Modeling Groundwater Flow And Contaminant Transport Theory And Applications Of Transport In Porous Media

Applied Contaminant Transport ModelingWater Stress in PlantsDiffusion in Natural Porous MediaGroundwaterAnalytic Element Modeling of Groundwater FlowGround Water ContaminationCharacterization, Modeling, Monitoring, and Remediation of Fractured RockApplied Contaminant Transport ModelingGuidelines for Evaluating Ground-water Flow ModelsGroundwater Models for Resources Analysis and ManagementFlow and Contaminant Transport in Fractured RockGeochemical Modeling of Groundwater, Vadose and Geothermal SystemsEnvironmental HydrologySeawater Intrusion in Coastal AquifersGeochemical and Biogeochemical Reaction ModelingThe Handbook of Groundwater EngineeringModeling Groundwater Flow and PollutionFundamentals of Ground-water ModelingModelling Groundwater Systems: Understanding and Improving Groundwater Quantity and Quality ManagementHydrogeologyModeling Groundwater Flow and Contaminant TransportModeling Groundwater Flow and Contaminant TransportIntroduction to Groundwater ModelingHydrogeology and Groundwater ModelingComputational Methods in Subsurface FlowGroundwater ScienceContaminant GeochemistryModeling Groundwater Flow and Contaminant TransportMigration and Fate of Pollutants in Soils and SubsoilsHydraulics of GroundwaterContaminants in the SubsurfaceBioremediation and Natural AttenuationNumerical Groundwater ModellingApplied Groundwater ModelingApplied Flow and Solute Transport Modeling in AquifersFEFLOW3D-Groundwater Modeling with PMWINConceptual Models of Flow and Transport in the Fractured Vadose ZoneAnalytical Modeling of Solute Transport in GroundwaterDynamics of Fluids in Porous Media

Applied Contaminant Transport Modeling

This book offer a complete simulation system for modeling groundwater flow and transport processes. The companion full-version software (PMWIN) comes with a professional graphical user-interface, supported models and programs and several other useful modeling tools. Tools include a Presentation Tool, a Result Extractor, a Field Interpolator, a Field Generator, a Water Budget Calculator and a Graphic Viewer. Book targeted at novice and experienced groundwater modelers.

Water Stress in Plants

In this updated and expanded second edition, new literature has been added on contaminant fate in the soil-subsurface environment. In particular, more data on the behavior of inorganic contaminants and on engineered nanomaterials were included, the latter comprising a group of “emerging contaminants” that may reach the soil and subsurface zones. New chapters are devoted to a new perspective of contaminant geochemistry, namely irreversible changes in pristine land and

subsurface systems following chemical contamination. Two chapters were added on this topic, focusing attention on the impact of chemical contaminants on the matrix and properties of both liquid and solid phases of soil and subsurface domains. Contaminant impacts on irreversible changes occurring in groundwater are discussed and their irreversible changes on the porous medium solid phase are surveyed. In contrast to the geological time scale controlling natural changes of porous media liquid and solid phases, the time scale associated with chemical pollutant induced changes is far shorter and extends over a “human lifetime scale”.

Diffusion in Natural Porous Media

Environmental Hydrology presents a unified approach to the role of hydrology in environmental planning and management, emphasizing the consideration of the hydrological continuum in determining the fate and migration of chemicals as well as micro-organisms in the environment, both below the ground as well as on it. The eco-hydrological consequences of environmental management are also discussed, and an up-to-date account of the mathematical modeling of pollution is also presented. Audience: Invaluable reading for senior undergraduates and beginning graduates, civil, environmental, and agricultural engineers, and geologists and climatologists.

Groundwater

Groundwater is increasingly subjected to excessive over-exploitation and contamination in many parts of the world. It faces the challenge of balancing its multiple functions in a sustainable manner. This thesis explores several specific problems related to contaminant migration, groundwater-surface water interactions and managed aquifer recharge, using a variety of simulation methods and combined simulation-optimization modelling approaches. The validity of these approaches for evaluating groundwater quantity and quality management options is explored. Case studies were performed on field applications in Belgium, Germany and Oman. The results of these studies demonstrate that better insights and improved groundwater resource management can be achieved through a combination of different simulation and optimization methods that take into account data availability and specific site conditions.

Analytic Element Modeling of Groundwater Flow

Water stress in plants is caused by the water deficit, as induced possibly by drought or high soil salinity. The prime consequence of water stress in plants is the disruption in the agricultural production, resulting in food shortage. The plants, however, try to adapt to the stress conditions using biochemical and physiological interventions. The edited compilation is an attempt to provide new insights into the mechanism and adaptation aspects of water stress in plants through a

thoughtful mixture of viewpoints. We hope that the content of the book will be useful for the researchers working with the plant diversity-related environmental aspects and also provide suggestions for the strategists.

Ground Water Contamination

Coupling the basics of hygrogeology with analytical and numerical modeling methods, Hydrogeology and Groundwater Modeling, Second Edition provides detailed coverage of both theory and practice. Written by a leading hydrogeologist who has consulted for industry and environmental agencies and taught at major universities around the world, this unique

Characterization, Modeling, Monitoring, and Remediation of Fractured Rock

This is the definitive work on the subject by one of the world's foremost hydrologists, designed primarily for advanced undergraduate and graduate students . 335 black-and-white illustrations. Exercises, with answers.

Applied Contaminant Transport Modeling

Modeling flow and contaminant transport in fractured rocks / J. Bear -- Solute transport in fractured rock--applications to radionuclide waste repositories / I. Neretnieks -- Solute transport through fracture networks / L. Smith, F.W. Schwartz -- Stochastic models of fracture systems and their use in flow and transport modeling / J.-P. Chilès, G. de Marsily -- Tracer transport in fracture systems / C.-F. Tsang --Multiphase flow in fractured petroleum reservoirs / H. Kazemi, J.R. Gilman -- Unsaturated flow in fractured porous media / J.S.Y. Wang, T.N. Narasimhan -- Simulation of flow and transport in fractured porous media / G.F. Pinder, P.S. Huyakorn, E.A. Sudicky -- A summary of field test methods in fractured rocks / P. Jouanna -- Index.

Guidelines for Evaluating Ground-water Flow Models

Fluid flow and solute transport within the vadose zone, the unsaturated zone between the land surface and the water table, can be the cause of expanded plumes arising from localized contaminant sources. An understanding of vadose zone processes is, therefore, an essential prerequisite for cost-effective contaminant remediation efforts. In addition, because such features are potential avenues for rapid transport of chemicals from contamination sources to the water table, the presence of fractures and other channel-like openings in the vadose zone poses a particularly significant problem, Conceptual Models of Flow and Transport in the Fractured Vadose Zone is based on the work of a panel established under the auspices of the U.S. National Committee for Rock Mechanics. It emphasizes the importance of conceptual models and

goes on to review the conceptual model development, testing, and refinement processes. The book examines fluid flow and transport mechanisms, noting the difficulty of modeling solute transport, and identifies geochemical and environmental tracer data as important components of the modeling process. Finally, the book recommends several areas for continued research.

Groundwater Models for Resources Analysis and Management

Modeling has become an essential tool for the groundwater hydrologist. Where field data is limited, the analytic element method (AEM) is rapidly becoming the modeling method of choice, especially given the availability of affordable modeling software. Analytic Element Modeling of Groundwater Flow provides all the basics necessary to approach AEM successfully, including a presentation of fundamental concepts and a thorough introduction to Dupuit-Forchheimerflow. This book is unique in its emphasis on the actual use of analytic element models. Real-world examples complement material presented in the text. An educational version of the analytic element program GFLOW is included to allow the reader to reproduce the various solutions to groundwater flow problems discussed in the text. Researchers and graduate students in groundwater hydrology, geology, andengineering will find this book an indispensable resource. * * Provides a fundamental introduction to the use of the analytic element method. * Offers a step-by-step approach to groundwater flow modeling. * Includes an educational version of the GFLOW modeling software.

Flow and Contaminant Transport in Fractured Rock

In many parts of the world, groundwater resources are under increasing threat from growing demands, wasteful use, and contamination. To face the challenge, good planning and management practices are needed. A key to the management of groundwater is the ability to model the movement of fluids and contaminants in the subsurface. The purpose of this book is to construct conceptual and mathematical models that can provide the information required for making decisions associated with the management of groundwater resources, and the remediation of contaminated aquifers. The basic approach of this book is to accurately describe the underlying physics of groundwater flow and solute transport in heterogeneous porous media, starting at the microscopic level, and to rigorously derive their mathematical representation at the macroscopic levels. The well-posed, macroscopic mathematical models are formulated for saturated, single phase flow, as well as for unsaturated and multiphase flow, and for the transport of single and multiple chemical species. Numerical models are presented and computer codes are reviewed, as tools for solving the models. The problem of seawater intrusion into coastal aquifers is examined and modeled. The issues of uncertainty in model input data and output are addressed. The book concludes with a chapter on the management of groundwater resources. Although one of the main objectives of this book is to construct mathematical models, the amount of mathematics required is kept minimal.

Geochemical Modeling of Groundwater, Vadose and Geothermal Systems

In many parts of the world, groundwater resources are under increasing threat from growing demands, wasteful use, and contamination. To face the challenge, good planning and management practices are needed. A key to the management of groundwater is the ability to model the movement of fluids and contaminants in the subsurface. The purpose of this book is to construct conceptual and mathematical models that can provide the information required for making decisions associated with the management of groundwater resources, and the remediation of contaminated aquifers. The basic approach of this book is to accurately describe the underlying physics of groundwater flow and solute transport in heterogeneous porous media, starting at the microscopic level, and to rigorously derive their mathematical representation at the macroscopic levels. The well-posed, macroscopic mathematical models are formulated for saturated, single phase flow, as well as for unsaturated and multiphase flow, and for the transport of single and multiple chemical species. Numerical models are presented and computer codes are reviewed, as tools for solving the models. The problem of seawater intrusion into coastal aquifers is examined and modeled. The issues of uncertainty in model input data and output are addressed. The book concludes with a chapter on the management of groundwater resources. Although one of the main objectives of this book is to construct mathematical models, the amount of mathematics required is kept minimal.

Environmental Hydrology

This second edition is extensively revised throughout with expanded discussion of modeling fundamentals and coverage of advances in model calibration and uncertainty analysis that are revolutionizing the science of groundwater modeling. The text is intended for undergraduate and graduate level courses in applied groundwater modeling and as a comprehensive reference for environmental consultants and scientists/engineers in industry and governmental agencies. Explains how to formulate a conceptual model of a groundwater system and translate it into a numerical model Demonstrates how modeling concepts, including boundary conditions, are implemented in two groundwater flow codes-- MODFLOW (for finite differences) and FEFLOW (for finite elements) Discusses particle tracking methods and codes for flowpath analysis and advective transport of contaminants Summarizes parameter estimation and uncertainty analysis approaches using the code PEST to illustrate how concepts are implemented Discusses modeling ethics and preparation of the modeling report Includes Boxes that amplify and supplement topics covered in the text Each chapter presents lists of common modeling errors and problem sets that illustrate concepts

Seawater Intrusion in Coastal Aquifers

Over recent years, important contributions on the topic of solving various aquifer problems have been presented in

numerous papers and reports. The scattered and wide-ranging nature of this information has made finding solutions and best practices difficult. Comprehensive and self-contained, Applied Flow and Solute Transport Modeling in Aquifers compiles the scattered literature on the topic into a single-source reference of the most up-to-date information in the field. Based on Dr. Batu's 20 years of practical experience tackling aquifer problems in a myriad of settings, the book addresses essentially all currently applied aquifer flow and contaminant transport solutions, combines theory with practical applications, covers both analytical and numerical solutions, and includes solutions to real world contaminant transport modeling scenarios. Batu approaches the subject from the practicing consultant's point of view and elucidates the difficulties real world professionals have faced in solving aquifer flow and contamination problems. The author simplifies the necessary theoretical background as much as possible and provides all derivational details of the theoretical background as worked examples. He uses this method to explore how the derivations were generated for those who need to know while allowing others to easily skip them and still benefit and learn from the practical applications of the mathematical approaches. Containing 51 tables and 323 figures, the book covers both the breadth and the depth of currently applied aquifer flow and contaminant transport modeling solutions.

Geochemical and Biogeochemical Reaction Modeling

The dramatic advances in the efficiency of digital computers during the past decade have provided hydrologists with a powerful tool for numerical modeling of groundwater systems. Introduction to Groundwater Modeling presents a broad, comprehensive overview of the fundamental concepts and applications of computerized groundwater modeling. The book covers both finite difference and finite element methods and includes practical sample programs that demonstrate theoretical points described in the text. Each chapter is followed by problems, notes, and references to additional information. This volume will be indispensable to students in introductory groundwater modeling courses as well as to groundwater professionals wishing to gain a complete introduction to this vital subject. Key Features * Systematic exposition of the basic ideas and results of Hilbert space theory and functional analysis * Great variety of applications that are not available in comparable books * Different approach to the Lebesgue integral, which makes the theory easier, more intuitive, and more accessible to undergraduate students

The Handbook of Groundwater Engineering

Groundwater constitutes an important component of many water resource systems, supplying water for domestic use, for industry, and for agriculture. Management of a groundwater system, an aquifer, or a system of aquifers, means making such decisions as to the total quantity of water to be withdrawn annually, the location of wells for pumping and for artificial recharge and their rates, and control conditions at aquifer boundaries. Not less important are decisions related to

groundwater qUality. In fact, the quantity and quality problems cannot be separated. In many parts of the world, with the increased withdrawal of ground water, often beyond permissible limits, the quality of groundwater has been continuously deteriorating, causing much concern to both suppliers and users. In recent years, in addition to general groundwater quality aspects, public attention has been focused on groundwater contamination by hazardous industrial wastes, by leachate from landfills, by oil spills, and by agricultural activities such as the use of fertilizers, pesticides, and herbicides, and by radioactive waste in repositories located in deep geological formations, to mention some of the most acute contamination sources. In all these cases, management means making decisions to achieve goals without violating specified constraints. In order to enable the planner, or the decision maker, to compare alternative modes of action and to ensure that the constraints are not violated, a tool is needed that will provide information about the response of the system (the aquifer) to various alternatives.

Modeling Groundwater Flow and Pollution

At hundreds of thousands of commercial, industrial, and military sites across the country, subsurface materials including groundwater are contaminated with chemical waste. The last decade has seen growing interest in using aggressive source remediation technologies to remove contaminants from the subsurface, but there is limited understanding of (1) the effectiveness of these technologies and (2) the overall effect of mass removal on groundwater quality. This report reviews the suite of technologies available for source remediation and their ability to reach a variety of cleanup goals, from meeting regulatory standards for groundwater to reducing costs. The report proposes elements of a protocol for accomplishing source remediation that should enable project managers to decide whether and how to pursue source remediation at their sites.

Fundamentals of Ground-water Modeling

This new edition adds several new chapters and is thoroughly updated to include data on new topics such as hydraulic fracturing, CO2 sequestration, sustainable groundwater management, and more. Providing a complete treatment of the theory and practice of groundwater engineering, this new handbook also presents a current and detailed review of how to model the flow of water and the transport of contaminants both in the unsaturated and saturated zones, covers the protection of groundwater, and the remediation of contaminated groundwater.

Modelling Groundwater Systems: Understanding and Improving Groundwater Quantity and Quality Management

Diffusion in Natural Porous Media: Contaminant Transport, Sorption/Desorption and Dissolution Kinetics introduces the general principles of diffusion in the subsurface environment and discusses the implications for the fate and transport of contaminants in soils and groundwater. Emphasis is placed on sorption/desorption and the dissolution kinetics of organic contaminants, both of which are limited by the slow speed of molecular diffusion. Diffusion in Natural Porous Media: Contaminant Transport, Sorption/Desorption and Dissolution Kinetics compiles methods for calculating the diffusion coefficients of organic compounds (in aqueous solution or vapor phase) in natural porous media. The author uses analytical solutions of Fick's 2nd law and some simple numerical models to model diffusive transport under various initial and boundary conditions. A number of these models may be solved using spreadsheets. The book examines sorption/desorption rates of organic compounds in various soils and aquifer materials, and also examines the dissolution kinetics of nonaqueous phase liquids in aquifers, in both the trapped residual phase and in pools. Diffusion in Natural Porous Media: Contaminant Transport, Sorption/Desorption and Dissolution Kinetics concludes with a discussion of the impact of slow diffusion processes on soil and groundwater decontamination and the implications of these processes for groundwater risk assessment.

Hydrogeology

This text combines the science and engineering of hydrogeology in an accessible, innovative style. As well as providing physical descriptions and characterisations of hydrogeological processes, it also sets out the corresponding mathematical equations for groundwater flow and solute/heat transport calculations. And, within this, the methodological and conceptual aspects for flow and contaminant transport modelling are discussed in detail. This comprehensive analysis forms the ideal textbook for graduate and undergraduate students interested in groundwater resources and engineering, and indeed its analyses can apply to researchers and professionals involved in the area.

Modeling Groundwater Flow and Contaminant Transport

Water inside the earth, the groundwater and the invisible resource is the most important source of survival of mankind on this globe. Part of the hydrological cycle between entry (percolation and recharge) and exit (natural or forced extraction and discharge), the groundwater fascinates all: engineers, hydrogeologists, agriculturists, environmentalists, scientists, academia, resource managers and domestic and industrial users. This book is the outcome of efforts of those eminent authors who despite their fascination were able to write upon some important facet of groundwater flow and the transport of pollutants with it. The dimensions covered range from simple descriptive narratives; to expose of analytical methods; to complex mathematical treatment; to numerical simulations and computer modeling. All areas have been touched upon for the sake of general readers, students, professional engineers and scientists.

Modeling Groundwater Flow and Contaminant Transport

Computational Methods in Subsurface Flow explores the application of all of the commonly encountered computational methods to subsurface problems. Among the problems considered in this book are groundwater flow and contaminant transport; moisture movement in variably saturated soils; land subsidence and similar flow and deformation processes in soil and rock mechanics; and oil and geothermal reservoir engineering. This book is organized into 10 chapters and begins with an introduction to partial differential and various solution approaches used in subsurface flow. The discussion then shifts to the fundamental theory of the finite element method, with emphasis on the Galerkin finite element method and how it can be used to solve a wide range of subsurface problems. The subjects treated range from simple problems of saturated groundwater flow to more complex ones of moisture movement and multiphase flow in petroleum reservoirs. The chapters that follow focus on fluid flow and mechanical deformation of conventional and fractured porous media; point and subdomain collocation techniques and the boundary element technique; and the applications of finite difference techniques to single- and multiphase flow and solute transport. The final chapter is devoted to other alternative numerical methods that are based on combinations of the standard finite difference approach and classical mathematics. This book is intended for senior undergraduate and graduate students in geoscience and engineering, as well as for professional groundwater hydrologists, engineers, and research scientists who want to solve or model subsurface problems using numerical techniques.

Introduction to Groundwater Modeling

Written by renowned experts in the field, this book assesses the status of groundwater models and defines models and modeling needs in the 21st century. It reviews the state of the art in model development and application in regional groundwater management, unsaturated flow/multiphase flow and transport, island modeling, biological and virus transport, and fracture flow. Both deterministic and stochastic aspects of unsaturated flow and transport are covered. The book also introduces a unique assessment of models as analysis and management tools for groundwater resources. Topics covered include model vs. data uncertainty, accuracy of the dispersion/convection equation, protocols for model testing and validation, post-audit studies, and applying models to karst aquifers.

Hydrogeology and Groundwater Modeling

Geochemical modeling is an important tool in environmental studies, and in the areas of subsurface and surface hydrology, pedology, water resources management, mining geology, geothermal resources, hydrocarbon geology, and related areas dealing with the exploration and extraction of natural resources. The book fills a gap in the literature through its discussion

of geochemical modeling, which simulates the chemical and physical processes affecting the distribution of chemical species in liquid, gas, and solid phases. Geochemical modeling applies to a diversity of subsurface environments, from the vadose zone close to the Earth's surface, down to deep-seated geothermal reservoirs. This book provides the fundamental thermodynamic concepts of liquid-gas-solid phase systems. It introduces the principal types of geochemical models, such as speciation, reaction-path or forward, inverse- and reactive-transport models, together with examples of the most common codes and the best-practices for constructing geochemical models. The physical laws describing homogeneous and heterogeneous chemical reactions, their kinetics, and the transport of reactive solutes are presented. The partial differential or algebraic equations representing these laws, and the principal numerical methods that allow approximate solutions of these equations that can provide useful solutions to model different geochemical processes, are discussed in detail. Case studies applying geochemical models in different scientific areas and environmental settings, conclude the book. The book is addressed to students, teachers, other professionals, and to the institutions involved in water, geothermal and hydrocarbon resources, mining, and environmental management. The book should prove useful to undergraduate and graduate students, postgraduates, professional geologists and geophysicists, engineers, environmental scientists, soil scientists, hydrochemists, and others interested in water and geochemistry.

Computational Methods in Subsurface Flow

Teaches, using simple analytical models how physical, chemical, and biological processes in the subsurface affect contaminant transport Uses simple analytical models to demonstrate the impact of subsurface processes on the fate and transport of groundwater contaminants Includes downloadable modeling tool that provides easily understood graphical output for over thirty models Modeling tool and book are integrated to facilitate reader understanding Collects analytical solutions from many sources into a single volume and, for the interested reader, shows how these solutions are derived from the governing model equations

Groundwater Science

In many parts of the world, groundwater resources are under increasing threat from growing demands, wasteful use, and contamination. To face the challenge, good planning and management practices are needed. A key to the management of groundwater is the ability to model the movement of fluids and contaminants in the subsurface. The purpose of this book is to construct conceptual and mathematical models that can provide the information required for making decisions associated with the management of groundwater resources, and the remediation of contaminated aquifers. The basic approach of this book is to accurately describe the underlying physics of groundwater flow and solute transport in heterogeneous porous media, starting at the microscopic level, and to rigorously derive their mathematical representation

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Contaminant Geochemistry

This book provides a comprehensive overview of reaction processes in the Earth's crust and on its surface, both in the laboratory and in the field. A clear exposition of the underlying equations and calculation techniques is balanced by a large number of fully worked examples. The book uses The Geochemist's Workbench® modeling software, developed by the author and already installed at over 1000 universities and research facilities worldwide. Since publication of the first edition, the field of reaction modeling has continued to grow and find increasingly broad application. In particular, the description of microbial activity, surface chemistry, and redox chemistry within reaction models has become broader and more rigorous. These areas are covered in detail in this new edition, which was originally published in 2007. This text is written for graduate students and academic researchers in the fields of geochemistry, environmental engineering, contaminant hydrology, geomicrobiology, and numerical modeling.

Modeling Groundwater Flow and Contaminant Transport

The challenges facing groundwater scientists and engineers today demand expertise in a wide variety of disciplines–geology, hydraulics, geochemistry, geophysics, and biology. As the number of the subdisciplines has increased and as each has become more complex and quantitative, the problem of integrating their concepts and contributions into a coherent overall interpretation has become progressively more difficult. To an increasing degree transport simulation has emerged as an answer to this problem, and the transport model has become a vehicle for integrating the vast amount of field data from a variety of sources and for understanding the relationship of various physical, chemical, and biological processes. Applied Contaminant Transport Modeling is the first resource designed to provide coverage of the discipline’s basic principles, including the theories behind solute transport in groundwater, common numerical techniques for solving transport equations, and step-by-step guidance on the development and use of field-scale modeling. The Second Edition incorporates recent advances in contaminant transport theory and simulation techniques, adding the following to the original text: -An expanded discussion of the role of aquifer heterogeneity in controlling solute transport -A new section on the dual-domain mass transfer approach as an alternative to the classical advection-dispersion model -Additional chemical

processes and reactions in the discussion of reactive transport -A discussion of the TVD (total-variation-diminishing) approach to transport solution -An entirely new Part III containing two chapters on simulation of flow and transport under variable water density and under variable saturation, respectively, and a third chapter on the use of the simulation-optimization approach in remediation system design Applied Contaminant Transport Modeling, Second Edition remains the premier reference for practicing hydrogeologists, environmental scientists, engineers, and graduate students in the field. In 1998, in recognition of their work on the first edition, the authors were honored with the John Hem Excellence in Science and Engineering Award of the National Ground Water Association

Migration and Fate of Pollutants in Soils and Subsoils

Experts in soil and environmental sciences as well as in the theory of wave propagation and numerical modeling methods provide a comprehensive account of different aspects of pollutant migration in soils, aquifers, and other geological formations. Emphasis is laid on the analysis of contributing phenomena and their interactions, modeling, and the practical use of such knowledge and models for guidance in disposal operations, preventive measures to minimize ecological damage, prediction of consequences of seepage, and design of remedial actions. Topics covered include the chemical behavior of soils, sorption and retardation, biochemistry of pollutants, ion exchange and kinetics of reactions in soils, measurement of adsorption and desorption, multiphase hydrodynamics, multicomponent wave theory and the coherence concept, nonlinear wave propagation in geological formations, multiphase convective transport, diffusion and fast reaction, modeling pollutant transport, numerical methods, dispersion of contaminants from landfills, risk analysis, water reuse, and radioactive soil contamination at Chernobyl.

Hydraulics of Groundwater

Applied Contaminant Transport Modeling Theory and Practice Chunmiao Zheng and Gordon D. Bennett The design of remedial systems for groundwater contamination requires a thorough understanding of how various interacting processes — advection, dispersion, and chemical reactions — influence the movement and fate of contaminants. Solute transport simulation provides an ideal vehicle to synthesize these controlling processes, evaluate their interactions, and test the effectiveness of remedial measures. Applied Contaminant Transport Modeling is the first complete resource designed to provide clear coverage of the basic principles of solute transport simulation — including the theory behind the most common numerical techniques for solving transport equations, and step-by-step guidance on the development and use of field-scale models. Written by two experts with extensive practical experience in the field, Applied Contaminant Transport Modeling clearly explains: Factors controlling the transport and fate of solutes in the subsurface —g including advective and dispersive transport and chemical reaction — and the equations governing these processes Development of mathematical

models of solute transport regimes and representative analytical solutions to the transport equation Particle tracking as a practical tool for solving many types of field problems Development of Eulerian-Lagrangian methods for solving advection-dispersion-reaction equations Step-by-step development and application of solute transport models — emphasizing problem formulation, model setup, parameter selection, calibration, and sensitivity analysis Sources of uncertainty in transport simulation, and methods of evaluating and managing uncertainty Applied Contaminant Transport Modeling presents detailed case histories illustrating how hydrologists, geologists, chemists, and environmental engineers apply transport models in real-life situations, including landfills, hazardous waste sites, and contaminated aquifers. An optional diskette designed to accompany the text provides software to help the reader explore the concepts and techniques presented in the text and gain hands-on experience in transport simulation. Driven by growing concern over groundwater quality and the rapid dissemination of computer technology, solute transport simulation has become an essential means of evaluating and solving groundwater contamination and remediation problems. Applied Contaminant Transport Modeling provides you with the tools to master this significant field of study.

Contaminants in the Subsurface

Fractured rock is the host or foundation for innumerable engineered structures related to energy, water, waste, and transportation. Characterizing, modeling, and monitoring fractured rock sites is critical to the functioning of those infrastructure, as well as to optimizing resource recovery and contaminant management. Characterization, Modeling, Monitoring, and Remediation of Fractured Rock examines the state of practice and state of art in the characterization of fractured rock and the chemical and biological processes related to subsurface contaminant fate and transport. This report examines new developments, knowledge, and approaches to engineering at fractured rock sites since the publication of the 1996 National Research Council report Rock Fractures and Fluid Flow: Contemporary Understanding and Fluid Flow. Fundamental understanding of the physical nature of fractured rock has changed little since 1996, but many new characterization tools have been developed, and there is now greater appreciation for the importance of chemical and biological processes that can occur in the fractured rock environment. The findings of Characterization, Modeling, Monitoring, and Remediation of Fractured Rock can be applied to all types of engineered infrastructure, but especially to engineered repositories for buried or stored waste and to fractured rock sites that have been contaminated as a result of past disposal or other practices. The recommendations of this report are intended to help the practitioner, researcher, and decision maker take a more interdisciplinary approach to engineering in the fractured rock environment. This report describes how existing tools-some only recently developed-can be used to increase the accuracy and reliability of engineering design and management given the interacting forces of nature. With an interdisciplinary approach, it is possible to conceptualize and model the fractured rock environment with acceptable levels of uncertainty and reliability, and to design systems that maximize remediation and long-term performance. Better scientific understanding could inform

regulations, policies, and implementation guidelines related to infrastructure development and operations. The recommendations for research and applications to enhance practice of this book make it a valuable resource for students and practitioners in this field.

Bioremediation and Natural Attenuation

Coastal aquifers serve as major sources for freshwater supply in many countries around the world, especially in arid and semi-arid zones. Many coastal areas are also heavily urbanized, a fact that makes the need for freshwater even more acute. Coastal aquifers are highly sensitive to disturbances. Inappropriate management of a coastal aquifer may lead to its destruction as a source for freshwater much earlier than other aquifers which are not connected to the sea. The reason is the threat of seawater intrusion. In many coastal aquifers, intrusion of seawater has become one of the major constraints imposed on groundwater utilization. As sea water intrusion progresses, existing pumping wells, especially those close to the coast, become saline and have to be abandoned. Also, the area above the intruding seawater wedge is lost as a source of natural replenishment to the aquifer. Despite the importance of this subject, so far there does not exist a book that integrates our present knowledge of seawater intrusion, its occurrences, physical mechanism, chemistry, exploration by geo physical and geochemical techniques, conceptual and mathematical modeling, analytical and numerical solution methods, engineering measures of combating seawater intrusion, management strategies, and experience learned from case studies. By presenting this fairly comprehensive volume on the state-of-the-art of knowledge and ex perience on saltwater intrusion, we hoped to transfer this body of knowledge to the geologists, hydrologists, hydraulic engineers, water resources planners, managers, and governmental policy makers, who are engaged in the sustainable development of coastal fresh ground water resources.

Numerical Groundwater Modelling

Groundwater Science, Second Edition - winner of a 2014 Textbook Excellence Award (Texty) from The Text and Academic Authors Association - covers groundwater's role in the hydrologic cycle and in water supply, contamination, and construction issues. It is a valuable resource for students and instructors in the geosciences (with focuses in hydrology, hydrogeology, and environmental science), and as a reference work for professional researchers. This interdisciplinary text weaves important methods and applications from the disciplines of physics, chemistry, mathematics, geology, biology, and environmental science, introducing you to the mathematical modeling and contaminant flow of groundwater. New to the Second Edition: New chapter on subsurface heat flow and geothermal systems Expanded content on well construction and design, surface water hydrology, groundwater/ surface water interaction, slug tests, pumping tests, and mounding analysis. Updated discussions of groundwater modeling, calibration, parameter estimation, and uncertainty Free software tools for

slug test analysis, pumping test analysis, and aquifer modeling Lists of key terms and chapter contents at the start of each chapter Expanded end-of-chapter problems, including more conceptual questions Winner of a 2014 Texty Award from the Text and Academic Authors Association Features two-color figures Includes homework problems at the end of each chapter and worked examples throughout Provides a companion website with videos of field exploration and contaminant migration experiments, PDF files of USGS reports, and data files for homework problems Offers PowerPoint slides and solution manual for adopting faculty

Applied Groundwater Modeling

A groundbreaking text and professional resource on naturalattenuation technology Natural attenuation is rapidly becoming a widely used approachto manage groundwater and soil contamination by hazardoussubstances in petroleum-product releases and leachate fromhazardous waste sites and landfills. This book provides, under onecover, the current methodologies needed by groundwater scientistsand engineers in their efforts to evaluate subsurface contaminationproblems, to estimate risk to human health and ecosystems throughmathematical models, and to design and formulate appropriateremediation strategies. Incorporating the authors' extensive backgrounds as educators,researchers, and consultants in environmental biotechnology andhydrogeology, the text emphasizes new concepts and recent advancesin the science, including: Quantification of the role of microbes in naturalattenuation Biodegradation and chemical transformation principles Immobilization and phase change Biotransformation mechanisms Groundwater flow and contaminant transport Analytical models for contaminant transport and reactionprocesses Numerical modeling of contaminant transport, transformation,and degradation Detailed descriptions of fundamental processes, characterizationapproaches, and analytical and numerical methods tied to relevantreal-world applications make Bioremediation and NaturalAttenuation: Process Fundamentals and Mathematical Models botha timely course text in hydrogeology and environmental engineeringand a valuable reference for anyone in the groundwater or riskassessment professions.

Applied Flow and Solute Transport Modeling in Aquifers

FEFLOW

This text explores the laws governing the flow and storage of groundwater in aquifers and provides all the necessary tools to forecast the behavior of a regional aquifer system. 1979 edition.

3D-Groundwater Modeling with PMWIN

This text addresses the scientific and engineering aspects of subsurface contaminant transport, analysis, and modeling as well as remediation in ground water. It offers a modern engineering approach to ground water contamination problems of the nineties and beyond.

Conceptual Models of Flow and Transport in the Fractured Vadose Zone

This valuable new book, with 2 programs on diskettes, will help practitioners in solving groundwater flow and contamination problems by integrating simulation techniques. The reader is expected to have knowledge of hydrogeology, and have access to books on groundwater hydrogeology. Two microcomputer programs, in compiled FORTRAN 77 with source codes for simulating quasi-three-dimensional groundwater flow and contaminant migration, are presented in this book. The numerical and analytical techniques incorporated in these programs are described in detail. Data entry has been simplified so that the user can run the programs without worrying about FORTRAN input file structures and editors. The basic requirements are a monitor, dot-matrix printer, and an IBM-PC or compatible computer running DOS Version 2.1 or compatible. Programs require a full 640K RAM (minus that used by DOS) for their operation.

Analytical Modeling of Solute Transport in Groundwater

FEFLOW is an acronym of Finite Element subsurface FLOW simulation system and solves the governing flow, mass and heat transport equations in porous and fractured media by a multidimensional finite element method for complex geometric and parametric situations including variable fluid density, variable saturation, free surface(s), multispecies reaction kinetics, non-isothermal flow and multidiffusive effects. FEFLOW comprises theoretical work, modeling experiences and simulation practice from a period of about 40 years. In this light, the main objective of the present book is to share this achieved level of modeling with all required details of the physical and numerical background with the reader. The book is intended to put advanced theoretical and numerical methods into the hands of modeling practitioners and scientists. It starts with a more general theory for all relevant flow and transport phenomena on the basis of the continuum approach, systematically develops the basic framework for important classes of problems (e.g., multiphase/multispecies non-isothermal flow and transport phenomena, discrete features, aquifer-averaged equations, geothermal processes), introduces finite-element techniques for solving the basic balance equations, in detail discusses advanced numerical algorithms for the resulting nonlinear and linear problems and completes with a number of benchmarks, applications and exercises to illustrate the different types of problems and ways to tackle them successfully (e.g., flow and seepage problems, unsaturated-saturated flow, advective-diffusion transport, saltwater intrusion, geothermal and thermohaline flow).

Dynamics of Fluids in Porous Media