to produce a series of publications on circum-Caribbean geology; this is the second, following a 1991 volume (G. S. A. Special Paper 262) on Hispaniola by Mann, Granville Draper, and John Lewis. Finally, Mann lists and briefly discusses four "unresolved geologic controversies in Central America". These are: (1) Did the Caribbean form in its present position or did it move in from the Pacific as an island-arc system or systems? (2) Is the basement of Costa Rica and Panama formed from accreted fragments of partially subducted Pacific crust, from subduction zones forming in place, or from uplifted pieces of Caribbean oceanic plateau? (3) Is the Caribbean a single plate or is it a set of microplates shifting as they move between the larger North and South American plates? (4) What forms the features near the end of the Central American arc in Panama and Costa Rica: the pattern of volcanism and seismicity, and the changes in topography and bathymetry? This volume presents arguments for different views of several of these problems, generally favoring the more dynamic alternatives but in several cases accepting two views as partially correct, both contributing to a general solution. I might add a fifth problem, slightly less general: Is the border between the Caribbean and Nazca plate a transform or a subduction margin? Evidence on both sides is presented, but I would favor a transform motion.

The book is divided into three parts of 4, 8 and 5 papers each. The first four papers describe and discuss geochemical and paleomagnetic findings in Costa Rica and Panama, describing tectonic blocks, terranes, and the subduction zone angle. Plate history of the region is described, as are the problems of the southern end of the Middle America subduction zone, possible transform movement along southern Panama (J. de Boer finds no paleomagnetic evidence for transform motion), and the northern end of the Nazca subduction zone along northern South America.

The remaining two sections emphasize modern tectonics, bathymetry, and seismicity. James Kellogg and others present GPS data showing transform motion along southern Panama, and suggests that the isthmus connection between the oceans closed 6 to 12 my ago. They present a gravity map of southern Central America. S-shaped bending of the isthmus is not supported by GPS data. Graham Westbrook and his group give multichannel seismic reflection profiles with considerable evidence of left-lateral movement along the plate boundary. Mann's group present detailed structural data from the deformed belts of southwestern Panama, describing oblique subduction, collision, and oroclinal bending of the isthmus. They seem to favor subduction over transform motion for southwest Panama plate margin, but leave open the possibility of both processes ocurring. They attempt, fairly successfully, to correlate stratigraphy between the onshore and offshore rock sequences. Finally, two papers by the Eli Silver group describe the North Panama Deformed Belt, both off- and onshore, with seismic and structural profiles, showing nice details of thrusting. They quote Keller (1989) for the closing of the Panama–Caribbean seaway at 1.8 m.y., rather than the earlier 6–12 m.y. date that Kellogg uses.

The final part of the book, 5 papers, is mostly on the effects of subduction of the Cocos Ridge beneath Costa Rica. Radim Kolarsky and the Paul Mann group interpret seismic profiles, onshore data, and detailed structures to give a picture of volcanism, uplift, subsidence, and deformation related to subduction of the Cocos Ridge bulge on the descending lithosphere. Collins and others give paleontological backing for the emergence timetable, and R. Von Huene and others describe slumping, submarine faulting, and other bathymetric features near the Costa Rican Pacific coast, related to the same subduction of the Cocos Ridge and adjacent seafloor. M. Protti and others describe seismicity, the configuration of the subducting plate, and the distribution of volcanism, and F. Tajima and others describe two large earthquakes, one on the subduction zone and the other on the Caribbean coast in a "back-thrusting" zone above the subduction zone. They briefly discuss recurrence times for the two regions: 40 years for the subduction zone earthquake and 5–28 times longer for the intraplate event.

I found the volume useful for Caribbean studies, especially emphasizing tectonic and plate history aspects. It is well illustrated, clearly written, and well-organized. It is, however, expensive at $100, as most special papers and memoirs are. I hope that research centers and specialists in western Caribbean geology would get this volume. It could serve as a text for a seminar on Central American plate tectonics or geology, but probably not for any more general course. Basic data from paleomagnetism, geochemistry, structural analysis, paleontology, and seismicity can be found in several papers, and there are abundant seismic reflection profiles and bathymetric interpretations. All these different specialities are integrated into a well-composed and readable volume.

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Structures are still fun

Davis, G. H. and Reynolds, S. J. 1996. *Structural Geology of Rocks and Regions*. John Wiley and Sons, New York 2nd Edition. Price £21.95 (hardback)

This textbook, first published in 1984, has been substantially expanded and restructured to yield a richly illustrated text of some 776 pages. In the 12 year interval since the first edition several excellent books of similar scope have appeared including Suppe (1985), Twiss and Moores (1992) and Hatcher (1995) and these, taken together with the authoritative volumes by Ramsay and Huber (1983; 1987), provide the current generation of geology students with an impressive choice of undergraduate textbooks. In spite of this stiff opposition the second edition of *Rocks and Regions* will, I predict, become adopted as a course text at a large number institutions around the world.

Part 1 of the book provides the essential theoretical background necessary for the effective discussion of geological structures which takes place in Part 2. Practical issues such as fieldwork procedures are bundled together to form Part 3.

Part 1 consists of four chapters. The first of these, *The Nature of Structural Geology*, defines the scope of the subject and successfully whets the appetite for what is to come. The reader is here introduced to the idea of structural analysis; the initial data collection/mapping phase followed by the building and testing of hypotheses. Here and throughout the book the reader is eased into unfamiliar territory by the use of analogies with the tectonics of pizzas, the shear deformation of garden gates and the preferred orientation of birds. A strong sense of fun pervades the book. The next chapter *Kinematic Analysis* explains and illustrates different aspects of deformation, translation, rotation and strain. The strain ellipse concept is explained well, as is the Mohr circle for strain, though the latter would have been made easier by employing the notion of the pole. Only minor criticisms can be made, e.g. the example of constant area deformation given on page 61 is not ideal since it implies incorrectly that the percentage shortening in the S_3 direction is equal to the percentage extension along S_1.

The fundamentals of stress and rock physics are the subject of the chapter *Dynamic Analysis*. The student lacking a maths/physics background will find the material here accessible and worthwhile. The choice of illustrative material is excellent. Incidentally, the authors clearly attach great significance to Fig 3.47, which appears twice more in later chapters. In the simple calculations of stress it may have been wise to spare the student such a variety of units. A potentially fatal error is made in the calculation of the stress exerted by an ice-skater on page 106. Chapter 4, *Deformation Mechanisms and Microstructures*, has been introduced since the first edition. Clear explanations, superb photographs and professional artwork make this a useful addition to the book.

Part 2 deals systematically with the major classes of structures and opens with a chapter on *Joints and Shear Fractures*. This detailed 70-page review reflects the current emphasis on this topic and provide a up-to-the-minute summary of ideas on geological fractures and fracturing. The appearance of these structures in the field is reconciled with theoretical failure criteria and the results of laboratory testing. The importance of these structures to economic and applied geology is emphasised. *Faults* are dealt with comprehensively in the succeeding section. These are discussed from the perspective of stress (Anderson's theory) and strain (balanced cross-sections). As elsewhere throughout the book, examples are chosen from around the world, but with a natural preference shown for the authors' geological back yard, the western USA. The statement on page 229 that "slickenlines and drag folds should be mutually perpendicular", suggests incorrectly that the hinges of drag folds can be used as indicators of the slip direction. However, I have few other quibbles.

It is remarkable that the chapter entitled *Folds* is one of the shortest in the book. Is this in keeping with lower importance presently attached to these structures relative to faults? This suspicion of mine is supported by the emphasis placed on those folds that form as a consequence of faulting, fault-bend folds and fault propagation folds.

There is a useful section on the terminology and on the geometrical classification of folds. I found the treatment of flexural slip folding a little confusing, perhaps by the attempt to incorporate here aspects of neutral surface folding under the same heading. Relatively little space is devoted to the analysis of multiply folded rocks, though the general concept is mentioned in the chapter that follows; *Cleavage, Foliation and Lineation.* Here again the reader is treated to a large number of photographs and drawings of these structures, illustrating the full range of foliation and lineation in tectonites. These are packed in within the text, with only a few suffering from being too reduced in size. Personally, I am not fond of the chosen system for coding structures produced by multiple deformations. Labelling all folds produced during a second folding event simply as F_2 folds, will make structural analysis difficult since folds of S_1 and of bedding (S_0) will be grouped together. The notation advocated by Bell and Duncan (1978) is more precise.

A newly added chapter on *Shear Zones and Progressive Deformation* does credit to this fine book incorporating the latest ideas on strain distributions, vorticity and sense-of-shear indicators. Tucked away at the end of Part 2 is a chapter describing the basic concepts of *Plate Tectonics* which, perhaps unavoidably, is somewhat detached from the preceding chapters.

Part 3 of this book provides a practical guide to the fieldwork-related topics such as geological mapping, keeping a field notebook, identifying primary structures, taking structural measurements, the construction of cross-sections, the use of the orthographic and stereographic projections, methods of joint analysis, fold analysis and studying shear zones. This section will be particularly welcomed by young students embarking on independent mapping projects.

In summary, I have decided to make *Rocks and Regions* a recommended course text for my second year module. Its humorous style and low price (£22 for hardback) will certainly appeal to the students. Most importantly, this book successfully gets across the idea that observing geological structures and interpreting them can be great fun.

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