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THREE-DIMENSIONAL CONVECTION WITHIN A CUBOIDAL POROUS CAVITY DUE TO UNIFORM VOLUMETRIC HEATING

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ABSTRACT A cuboidal cavity is filled with a fluid-saturated porous medium which is subjected to a uniform volumetric internal heating where all six boundaries are held at identical constant temperatures. The ensuing free convection is computed using finite difference approximations of the equations written using the velocity-potential/temperature formulation. Both steady and unsteady solvers have been written, and both employ a Full Approximation Scheme multigrid methodology with pointwise Gauss-Seidel smoothing. Our aim is to determine the evolution with Darcy-Rayleigh number, Ra, of the flow and temperature fields within the cavity and how they undergo successive transformations from a steady single-cell pattern at relatively low values of Ra via symmetry-breaking bifurcations to more complicated states. The ensuing free convective flow is visualised by means of heat transfer contours and horizontal velocity vectors at the upper surface. In this preliminary work, attention is confined to a $2 \times 2 \times 1$ cavity and Darcy-Rayleigh numbers which are below 6000. Nevertheless we uncover a variety of competing steady-state solutions.