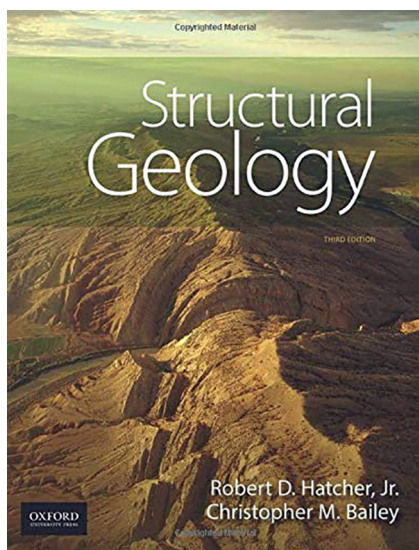


Book reviews

Structural geology: principles, concepts, and problems (3rd edition), by R.D.Hatcher, Jr. and C.M. Bailey, 2019. Oxford University Press/Academic US, 656 pages. Hardback: price \$149.99, ISBN 9780190601928.



A diversity of textbooks within a given scientific discipline guarantees that any an inquiring student or specialist the opportunity to look at specific issues from different perspectives. Seen in this light, I was pleased to see the information on a new, revised edition of “Structural geology” by R.D. Hatcher Jr., this time co-authored by C.M. Bailey. After reading this, I concluded that any shelf with textbooks related to tectonics and structural geology may be enriched by a new valuable, updated item. As suggested by the extended title (“Principles, concepts and problems”), this voluminous work (well over 600 pages) not only introduces the most fundamental knowledge, but also refers to more advanced, in-depth issues as well as to open questions in the field of modern structural geology.

They facilitate reading this tome, for instance by selecting particular topics significant to their readers. The book is subdivided into six large sections (called parts), the last of which includes appendices. Each of the remaining five parts comprises several chapters. The chapters are numbered in a continuous way throughout all the book and each consists

of smaller subunits having their own titles, but without numbers. The individual chapters logically and fluently pass into each other. However, both the major units (parts) and their minor components (chapters) can be read separately, as independent entities. Every chapter concluded with a summary (so-called chapter highlights) intended to be recapitulate the data offered. They are written in short, lapidary sentences. I strongly appreciate such conciseness of highlights, as this appears to be the most appropriate solution in terms of educational effectiveness. Additionally, extensive sets of questions, including computational tasks and occasionally illustrated with photographs or sketches; photographs are also found on the final pages of all chapters. Perhaps a good solution for the future would be to add to the book itself, or as accessible supplementary online material, the answers to some of the questions, especially those which require practical activities on the reader’s part. Finally, the chapters conclude with lists of recommended papers for further reading. Most of the proposed titles are briefly described. Those comments are a valuable and convenient help to the reader in selecting additional works that may help in widening his or her knowledge of the given topic.

The language used in the book is simple, clear and precise; sentences are not unnecessarily complicated. The authors appear to have done their best to make the text easily understood, also by a starting student. Colloquial metaphors and comparisons and references related to everyday life enrich the purely factual content of the book. A huge merit of this volume are the elegantly explained examples of phenomena that are parallel to strictly geological processes. Many of the concepts described include calculations, helping the reader to understand the phenomena or concepts presented (e.g., the viscosity of the Earth’s mantle based on isostatic rebound effects).

Illustrations, which constitute a substantial part of any structural geology textbook, are ubiquitous and aesthetic, which indisputably add to the value of this volume. The figures include numerous sketches, photographs, maps and tables. The drawings, plentiful and many in full colour, are clear and instructive. Sometimes, they are the straightest way to present ideas, such as Figure 16-29, congenially presenting an uneasy issue of interrelationships between different folding mechanisms. Rich is also the collection of photographs that illustrate structures from different parts of the world, with justified prevalence of examples from the United States, the homeland of the authors. Sketches are quite often coupled with the corresponding photographs, and together form complementary, instructive sets of illustrations. The figures have detailed captions, which make for good understanding.

Physical formulas are indispensable components of the structural geologist's workshop. Therefore, they are present throughout; added are exemplary calculations referring to the theories and concepts described. Both of these facilitate mastering the material at the appropriate level. However, it must be admitted that the number of equations is rather moderate and the content should not discourage students with rather basic mathematic competences. The wise attitude of its authors towards the physical background of tectonic processes, manifested by simply explained working examples, should even assist such readers in understanding the computational side of different issues.

References to the literature in the main body of text, which are not obligatory in textbooks at rather introductory levels, are common and widespread in this book. The list of works cited comprises 21 pages in print. It should be noted that the vast majority of the papers listed appeared during the last decades of the twentieth century, and thus do not refer to the most recent publications. However, citations include also a considerable number of more recent publications. Most of these refer to scientific papers, but the list comprises also numerous textbooks (covering different fields of geology and related sciences), as well as monographs, databases, atlases etc.

Special boxes within the so-called essays are independent, isolated components of book chapters. They contain additional information and topics that supplement and enrich the main body of the text, but are not necessary for the general, basic understanding of issues discussed. Some essays have catchy and witty titles, such as "The Value of Rosetta Stones". Frequently, the essays refer to cases of accurately selected, real regional problems or to

laboratory experiments (e.g., the charming essay related to the experiments of Daubrée and Mead on fracture sets formation). They also show historical perspective on the development of tectonic thought (e.g., the essay on slaty cleavage) or touch currently hot topics in geology (such as the essay on hydraulic fracturing). The texts in these boxes are concise and usually brief, often not longer than one page, but concomitantly they comprise their own figures and lists of references. Unfortunately, the boxes are not numbered. There are mentions to them in the main body of the text; however, these are too general and are not always sufficiently helpful for rapidly locating their precise place in the book.

A very valuable and useful section is the glossary, covering the last pages of the book, just ahead of the list of references and index. Definitions included in the glossary are numerous (several hundred items) and succinctly formulated, which makes them perfect to absorb and remember. At least in the electronic version, the terms defined are supported by references to the number of the particular chapter in which they are mentioned.

Part 1, which I find an especially interesting unit of the book, is the "Introduction" which focuses on the most general issues, partly beyond the strict scope of structural geology. This is why I decided to use more space to comment it. In the first chapter of this part, a bit unluckily entitled "Introduction" again, the authors clearly show that their work is an accurate choice for those who have only just started their adventure with structural geology. Part 1 familiarises the reader with the most basic terms and concepts, such as fundamentals of plate tectonics and isostasy. The significant role of structural geology studies for society (in the real world) is stressed here, which I find to be a really important voice, shaping the appropriate attitude of a beginning student to the contents of the volume, as structural geology is often treated by students as difficult and unfortunately unattractive branch of the geosciences. It is distinctly stated that, for instance, earthquake hazards or issues dealing with constructing buildings, dams, power plants, tunnels, etc. always need to be considered with reference to possible activity of tectonic structures in a given area. Also the relationships with the application side of geosciences, represented by petroleum geology and mining geology, are emphasised. This information is apparently obvious, but not always as clearly stated as in the present tome. In the valuable Chapter 2, entitled "Fundamental concepts...", the authors recollect the most fundamental geological concepts, such as uniformitarianism, the law of superposition and even the law of faunal succession. While such a re-

view of fundamentals is rather atypical of structural geology textbooks, it skilfully sets the structural geology in a general framework of geological sciences. The basics related to sedimentary and igneous structures and unconformities are also presented in detail. Landslide features and primary, non-tectonic salt structures are discussed as examples of gravitational features. The basics and intricacies of geochronological methods, mostly based on radioactive isotopes, as well as stable isotope studies are clearly explained and capably set in the context of structural geology research. Finally, the still increasing role of indirect, geophysical methods in our understanding of tectonic problems is evidenced. Seismic and potential field methods, borehole geophysics, as well as the nature of the related physical phenomena, like magnetism of the Earth are characterised. What should be appreciated, in the introductory part, is that the authors briefly refer also to more general, yet important principles of scientific thinking, namely to the fundamental role of formulating hypotheses.

The second part ("Mechanics: how rocks deform") deals with widely understood stress and strain issues, i.e., rock deformation and its causes, as well as with the rheology of rocks. These rather difficult concepts are presented very clearly and vividly (e.g., explanation of the difference between force and stress), which is a substantial advantage of this section in terms of introductory textbook features. The definitions are very well formulated and properly explained. The theoretical issues are presented in a succinct, not too wordy, way. Instead, they are developed into more practical continuations referring to geological reality (e.g., in Chapter 6, where major strain measurement methods are explained by examples). Still, all the main terms and concepts, which are to be expected in this part, are included and appropriately presented. The presentation of deformation mechanisms behind the formation of microtectonic features is also included, as the concluding chapter, in the rather theoretical Part 2 of the book.

Parts 3 and 4 are devoted to two main groups of tectonic features, namely brittle and ductile structures, respectively. The first of these is called "Fractures and faults", while the second part is entitled "Folds and folding". There is some kind of inconsequence in the case of the first title, as the authors state in the book (which I fully support), that faults are a kind of fractures. Both units comprehensively cover their subjects, by presenting in detail different types of structures and by thoroughly explaining the mechanisms behind their generation. Perhaps, the content related to classifications of faults

could have been slightly expanded, but in case of folds the classification issues are fully satisfactory. Separate, large chapters describe three main categories of faults: thrust, strike-slip and normal. Such a subdivision harmoniously arranges our knowledge of these groups of structures and accurately reflects their importance. The box depicting fault rocks, now in Part 2, would better have been placed in Part 3. In the case of folds (Part 4), special attention should be paid to the valuable chapter "Complex folding", devoted to fold superposition and formation of sheath folds. Parts 3 and 4 both have abundant illustrations, including numerous photographs – these are critical to the efficient transfer of knowledge on tectonic structures. Both parts contain insightful chapters focused on the mechanics of the processes: faulting and folding, respectively.

The last unit of the volume (Part 5), dealing with factual issues, is entitled "Fabrics and structural analysis", which may be perceived as not fully congruent. It deals with a quite large scope of topics that are not always well connected. At the start of Part 5, planar and linear tectonic structures are discussed in two separate chapters. Quite surprisingly, boudinage, a basic and common type of tectonic structures, is relatively marginally discussed in the chapter dealing with linear structures. Following chapters on foliations and lineations of different type, the next one discusses deformational features of plutonic bodies. In my opinion, this is one of the most valuable pieces of the book, being an extraordinary review of our knowledge on interrelationships between magmatism and tectonics. Finally, Part 5 is concluded by a chapter on general issues of structural analysis. It refers to a wide range of scales and methods, from an orogenic belt or even a continent size through geological mapping and cross-section interpretation of a local area, mesoscopic analysis at the scale of an outcrop to microstructural (here: microtextural) studies conducted in thin sections. As the first paragraph of this chapter suggests, the integration of data from different scales of observation and their common interpretation is, whenever possible, the best way to attain plausible and complete results of structural research. Worth mentioning is also a separate subunit of this chapter; this is focused on the structural analysis of salt bodies.

Unit 6 includes four appendices, three of which are sets of valuable instructions for practical activity related to structural geology. The first one is related to structural measurements in the field, using a geological compass. Appendix 2 clearly explains the basics of stereographic projection techniques, while the third focuses on drawing cross-sections from a structural geologist perspective, and special

attention to their geometric accuracy. The last Appendix 4 includes data intended for use in connection to one of the problems described in the book (seemingly based on personal research by one of the authors, R.D Hatcher, in South Carolina) or simply as a data set for exercises.

I had the chance to examine only the electronic online version of this book. The hyperlinks located there enable to move smoothly to references cited and to figures and glossary definitions. Unfortunately, not all website links were active while reading (e.g. <http://www.ymp.gov/>, at p. 5 was disfunctional). What is surprising is that not all the important definitions throughout the main body of the book are linked to the glossary which concludes the volume (e.g., lithostatic pressure or homogeneous strain lack such links). Also the quality of some illustrations (in terms of size and resolution) in the online version of the volume could have been better, such as the photograph on page 42, which, when zooming in, lose sharpness and/or pixels become apparent.

Summing up, the thorough, detailed and precise descriptions and explanations of specific processes, phenomena and concepts of structural geology, which are repeatedly observed in the present tome, are to be highly appreciated. The text is efficiently supplemented by accurately selected, abundant figures, including numerous, well-drawn sketches and astounding photographs. This makes the volume a full-bodied textbook that offers any student a deep insight into the wide-ranging material pre-

sented and a genuine understanding. The well-constructed, richly illustrated and very content-rich textbook undoubtedly deserves to be widely used by students and practitioners of structural geology. Especially recommended to undergraduate students, this tome can also be seen as a useful source of knowledge and reference for more advanced readers, including graduates and scientific workers (especially academic teachers), as well as geologists outside academia. This ravishingly rich book bears testimony to the enormous, wide expertise and well-ordered knowledge of its authors. This tome may frequently constitute a demanding read; yet it guarantees a substantial increase in competences to anybody who will study it thoroughly.

Evaluating the third edition of "Structural geology: principles, concepts and problems", the "inner" values of the tome (related to its content) are complemented by external, editorial features of the publication. There is a metaphoric saying "You can't tell a book by its cover". The impressive front cover of the reviewed volume, with a beautiful aerial photograph of a large-scale tectonic structure shaping the landscape, attracts potential readers, who, in my opinion, may find the contents fully adequate in terms of quality and doing justice to the decorative pictorial invitation.

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