Geophysical Research Abstracts
Vol. 12, EGU2010-9524, 2010
EGU General Assembly 2010

Stability of haline density-driven flows in saturated heterogeneous media

Jude Musuuza (1), Sabine Attinger (1,2), Florin Radu (1,2)

(1) University of Jena, Institute for Geosciences, Jena, Germany (jlmusuuza@gmail.com), (2) UFZ-Helmholtz Centre for Environmental Research, Permoserstr. 15, D-04318 Leipzig, Germany

Density-driven flows occur in deep aquifers due to temperature differences and in coastal aquifers and refuse dumps due to solute concentration differences. Its relevance cuts across many practical applications like (normal and nuclear) waste repository management, exploitation of geothermal energy resources, enhanced oil recovery from aquifers and remediation of contaminated sites. A typical feature of density dependent flow problems is that they can become unstable (physically or numerically).

A big challenge has been the absence of a general criterion that states whether flow is physically stable or unstable and the optimum computational grid resolution needed to solve the problem without creating numerical (artificial) instabilities. The homogenization theory ideas from [1] were extended in [2] to derive a stability criterion for density-driven flows in saturated homogeneous porous media. The criterion included the effects of density, viscosity and velocity but could not adequately predict the onset of fingering when velocity was varied.

That study is extended here to include dispersive and medium heterogeneity effects. The specific objective is to answer the question: *under what conditions do heterogeneities stabilise or destabilise flow?* The homogenization theory ideas from [1] are again used to derive expressions for the elements of the macrodispersion tensor for flow aligned parallel to gravity. The dependency of the temporal evolution of the coefficients on the density contrast, heterogeneity variance, transverse dispersivity, anisotropy and correlation length are then investigated and the results checked against numerical simulations performed with the software toolbox d^3f.

The work will be extended to include temperature effects and it is hoped that the ideas can be extended to flow in unsaturated soils.

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] Musuuza J. L., S. Attinger, and F. A. Radu (2009), An extended stability criterion for density-driven flows in homogeneous porous media, Advances in Water Resour., 32, doi:doi:10.1016/j.advwatres.2009.01.012.