J. Fluid Mech. (1989), *vol.* 202, *pp.* 595–598
Printed in Great Britain

REVIEWS

Movement of Sediment in Open Channels. By YU. A. IBAD-ZADE. Balkema, 1987. 364 pp. £23.

The contribution of Eastern European scientists to our knowledge of the hydraulic and Aeolian transport of sediments is significant. Consequently, the opportunity to study a treatise on sediment transport in open channels presented from a Soviet viewpoint was most welcome and certainly did not prove disappointing. However, it is unfortunate that this translation from Russian has taken thirteen years to appear, as some of the concepts discussed have been overtaken by more recent discoveries.

In its structure the book follows a conventional course. It begins with an extensive discussion of sediment characteristics and the factors affecting their movement. This is followed by a comprehensive survey of methods by which the granulometric composition and settling velocities can be characterized and measured. In many ways the book's strength lies in these first five chapters which take up over a third of the text. There are few other books which consider these aspects of sediment transport in such detail and which illustrate their importance by highlighting the pitfalls of not giving them such attention.

The next three chapters are primarily devoted to the hydraulics of open channel flow with some discussion on the vertical distribution of turbidity and its impact on suspended load. Here the intention appears to be to provide the reader with a sufficient foundation in hydraulic theory on which to base the following discussion of sediment movement. Of particular note is the author's emphasis on the transverse energy distribution pattern and the impact of velocity variations on this distribution. Further, throughout the book, the curved and irregular section of real channels is never allowed to fade from the reader's mind. This contrasts with some textbooks on this subject which give the impression that all rivers and canals can be assumed to be straight with uniform trapezoidal section! Unfortunately, this second third is the weakest section of the book and the one that most illustrates the age of the original text. Much of the analysis it contains, particularly on vertical turbidity structure and transverse velocity and energy distributions, has been superseded by extensive recent research. Particularly, the relatively recent realization that the interaction between suspended solids, even at low concentrations, and the vertical velocity distribution cannot be disregarded in the evaluation of suspended load, is a notable omission.

The final two chapters are a delight to read. The penultimate chapter begins with the practical application of the energy transfer theories developed earlier in the solution of real problems. It is these case studies that are the heart of the book, providing a fascinating insight into Soviet methods for undertaking sedimentation engineering projects. Indeed, practical examples taken from specific projects are used throughout the text and this greatly assists the reader in understanding the particular points the author is discussing.

The final chapter is devoted to a discussion of bed-load transport and is unique within the book in that much of its content is based on work published in the West. The objective of the chapter is to produce a generalized, semiempirical bed-load transport formula, the results of which are then compared with a number of other formulae. In its final form, the author's model is very similar to the Bijker–Frijlink formula albeit with notable differences in derivation. The author also chooses to compare his model with other formulae analytically rather than by a numerical comparison of predictions. This is a very effective treatment as it readily highlights regions of parameter space where the various models diverge.

The book concludes with a bibliography of some 262 references, just under one-third of which relate to Western literature. Unfortunately, most of the references were somewhat dated even when the original Russian text was published, and there is now little value in the bibliography. There were also a number of significant omissions. One example is the pioneering paper published by Rouse in 1937, the results of which are accredited to a Russian author more than five years later.

Further, more significant omissions are also apparent. The first concerns the use of statistical methods in the analysis of sediment transport. Eastern European scientists are noted for their advances in this field and it was a disappointment to find little discussion of this subject, particularly as it represents a very different approach to the solution of sedimentation problems. A second major omission was any consideration of flocculated sediments and the impact of aggregation on sediment transport. While such a subject deserves a whole book in its own right, the impression given in the present text is that the transport of silts and clays can be quantified in exactly the same way as sands. This is not the case and attempts to do so have resulted in some notable and expensive failures in practice.

A noticeable feature of the whole book is the extensive mathematical content which in some instances becomes laborious and pedantic with some formulae taking up more than one printed page each. There is also significant repetition, particularly with respect to solutions of equations of the type $\mathrm{d}y/\mathrm{d}x = y$ which are presented step by step in full every time they occur. However, in general this does not detract from the presentation. The translation is excellent leading to a very readable text, the credit for which must be shared between the author and the translator Dr S. P. Ghosh. Also great care appears to have been taken in the transcription of the mathematics as very few typographical errors were detected. It is a pity that the quality of the printing and the paper do not match up to the quality of the text.

Overall, this is a book which I am pleased to have had the chance to read. However, in view of its content and age, I could not recommend it as a basic text on the subject. There are a number of books available which are far superior in this respect. As a reference book, it is one which should find its way on to a number of library shelves.

T. J. Smith

Very Slow Flows of Solids. By L. A. Lliboutry. Martinus Nijhoff, 1987. 510 pp. £102 or $145.

Flows in which the momentum of the fluid can be neglected are of enormous importance to two branches of the earth sciences: glaciology and mantle convection. The subtitle of this book, 'Basics of modelling in Geodynamics and Glaciology', reflects the author's interests in these aspects of the subject: he is not concerned with a wide variety of other fluid dynamical problems where momentum can also be neglected.

The two applications have some important similarities: they are both concerned with low-Reynolds-number flows that are of limited interest and familiarity to many fluid dynamicists, and in both non-Newtonian and non-Boussinesq effects are important. The relationship between the complicated microscopic deformation that occurs when solid crystals deform and the macroscopic constitutive laws is a difficult and important aspect of both subjects, and one which is more familiar to metallurgists and material scientists than to most fluid dynamicists. The two applications also share observational problems. It is only slightly easier to make measurements of the velocity and strain within an ice sheet or a glacier than it is of that within the Earth's mantle. It is therefore of great importance in both fields to exploit every possible observation that could be relevant to the flow. In both fields the preferred orientation of crystals within the deforming region, produced by finite strain, is one such observation, and one that is not easily related to the more usual fluid dynamical descriptions of the flow. Others are the gravity field and surface deformation associated with mantle convection.

There is a great need for a good book in this area. The results and methods required in the study of these problems are spread over a wide variety of subjects and have been published in a large number of journals over a long period. Unfortunately the same problems make such a book very difficult to write. Since it is impossible to cover all the areas involved, it is essential to omit those likely to be familiar to most readers, or which have been well covered elsewhere, and to concentrate on unfamiliar problems. Non-Newtonian flow and finite strain in particular are not clearly dealt with in any of the fluid dynamical texts in common use, and are not in my view easily understood by reading the original papers of authors such as Truesdell. Lliboutry is one of the few people I know whose interests are sufficiently catholic to attempt such an undertaking, since he has worked in both fields and has made important contributions to glaciology especially. But I am sad to say that I do not think he has succeeded.

Many of the topics he discusses are better covered in a number of widely used texts. For instance Chapter 2 is concerned with diffusion and advection of heat, Chapter 11 with elasto-statics, Chapter 13 with the finite-element method, Appendices 1–6 with standard numerical methods, vector analysis, coordinate transformations, Fourier, Fourier–Bessel and Laplace transformations, spherical harmonics and the gravity field. These topics will be familiar to anyone who is interested in the rest of the book. In contrast the special problems of very slow flow in solids receive insufficient attention. I was especially disappointed by his treatment of geophysical and glaciological observations. In both fields it is impossible to make accurate three-dimensional measurements of velocity fields. The relationship of other measurements to the flow is complicated and often controversial, yet until such problems are resolved no understanding of the processes involved is soundly based. Lliboutry almost entirely ignores this area of both subjects.

From the theoretical point of view he has not been sufficiently thorough. For instance nowhere does he carefully derive the equation governing the conservation of energy in creeping flows. Such a derivation is not straightforward when the fluid is viscoelastic or has some other form of memory and needs careful discussion, especially of the definition of pressure. Nor does he attempt to use consistent notions: he uses σ_{xx}, σ_x, τ_1 and σ_{11} in different places to denote the x, x component of the stress tensor. An extremely important concept in finite strain is the velocity-gradient tensor, from which the finite strain can be obtained by integration. I was thoroughly puzzled by Lliboutry's statement (on p. 48) that it was *not* a tensor. The solution to my puzzle is that he restricts a tensor to be a quantity $\boldsymbol{M}$ which transforms as $\boldsymbol{R}^{\mathrm{T}}\boldsymbol{M}\boldsymbol{R}$ on changing frame from $\boldsymbol{x}$ to $\boldsymbol{x}'$, where

$$\boldsymbol{x}' = \boldsymbol{R}\boldsymbol{x}$$

and $\boldsymbol{R}$ is allowed to be a function of time. Because the antisymmetric part of the velocity-gradient tensor corresponds to the vorticity, it does not transform in the way Lliboutry requires on transforming to a rotating frame. It does of course do so when $\boldsymbol{R}$ is constant, as it is in the standard definition of a tensor which Lliboutry himself gives on the previous page. This confusion continues in Chapter 15 and I found the whole discussion of this important subject unintelligible.

Another area in which I hoped Lliboutry would provide a good account of our present understanding was the response of the Earth to glacial loading and unloading. During the last glaciation the icecaps on Finland, Scandinavia and Canada depressed the continents by as much as 1 km. When the ice melted a considerable amount of this depression remained, and has since slowly been removed by flow within the mantle. The problem involves both glaciological issues, since only the extent and not the thickness of the ice load can be directly observed, and also the problem of how best to describe the mantle deformation. Lliboutry gives an extensive discussion of the early work on this problem in Chapter 6, all of which is included as special cases of the more recent work on Peltier. With regard to Peltier's work Lliboutry remarks that he will restrict himself 'to some indications of its successive steps' since 'the theory is thoroughly exposed in the literature'. Yet Lliboutry can scarcely be ignorant of how controversial Peltier's work is at present, and a careful analysis of the reasons why would have been particularly useful from an informed and disinterested author.

To me the most useful part of this book are the references at the end of the chapters. These are often to major works where the arguments of the chapter concerned are developed further, and are generally well chosen. Several are to works with which I am not familiar, which is scarcely surprising in such an extensive field.

The discussion of slip-line theory and its application to continental tectonics is also well presented, and indeed is better than the original papers on the subject. But I was disappointed that there was no discussion of why such an approach is not satisfactory (because it is restricted to plane strain and therefore does not allow crustal thickening) and of the recent application of ideas originally developed for floating ice shelves to this problem.

Disappointing though this book is, it is the only one I know which attempts to cover this area. Sadly it does not do so at all well, and is outrageously expensive.

D. McKenzie

CORRIGENDUM

Spreading of the interface at the top of a slightly polydisperse sedimenting suspension. By Robert H. Davis and Mark A. Hassen

Journal of Fluid Mechanics, vol. 196 (1988), pp. 107–134

An error was made in the analysis of our measurements of the rate of spread of the diffuse interface at the top of a sedimenting suspension. This led to reported values of the hydrodynamic diffusivity which are too high by a factor of two. The source of the error is that the correct solution for the one-dimensional convective diffusion