Journal of Structural Geology, Vol. 14, No. 1, pp. 121 to 123, 1992
Pergamon Press plc. Printed in Great Britain

BOOK REVIEWS

Mechanical principles for geological structures

Price, N. J. and Cosgrove, J. W. 1990. *Analysis of Geological Structures*. Cambridge University Press, Cambridge, U.K. Price £75.00, $125 (hardback); £25.00, $49.50 (paperback).

Analysis of Geological Structures by N. J. Price and J. W. Cosgrove is a significant addition to the literature on the mechanics of mesoscopic and macroscopic deformation structures. The authors devote separate chapters to rock fracture, igneous intrusions, diapirs and impact structures, boudinage, cleavage, and structural analysis. The clear emphasis of the book, and the focus of 11 of its 18 chapters, is, however, the analysis of faulting and folding. The authors use experimental models and analytical solutions to elastic, viscous, and plastic boundary value problems to examine the formation of faults and folds in different structural settings. Notably, they discuss in a clear manner the difficulty of extrapolating the results of experimental investigations to natural deformation. They do not, however, discuss extensively the micromechanisms of deformation. As a result, this book is more reminiscent of *Elasticity, Fracture, and Flow* by J. C. Jaeger (Methuen) or *Fundamentals of Rock Mechanics* by Jaeger and N. G. W. Cook (Chapman and Hall) than other recent monographs in structural geology. *Analysis of Geological Structures* is, in my opinion, more likely to be useful in the classroom than either Jaeger or Jaeger and Cook because it analyses a wider range of deformation structures in greater depth.

The material on folding is presented very effectively, with points cogently argued and thoroughly supported by the literature. This is, in my opinion, particularly true of the chapters on the folding of multilayers and anisotropic materials, where the authors compare expertly theoretical and experimental models with selected field studies of fold development. Two points given particular emphasis in their discussions are the importance of elastic deformation in controlling the eventual shape and distribution of inelastic deformation within folded layers, and the effects of migrating stress fronts on the deformation of large layered packages. Both arguments are well supported by their citations to experimental and analytical models. At several points in the book, the authors argue for the importance of pore fluid pressure in the development of folds. Those discussions, and their assertions about elastic deformation and migrating stress fronts, are thought-provoking reading for those concerned with the development of mountain belt structures.

The chapters on fracturing and faulting present many innovative and closely-argued uses of Mohr–Coulomb theory. The discussion of the development of systematic fracture sets is particularly elegant and enlightening. The material on faulting is, however, somewhat idiosyncratic. For example, the authors imply (on p. 126) that non-fibrous slickensides result only from frictional melting along fault planes. Similarly, throughout the text but especially in Chapter 17 (pp. 448–450), the authors argue for the resurrection of the term *fracture cleavage*. Moreover, in their discussion of thrust belts, the authors do not consider the Coulomb wedge model of Davis and others, despite their reliance on the Hubbert and Rubey Mohr–Coulomb analysis to explain the motion of large thrust sheets. These are points where the authors are not in agreement with large numbers of structural geologists. More significant, in my opinion, are two recurring themes in their treatment of fracturing and faulting. First, by ignoring three-dimensional treatments of faulting, the authors contend, in effect, that even in three-dimensional strain states, only conjugate faults whose intersection parallels the intermediate principal stress direction may form. The work on three-dimensional fault sets by Reches and others suggests that the two-dimensional analysis of faulting presented in this book has some limitations. Second, in their focus on experimental models for faulting, the authors de-emphasize relationships between localized plastic deformation and faulting noted by Rice, Means and others, and alternatives to the Mohr–Coulomb failure criterion for faulting. This leads to some omissions. Notably, their analysis of the mechanics of mountain belts does not consider the yielding-wedge model of Chapple, even though the authors cite Schmid's work on localized plastic flow in major detachments. Thus, their coverage of faulting will, in my opinion, prove to be more controversial than the discussion of folding.

Because this book is designed for classroom use, it is appropriate to note a few minor problems in the presentation. Some potential for confusion arises with the notation that the authors chose for stress (S) and effective stress (σ), particularly since the authors use σ throughout the chapters on folding theory while referring only to 'stress'. There is, moreover, one instance (in fig. 11.41) where S refers to a strain ratio. Second, as is true in many first editions, there are several instances where notations in the text and in figures do not coincide. These are decidedly minor points, but they might be vexing for students. More important, many reproductions of photographs are very dark or have a distinctly muddy appearance. The reproduction problems detract from a potentially highly attractive publication, and may cause difficulty for students unfamiliar with the rock structures analysed in the book.

Overall, *Analysis of Geological Structures* is an impressive contribution. Those beginning in structural geology will benefit from its direct expository style, cogent arguments, and comprehensive use of experimental and analytical models to analyse rock structures. Those with greater experience in the field may take issue with the authors' conclusions in some places, but they will find thoughtful and carefully argued presentations throughout. With its focus on experimental and analytical models for rock structures, this monograph occupies a niche in structural geology that few others do. It fills that niche admirably well, and I anticipate that *Analysis of Geological Structures* will enjoy an enthusiastic audience for some time to come.

S. F. Wojtal

Oberlin, U.S.A.

Windows on deep continental crust

Salisbury, M. H. and Fountain, D. M. (editors) 1990. *Exposed Cross-sections of the Continental Crust*, NATO ASI, Series C, Mathematical and Physical Sciences, Vol. 317. Kluwer Academic, Dordrecht, The Netherlands. 662 pp. Price Dfl.315.00; £110.00 ($185.00) (hardback).

Over the last decade remote geophysical methods have revealed signatures characteristic of the deep continental crust. It seems a logical step to relate those signatures to areas where portions of the deep crust have been brought to the surface. As a whole, papers in this volume show the step to be wise and necessary, yet a step along a very slippery path. True, the rocks discussed probably resided for some time in deep parts of the continent, but *exposed* cross-sections do not necessarily relate to *unexposed* sections of continental crust. Indeed, processes that result in exhumation may themselves alter or selectively expose portions of the crust: (1) intra-crustal detachments expose the upper to mid-crust, leaving the lower crust behind; (2) some crusts are attenuated by extension prior to convergent emplacement; (3) crusts are altered in orogens that have a high geothermal gradient; and (4) underplating during uplift alters the lower crust. The volume is a realistic guide to structural and petrologic relationships in exposed continental crust, seismic and electrical signatures of deep crust that is exposed, and to the processes that create the dilemma in relating the two.

The collection of 28 papers evolved from a NATO Advanced Studies Institute symposium held in Killarney, Ontario, in 1988. The papers are arranged so that actual field studies constitute the first half of the book, while the second half contains general discussions of