Book review: Sedimentary processes - quantification using radionuclides

by J. Carroll and I. Lerche, 250 pp., Elsevier, 2003. In the series: Radioactivity in the environment Vol. 5, edited by M. S. Baxter.
ISBN: 0-08-044300-1

Radionuclides are widely applied in environmental sciences because they may provide age information that can otherwise not be obtained. A variety of tracers is available for this task, ranging from the natural uranium and thorium decay series and the cosmogenic nuclides like ^{10}Be and ^{14}C, to the anthropogenic tracers like ^{3}H or the various plutonium isotopes. The work presented here concentrates on one central aspect of this broad issue. The interpretation of radioisotope signals in modern aquatic sediments often suffers from the complicated combination of the effects of decay, variations in sediment flux, and variations in radionuclide flux. This book contributes to our knowledge how these effects may be separated by means of a computer-based model, mainly using ^{210}Pb and ^{137}Cs.

After a brief introduction to dating methods in general in the first chapter, the second chapter focuses on radiometric methods. As promised by the term “quantification” in the title, emphasis is placed on mathematical backgrounds of radiometric methods for sediment dating and determination of sedimentation and sediment accumulation rates, mainly illustrated by examples with ^{210}Pb. The relevant parameters are clearly defined, and some basic radiometric approaches for different environmental settings are presented. The main focus of this section is the “Sediment Isotope Tomography”- approach (SIT), an iterative method which allows to simultaneously consider variations in sediment accumulation rates and radionuclide fluxes.

In the following chapter, examples for the application of radiometric methods (basically the SIT method) from single site studies are presented. In addition to ^{210}Pb, applications of ^{230}Th and ^{231}Pa for the marine environment are introduced here. Chapter 4 extends the application of the SIT method to multiple site studies, also adding new tracers. The potential of the method to disentangle variations in sediment and radiotracer fluxes is demonstrated.

The following section is dedicated to sediment mixing, a complex and important problem in many radiometric approaches. Chapter 5 gives a general introduction to various mechanisms of sediment mixing and their mathematical description together with some instructive examples. Chapter 6 is titled “biological mixing coefficients”. It reports in greater detail aspects of simple linear adsorption and different types of diffusion.

Chapter 7 is somewhat misleading titled “marine contaminant studies”. Here, four examples are given how radionuclides can be used to quantify the fluxes of various sedimentary components, including pollutants and organic carbon. It remains unclear why the latter is placed in this chapter, especially when considering that the presented example is a case study from Lake Baikal. The last chapter then addresses a very important issue in environmental radionuclide studies, error estimates, restricted here to the dating of stage boundaries. The appendix, representing more than one third of the volume, gives the C++ source code of the SIT-software.

The work of Carroll and Lerche offers instructive examples for the application of radionuclides to sedimentary processes in the aquatic environment. It clearly focuses on several aspects of this broad subject. In terms of tracers, most examples are using ^{210}Pb and ^{137}Cs. Concerning radiometric models, the work is clearly focussed on the SIT-method that offers advantages compared to other radiometric methods when separating effects of age, sedimentation rate and radiotracer flux. Also, error consideration is concentrated on one single aspect, the age dating of stage boundaries.

The work is a helpful reference for readers familiar with radiometric methods by addressing some complex questions in the field of radiometric applications in a comprehensive way, especially from a mathematical point of view. Introductory material like an overview of radionuclides used in environmental studies, or basic error considerations in radiometric applications are not provided, indicating that the work is not intended to serve as an introduction. A problem when reading the book are the often unspecific or even misleading headings, which make looking for a specific example or application a time-consuming task. However, the book is a recommendable reference for professionals engaged in modelling of radiotracers in sedimentary environments. The promising SIT-approach presented in this

volume would certainly profit from a better availability of the software, e.g. by providing a source for download.
Walter Geibert