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BOOK REVIEWS

Structures are Fun

Davis, G. H. 1984. *Structural Geology of Rocks and Regions*. John Wiley & Sons, New York. Price £13.95.

This 1984 book is a latecomer for review. It is a comprehensive text-book of structural geology for non-specialists, and I presume its prime target is the university/college student in North America. By now, its success (or not) as an American course book will be decided. My own interest in reviewing the book is the insight into George H. Davis's view of structural geology.

Structural Geology of Rocks and Regions has 492 pages of large size, generously illustrated with photographs, diagrams and cartoons. It is divided into two main parts: I *Fundamentals* (Chapters 1–6), and II *Structures* (Chapters 7–12). This division allows principles, techniques and concepts to be treated first, and particular structures and associations to be dealt with later.

Chapter 1, Nature of Structural Geology, introduces the subject as the architecture of the Earth. Concepts of Detailed Structural Analysis such as distortion, slip, etc., are introduced in Chapter 2, and Davis employs some interesting 'models' such as air balloons, garden gates and pizzas to encourage readers to visualise these concepts. Descriptive Analysis (Chapter 3) provides a rigorous introduction to geological mapping techniques, and stereographic projection of data. In Chapter 4, Kinematic Analysis, displacements and strain are treated in greater detail. Chapter 5, Dynamic Analysis, follows, dealing with stress, rock mechanics, etc. Part I ends with Plate Tectonics (6) which provides some imaginative models to illustrate plate motions.

Part II, *Structures*, considers in sequence (7) Contacts, (8) Primary Structures, (9) Faults, (10) Joints, (11) Folds and (12) Cleavage, Foliation and Lineation. The first two provide a link with mapping techniques, but the last four are the more 'traditional' divisions of structural geology. Chapter 12 also includes passive folding, boudinage, shear zones and refolding in tectonites. Much of the content of these chapters is as expected in a comprehensive text book, but with Davis's personal touches, together with an emphasis on North American 'benchmarks' works. Since the content of Part II is the meat of structural geology, I found myself drawn to reviewing some parts in detail, as I am used to doing for scientific papers. As a result, my comments are specific rather than general. I suspect my principal criticisms have been made by many others, by now, and will be attended to in the next print.

In Chapter 9, faults are treated in sequential sections on thrusts, normal and strike–slip faults. The sections on thrusts and normal faults seem clear enough, but the presentation of strike–slip faulting is confused by introducing conjugate faulting here (p. 298). Conjugate faults are not unique to strike–slip zones, as the author says, but the diagram shows conjugate *normal* faults (Fig. 9.51). My more serious criticism of Fig. 9.51 is that it shows the relationship of conjugate faults to axes of strain, $\lambda_1, \lambda_2, \lambda_3$. The same diagram appears twice later, with axes labelled X, Y, Z in Fig. 9.62, and σ_1/Z, etc., in Fig. 9.64. In all these, but particularly the last, there is the strong message that stress and strain axes are parallel. Surely, one of the most important lesson of structural geology to be conveyed to students is that stress and finite strain axes, in general, are not the same? If Davis is just talking about the small increment of strain associated with faulting, he should not use the labels, X, Y, Z or λ normally used for finite strain. It is seriously misleading to suggest that fault pairs are conjugate to finite strain axes; the more so, that it is made three times in succession.

If this were not confusing enough, on the same page as the first illustration of faults conjugate to strain axes (p. 298), is one (Fig. 9.52) representing an 'initial' strain ellipse (A) with its conjugate fault pair, which is deformed by simple shear to a 'final' strain ellipse (B). I cannot understand this figure, nor an almost identical one (Fig. 10.33) for joints: I can only presume they are wrong, both in the sense of shear shown, and for the orientations of the deformed conjugate planes. Whether through error or intent, these figures convey the message that during simple shear the conjugate angle increases, but the fault pair remain symmetrical in the finite strain ellipse. This cannot be so for simple-shear deformation because finite ellipse axes are not the same material lines as deformed earlier axes. It alarms me to see such confusion about strain in an undergraduate text-book. I hope the errors will be corrected for the next edition.

Other criticisms I have are minor in comparison. I do not understand why Fig. 11.54, illustrating schematic strain in a flexural slip fold, shows ellipses of equal shape but increasing size from hinge to limb, rather than ellipses of increasing axial ratio from zero at the hinge to a maximum on the limbs. This seems a rather poor way of illustrating strain in flexural slip.

I suspect readers will either love or hate the 'happy family' flavour which makes this book more personal than other structural text-books that I know. It was good to be reminded that books represent a huge investment of time and energy, and considerable forebearance of family and friends. Davis uses some unusual methods to illustrate geological processes. I wondered how much novelties like the 'geological' history of a pizza were part of the American way of teaching (in the beer-can mould) or Davis's individual approach. I found them refreshingly different and thought-provoking, but others might be irritated by these seemingly frivolous anecdotes.

Of all Davis's models and cartoons, one is so hilarious it deserves special mention. It is either a huge leg-pull, or an example of student aquiescence which I am certain we could not achieve from Manchester students! There, on p. 52, is a "human ladder" comprising three or four students stacked one above the other in the direction of dip, on a steep fault plane. This must surely be the most bizarre means of illustrating dip; why was the face of the poor soul at the bottom obscured from view?

I think this book is well-suited to the student market. It is very good value for money, considering its size and the number of lovely photographs. Whether there is too much for non-specialist structural geologists is a matter of opinion, but the emphasis on field geology and mapping techniques will be important for future survey and exploration geologists. They may be muddled on stress and strain, but they will surely have absorbed Davis's infectious enthusiasm for geological structures.

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Himalayan Thrusts

Saklani, P. S. (Editor) 1986. *Himalyan Thrusts and Associated Rocks*. Today & Tomorrow's Publishers, New Delhi. 290 pp. Price: $65.

It can well be argued that thrusting was the principal structural mechanism responsible for the formation of the Himalayas. Thrusting controlled the obduction of ophiolites onto the continental margin in pre-collisional times, it took place during the collision of India and Eurasia causing repetition of rock units within the suture zone, it enabled the Indian plate to underthrust northwards, and it continued during post-collision times when delamination of the northern margin of India took place by major southward thrusting towards the continental foreland and finally it caused northward backthrusting. This book is concerned with the foreland-directed post-collisional thrusts.

One difficulty in following Himalayan literature is that much is published in a myriad of journals, many of which have limited circulation. Therefore edited books provide a useful service by bringing together groups of papers with a common theme. This is the fourth such book on Himalayan geology to be edited by Professor Saklani. It contains 15 papers, of which only three are on thrust tectonics, seven are concerned with an analysis of associated folds and with the petrography of rocks such as mylonites, gneisses, schists and phyllites, three deal with general Himalayan tectonic models, one describes Quaternary to Recent faults and another an experimental study of listric faults. Thus this is a very mixed bag. Six papers describe structures and rocks from Garhwal, two from Nepal, two from Kumaun and one from Himachal Pradesh. The main thrusts described are the Main Central Thrusts, the Vaikrita, Jutogah, Krol, Berinag, North Almora, Singuni and Main Boundary Thrust. There are only two papers which treat thrust tectonics in terms of modern concepts of ramps, flats and the piggy-back model (and these are the two most original contributions). P. S. Saklani and V. K. Bahuguna interpret the imbricate thrust stack of the Garhwal Himalayas as a duplex system which was shortened by up to 10.9 km or 49%, and M. R. W. Johnson analyses the structural evolution of the Kumaun Lesser Himalayas in terms of the piggy-back stacking of thrust sheets folded above ramps on the sub-surface sole or Main Frontal Thrust.

Other papers are as follows: strain analysis of folds of the North Almora thrust zone is by D. B. Yedekar and K. B. Powar, of the Krol syncline by P. S. Saklani and Satendra, and of the Chamba syncline by A. M. Bhola and Y. Sharma. N. S. Virdi has an interesting paper which describes the lithostratigraphy, fold structure and inverted metamorphic isograds in the Central Crystallines above the Main Central Thrust in the Joshimath–Badrinath section in the Garhwal region. P. S. Saklani and D. C. Nainwal produce a petrological and geochemical study of the problem of the migmatisation of granitic gneisses and migmatites in the Garhwal Central Crystallines; this partial melting was a response to deep burial caused by the thrust stacking. A. K. Bahattacharya and P. S. Saklani describe quartzites, metabasics and cataclasites with pitchblende/uraninite mineralization in the vicinity of the Main Central Thrust, and the petrofabrics and deformational history of mylonites associated with the Singini thrust in the Lesser Himalaya are analysed by R. K. Prasad; these papers deal with high level effects of the thrusting. In central Nepal post-metamorphic movements illustrated by lineations, joints and slickensides are recorded by W. Bogacz and J. Krokowski, who in another paper analyze the well-known mega-scale simple shear motions that took place during the northward indentation of India. From an experimental study A. K. Dubey and M. I. Bhat conclude that basement listric faults had a considerable influence on the location of many Himalayan structures, and in a similar vein, D. P. Dhoudial concludes that differences in the nature of the Precambrian basement influenced the evolution of the Himalayan belt. Seismicity indicates that crustal-scale thrusting is still taking place in the mountain range and field evidence indicates displacements have taken place along Quaternary to Recent faults in regions such as Nepal (T. Nakata). Rather out-of-place in this volume, J. Jaros gives a simplistic overview of the pre-Himalayan stages of tectonic evolution via island arcs, Andean-type margins and Zagros-type collision.

It is a pity this book did not include research results on the major thrusts that dominate the Northwestern Himalayas in Pakistan and the Zanskar range, the thrusts in the suture zone along the mountain belt or the thrusts associated with ophiolites such as Spongtang. Also little is included on the thrusts so well developed in Nepal, and there is nothing on the thrusts of southern Xizang (Tibet) or the eastern Himalayas. The papers seem like a result of a symposium focused on the central Indian Himalayas. This may be fine in itself, but it does raise the suggestion that it would be useful to have a comprehensive volume on Himalayan thrust tectonics.

Indian publishers have an unfortunate tendency to double or triple the price of a book for foreign sales. The Indian price of 395 rupees for this book is reasonable, but the foreign price of $65 is not.

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Journal for Southeast Asia

Journal of Southeast Asian Earth Sciences. Pergamon Journals Ltd, Oxford. Price: DM 260.00 per annum.

The new *Journal of Southeast Asian Earth Sciences* gets off to a promising start with its first issue. Of the four papers in it, two deal with regional tectonics (of the Philippines and East Indonesia), one with palaeomagnetic data from Thailand and the tectonic implications and one with a mineral resource assessment of Indonesia. All four are interesting and useful.

The aim of the Journal is "to serve and to assist in the promotion of the geoscientific development in Southeast Asia". It is an international interdisciplinary journal, to be published quarterly. The region primarily covered includes about a dozen countries, between India, China and Japan to the north and Australia to the south. This region is of outstanding interest to earth scientists, expecially for its tectonics and structures and because of its important oil and mineral resources. Until now much of the work done there has often been buried in local journals and reports which are not easily accessible, besides being written in a variety of languages, so there is plainly the need for a unifying journal which disregards political boundaries and enables both workers on the spot and the many interested outsiders to know about significant work being done in the whole region.

Problems for a regional journal are to encourage earth scientists working, often under difficulties, in the region, yet avoid letting the journal become a vehicle for ego trips for mediocrities; and to keep an international readership aware of what is being done, not just in Universities but also in Geological Surveys and by mining and oil companies, some of whom prefer to publish—or not publish—their own reports.

The Journal meets a real need; it has made a good start. It deserves support.

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