow in unfractured homogeneous porous rock. The equivalent hydraulic conductivity was preserved when fractures were added. Simulation results suggest that fractures affect free-convective flow if: (i) fracture permeability is more than five orders of magnitude larger than matrix permeability, and if (ii) fracture spacing is large. With decreasing fracture spacing, flow patterns approximate those of the corresponding unfractured HRL problem. Furthermore, a diffusion-only case at low Rayleigh number in homogeneous unfractured rock is regarded. It is shown that adding few fractures with large fracture spacing promotes free convective flow compared to the unfractured case of the same equivalent permeability.

Key words groundwater; fractures; Rayleigh; density; HydroGeoSphere; numerical modelling