

Isotopes Principles And Applications

The time-dependent decay of naturally occurring radioactive isotopes or in-growth of their radioactive or stable daughter products form the basis of radiometric dating of several natural processes. Developed in the beginning of the last century mainly to determine the absolute ages of rocks and minerals, radiometric chronology now plays a central role in a broad range of Earth and planetary sciences - from extra-solar-system processes to environmental geoscience. With the prerequisite of only college-level knowledge in physics, chemistry and mathematics, this concise book focuses on the essential principles of radiometric dating in order to enable students and teachers belonging to diverse fields of studies to select, understand and interpret radiometric dating results generated and published by professionals.

This book is a welcome introduction and reference for users and innovators in geochronology. It provides modern perspectives on the current state-of-the-art in most of the principal areas of geochronology and thermochronology, while recognizing that they are changing at a fast pace. It emphasizes fundamentals and systematics, historical perspective, analytical methods, data interpretation, and some applications chosen from the literature. This book complements existing coverage by expanding on those parts of isotope geochemistry that are concerned with dates and rates and insights into Earth and planetary science that come from temporal perspectives. Geochronology and Thermochronology offers chapters covering: Foundations of Radioisotopic Dating; Analytical Methods; Interpretational Approaches: Making Sense of Data; Diffusion and Thermochronologic Interpretations; Rb-Sr, Sm-Nd, Lu-Hf; Re-Os and Pt-Os; U-Th-Pb Geochronology and Thermochronology; The K-Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ Systems; Radiation-damage Methods of Geo- and Thermochronology; The (U-Th)/He System; Uranium-series Geochronology; Cosmogenic Nuclides; and Extinct Radionuclide Chronology. Offers a foundation for understanding each of the methods and for illuminating directions that will be important in the near future Presents the fundamentals, perspectives, and opportunities in modern geochronology in a way that inspires further innovation, creative technique development, and applications Provides references to rapidly evolving topics that will enable readers to pursue future developments Geochronology and Thermochronology is designed for graduate and upper-level undergraduate students with a solid background in mathematics, geochemistry, and geology. Read an interview with the editors to find out more: <https://eos.org/editors-vox/the-science-of-dates-and-rates>

This book is intended to serve as a text for an introductory course in geochemistry for undergraduate/graduate students with at least an elementary-level background in earth sciences, chemistry, and mathematics. The text, containing 83 tables and 181 figures, covers a wide variety of topics ranging from atomic structure to chemical and isotopic equilibria to modern biogeochemical cycles which are divided into four interrelated parts: Crystal Chemistry; Chemical Reactions (and biochemical reactions involving bacteria); Isotope Geochemistry (radiogenic and stable isotopes); and The Earth Supersystem, which includes discussions pertinent to the evolution of the solid Earth, the atmosphere, and the hydrosphere. In keeping with the modern trend in the field of geochemistry, the book emphasizes computational techniques by developing appropriate mathematical relations, solving a variety of problems to illustrate application of the mathematical relations, and leaving a set of questions at the end of each chapter to be solved by students. However, so as not to interrupt the flow of the text, involved chemical concepts and mathematical derivations are separated in the form of boxes. Supplementary materials are packaged into ten appendixes that include a standard-state (298.15 K, 1 bar) thermodynamic data table and a listing of answers to selected chapter-end questions. Additional resources for this book can be found at: www.wiley.com/go/misra/geochemistry.

Cosmogenic radionuclides are radioactive isotopes which are produced by natural processes and distributed within the Earth system. With a holistic view of the environment the authors show in this book how cosmogenic radionuclides can be used to trace and to reconstruct the history of a large variety of processes. They discuss the way in which cosmogenic radionuclides can assist in the quantification of complex processes in the present-day environment. The book aims to demonstrate to the reader the strength of analytic tools based on cosmogenic radionuclides, their contribution to almost any field of modern science, and how these tools may assist in the solution of many present and future problems that we face here on Earth. The book provides a comprehensive discussion of the basic principles behind the applications of cosmogenic (and other) radionuclides as environmental tracers and dating tools. The second section of the book discusses in some detail the production of radionuclides by cosmic radiation, their transport and distribution in the atmosphere and the hydrosphere, their storage in natural archives, and how they are measured. The third section of the book presents a number of examples selected to illustrate typical tracer and dating applications in a number of different spheres (atmosphere, hydrosphere, geosphere, biosphere, solar physics and astronomy). At the same time the authors have outlined the limitations of the use of cosmogenic radionuclides. Written on a level understandable by graduate students without specialist skills in physics or mathematics, the book addresses a wide audience, ranging from archaeology, biophysics, and geophysics, to atmospheric physics, hydrology, astrophysics and space science.

Applications of radioactive and stable isotopes have revolutionized our understanding of the Earth and near-earth surface processes. The utility of the isotopes are ever-increasing and our sole focus is to bring out the applications of these isotopes as tracers and chronometers to a wider audience so that they can be used as powerful tools to solve environmental problems. New developments in this field remain mostly in peer-reviewed journal articles and hence our goal is to synthesize these findings for easy reference for students, faculty, regulators in governmental and non-governmental agencies, and environmental companies. While this volume maintains its rigor in terms of its depth of knowledge and quantitative information, it contains the breadth needed for wide variety problems and applications in the environmental sciences. This volume presents all of the newer and older applications of isotopes pertaining to the environmental problems in one place that is readily accessible to readers. This book not only has the depth and rigor that is needed for academia, but it has the breadth and case studies to illustrate the utility of the isotopes in a wide variety of environments (atmosphere, oceans, lakes, rivers and streams, terrestrial environments, and sub-surface environments) and serves a large audience, from students and researchers, regulators in federal, state and local governments, and environmental companies.

The first edition of this book was published in 1973, the second, totally rewritten, followed 7 years later in 1980. Because the field of stable isotopes is still growing and exerting an increasing influence on geosciences in general, it seems to be necessary, after a further 7 years, to revise the edition again accordingly. Not only has the previous edition been updated, but two completely new chapters on the isotopic composition of mantle-derived material and on the isotopic composition of the ocean during the geologic past, have been added. The references concentrate on recent literature. In some cases, older references have been omitted to save space. I do not intend to underrate the value of older publications, but only to keep the reference list - already very voluminous in relation to the total length - from becoming even larger. An early draft has been reviewed by Russell Harmon and Alan Matthews. John Valley has sent me a preprint of an article on metamorphic rocks. To all three of them I owe my deepest thanks.

Designed to show readers how to use chemical principles in solving geological problems, this book emphasizes a quantitative approach to problem solving and demonstrates how chemical principles control geologic processes in atomic and large-scale environments. **KEY TOPICS:** The book starts with basic principles and emphasizes quantitative methods of problem-solving. It uses the principles of isotope geology to enhance the understanding of appropriate geochemical subject areas. The book also examines the geochemical processes that affect the chemical composition of surface water and that determine its quality for human consumption. **MARKET:** For anyone interested in Geochemistry or Geology.

Nuclear engineering could be viewed as the engineering field that ensures optimum and sustainable technological applications of natural and induced radioactive materials in different industrial sectors. This book presents some advanced applications in radiation effects, thermal

hydraulics, and radionuclide migration in the environment. These scientific contributions from esteemed experts introduce some nuclear safety principals, current knowledge about radiation types, sources and applications, thermal properties of heat transfer media, and the role of sorption in retarding radionuclide migration in the environment. This book also covers the advances in identifying radiation effects in dense gas-metal systems, application of dense granular materials as high power targets in accelerator driven systems and irradiation facilities, evaluation of boiling heat transfer in narrow channels, and application of fluorescence quenching techniques to monitor uranium migration. This book provides a comprehensive introduction to radiogenic and stable isotope geochemistry. Beginning with a brief overview of nuclear physics and nuclear origins, it then reviews radioactive decay schemes and their use in geochronology. A following chapter covers the closely related techniques such as fission-track and carbon-14 dating. Subsequent chapters cover nucleosynthetic anomalies in meteorites and early solar system chronology and the use of radiogenic isotopes in understanding the evolution of the Earth's mantle, crust, and oceans. Attention then turns to stable isotopes and after reviewing the basic principles involved, the book explores their use in topics as diverse as mantle evolution, archeology and paleontology, ore formation, and, particularly, paleoclimatology. A following chapter explores recent developments including unconventional stable isotopes, mass-independent fractionation, and isotopic 'clumping'. The final chapter reviews the isotopic variation in the noble gases, which result from both radioactive decay and chemical fractionations.

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The number-one guide, internationally, to all aspects of forensic isotope analysis, thoroughly updated and revised and featuring many new case studies This edition of the internationally acclaimed guide to forensic stable isotope analysis uses real-world examples to bridge discussions of the basic science, instrumentation and analytical techniques underlying forensic isotope profiling and its various technical applications. Case studies describe an array of applications, many of which were developed by the author himself. They include cases in which isotope profiling was used in murder, and drugs-related crime investigations, as well as for pharmaceutical and food authenticity control studies. Updated with coverage of exciting advances occurring in the field since the publication of the 1st edition, this 2nd edition explores innovative new techniques and applications in forensic isotope profiling, as well as key findings from original research. More than a simple update, though, this edition has been significantly revised in order to address serious problems that can arise from non-comparable and unfit-for-purpose stable isotope data. To that end, Part II has been virtually rewritten with greater emphasis now being placed on important quality control issues in stable isotope analysis in general and forensic stable isotope analysis in particular. Written in a highly accessible style that will appeal to practitioners, researchers and students alike Illustrates the many strengths and potential pitfalls of forensic stable isotope analysis Uses recent case examples to bridge underlying principles with technical applications Presents hands-on applications that let experienced researchers and forensic practitioners match problems with success stories Includes new chapters devoted to aspects of quality control and quality assurance, including scale normalisation, the identical treatment principle, hydrogen exchange and accreditation Stable Isotope Forensics, 2nd Edition is an important professional resource for forensic scientists, law enforcement officials, public prosecutors, defence attorneys, forensic anthropologists and others for whom isotope profiling has become an indispensable tool of the trade. It is also an excellent introduction to the field for senior undergraduate and graduate forensic science students. "All students of forensic criminology, and all law enforcement officers responsible for the investigation of serious crime, will want to study this book. Wolfram highlights the value, and future potential, of Stable Isotope Forensics as an emerging powerful tool in the investigation of crime." —Roy McComb, Deputy Director, Specialist Investigations, National Crime Agency (NCA), UK "A single author text in these days is rare and the value of this book lies in the dedication and experience of the author which is evident in the clarity of prose, the honest illustration of evidence and the realistic practical application of the subject - it makes this a text of genuine scientific value." — Prof Dame Sue Black, PhD, DBE, OBE, FRSE, Leverhulme Research Centre for Forensic Science, University of Dundee, UK The book provides an excellent, vivid and comprehensible introduction into the world of stable isotope science and analytics. Compared to the first edition, the aspects of quality control and assurance in the analysis of stable isotopes in general, and forensic application in particular, are now taking much more room. This allows the book to serve the target groups: students, academic professionals and practitioners, and serves as a solid resource of basic and applicable information about the strengths and potential pitfalls of the application of stable isotope signatures. The present high-quality book shows the great potential of stable isotopes and is a must for everyone interested in isotope forensics. M.E. Böttcher & U. Flenker, *Isotopes in Environmental and Health Studies*, January 2018.

The pace of revolution in analytical chemistry in the field of Geosciences has been dramatic over recent decades and includes fundamental developments that have become common place in many related and unrelated disciplines. The analytical tools (nano to macro-scale from stable to radioactive isotopes, compound specific sulfur isotopes) used have been applied to wide-ranging applications from inorganic to organic geochemistry, biodiversity and chronological tools, to build an understanding of how the Earth system evolved to its present state. This book will provide an essential guide to exploring the earth's natural resources and changing climate by detection science. Individual chapters bring together expertise from across the globe to present a comprehensive outlook on the analytical technologies available to the geoscientist today. Experienced researchers will appreciate the broad treatment of the subject as a valuable reference, while students and those new to the field will quickly gain an appreciation of both the techniques at hand, and the importance of constructing, and analysing, the complex data sets they can generate.

Understand the Environmental Processes That Control Groundwater Quality The integration of environmental isotopes with geochemical studies is now recognized as a routine approach to solving problems of natural and contaminated groundwater quality. Advanced sampling and analytical methods are readily accessible and affordable, providing abundant geoc Edited by two very well-known and respected scientists in the field, this excellent practical guide is the first to cover the fundamentals and a wide range of applications, as well as showing readers how to efficiently use this increasingly important technique. From the contents: * The Isotopic Composition of the Elements * Single-Collector ICP-MS * Multi-Collector ICP-MS * Advances in Laser Ablation - Multi-Collector ICP-MS * Correction for Instrumental Mass Discrimination in Isotope Ratio Determination with Multi-Collector ICP-MS * Reference Materials in Isotopic Analysis * Quality Control in Isotope Ratio Applications * Determination of Trace Elements and Elemental Species Using Isotope Dilution ICP-MS * Geochronological Dating * Application of Multi-Collector ICP-MS to Isotopic Analysis in Cosmochemistry * Establishing the Basis for Using Stable Isotope Ratios of Metals as Paleoredox Proxies * Isotopes as Tracers of Elements Across the Geosphere-Biosphere Interface * Archaeometric Applications * Forensics Applications * Nuclear Applications * The Use of Stable Isotope Techniques for Studying

Mineral and Trace Element Metabolism in Humans * Isotopic Analysis via Multi-Collector ICP-MS in Elemental Speciation A must-have for newcomers as well as established scientists seeking an overview of isotopic analysis via ICP-MS.

The origin of different kinds of igneous rocks can be understood in terms of their tectonic setting, and by way of the isotope compositions of strontium, neodymium, and lead. This book explains the petrogenesis of igneous rocks as a consequence of tectonic processes resulting from interactions between asthenospheric plumes and the overlying lithospheric mantle. The relevant principles of isotope geochemistry are explained in the first chapter, making it accessible for university students as well as professionals. The relevant isotopic data is presented in diagrammatic form. The book contains more than 400 original drawings. Neutron capture therapy (NCT) is based on the ability of the non-radioactive isotope boron-10 to capture thermal neutrons with very high probability and immediately to release heavy particles with a path length of one cell diameter, which in principle allows for tumor cell-selective high-LET particle radiotherapy. This book provides a comprehensive summary of the progress made in NCT in recent years. Individual sections cover all important aspects, including neutron sources, boron chemistry, drugs for NCT, dosimetry, and radiation biology. The use of NCT in a variety of malignancies and also some non-malignant diseases is extensively discussed. NCT is clearly shown to be a promising modality at the threshold of wider clinical application. All of the chapters are written by experienced specialists in language that will be readily understood by all participating disciplines.

This book represents a new "earth systems" approach to catchments that encompasses the physical and biogeochemical interactions that control the hydrology and biogeochemistry of the system. The text provides a comprehensive treatment of the fundamentals of catchment hydrology, principles of isotope geochemistry, and the isotope variability in the hydrologic cycle -- but the main focus of the book is on case studies in isotope hydrology and isotope geochemistry that explore the applications of isotope techniques for investigating modern environmental problems. Isotope Tracers in Catchment Hydrology is the first synthesis of physical hydrology and isotope geochemistry with catchment focus, and is a valuable reference for professionals and students alike in the fields of hydrology, hydrochemistry, and environmental science. This important interdisciplinary text provides extensive guidelines for the application of isotope techniques for all investigators facing the challenge of protecting precious water, soil, and ecological resources from the ever-increasing problems associated with population growth and environmental change, including those from urban development and agricultural land uses.

At last geochemists are offered one comprehensive reference book which gives the Eh-pH diagrams for 75 elements found in the earth's surface environment, including transuranic and other radioactive species. For each of these newly calculated diagrams short explanatory texts are added. For the first time the primary elements are considered in water with metal, sulfur, carbon, and other species as appropriate. Furthermore, based on these figures and up-to-date thermodynamic data presented in this reference, researchers can predict the behavior of elements in the surface environment. Geoscientists, chemists and environmental agencies will also benefit from several brief texts on the importance of various elements to problems of radioactive waste disposal.

Isotope in Biology is a six-chapter supplementary text that covers the properties and application of isotopes as labels or analytical tools in biological research. The first chapters deal with the physico-chemical properties and radioactivity of isotopes. These chapters also explore their synthesis, preparation, radiation decomposition, and decay of radioactivity. The succeeding chapter considers other aspects of isotopes, including their effect of health, disposal, spills, and laboratory use. Another chapter examines the chemical and biochemical behavior, natural abundance, and the chemical stability of isotopic compounds. The final chapters describe several isotopic methods, namely, isotope dilution, paper chromatography, and autoradiography, with emphasis on their application in biological studies. This book will be of value to biologists, and graduate and undergraduate biology students.

Carbon Isotope Stratigraphy, Volume Five in the Advances in Sequence Stratigraphy series, covers research in stratigraphic disciplines, including the most recent developments in the geosciences. This fully commissioned review publication aims to foster and convey progress in stratigraphy with its inclusion of a variety of topics, including Carbon isotope stratigraphy - principles and applications, Interpreting Phanerozoic $\delta^{13}\text{C}$ patterns as periodic glacio-eustatic sequences, Stable carbon isotopes in archaeological plant remains, Review of the Upper Ediacaran-Lower Cambrian Detrital Series in Central and North Iberia: NE Africa as possible Source Area, Calibrating $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ chemostratigraphic correlations across Cambrian strata of SW, and much more. Contains contributions from leading authorities in the field Informs and updates on all the latest developments in the field Aims to foster and convey progress in stratigraphy, including geochronology, magnetostratigraphy, lithostratigraphy, event-stratigraphy, and more Tracking Animal Migration with Stable Isotopes, Second Edition, provides a complete introduction to new and powerful isotopic tools and applications that track animal migration, reviewing where isotope tracers fit in the modern toolbox of tracking methods. The book provides background information on a broad range of migration scenarios in terrestrial and aquatic systems and summarizes the most cutting-edge developments in the field that are revolutionizing the way migrant individuals and populations are assigned to their true origins. It allows undergraduates, graduate students and non-specialist scientists to adopt and apply isotopes to migration research, and also serves as a useful reference for scientists. The new edition thoroughly updates the information available to the reader on current applications of this technique and provides new tools for the isotopic assignment of individuals to origins, including geostatistical multi-isotope approaches and the ways in which researchers can combine isotopes with routine data in a Bayesian framework to provide best estimates of animal origins. Four new chapters include contributions on applications to the movements of terrestrial mammals, with particular emphasis on how aspects of animal physiology can influence stable isotope values. Includes an animal physiology component that is an in-depth overview of the cautions and caveats related to this technique Covers marine and aquatic isoscapes and methods to track marine organisms for researchers trying to apply isotopic tracking to animals in these environments Features state-of-the-art statistical treatments for assignment and combining diverse datasets

This is the first dedicated book to cover the basics of a wide range of stable isotope applications in a manner appropriate for someone entering the field. At the same time, it offers sufficient detail – and numerous references and examples – to direct research for further inquiry. Discusses diverse topics such as hydrology, carbon in plants, meteorites, carbonates, metamorphic rocks, etc. Explores the theory and principles of isotope fractionation. Offers unique, up-to-date discussion of meteorite (extraterrestrial) isotope data. Presents the subject in an interesting historical context, with the classic papers noted. A useful reference for students taking the course and professionals entering the field of Geochemistry.

This book provides a comprehensive introduction to the field of geochemistry. The book first lays out the 'geochemical toolbox': the basic principles and techniques of modern geochemistry, beginning with a review of thermodynamics and kinetics as they apply to the Earth and its environs. These basic concepts are then applied to understanding processes in aqueous systems and the behavior of trace elements in magmatic systems. Subsequent chapters introduce radiogenic and stable isotope geochemistry and illustrate their application to such diverse topics as determining geologic time, ancient climates, and the diets of prehistoric peoples. The focus then broadens to the formation of the solar system, the Earth, and the elements themselves. Then the composition of the Earth itself becomes the topic, examining the composition of the core, the mantle, and the crust and exploring how this structure originated. A final chapter covers organic chemistry, including the origin of fossil fuels and the carbon cycle's role in controlling Earth's climate, both in the geologic past and the rapidly changing present. Geochemistry is essential reading for all earth science students, as well as for researchers and applied scientists who require an introduction to the essential theory of geochemistry, and a survey of its applications in the earth and environmental sciences. Additional resources can be found at: <http://www.wiley.com/go/white/geochemistry>

As the title suggests, *Isotope Effects in the Chemical, Geological and Bio Sciences* deals with differences in the properties of isotopically substituted molecules, such as differences in the chemical and physical properties of water and the heavy waters. Since the various fields in which isotope effects are applied do not only share fundamental principles but also experimental techniques, this book includes a discussion of experimental apparatus and experimental techniques. *Isotope Effects in the Chemical, Geological and Bio Sciences* is an educational monograph addressed to graduate students and others undertaking isotope effect research. The fundamental principles needed to understand isotope effects are presented in appropriate detail. While it is true that these principles are more familiar to students of physical chemistry and some background in physical chemistry is recommended, the text provides enough detail to make the book an asset to students in organic and biochemistry, and geochemistry.

Bioconjugate Techniques, 3rd Edition, is the essential guide to the modification and cross linking of biomolecules for use in research, diagnostics, and therapeutics. It provides highly detailed information on the chemistry, reagent systems, and practical applications for creating labeled or conjugate molecules. It also describes dozens of reactions, with details on hundreds of commercially available reagents and the use of these reagents for modifying or crosslinking peptides and proteins, sugars and polysaccharides, nucleic acids and oligonucleotides, lipids, and synthetic polymers. Offers a one-stop source for proven methods and protocols for synthesizing bioconjugates in the lab. Provides step-by-step presentation makes the book an ideal source for researchers who are less familiar with the synthesis of bioconjugates. Features full color illustrations. Includes a more extensive introduction into the vast field of bioconjugation and one of the most thorough overviews of immobilization chemistry ever presented.

An accessible overview of radiogenic isotopes, dataset evaluation and real-world applications for advanced undergraduate students and industry professionals.

A new edition of a very well regarded textbook on isotope geochemistry, this text covers both radiogenic & stable isotopes, & offers up-to-date coverage of the U-Pb methods, Helium & Tritium methods, the petrogenesis of metamorphic rocks, carbon-14 dating methods & much else.

This text attempts to enhance students' understanding of geological processes by showing them how to use chemical principles in solving geological problems. Emphasizing a quantitative approach to problem solving, this new text demonstrates how chemical principles control these processes in atomic and large-scale environments. In this way, students may see that the principles and applications of inorganic geochemistry are accessible, internally consistent, and useful for understanding the world around us. And as professional geologists, this understanding may help them to predict the outcome of chemical reactions occurring in geological processes and to realize the important role they play in characterizing our environment.

This is the first book to provide a comprehensive and state-of-the-art introduction to the novel and fast-evolving topic of in-situ produced cosmogenic nuclides. It presents an accessible introduction to the theoretical foundations, with explanations of relevant concepts starting at a basic level and building in sophistication. It incorporates, and draws on, methodological discussions and advances achieved within the international CRONUS (Cosmic-Ray Produced Nuclide Systematics) networks. Practical aspects such as sampling, analytical methods and data-interpretation are discussed in detail and an essential sampling checklist is provided. The full range of cosmogenic isotopes is covered and a wide spectrum of in-situ applications are described and illustrated with specific and generic examples of exposure dating, burial dating, erosion and uplift rates and process model verification. Graduate students and experienced practitioners will find this book a vital source of information on the background concepts and practical applications in geomorphology, geography, soil-science, and geology.

Our colleagues from the French-speaking parts of Switzerland - the *Suisses romands* - and above all the committee of the 3rd Cycle, *Earth Sciences (3 Cycle, Sciences de la Terre)* honored us by asking us to give a course on Isotope Geology for the year 1977. The course, entitled *Evaluation et Interpretation des Donnees Isotopiques (evaluation and Interpretation of Isotopic Data)*, was intended to inform earth scientists, graduate and postgraduate, from the western Swiss Universities on the subject of Isotope Geology. Such courses usually consist of two parts: lectures and excursions. Thus, in March 1977, we gave such a two-week course at the Mineralogical Institute of the University of Berne. The first week was devoted essentially to the methods of dating, the second week to the behavior of stable isotopes. In July 1977, on the occasion of an excursion to the Central and Western Alps, we were able to demonstrate our results. Guest professors were invited to make contributions to the course.

Applications of stable and radioactive isotopes are supporting sustainable development goals. They are used to study different ecological, biological, chemical and geological systems and understand their dynamics and interactions. Environmental applications of these isotopes include tracing pollutant migration, assessing and predicting climatic changes and planning for water management. This book highlights recent isotope applications in studying the hydrosphere and lithosphere compartments of the Earth. These applications include the use of natural and anthropogenic isotopes to understand the natural processes in these compartments. Chapters focus on soil distribution and sedimentation, dating tectono-metamorphic events, assessing brine origin, planning for water management and the effect of variation of environmental conditions on the biological and isotopic changes in coral skeletons.

Groundwater is an increasingly important resource to human populations around the world, and the study and protection of groundwater is an essential part of hydrogeology - the subset of hydrology that concentrates on the subsurface. Environmental isotopes, naturally occurring nuclides in water and solutes, have become fundamental tools for tracing the recharge, history, and contamination of groundwater.

This book presents a quantitative treatment of the theory and natural variations of light stable isotopes. It discusses isotope distribution in the context of fractionation processes, thermodynamics, mass conservation, exchange kinetics, and diffusion theory, and includes more than 100 original equations. The theoretical principles are illustrated with natural examples that emphasize oxygen and hydrogen isotope variations in natural waters, terrestrial and extraterrestrial rocks, and hydrothermal systems. New data on meteoric precipitation, rivers, springs, formation fluids, and hydrothermal systems are included in relation to various natural phenomena. Essentially, this book seeks to reconnect the diverse phenomenological observations of isotope distribution to the quantitative theories of physical chemistry and the language of differential equations. It may serve as a textbook for advanced students, as a research reference, or as a quick source of information. The book is organized into five chapters, each followed by suggested quantitative problems and a short reference list. The three theoretical chapters progress from an elementary review of the physical chemistry of stable isotopes, to the thermodynamics of isotopic compounds, and finally to the calculation of isotope distribution in dynamic systems. The third and fifth chapters emphasize oxygen and hydrogen isotope variations in Earth's hydrosphere and lithosphere, constituting the most important examples of the theoretical principles. Appendices provide data on atomic weights of light elements, physical constants, mathematical relationships, and isotopic fractionation factors.

The field of nuclear and radiochemistry is wide-reaching, with results having functions and use across a variety of disciplines. Drawing on 40 years of experience in teaching and research, this concise book explains the basic principles and applications of the primary areas of nuclear and radiochemistry. Separate chapters cover each main area of recent radiochemistry. This includes nuclear medicine and chemical aspects of nuclear power plants, namely the problems of nuclear wastes and nuclear analysis (both bulk and surface analysis), with the analytical methods based on the interactions of radiation with matter. Furthermore, special attention is paid to thermodynamics of radioisotope tracer methods, the very diluted system (carrier-free radioactive isotopes) and the principles of chemical processes with unsealed radioactive sources. This book will be helpful to students and researchers in chemistry, chemical engineering, environmental sciences, and specialists working in all fields of radiochemistry. Basic concepts are introduced and practical applications explained, providing a full view of the subject. Laboratory work with unsealed radiochemicals is discussed in details that can be applied in research and authority in the lab environment. New and updated edition of a popular textbook on the geological applications of radiogenic isotopes.

Providing an exhaustive review of this topic, *Inorganic Mass Spectrometry: Principles and Applications* provides details on all aspects of inorganic mass spectrometry, from a historical overview of the topic to the principles and functions of mass separation and ion detection systems. Offering a comprehensive treatment of inorganic mass spectrometry, topics covered include: Recent developments in instrumentation Developing analytical techniques for measurements of trace and ultratrace impurities in different materials This broad textbook in inorganic mass spectrometry, presents the most important mass spectrometric techniques used in all fields of analytical chemistry. By covering recent developments and advances in all fields of inorganic mass spectrometry, this text provides researchers and students with information to answer any questions on this topic as well as providing the basic fundamentals for understanding this potentially complex, but increasingly relevant subject.

Enhanced analytical capabilities and separation techniques, improved detection limits, and accessibility of instrumentation have led to massive strides in the use of isotopes to assess microbial processes in surface and subsurface sediments. Considering the rapid growth of research and commercial interest in stable isotope and radioisotope applications for contaminant hydrology and microbial ecology, an up-to-date overview of the field is long overdue. *Environmental Isotopes in Biodegradation and Bioremediation* comprehensively covers established and emerging isotope methods for environmental applications, focusing on biodegradation and bioremediation. This book is an invaluable tool for researchers, practitioners, and regulators who require an extensive understanding of the application of isotope methods to natural compounds and environmental contaminants. It addresses questions including: What amount of a compound comes from anthropogenic release? Do the chemicals involved undergo degradation in the environment? Do they persist and accumulate? This book is divided into four sections: *Isotope Fundamentals* covers important background and theoretical information needed to understand later chapters *Isotopes and Microbial Processes* discusses the application of isotopes to different environmental redox conditions that dictate the predominant microbial processes that will occur *Isotopes in Field Applications* describes the transformation of anthropogenic pollutants and the application of isotope tools to field sites *Isotope Emerging Areas* addresses the use of compounds labeled with stable isotopes, including stable isotope probing and the use of radiocarbon at natural abundance and novel stable isotopes This reference details how isotope tools can be used to gain insight into the origin and fate of natural compounds and contaminants in the environment. Integrating theoretical and practical knowledge, the authors examine the principles of isotope tools and then present an extensive overview of key environmental processes that can be investigated with isotope methods. They also discuss analytical and data evaluation procedures, addressing established and emerging applications. To illustrate concepts and methodology, the authors use a wide range of case studies and recent field and laboratory research from various disciplines currently employing these methods. This book is a valuable tool for expanding the application of both stable isotopes and radioisotopes into untapped areas.

This wide-ranging text in isotope geology/geoscience allows students to integrate material taught in various courses into a unified picture of the earth sciences. Gives a rational exposition of the principles used in the interpretation of isotopic data and shows how such interpretations apply to the solution of geological problems. Current with references up to 1985, chapters in this edition have been revised, and new chapters on Sm-Nd, Lu-Hf, Re-Os, and K-Ca decay schemes and cosmogenic radionuclides have been added. Data summaries and references have been expanded. Also includes problems for student study and abundant line drawings with explanatory captions.

This book provides the first comprehensive, overview and guide to forensic isotope analysis, an exciting new application of stable isotope analytical techniques. Topics are introduced using examples and real-life case studies such as food quality control where isotope analysis has already had a major impact, in terms of consumer protection, These examples illustrate the underlying principles of isotope profiling or fingerprinting. A section comprising actual criminal case work is used to build a bridge between the introduction and the technical section to encourage students to engage with this novel departure for analytical sciences while at the same time providing hands-on examples for the experienced researcher and forensic practitioner to match problems and success stories encountered with the topics discussed in the

technical section. What little information is available on the subject in book form so far, has been published as individual chapters in books dealing either with mass spectrometry, forensic geoscience or environmental forensics, this is the first book to focus on the entire spectrum of forensic isotope analysis and will be an invaluable reference to both researchers in the field and forensic practitioners.

International Series of Monographs in Analytical Chemistry, Volume 49: Isotope Dilution Analysis focuses on the method of isotope dilution analysis (IDA). The book first discusses the principles, types, and theory of IDA. Classification of the methods of IDA; precision, accuracy, and sensitivity of IDA; and types of IDA are described. The text also examines experimental techniques, separation, and mass determination. The separation of components, reagents and tracers, and amount of substance separated are underscored. The text takes a look at the inorganic applications of IDA, including determination of elements and selected procedures. The text examines the applications of IDA in organic chemistry and biochemistry, particularly in the analysis of alcohols and ethers, steroids, penicillin, proteins and amino acids, and insecticides. The book discusses IDA with stable isotopes. Methods for the determination of isotopic composition, fundamentals and technique, and practical applications are underscored. The text also emphasizes the special applications of isotope dilution. Determination of the content of isotopic carriers in radioactive preparations; determination of the coefficient of self-absorption and specific activity; and determination of radioactive contaminants are discussed. The text is a vital reference for readers interested in isotope dilution analysis.

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