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Book review

***3-D Structural Geology—A Practical Guide to Surface and Subsurface Map Interpretation*. Groshong, R.H., Springer-Verlag, 1999, ISBN 3-540-65422-4, 324 pp. List Price: Hardcover US $80**

Three-dimensional structural geology is a broad topic, one that varies in scale from porphyroclasts to entire orogens. This book is aimed at an intermediate scale that includes map-scale, or oilfield-scale features. As the title suggests it is a practical guide, reflecting a need to quantify the geometry of structures based on incomplete datasets and assess uncertainty in interpretations.

This text seems written largely for the professional user. Although I enjoyed the author's succinct writing style, a reader with no prior knowledge of structural geology might miss any number of key points that flash by in only a sentence or two. Rather, the material is best suited for a somewhat more experienced user, say an entry-level geologist at an oil company or geotechnical firm. Here the book clearly reaches its intended audience, for it offers up a comprehensive set of methods, as well as a few tricks of the trade, that are indeed useful. A savvy undergraduate might use the book as a reference text, for there are some sections that offer clearer explanations of mapping or cross-section construction than many commonly used structure texts and lab workbooks. The reference list is similar to the text; relatively complete but not exhaustive in scope.

Other strong points of the book include its use of crisp perspective figures to illustrate complex geometric relationships where the selection of a particular viewpoint is critical to understanding a concept. The problem sets at the end of each chapter are also a great resource for the motivated reader who intends to immediately apply the methods presented in the previous chapter. I thought one of the best parts of the book was its consistent consideration of uncertainty; this is rare in any text and is important for assessing the economic implications of petroleum or mineral exploration where real dollars are on the line.

The text was organized into eight chapters, which generally moved from relatively simple concepts to more complex ones. Each section had brief introductory paragraphs that listed the methods presented and linked them to related problems in other portions of the book. The *Introduction* briefly touched on aspects of map units, geologic contacts and structural styles. An important part of this chapter was the author's treatment of mechanical stratigraphy-required reading for anyone working on structures developed in layered sedimentary sequences. The text then proceeded into simple classification of folds and faults and a clear and succinct section on slip vs. separation. The discussion on the use of dipmeter data was really useful; the brief introduction to the use of seismic reflection profiles perhaps less so. Much of this book presents techniques based on datasets comprised of well data; if the reader is looking for a solid text based on interpreting seismic reflection datasets, they are better off looking somewhere else.

*Elements of Map-Scale Structure* is similar to many lab workbooks that introduce the beginning student to the orientation of lines and planes in space, three point problems, structure contours and isopach maps. The use of tangent diagrams was also presented and seemed like a useful alternative to many stereographic techniques. I thought the addition of Excel spreadsheet formulas for problems involving a large number of data points was a particularly nice touch, as well as hints for using commercial drafting programs commonly used by geoscientists.

*Location, Attitude, and Thickness* focused on structure contours and appeared as one of the best primers on this topic I've encountered as an academic, certainly as good or better than any other undergraduate textbook or set of lab exercises. A subsequent section discussed TINs and gridding techniques, an increasingly important tool for users who have access to large digital datasets. Again, uncertainty raised its ugly head and was properly beaten down with a discussion of digital contouring artifacts and methods for recognizing errors in mapping across dense data grids. The last part of the chapter brought the treatments of single layers to a higher level by integrating multiple horizons in 3-D volumes, and by outlining the importance of contour compatibility across multiple structural levels.

*Structure Contouring–Fold Geometry* began with


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methods of defining fold geometry from bedding attitudes using standard stereographic methods, and not-so-standard methods using tangent diagrams. The best part of this chapter is the section on projection; this is rarely covered in other structure texts, yet it is a common technique where outcrop data are available. I would have used this chapter for an undergraduate mapping course I taught along the Colorado Front Range last fall. As things stood, I ended up making up my own instruction sheet for the class exercise, which was no match for the author's detailed and well-illustrated consideration of the same topic. The last part of the chapter was focused on statistical curvature analysis techniques, or SCAT. I found this section intriguing, but its use is limited by the availability of modern dipmeter logs. As in prior sections, the text revealed its utility for structural geologists working in the petroleum industry where datasets were comprised of electric logs. My one criticism of this chapter was its lack of consideration of modern fault-related fold theory, in spite of the recognized utility of numerous restoration techniques and concepts involving stratigraphic growth architecture.

*Faults and Unconformities* began with a section on seismic interpretation in faulted regions and methods of assessing fault separation in wellbores. SCAT was again used as a method to identify faults and drag folds. As someone who works on subtle surface folds in active orogens, I appreciated the section on cumulative dip vs. depth plots, which allows one to identify accurately the location of axial surfaces. Again this is limited to the availability of dipmeter logs. The next section included an introduction on displacement transfer in dip-slip faults with further discussion on fault scaling. The chapter ended with a simple treatment of growth in extensional fault systems.

*Mapping faults and fault surfaces* introduced common-sense concepts for mapping fault surfaces that an experienced user would take for granted, however these are very useful for the inexperienced interpreter. The best part of the chapter revolved around validation of offset horizons by discussing a series of checks against initial interpretations. Displacement transfer structures in normal faults were used to illustrate the concept of branch and tip lines. I was particularly interested in the author's method for defining the relative timing of cross-cutting normal faults, which I modified to test maps of extensional fault scarps in the Afar Depression to see if the method really worked (it did).

*Cross-section construction* presented standard methods for constructing cross-sections, standard curriculum in an undergraduate structure course. This included choosing an appropriate location for the section, transferring data and projection. The related section on applying the kink-method to section construction was particularly well written, better than other available texts or workbooks. The last section included methods for constructing hanging wall and footwall cutoff maps, again aimed at the central theme of validating structure contour maps.

*Restoration and Validation* included a brief introduction to several restoration techniques and the assumptions used in each. Although this has utility for a petroleum geologist as an initial primer, much more powerful software packages would presumably be used to actually restore sections in a corporate environment.

In summary this book should appeal to petroleum and geotechnical professionals, and the advanced student who wishes to map geologic structures at map and oilfield scales. The book is clearly biased toward oil and gas exploitation where datasets are comprised of numerous oil wells, particularly those with modern dipmeter logs. Many of the methods presented in the text will have more far-reaching utility given minor modification of the input data by the user. As I read the text, I thought of several new ways to characterize active fault-related folds in my own research where data types are more limited to large-scale geologic maps and shallow boreholes. In short, this book will have a welcome place in my office bookshelves.

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