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Buoyancy-driven instabilities of miscible two-layer stratifications

P.M.J. TREVELYAN, C. ALMARCHA, A. DE WIT, NLPC, Universite Libre de Bruxelles, Belgium — Buoyancy-driven instabilities of a horizontal interface between two miscible solutions in the gravity field are studied for porous media by a theoretical approach. Beyond the classical Rayleigh-Taylor and double-diffusive instabilities that can affect such a two-layer stratification right at the initial time of contact, diffusive-layer convection as well as delayed-double diffusive instabilities can set in at later time when differential diffusion effects act upon the evolving density profile starting from a step-function initial condition between the two miscible solutions. The conditions for these instabilities to occur can therefore not be obtained using linear base state profiles but can be computed only by considering time evolving base state profiles. To do so, we perform a linear stability analysis based on a quasi steady state approximation as well as nonlinear simulations of a diffusion-convection model. We classify and analyze all possible buoyancy-driven instabilities of a stratification of a solution of A on top of a miscible one of B as a function of a buoyancy number R quantifying the ratio of the relative contribution of B and A to the density and of δ the ratio of diffusion coefficients of these two species.

P.M.J. Trevelyan
NLPC, Universite Libre de Bruxelles, Belgium

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