Geophysical Research Abstracts,
Vol. 11, EGU2009-4426-1, 2009
EGU General Assembly 2009

A stability criterion for heterogeneous density-driven flows

J. Musuuza (1) and F.A. Radu (2)

(1) Institute for Geosciences, University of Jena, Germany (jude.musuuza@uni-jena.de), (2) UFZ-Helmholtz Center for Environmental Research, Permoserstr. 15, D-04318 Leipzig, Germany

Variable density flows can occur due to temperature differences in deep aquifers and due to salinity differences at normal and nuclear waste repositories; and in coastal aquifers. Therefore, their relevance cuts across many practical applications like exploitation of geothermal energy resources, oil recovery from aquifers and leachate migration at waste disposal sites. A typical feature of density dependent flow problems is that they can become unstable (physically or numerically).

Variable density flow problems are difficult to solve due to the non-linearities and coupling between fluid flow and solute transport processes. A big challenge to-date is to derive a general criterion that states whether flow is physically stable or unstable; and the optimum computational grid resolution required to solve a problem without creating numerical (artificial) instabilities.

We extend the ideas introduced in [1] to develop an explicit criterion based on homogenization theory techniques. At present, the criterion only includes the effects of density, viscosity medium heterogeneity and flow velocity. The validity of the criterion is carefully tested in numerical simulations for the problem defined in [2], with the solution stability guaranteed by the appropriate choice of dispersivities, mesh diameter and time step. The numerical simulations are performed with the software toolbox UG and the investigations then proceed by varying the 4 above-named parameters.

REFERENCES

[1] Held, R., S. Attinger, and W. Kinzelbach (2005), Homogenization and effective parameters for the Henry problem in heterogeneous formations, Water Resour. Res., 41, W11420, doi:10.1029/2004WR003674.

[2] Schincariol R. A., F. W. Schwarz, and C. A. Mendoza (1997), On the generation of instabilities in variable density flow, Water Resour. Res., 30(4), 913-927.