The numerical modelling of the convection of a Bingham fluid in a porous medium

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ABSTRACT We consider the free convection of a Bingham fluid which is saturating a porous medium. Attention is focused on the classical problem of a sidewall-heated cavity. For a Newtonian fluid convection arises at all values of the Darcy-Rayleigh number, but for a Bingham fluid buoyancy forces need to be sufficiently strong to overcome the microscopic yield stress. We consider both an isotropic and an anisotropic form of the Darcy-Bingham law, and numerical simulations are aided by the use of a regularized form of that law. F.A.S. multigrid with line relaxation is used to obtain the streamfunction. We find that stagnation arises in the corners and at the centre of the cavity. As the strength of the yield criterion, as measured by the Rees-Bingham number, increases, convection becomes increasingly confined to the outer regions until full stagnation eventually occurs.