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A new approach to the stability analysis of transient natural convection in porous media NILS TILTON, Colorado School of Mines — Onset of natural convection due to transient diffusion in porous media has attracted considerable attention for its applications to CO_2 sequestration. Stability analyses typically investigate onset of convection using an initial value problem approach in which a perturbation is introduced to the concentration field at an initial time $t = t_p$. This leads to debate concerning physically appropriate perturbations, the critical time t_c for linear instability, and to the counter-intuitive notion of an optimal initial time t_p that maximizes perturbation growth. We propose a new approach in which transient diffusion is continuously perturbed by small variations in the porosity. With this approach, instability occurs immediately ($t_c = 0$) without violating any physical constraints, such that the concepts of initial time t_p and critical time t_c have less relevance. We argue that the onset time for nonlinear convection is a more physically relevant parameter, and show that it can be predicted using a simple asymptotic expansion. Using the expansion, we consider porosity perturbations that vary sinusoidally in the horizontal and vertical directions, and show there are optimal combinations of wavelengths that minimize the onset time of nonlinear convection.

Nils Tilton
Colorado School of Mines

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