Geophysical Research Abstracts
Vol. 18, EGU2016-13122, 2016
EGU General Assembly 2016

Laboratory measurements of density-driven convection in analogy with solubility trapping of geologically sequestered CO_2

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Density-driven convection is of interest to several areas of groundwater-science: nuclear waste storage, industrial waste disposal, deep geothermal energy extraction, and seawater intrusion into coastal aquifers. Lately it has been identified to accelerate the rate of CO_2 solubility trapping for geological CO_2 storage in deep saline aquifers. We present an experimental method based on the light transmission technique and an analogue system design that enable comprehensive study of solutally induced density-driven convection in saturated porous media. The system design affords an examination of the convective process in general as well as a two-dimensional laboratory analogue for field phenomena. Furthermore, the method can be used to verify numerical results from density-driven flow simulation codes as part of benchmarking. With application to geological CO_2 storage, we show how the method is used to measure density-driven convection in both homogenous and heterogeneous porous media and for different Rayleigh numbers. The results demonstrate that the solute concentration distribution in the system can be accurately determined with high spatial and temporal resolution. Thus, the onset time of convection, mass flux and flow dynamics can be quantified for different systems under well-controlled conditions.