Journal of Sedimentary Research
An International Journal of SEPM
Colin P. North and Kitty L. Milliken, Editors
A.J. (Tom) van Loon and Leslie A. Melim, Associate Editors for Book Reviews
Review accepted 20 October 2004

Sedimentary Processes: Quantification using Radionuclides, by J. Carroll and I. Lerche, 2003. Volume 5 in the series adioactivity in the environment (series editor M.S. Baxter). Elsevier, P.O. Box 211, 1000 AE Amsterdam, The Netherlands; 250 pp., hardbound; price USD 120.00, EUR 120,00, GBP 80,00. ISBN 0-08-044300-1.

The use of radiometric methods - for example the natural radioisotope ^{210}Pb and the fallout radioisotope ^{137}Cs - to date modern sediments has become increasingly important for environmental studies. Applications include studies of water and atmospheric pollution, analyses of catchment erosion, and monitoring of radioactive discharge. The observed changes of radionuclides with sediment depth are the result, however, of an unknown combination of changes in sedimentation rate, nuclide flux, and losses or additions of the parent or daughter radionuclides after deposition. The authors argue successfully in their Preface (and this is also repeatedly stated in many of the chapters) that these factors can affect the accuracy of the ages determined, hence mask the real depositional rates and flux variations of proxies.

The book provides an introduction to mathematical procedures that can be used to unscramble the masking effects encountered when using radiometric methods. Its background, objective and purpose, as well as its structure and main ideas are clearly explained in the Preface. The book consists of nine chapters (the last one being an epilogue), and an appendix.

In chapter one, an introduction to dating methods is given with emphasis on radiometric dating (e.g. ^{210}Pb and ^{137}Cs). Chapter two deals with mathematical modeling approaches that can be used to distinguish the signal of radioactive decay related to depositional events from masking effects. The approaches vary in conceptual models and signal theory methods, i.e. the Constant Flux/Constant Sedimentation Model, the Constant Flux Model, the Constant Specific Activity Model, and Sediment Isotope Tomography (SIT). The last-mentioned method, which is promising and represents an emerging field, is further elaborated on by presenting synthetic case applications as well as its technical development. Chapter three comprises case studies to demonstrate how signal-theory approaches are used to interpret single-site measurements of radionuclides in a variety of aquatic systems. From these cases, one can judge how reliable the method works. Measure of resolution, uniqueness, precision and sensitivity of the method are addressed in Appendix A to this chapter. Chapter four illustrates the use of the SIT procedure to study areas with multiple profiles of lead, cesium and strontium nuclides to unravel the effects that are due to sediment variations with time from intrinsic source variations. Chapter five focuses on the effects of post-depositional biological and physical mixing of sediments. Two cases are presented using conceptual models and a signal-theory model for establishing the effects of sediment mixing on the determination of sedimentation rates. Chapter six examines the diffusion and partitioning of nuclide

concentrations between sediments and surrounding water. After an introduction to simple linear adsorption following a general mathematical development and an illustrative example, various types of diffusion and near-surficial rapid mixing and partition coefficient effects are discussed. Chapter seven deals with the transport of contaminants in marine environments. Four case studies are detailed to illustrate how the radionuclide method can help to reconstruct the sedimentation histories, and how they can help to identify the sources of contaminants and their influence on the water column. Chapter eight provides quantitative methods and techniques for answering questions concerning errors and their influence on age determinations. The last chapter is an epilogue, once more emphasizing the importance of accurate age determination applying methods capable of unraveling complex situations in a wide variety of geological settings. In the appendix, Sediment Isotope Tomography software is provided which allows to distinguish the components of variations in radionuclide activity with sediment depth caused by variations in sediment accumulation rates and radionuclide fluxes; both its C++ source code and detailed instructions and examples for its use are included.

The book is successful in applying radionuclide methods in combination with modeling approaches to describe modern sedimentary processes quantitatively. The introductions to methods and procedures include theoretical backgrounds and technical developments. The examples from various geological settings show how the approaches can contribute to solving environment-related problems. And, more important, the assumptions and consequences of models are dealt with when they are applied in specific cases, so that the reader knows the advantages and limitations involved when choosing a particular model for a specific application. The attached SIT software code, which occupies about one third of the book, is remarkable. This promising model would, however, attract more users if the authors would have provided a website from which the code can be downloaded.

In conclusion, it is a rather practical and instructive book, which must be considered very useful for professional researchers in marine geology, environmental geology, and coastal engineering. It is also well suited for graduate student courses, although the price seems rather high for a student textbook.

Xiqiu Han
Key Laboratory of Submarine Geosciences & Second Institute of Oceanography
State Oceanic Administration
36 Baochu North Road, Hangzhou
Zhejiang, 310012
China

SEPM - The Society for Sedimentary Geology