Preface

This book consists of six invited expository chapters resulting from the workshop *Simulation of Flow and Transport in Porous Media and Applications in Waste Management and CO_2 Sequestration* which took place on October 3–7, 2011, at the Johann Radon Institute for Computational and Applied Mathematics (RICAM), Austrian Academy of Sciences, Linz, Austria. This workshop with 21 invited speakers and more than 60 participants was part of a special semester on *Multiscale Simulation and Analysis in Energy and Environment* that took place between October 3 and December 16 at RICAM with a total of about 200 participants (Chair: R. Scheichl). The goal of the special semester was to stimulate interdisciplinary cooperation between engineers, hydrologists, meteorologists, and mathematicians for these highly important societal problems. It consisted of four focused workshops and a large visitors program, with long-term visitors interacting with RICAM staff and with each other, including graduate courses and "research kitchens."

The workshop, from which the present chapters arose, focused on mathematical and computational issues in subsurface flow. Subsurface flow problems are inherently multiscale in space due to the large variability of material properties, as well as in time due to the coupling of many different physical processes, such as advection, diffusion, reaction, and phase exchange. Mathematical models for these processes still need considerable development. However, significant progress is crucial, in particular in energy and environmental applications, to successfully tackle such important societal challenges as long-term radioactive waste management and sequestration of CO_2 underground. The workshop focused on cutting-edge issues such as *multiphase flows* and *coupled problems*, and this book gives a cross section of the talks as well as the current state-of-the-art. The seemingly disparate, but equally timely topic of *fuel cell modeling* is mathematically very similar and so the workshop included a special session with three speakers also on that topic.

The chapters in this book are written by invited speakers and their collaborators and are intended to provide an overview of the topics covered by the workshop. The contributions may be grouped into two larger themes:

(1) *Multiphase Flow.* The chapter of S. Gasda et al. treats upscaling aspects of CO_2 sequestration in realistic geologic settings. M. Wolff et al. concentrate on accurate discretization schemes for multiphase flow on nonorthogonal meshes. A. Bourgeat et al. present results of a benchmark study in the context of nuclear waste storage.

(2) *Coupled Problems.* The mathematical and computational aspects of coupling surface or free flow with subsurface flow are addressed by the contribution of M. Discacciati. The contribution of J. Fuhrmann resulted from a special session on fuel cell modeling and gives an overview of mathematical and computational aspects of electrochemical devices. Last but not least the contribution of B. Ganis and coworkers covers multiscale aspects of coupled flow and geomechanics.

First and foremost, we thank all the authors of the chapters for sacrificing their valuable time to help us produce this exciting book. We would like to thank the former Director of RICAM, Prof. Heinz Engl, and the current Director, Prof. Ulrich Langer, for the invitation and for the opportunity to organize this special semester. We also want to particularly thank the administrative team at RICAM around Susanne Dujardin, Annette Weihs, Wolfgang Forsthuber, and Florian Tischler, as well as the local scientific organizers Joerg Willems, Johannes Kraus, and Erwin Karer. The special semester, the workshops, and this book would not have been possible without their efforts and commitment. A great thank you is also in order for the remaining members of the Program Committee, Mike Cullen (UK Met Office), Melina Freitag, Ivan Graham (both University of Bath), and Markus Melenk (TU Vienna). Finally we also thank the speakers and participants at the workshop for making it such an outstanding event.

More information on the special semester and the four workshops can be found at

http://www.ricam.oeaw.ac.at/specsem/specsem2011/

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