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BOOK REVIEWS

Teaching geological maps

Maltman, A. 1990. *Geological Maps: An Introduction.* Open University Press, Milton Keynes. 208 pp. Price £15.95 (softback; ISBN 0-335-15215-5).

This book has clearly been written by a geology lecturer who has experienced the difficulties of teaching Earth Science students to read geological maps. The extensive use of illustrations, particularly block diagrams, enables both the novice and the more advanced student to visualize the geological features described in the book. This book is not only suitable for geology students, but could also be a useful revision and reference text for geology teachers.

Throughout the book the author has given careful thought to ways of helping the student transfer the mental picture of a two-dimensional map to an understanding of what is happening below the surface. The technique of drawing the surface geology on a plane slightly raised above an underlying block diagram is particularly effective.

The examples selected are straightforward, and the majority have been selected from U.K. geological maps, which means that they can be easily accessed by both students and teachers. The descriptions of features such as folds and faults avoid the temptation to go into detail; this enables the reader to concentrate on the map interpretation of these structures.

The order and grouping of the different topics can be difficult in this particular subject area; the author has been aware of this and has taken the student step by step through the kaleidoscope of information which is presented by a geological map. The first six chapters deal with basic but essential topics such as map scales, map availability, outcrop widths, structure contour techniques, geological cross-sections and the recognition of simple outcrop patterns. In each of these chapters there is a section of maps and questions related to the material covered. These questions help to consolidate the reader's understanding of the topic covered. The chapter on cross-sections, fence diagrams and block diagrams deals with a difficult subject area in a series of logical and clearly explained steps.

The middle of the book consists of eight plates selected from B.G.S. sheets and maps published by overseas surveys. The text guides the reader through the different geological features by means of a series of questions, which enable the student to focus on a particular geological structure and not to be overawed by the complexity of the data present. In addition to showing geological features on 'real maps', this makes the student aware of the wealth of geological information available on U.K. and overseas maps.

The second half of the book has nine chapters dealing with the recognition and description of geological features such as unconformities, faults, folds, igneous activity and mineralization. The last three chapters provide interesting and useful information on the production of maps, contributions made by eminent geologists, and new trends. The chapters are again well illustrated with extensive use of maps, block diagrams and excellent annotated diagrams. The two chapters on faulting were particularly good.

The chapter on geological history deals with a subject which can be difficult to teach. The understanding of geological history, compared with folding, etc., is more dependent on a general geological background in which the student needs some knowledge of subjects such as conditions of sedimentation and stratigraphy. This is also an area where experienced geologists emphasize different aspects; the author is clearly aware of this when he refers to the "problem of preferred interpretation". The maps and diagrams in this chapter do not guide the reader to the same extent as in the other topic areas. The geological history of the Shrewsbury sheet could provide problems to the non-supervised student due to the number of 'ifs' and 'buts' involved. Even with the aid of the cross-section, the map of the Baraboo area could prove challenging.

In conclusion, I find that this book provides a comprehensive and clear treatment of geological maps. My only disappointment was that the author had not taken the opportunity of providing a 'type' description of one of the maps available. This would have given students a guide to the technique of writing a full report of a geological map. It is also debatable whether there should have been some discussion of superficial deposits; these are often present on geological maps and are of interest to both the geologist and the geographer.

In the present educational climate of modular degrees and very large undergraduate classes, this book provides an excellent self-learning teaching package. It also provides a good guide to staff involved in constructing modules covering the teaching of geological maps. At £15.95 for the paperback this book is very good value.

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Teaching structures through maps

Powell, D. 1992. *Interpretation of Geological Structures Through Maps.* Longman, London, U.K. Price £13.99.

This is certainly one of the clearest and most useful books on mapwork which I have seen in recent years, and is likely to become a standard text in mapwork and structural courses at University level. It concentrates on structural aspects of map interpretation, and unlike recent books by Maltman (1990) (see preceding review) and Butler & Bell (1988), does not stress the interpretation of published geological maps. Instead, Derek Powell presents a set of clearly illustrated worked examples and problem maps, which introduce all the main types of geological structure. It is not simply an introductory text, and contains examples at the end which would test many academics, let alone final year students. A particularly welcome feature is that all the problems are matched by an exhaustive worked answer at the end of the book, so the student is never left wondering just what the author is getting at!

For many students, three dimensional thinking and map interpretation is the most difficult skill they have to learn in a geology degree. I'm sure many colleagues will have experienced the difficulty of finding or designing a set of map exercises which are at once clear and simple to understand, and at the same time can be related to real geological maps. The first criterion can be met by traditional books of strike line exercises such as that by Bennison, but the exclusive use of straight parallel strike lines tends to hinder more advanced interpretation and work on real maps. On the other hand, structure contours are widely used in industry, and are the only way to represent on a map the topology of complexly folded surfaces. I agree with Derek Powell that teaching of structure contours is an essential part of any serious map course. In his 1990 book, Alex Maltman pioneered an approach in which the ruler is never used to draw structure contours, and real field examples are used wherever possible. Derek Powell has a similar, but less extreme philosophy; there are relatively few examples which use straight structure contours, but on the other hand the problem maps are precisely drafted, and avoid the 'noise' which tends to frustrate students in their understanding of published geological maps.

At first sight the organization of the book is rather idiosyncratic. After a brief introduction, the reader is introduced to all sorts of geological surfaces through a series of nicely drawn block diagrams. These surfaces include unconformities, and both extensional and compressional faults, with discussion of geological histories. This may prove rather indigestible to students with no previous geological experience, but does, on the other hand, give a good feel for the scope of the subject. Chapter 3 gets down to business with a well illustrated introduction to structure contours on both planar and curviplanar surfaces, strike, dip and apparent dip, and drawing a simple cross-section. The tone of the book is set by the very first exercise, which

includes two unconformities! Other exercises in this chapter include constructing an outcrop pattern, a folded surface, and drawing curvilinear structure contours. The beauty of these exercises lies in their size and simplicity. Having drawn one surface, students are not expected to add a further 10 parallel boundaries to their cross-section, and each map is only 7–8 cm square. I have tried some of these out on Leeds first-year students, and they completed them rapidly, spending their time on the substance of the problem rather than endless repetition of the same tasks. Like all the exercises in the book, the worked answers are painstaking, with several diagrams showing the stages by which the problem is solved. Alternative ways of drawing structure contours are explored and rejected, and any student with the patience to study the worked answers in detail will learn a great deal.

Chapter 4 deals with outcrop shapes, true and apparent thickness, and fold structures, including overturned limbs. Again, the pace at which new concepts are introduced is rapid, and the exercises will take the average student several hours. The next two chapters deal with linear structures, including lines of intersection, and with three-point problems. These exercises are necessarily rather artificial, relying on straight strike lines. If time is limited, some may wish to skip these chapters, and the next one on isopachytes, moving straight on to faults.

The calculation of movement across faults from displaced linear markers is dealt with in Chapter 8, before fault classification in Chapter 9. Although I can appreciate the philosophy behind this approach, I think the quantitative analysis of fault slip in rather artificial circumstances is overemphasized, particularly since the much more common situation of displaced fold axes is not dealt with until Chapter 13. There is a danger that students come to see map work in terms of precise geometrical constructions, and then become frustrated when these constructions don't work on real maps, and the answers have to be fudged or estimated. This is where Powell's approach begins to differ from that of Maltman (1990), who tries to get students doing simple calculations of fold plunge, fault separation etc on undoctored field examples. I have found some of Maltman's examples frustratingly unconstrained, but that is the real world! Having said that, Powell includes in these chapters some particularly clear illustrations of linked fault systems, and problem maps on simple thrust faults and more complex linked fault systems which are simply not available elsewhere.

Chapters 10–12 deal with folds, including structure contour patterns associated with plunging and non-cylindrical folds, fold profiles and associated structures such as cleavage. Many of these topics are conventionally dealt with in structural geology courses rather than map courses, and numerous examples exist in more conventional structural texts. Nevertheless, teachers of structural geology will find some novel new problem maps, and the worked answers make these an extremely valuable resource. A clear explanation of how fault types can be estimated by their effects on pre-existing folds is contained in Chapter 13, with some tricks in the examples to catch the unwary!

The final chapter consists of eight problem maps. These are all difficult, and have been designed by the author to combine many of the elements of mapwork. Examples include a linked thrust system which can be restored, a set of listric syn-sedimentary faults linked by transfer faults, folded thrusts, recumbent folds, and complex stratigraphic relationships. A variety of sources of data are used, and in some cases considerable inference must be made about topography. Any student capable of completing all these exercises without reference to the answers would have an exceptional feel for structural mapwork. The answers are exceptionally detailed, running to several pages and up to 11 diagrams each. The one major type of structure which is omitted is a complex strike-slip fault with flower structures, and indeed strike-slip faulting is not given the same attention as thrust and normal faulting anywhere in the book. Strike-slip fault exercises are difficult to devise, and I'm sure many would welcome their inclusion in a future edition.

All in all, I can thoroughly recommend this book, both as a do-it-yourself workbook for students at all levels, and as a source of ideas for hard-pressed lecturers. Both I and my colleagues have tested some of the exercises on Leeds students, and have found them user-friendly. At £13.99, the book is not beyond the reach of most pockets, particularly since it covers more than 1 year's work in most departments. It must be remembered however that the book is very structural in its approach, and graduates onto really quite difficult examples, which may be beyond some students. It is not a substitute for work on real, coloured geological maps at various scales, which students often find difficult even when structural geometries are relatively simple. As a text on appreciating three-dimensional geometries from maps, however, it is unequalled, and Derek Powell is greatly to be congratulated in finding a real niche in a crowded market.

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Cutting through Europe

Blundell, D., Freeman, R. and Müller, S. (editors) 1992. *A Continent Revealed: The European Geotraverse.* Cambridge University Press, Cambridge, U.K. Price £15.95 (paperback); £35.00 (boxed set).

This publication summarizes the results from a series of geophysical experiments and data compilations carried out over about a 10 year period along a corridor 200–300 km wide running 4600 km from northern Scandinavia to Tunisia. These efforts were co-ordinated and planned under an umbrella project known as the European Geotraverse (EGT), which involved scientists and research council funding from all over western Europe. The aim of this book was to condense the essentials of the numerous publications in the professional literature resulting from this project into a series of short summary chapters with accompanying maps.

There are many good things to say about this publication. It is beautifully produced. The figures and maps are clearly drawn in the same style throughout. The maps (of tectonic units, gravity, heat flow, magnetics, Moho depth and earthquake focal mechanisms) are in colour, are easy to look at and uncluttered. The production quality of the whole package is very high indeed; it is data presentation at its best. The accompanying CD-ROM, containing much of the data used to compile the summary maps, is an excellent innovation, on which the authors and publishers are to be congratulated. For once, it is difficult to squeal at the price, which is most reasonable, given the quantity and quality of the maps.

The book itself is organized into seven chapters. The meat is in the central three chapters, one each on the seismic structure of the lithosphere, physical properties of the lithosphere, and recent activity (earthquakes, volcanism and vertical motions). Two short preceding chapters outline the history of the EGT project and the geological setting of western Europe. The final two chapters summarize the tectonic evolution of Europe and speculate on what wider significance this may have for the processes that operate in geodynamics. The whole book is astonishingly coherent. It really does read as if it were written by one author (in fact 15 contributed), and as if all the projects were carried out by a group of people who met regularly in a pub (perhaps wine bar, or bistro) to decide what to do next. It is quite an achievement to produce a multi-author book with such an internal coherence, and the book is much easier and more enjoyable to read as a result. Well done the editors.

Most people will be interested in the three data chapters that make up the core of the book. The chapter on seismic reflection and refraction experiments in particular summarizes a vast amount of data and analysis. Such a summary is certainly useful, and would be difficult to extract from the journal publications, particularly as this chapter helpfully puts each line segment in the context of the segment adjacent to it to the north or the south. However, there is little attempt to be critical of the data quality or interpretation in these chapters, nor, realistically, was there space for this in such a summary volume. Those interested in looking deeper will have to nerve themselves to plunge back into the journal literature. The necessary references are all given in this text. Certainly some interpretations, particularly of structure, are controversial and may not stand the test of time, and contoured or summary maps give an apparent uniformity to data that may be sparse or variable in quality. But it was never the function of this book to defend points of view. What it does do, and effectively, is allow one to compare different data sets in different places quickly.

It is obvious that the European Geotraverse project has been effective in promoting collaboration and goodwill between Europeans. But what of its scientific achievements? Are the huge resources that such collaborative programs tie up at the expense of smaller individual projects wisely spent? It is the assertion of the editors, announced in the Preface, that "the whole is greater than the sum of its individual parts". On this assertion hangs the justification for 'big science'. There is no doubt that some of the individual parts of the EGT are impressive, and will contribute to our general armoury of insights into the way continents evolve and deform. It is a significant observation, for example, that parts of Finland, which are virtually at sea level, have a crustal thickness of 60 km. The probability is that the lithosphere is 200 km thick under that region, and wondering why some Archean shields are like this will occupy many a geodynamicist whose interests are not confined to Europe. Do other EGT individual parts produce similarly general insights? I think most do not. The best