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Strongly Coupled Density-Dependent Flow

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Strongly Coupled Density-Dependent Flow

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Foreword

Introduction to the Special Issue

Interest in strongly coupled density-dependent flow of groundwater in porous media has grown in recent years because of the need to understand the transport of contaminants from accidental spills and leaks of industrial chemicals, from deep well injections of hazardous waste, and from potential releases from nuclear waste repositories located in evaporitic salt deposits.

An integral part of investigations of strongly coupled density-dependent flows in subsurface systems is numerical simulation. Yet this approach is not without drawbacks, as debate has arisen in the past about differences in simulation results for what were intended to be simple test problems (e.g., Konikow et al., 1997). Because of the importance of the issues surrounding contaminant transport for decision making by environmental agencies in countries around the world, there is a clear need to improve simulation models and the practice of numerical simulation. While some researchers will argue that no actual validation of simulation models is possible insofar as the actual natural system cannot be simulated *sensu stricto* (Oreskes, 1994), the approach of numerical simulation is valuable, widely used, and will continue in some manner to help answer key scientific questions of flow and transport in the subsurface.

The process of improving simulation models involves code development and testing. To date, opportunities for testing strongly coupled density-dependent flow simulation models have been limited by the number of acceptable test problems available. Strongly coupled density-dependent flow problems are defined as those where the density differences in the groundwater are greater than 5%. This is a somewhat arbitrary distinction chosen to separate this class of problems from those of seawater intrusion, where maximum density differences are typically less than 3%. While test problems such as the Henry problem (Henry, 1964), Elder problem (Elder, 1967), and salt-dome flow problem (Andersson et al., 1986) have served as test problems up to now, there is a clear need for more published field and experimental results suitable for testing simulation models and demonstrating competence in simulation practice.

The purpose of this Special Issue of TIPM is to bring together in one place a series of papers on experimental and field studies of strongly coupled density-dependent flows. Through the papers presented, natural flow and transport phenomena related to density dependence such as mixing, fingering, recirculation, and stagnation are described.

The papers emphasize laboratory or field observations and discussions of underlying physics rather than simulation results. It is the intent of this Special Issue to promote progress in both the understanding of strongly coupled density-dependent flows in nature, and in the modeling of these natural phenomena through the future use of the problems presented here as simulation test problems.

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References

Andersson, K., B. Grundfelt, D.P. Hodgkinson, B. Lindbom, and C.P. Jackson, *HYDROCOIN Level 1 Final Report: Verification of Groundwater Flow Models*, Swedish Nuclear Power Inspectorate (SKI), 1986.

Elder, J.W., Transient convection in a porous medium, *J. Fluid Mech.*, *27*(3), 609–623, 1967.

Henry, H.R., Effects of dispersion on salt encroachment in coastal aquifers, *U.S. Geol. Surv. Water Supply Pap.*, *1613-C*, C71–C84, 1964.

Konikow, L.F., W.E. Sanford, and P.J. Campbell, Constant-concentration boundary condition: Lessons from the HYDROCOIN variable-density groundwater benchmark problem, *Water Resour. Res.* (33(10), 2253–2261, 1997.

Oreskes, N., K. Shrader-Frechette, and K. Belitz, Verification, validation, and confirmation of numerical models in the earth sciences, *Science 263*, 641–646, 1994.