

BOOK REVIEWS

Textbook of structural geology

Twiss, R. J. and Moores, E. M. 1992. *Structural Geology*. W. H. Freeman & Co., New York. Price \$59.95 (hardback; ISBN 0-7167-2252-6).

In an ideal world, the recommended textbook for a given course would be one written by the course teacher. However, given the real situation where the vast majority of courses have to make do with texts written by third parties, this new textbook by Robert Twiss and Eldridge Moores is probably the next best thing. Described in the Preface as an introductory text, this hefty 530-page work could be used to support several structural geology courses spanning the range from undergraduate to post-graduate levels. This is made possible because of the unique layout of the text which separates the observational, descriptive aspects of geological structures (which are more accessible for the beginner) from sections dealing with their mechanical interpretation (and requiring some background in physics and mathematics).

This book has most of the essential ingredients of a good structural geology course text. Structural geology is concerned to a large extent with the variety and beauty of natural forms and the authors have done service to their subject by collecting together a large number of visually attractive images to catch the eye of the student. Through more than 500 figures, the student is treated not only to the usual line drawings and outcrop snapshots but also to a fair number of air photos and seismic sections. These figures are not only abundant but are of excellent quality. The third dimension, so vital yet so often ignored, receives full attention. The coverage of topics is encyclopedic. Attempts by the reviewer to discover new areas of the subject which have been omitted failed totally.

The book's 22 chapters are grouped into five parts: Introduction; Brittle Deformation; Ductile Deformation; Rheology; and Tectonics. The first of these includes a chapter entitled Overview which defines the subject areas of structural geology and tectonics in terms of rock deformation on different scales. This is followed by a rather mixed chapter called Techniques of Structural Geology and Tectonics which, in spite of its name, devotes little space to practical methods but instead gives brief mention of the popular formats for representing geological structures (maps, sections, etc.). For example, stereographic projection is described here in concept but plotting procedures are not gone into.

Part 2 begins with a systematic survey of the principal classes of brittle structures dealt with from a largely geometrical standpoint. This is achieved in chapters entitled Fractures and Joints; Introduction to Faults; Normal Faults; Thrust Faults; and Strike-slip Faults. Coverage is exhaustive with the inclusion of up-to-the-minute topics such as metamorphic core complexes, shear criteria and models for hanging-wall deformation in normal faults. In common with some other texts, the basis of the klippe-window method of estimating minimum thrust displacement is poorly explained. Surely the sinuosity of the outcrop trace is irrelevant. Thankfully though we are spared the alternative, so-called *bow-and-arrow rule* for finding thrust movement; a rule no-one has successfully convinced me is valid. There are errors (e.g. Fig 4.2) where the throw of a fault is defined as the equivalent to vertical component of the net slip instead of the vertical component of the dip separation, but these are few and far between. In keeping with the overall layout of the book, we are kept waiting for the theoretical aspects of brittle deformation. We thus encounter stress for the first time in Chapter 8 though the wait is worth it. The treatment is serious and at the same time reader-friendly. For example the average reader will appreciate the pages headed "What is a vector?" and "What is a tensor?" Although the stress tensor is defined, the Mohr construction is the route chosen for stress calculations, including those in three dimensions. I would like to have seen mention of the pole of the Mohr circle because it simplifies understanding of how orientations are expressed in Mohr space. This chapter benefits from the worked out examples included at the end. Chapter 9, Mechanics of Fracturing and

Faulting, deals with theoretical fracture criteria and experimental brittle deformation. The geological applications of these subjects, including those in the field of palaeostress analysis, are developed in Chapter 10, Mechanics of Natural Fractures and Faults.

The first chapter of the book devoted to ductile deformation is called The Description of Folds. The terms that a geologist uses to describe the finer points of a fold's anatomy are all there together with alternative schemes used for geometrical fold classification. Kinematic folding models receive attention in Chapter 12 but I cannot help but think that the discussion here and in the two chapters which follow is hindered by the fact that strain theory has not been dealt with at this stage in the book. For example, flexural-slip folding is explained in terms of flexed card decks but the resulting strain patterns are not discussed. In this chapter the geometrical features of superposed folds are well illustrated but the 2-page discussion is probably insufficient for the student intending a practical analysis of real field data. Chapters 13 and 14 are concerned with foliations and lineations; their morphology and genesis, respectively. Geometry of Homogeneous Strain receives rigorous treatment pitched at an advanced undergraduate/post-graduate level. Again quantitative aspects are not side-stepped but this time the Mohr construction is not used. I was somewhat disappointed by the fact that although it is explained that tensors can be used to describe strain, the example used is not applicable to the large magnitude strains found in rocks. Besides this, the authors are to be commended on the way they lead the reader through the terminological minefield of rotational strain, coaxial strain and vorticity. The succeeding chapter looks at structures such as folds and foliations from the point of view of strain distributions. This is followed by a chapter, Observations of Strain in Rocks, dealing with the principal techniques of finite strain analysis.

Part 4 consists of three chapters on rock rheology. The first deals with the flow behaviour of rocks during laboratory deformation conditions. Here and throughout the book results are presented in text and diagram form without reference to their source. To have to do detective work to match the items with the reference lists at the end of each chapter could irritate slightly. The chapter that follows contains a useful summary of the deformation mechanisms operating on a microscopic scale in rocks undergoing ductile deformation. Discussion of mechanisms involving the movement of dislocations leads on in a natural way to the subject of crystallographic fabric development. The section is concluded by Chapter 20 which is concerned with the mathematical and analogue modelling of ductile deformation.

The final part of the book is devoted to tectonics. A general survey of the principal tectonic features of the Earth is followed up by looking at greater detail at the make-up of orogenic belts. This chapter provides the opportunity for pointing out the value of several sub-disciplines of our subject, such as kinematic analysis (using folds and foliations) together with fabric and strain analysis.

In summary, this attractive well-produced book, with its comprehensive coverage of topics, is the one to refer to for finding out what terms like crenulation cleavage, Nabarro-Herring creep and strike-slip duplexes mean; there are better books around for finding out how to implement practical techniques for structural analysis. *Structural Geology* is therefore an ideal book to complement other existing texts which place greater emphasis on problem solving, worked examples and exercises for the student.

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Shear sense, and more

Hanmer, S. and Passchier, C. 1991. *Shear-sense Indicators: A Review*. Geological Survey of Canada, Paper 90-17. Geological Survey of Canada, Ottawa, Canada. Price Can \$9.10 (Canada); \$10.20 elsewhere. Twelve 35