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Dissolution driven convection for carbon dioxide sequestration: the stability problem SHREYAS MANDRE, XINJUN GUO, Brown University, ANJA SLIM, Schlumberger-Doll Research Center — The dissolution-driven convection in porous media is potentially a rate limiting process for sequestering carbon dioxide in underground aquifers. Super critical carbon dioxide introduced in the aquifer is lighter than the water that fills the surrounding porous rock, and hence quickly rises to the top. However, the solution of carbon dioxide in water is heavier than water. Hence, as the layer of carbon dioxide dissolves in the water, convection may ensue. The threshold criteria for convection is obscured by the continually changing background density profile as the carbon dioxide diffuses through the pores. Commonly used techniques such as frozen coefficient analysis or non-modal theories using transient amplifications yield substantially different results for the threshold, which has been the cause of a debate in the scientific community. We present a general theory for the linear stability of non-autonomous systems and apply it to dissolution driven convection. The theory unifies the classical modal stability theory using eigenvalues, the non-modal approaches using optimal growth of energy and the frozen coefficient analysis. We settle the debate, and demonstrate the existence of a threshold time for convection to commence.

Shreyas Mandre
Brown University

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