

Mathematical modelling for earth sciences, by Xin-She Yang, 2008. Dunedin Academic Press, Ltd., Hudson House, 8 Albany Street, Edinburgh EH1 3QB, Scotland. Paperback, x + 310 pages. Price GBP 25.00; USD 49.95; EUR 39.95. ISBN 978-1-903765-92-0.

Modelling is currently one of the most 'hot' activities in the earth sciences. However, it is not always clear from publications how the models have been established, or what was the reasoning behind the choices on the basis of which the input into the model was chosen. The mathematics underlying a model are often even less clear.

A main problem is that the mathematical knowledge of many earth-science students is fairly limited. I remember from some 35 years ago that I had myself to teach my sedimentology students what I consider rather basic mathematics. And the education in mathematics at pre-university level has, in most western

countries, certainly not become better in the past few decades... It is my experience that many students who want to specialize in geophysics, oceanography, atmospheric sciences or geochemistry often refrain from doing so because they find out that the mathematics are too complicated for them. This leaves the question what is the mathematical accuracy of the models shown on the thousands of posters that are presented at large earth-science conferences (EGU, AGU, GSA, AAPG, etc.).

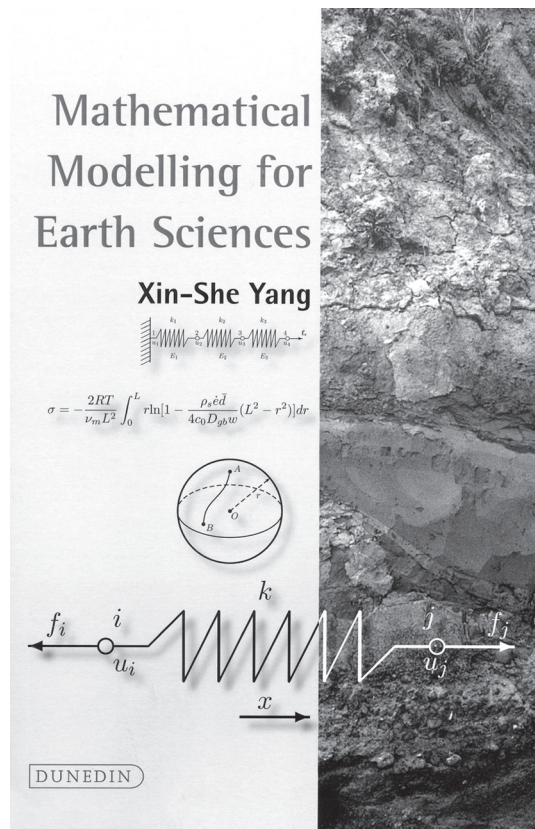
A book on mathematical modelling for earth sciences is therefore most welcome. The author is, however, not an earth scientist: he received his Ph.D. from the University of Oxford

in applied mathematics. Being a research fellow at the University of Cambridge now, he is in the Structure Group in the Civil, Structural and Environmental Engineering Division. This background, and this current position are certainly a guarantee for a thorough mathematical approach of modelling, but the question arises immediately what is the applicability of the presented material for the 'average' earth scientist; one might even wonder why he has chosen the earth sciences as the discipline that the book is said to focus on.

It seems, indeed, that the author is not truly confident that his book is understandable for the average geologist (although he wrote it for both undergraduate and graduate students), considering that he mentions in his Preface (and this is apparently considered so important, also by the publisher, that it is mentioned on the back-side cover as well) that the book is designed to be 'theorem-free'. This approach could not be followed entirely, however, because section 3.1.6 is headed 'Some important theorems'.

The book is divided into three parts: after the Preface, there follow Part I 'Mathematical methods'; Part II 'Numerical algorithms'; and Part III 'Applications to earth sciences'. These parts are followed by two appendixes: Appendix A deals with 'Mathematical formulae', and Appendix B deals with 'Matlab and Octave programs'. The book concludes with a useful 'Bibliography' and a 4-page 'Index'. It must be concluded that mathematics dominate: the first two parts take 224 pages and the two appendixes take jointly 12 pages, whereas the earth-science applications take only 66 pages; this makes me, as a reader, once more wonder why the book pretends to be aimed at earth scientists.

To give an impression of the contents: Part I contains 8 chapters: (1) Mathematical modelling, (2) Calculus and complex variables, (3) Vectors and matrices, (4) ODEs and integral transforms, (5) PDEs and solution techniques, (6) Calculus of variations, (7) probability, and (8) Geostatistics. Part II contains 4 chapters: (9) Numerical integration, (10) Finite difference method, (11) Finite volume method, and (12) Finite element method. Part III has, unfortu-



nately, only 3 chapters: (13) Refraction-diffusion system, (14) Elasticity and poroelasticity, and (15) Flow in porous media. This third part is without doubt too restricted for a book that pretends to deal with modelling for the earth sciences; it is obvious that many important subjects (sediment transport, volcanic eruptions, palaeobiogeographic developments, etc., etc.) are not dealt with at all. The author seems to restrict himself to the applied earth-sciences, and particularly to engineering geology. Mathematics are clearly more important for the author than the earth as an entity that is to be investigated, unravelled and understood by a combination of all kinds of earth-scientific disciplines in combination with the help from other 'hard' sciences such as mathematics.

That the mathematics dominate becomes also clear from the numerous formulae: in Parts I, II and III together (so, without the appendixes) not less than 1048 formulae are present; and that is without the also numerous equations in the examples that the author presents. The book therefore reads as a mathematics book rather than as the earth-science book that I had expected on the basis of the title.

One might even wonder whether the book is useful for the majority (or even a significant part) of earth scientists. Reading the many examples in the book where the author leads the reader step by step in the modelling of practical situations (mainly aimed at finding values for specific properties), I came to two main conclusions. The first is that the book is far too difficult for the average student, certainly for undergraduates who are not typically numerically interested; the second is that the book is hardly aimed at scholarly research, but much more directed to engineering geology. For those who work in this field, the book can be highly recommended: it has thoroughly been composed, it is clearly written for those with sufficient mathematical background, and the

cases analysed by the author will be appealing for this group of readers. For others, however, I think that this book will be fairly frustrating, and of little help in modelling, particularly in the case that qualitative aspects play a role in the modelling.

The publisher has to be congratulated with finding an author who dared tackle the difficult challenge of writing a book on this subject. The book is very well printed (I did not find any typos, but perhaps I was too busy understanding the mathematics) and easily readable. The price is certainly not too high, but the book may be too difficult for the majority of students.

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