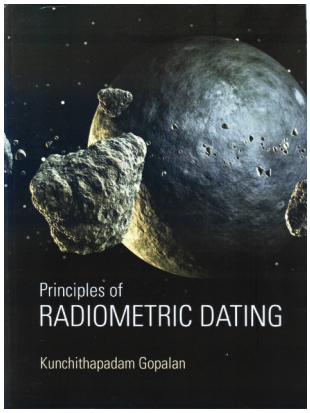

Principles of Radiometric Dating. Kunchithapadam Gopalan. Cambridge University Press, University Printing House, Cambridge CB2 8BS, United Kingdom. 2017. xiv + 207 pages. Price: £ 59.99.

Even after more than 100 years of the initial discovery of isotopes, we are yet to fully utilize their potential in science and technology. The unique properties of isotopes of elements covering the entire periodic table have wide-ranging applications. The modern earth and planetary sciences owe a lot to such exploits for understanding of the fundamental aspects of evolution of the solar system and planetary interiors. Isotopes have remained the most advanced tools in determining the timescales of various events that shaped the solar system and understanding the nature of processes that occur in it. Isotopes are either stable or radioactive. Stable isotopes are powerful tracers of geochemical processes, whereas radioactive isotopes and their products (radiogenic isotopes) are the basis of geochronology or radiometric dating.

Numerous books have been published during the last 40 years dealing with the principles and applications of isotopes. In recent times most books have become more specialized, which is understandable considering that the field has progressed tremendously because of analytical/technological advancements. However, this has become detrimental to teaching and learning of the basic concepts that are a must for the beginners. The book under review is a welcome addition in this regard. Although not exhaustive, it covers most of the physical and chemical fundamentals of isotopes leading to geochronology. The strongest attribute of the book is the mathematical treatment/explanation for most of the equations that are used in radioactive dating methods and isotope geology. A separate chapter on 'Error analysis' involving data reduction and regression analysis is unique to the book; only a few other text or reference books on isotopes cover this aspect in such detail. The book provides a good combination of concepts from nuclear chemistry, cosmochemistry and isotope geology. It has apparently evolved from the author's own experience in geochronology during an active research career spanning more than four decades. Most difficult concepts and tricky experimental aspects are explained in simple language for the benefit of students and non-experts.

The book contains 11 chapters, beginning with the basics of physics of the nucleus and ending with the chronology of differentiation events in the earth's history, through discussions on decay mechanisms, nucleosynthesis, isotopic abundance and mixing, radiometric dating methods, mass spectrometry, error analysis, cosmochemistry, evolution of the solar system and chemical evolution of the earth. Chapters 1 and 2 discuss the fundamental aspects of the nucleus such as mass, binding energy and nuclear transformations (radioactive decay and nuclear reactions). Discussion on statistical aspects of radioactivity is a plus point for chapter 2; however, it would have been better if potential energy diagrams explaining various decay modes were provided. Discussion on nucleosynthetic processes, leading to formation of various nuclides, in chapter 3, is brief but adequate. The purpose of chapter 4, entitled 'Isotopics' is not clear. It provides the concepts of isotopic abundance and atomic weight, and derivations of mixing equations, all of which could have been easily accommodated in other chapters, e.g. the first two could have been given in chapter 1. Unlike most other books, all isotopic dating methods are discussed at one place in chapter 5, which would definitely be useful for the readers. Many aspects of temporal evolution of radiogenic isotopic ratios in various reservoirs on the earth are well explained using appropriate figures and mathematical equations.

Chapter 6 introduces the readers to the technique of mass spectrometry for measurement of isotopic ratios. Starting with the principle of mass spectrometry, the chapter goes on to describe various parts of a mass spectrometer. For some reason, the author chooses to start the discussion from the detector backwards to the source. The chapter would have benefited from a discussion on sample preparation, modes of data collection (static versus dynamic) and data reduction methods (e.g. correction for isobaric interferences). Chapter 7 provides valuable information on types of errors, calculation of various statistical parameters from acquired data, principles of error propagation and most importantly, methods of linear regression analyses for data with associated with errors – a data-handling procedure that is an integral part of the isochron method of dating. Chapters 8 and 9 provide details of evolution of the solar system as deciphered from the study of isotopes in meteorites. Use of short-lived (now extinct) and long-lived radionuclides to determine the timing of formation of early solar system objects and meteorites is discussed in detail. Chapter 9 also provides information on determination of two important parameters for meteorites, the cosmic-ray exposure ages and terrestrial residence times, which are difficult to find in books.

Chapters 10 and 11 are dedicated to discussions on geochemical and isotopic evolution of the earth since its formation. Chapter 10, although entitled 'Chemical evolution of the earth', essentially provides information on trace elemental behaviour during igneous processes and their applications as tracers of differentiation processes within the earth's mantle. The last chapter (11), however, provides important and up-to-date information on the timings and processes of early differentiation events on the earth garnered from the use of various short-lived radionuclides. These processes include core formation, formation of primitive atmosphere and early silicate earth differentiation. The chapter goes on to discuss, in brief, evolution of various modern mantle isotopic components/reservoirs and isotopic evolution of sea water. The evolution of the continental crust, as understood from isotopes, is completely missing. Although I did not specifically look for errors in the texts, tables or figures, a few of them can easily be noticed. Here are some examples: use of mixed units (SI and CGS) in the same quantity (e.g. p. 3), lack of references for data used (e.g. masses of particles, abundances, half-lives, etc.), and use of incorrect units and values in figures/tables (e.g. figure 1.6; table 5.3).

This book is a useful reference for teachers of isotope geology as well as practising geoscientists who use geochronological data for their research. Unfortunately, it lacks the desirable attributes for a textbook. There are no worked-out examples, no problem sets and fewer illustrations. Considering that the author's main target is students, the book would have greatly benefited from information on methods of determination of decay constants, concept and derivation of mean life, derivation of decay equation from statistical principle, error propagation in isotope dilution analysis and mass spectrometric data reduction techniques, most of which are rarely covered in books on the subject. I sincerely hope that subsequent editions of the book would be more comprehensive. Notwithstanding my above comments, I would strongly recommend the book to all my colleagues who teach isotope geochemistry and all the geoscience departments. I commend the author for writing such a brilliant book on isotope dating.

JYOTIRANJAN S. RAY

Physical Research Laboratory,
Navrangpura,
Ahmedabad 380 009, India
e-mail: jsray@prl.res.in

Annual Review of Entomology, 2017. May R. Berenbaum, Ring T. Cardé and Gene E. Robinson (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 62. xii + 482 pp. Price: US$ 107.

Insects nurture and protect us, sicken us, kill us. They bring us joy and sorrow. They drive us from fear to hate, then to tolerance. At times they bring us up short to a realisation of the way the world really is, and what we have to do to improve it. Their importance to human welfare transcends the grand battles we fight against them to manage them for our own ends. Most of us hate them, but some of us love them. Indeed at times they even inspire us.

– McKelvey

Insects have been central to many advances in science. The inspiration from insects has prompted the *Annual Review of Entomology* (*ARE*) to review significant developments in the field of entomology, including biochemistry and physiology, morphology and development, behaviour and neuroscience, ecology, agricultural entomology and pest management, biological control, forest entomology, acarines and other arthropods, medical and veterinary entomology, pathology, vectors of plant disease, genetics and genomics, and systematics, evolution and biogeography from 1956. It is indeed refreshing to see that *ARE* has been at the forefront of publishing excellent reviews dealing with many different facets of entomology for the last 62 years, when we have tried to place the many disciplines of science into compartments, even though the boundaries between different disciplines are difficult to delineate clearly. Insects have been, for nearly 400 million years, the most dominant animal group and the most successful in the evolutionary history of the earth. It is appropriate that the study of insects spans many disciplines and entomological research has taken great strides in these different areas.

This volume of *ARE* begins with a wonderful introduction by Subba Reddy Palli (an editorial committee member), where he traces the process the editorial committee uses to select contents for each and how the planning for each volume starts three years before the publication date. Only 50% of the proposals received from potential contributors is turned into articles in this volume. Covering a range of topics in most of the subdisciplines of entomology, this volume includes 24 excellent and comprehensive reviews. Through this array of reviews covering a perfect balance of both basic and applied aspects, this volume seeks to make it delectable reading for a large number of readers. Some of the subdisciplines covered include biochemistry and physiology, morphology and development, behaviour and neuroscience, ecology, agricultural entomology, biological control, forest entomology, medical and veterinary entomology, insect pathology, genetics and genomics, systematics, evolution and biogeography, history of entomology, autobiography and spider silk. I would like to discuss a few of the compelling and thought-provoking reviews and present a tingling taste of the flavours in this volume.

Choosing 'Yellow brick road' as a title for his autobiographical sketch, Charles H. Calisher, the arbovirologist (one who studies viruses that are transmitted between vertebrates by hematophagous arthropods), nicely brings out how the road to happiness or good things as in the *Wizard of Oz* is simply being in the right place at the right time. In his wonderfully clear and conversational tone, the author brings out his satisfying career spanning almost 27 years at the Centres for Disease Control and Prevention (CDC), USA. Some of the quotes of significance from this piece are – 'Perhaps a bit of my personal history will provide more perspective as to how I got from hither to yon', 'People were not hired to fill professional positions', 'Italicization of a virus name is simply incorrect and those who use such typeface when writing about a virus err', '... and to have the opportunity to present my often very subjective opinions, not simply my objective findings'. Calisher recounts how on his retirement at the age of 75 and having had enough of meetings, grant applications, editing students' dissertations, serving on committees, and dealing with parking regulations, he simply shifted to an easier schedule, writing reviews, reviewing manuscripts, staying in contact with long-time friends and colleagues, and generally not keeping to a well-defined schedule. I would highly recommend this delightful article for the sheer joy of reading it.

Next let me highlight the brilliant article 'Beekeeping from antiquity through the Middle Ages' by Gene Kritsky, which artfully takes you through the history of beekeeping practice starting from the 7000 to 8000 yr-old rock paintings in Spain, depicting rope ladder-suspended honey hunters harvesting honey from wild bee colonies to the tryst with apiculture of the Egyptians, Romans, Asians and Mayans, illustrating how beekeeping developed in isolation in many parts of the world. The absolutely fascinating history of our relationship with honey bees is well illustrated through the evolution of different hive structures in Egypt, Rome, Greece and Europe as a whole. Evidence of the knowledge of beekeeping with the cavity-nesting honey bee, *Apis cerana*, especially in China, dates back to 3500–4000 years, with later beekeepers being aware of the different castes, understanding swarming, how to unite and separate colonies, etc.