Foreword

George J. Moridis

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This Special Issue of *Transport in Porous Media* features selected papers from the 2009 TOUGH Symposium, which took place on September 14–16, 2009 in Berkeley, CA, USA. Such symposia are held every 3 years and are a forum where users of the TOUGH family of numerical simulators meet for an open exchange on the code applications and recent enhancements. The acronym “TOUGH” stands for “Transport Of Unsaturated Groundwater and Heat” and reflects the original geothermal focus of the code, which has over the years expanded into a family of multi-dimensional, multi-component models that are designed for the simulation of the coupled transport of fluids and heat in porous and/or fractured geologic media.

Since its first release in 1987 by a team of researchers at the Lawrence Berkeley National Laboratory headed by Karsten Pruess, the TOUGH family has been enriched by a large number of modules that describe a variety of important Equations-Of-State (EOS, involving various mass components) and has evolved to include several derivatives and descendants (e.g., EOS modules for multi-component volatile organic compounds; decay chains of multiple radionuclides, gas hydrates, and supercritical CO₂; modules for coupled multi-phase flow and reactive transport, and coupled thermo-hydrologic-mechanical processes; inverse modeling for parameter estimation, sensitivity analysis, and uncertainty quantification; parallelization for multi-core PCs, workstation clusters, supercomputers, etc.). The TOUGH family of codes is currently used to address a wide spectrum of problems, which includes applications to geothermal reservoir engineering, nuclear waste disposal in geologic formations, geologic carbon sequestration, gas hydrate research, vadose zone hydrology, environmental remediation, oil and gas reservoir engineering, and other coupled mass transport and energy transfer problems in complex subsurface geologic settings. The international TOUGH user community currently numbers almost 400 organizations (research laboratories, government agencies, private companies, universities, etc.) in over 40 countries.

George J. Moridis was the Chair of the 2009 TOUGH Symposium.

G. J. Moridis (✉)
Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA
e-mail: gjmoris@lbl.gov

Approximately 200 researchers and engineers from a dozen countries attended the 2009 TOUGH Symposium. The 108 papers presented by international researchers and research groups at the Symposium covered a wide range of topics, including:

- Coupled process modeling (thermal, hydrological, chemical, mechanical, biological) in porous and fractured geologic media
- Hydrocarbon recovery
- Geologic CO₂ storage/sequestration
- Methane hydrate dissociation and gas recovery
- Performance assessment of nuclear waste repositories
- Geothermal reservoir studies
- Vadose zone hydrology
- Fate and transport of volatile organic compounds
- Reactive transport modeling for environmental remediation
- Design and analysis of laboratory and field experiments
- Automatic model calibration and uncertainty analysis
- Code verification and validation
- Enhanced process capabilities and user features
- Numerical methods, grid generation, and parallel computing

Fifteen representative papers that cover a wide spectrum of subjects involved in the most important current applications of the TOUGH family of codes were selected for inclusion in this Special Issue of *Transport in Porous Media*. We hope that this Special Issue will be a valuable addition to the library of nuclear engineers, scientists, and technology specialists, and especially to current and future users of the TOUGH codes.

On behalf of the members of the 2009 TOUGH Symposium Organizing Committee (Chris Doughty, Eric Sonnenthal, and George Moridis), I would like to express my thanks and appreciation to the many session organizers and chairs that made the Symposium an unequivocal success, and my gratitude to the various reviewers for their outstanding efforts in evaluating the papers and making the publication of this Special Issue possible.