R. I. & Cresswell, M. M., 1979), which forms a useful supplement to these volumes.

On a lesser scale the structural geologist will find much of interest, from Quaternary fault tectonics to the nappes of the Tuhua Orogeny and the relationships between deformation and metamorphism in the rocks of the N.Z. Geosyncline, first made famous by F. J. Turner in his classic studies of the Otago Schists (now, the Haast Schist Group). Other structural aspects worth attention are the interrelationships between faulting and sedimentation and the great prevalence of syn-sedimentary slump folding, often on a massive scale, through much of the stratigraphic record.

To update fully a massive compilation such as these volumes must be a daunting task. One can only regret the extent to which the long delay in publication has detracted from what is basically a well constructed and beautifully presented book.

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R. H. Sibson

Predicting Earthquakes

Wyss, M. (editor) 1979. *Earthquake Prediction and Seismicity Patterns.* Contributions to Current Research in Geophysics, No. 8, Birkhauser, Basel. 238 pp. Price: hard-cover sFr68, DM72, US $45.

Bolt, B. (author of introductory passages) 1980. *Earthquakes and Volcanoes.* (Readings from Scientific American), Freeman, San Francisco. 154 pp, 89 colour illustrations, 36 black & white figures. Price: hard-cover £8.90; soft-cover £4.30.

For scientific and socio-economic reasons earthquakes continue to generate interest and concern and a specialist literature of their own. Although the two books under review differ somewhat in their scope and are intended for different readerships they both reflect this interest and concern.

Earthquake Prediction and Seismicity Patterns is one of an increasing number of books about prediction and seismic hazard reduction which have been published in the last five years. Many of these books are principally of value to seismologists and engineers but this one also contains much information of significance to structural geologists.

The book, eighth in the series *Contributions to Current Research in Geophysics*, is a reprint without repagination of Volume 117, Number 6 for 1979 of *Pure and Applied Geophysics*. It arose from an international conference on 'Seismic Gaps and Soon-to-Break Gaps' convened in 1978 by the U.S. Geological Survey. As the editor, Max Wyss, explains in his introductory notes, some of the eleven articles are almost unchanged from those delivered at the conference while others are revised or new. Wyss also emphasises the uncertainties involved in earthquake prediction and he notes that an originally cautious prediction may be sensationalised by the news media, with economically and socially harmful consequences. Because earthquake prediction is a sensitive issue in some parts of the World it was not possible for Wyss to gain the cooperation of a truly international panel of experts, and thus by way of explanation he was obliged to state (p. 1081): "... scientists from a major country have declined to contribute articles to this volume, unless all earthquake predictions for territories other than each author's native country are excluded. Editors cannot possibly suppress scientific information, but they must make sure that such articles are submitted to a rigorous peer review, in which, if possible, scientists from the country involved in the prediction should be included. Also, criticism of articles containing predictions, and editorials pointing out the rudimentary state of our knowledge, should be published along with the article in question".

The first article, by W. R. McCann, S. P. Nishenko, L. R. Sykes and J. Krause on 'Seismic gaps and plate tectonics: seismic potential for major boundaries', presents an overview of the potential for large shallow shocks in the Pacific (excluding New Zealand), South Sandwich, Caribbean and Indonesian regions. The paper, which is 66 pages long and superbly illustrated, deserves to become a classic reference in its field. A large coloured map (Fig. 1) shows the distribution of six categories of seismic potential, sites of successful forecasts, active volcanoes related to subduction, areas of tsunami risk, and a few representative focal mechanisms. Detailed information about specific regions follows in the main body of the paper. In their introductory sections the authors provide the reader who is unacquainted with the literature on seismic gaps with a concise account of the relationships between the characteristics of plate boundaries and the locations and magnitudes of earthquakes. Their Table 1 lists successful forecasts, and a note added in proof lists five $M \geqslant 7$ events which have occurred in predicted gaps since the manuscript was completed in May 1978. So that a global view of seismic gaps is available there is a need for a companion article on the Alpine–Himalayan zone.

In the succeeding paper J. W. Dewey and W. Spence discuss seismic gaps along the Peruvian coast. They recognize two parallel seismic zones; one the interface thrust, the other the coastal plate interior, and they conclude that earthquakes in one zone do not relieve strain in the adjoining one.

K. Mogi discusses 'Two kinds of seismic gaps' in the third article, which refers to Japanese examples.

Although it is the shortest paper in the book, that by T. Garza and C. Lomnitz on 'The Oaxaca gap: a case history' is the most fascinating to read because it is a vivid account of the economic and social impact of the publication of a paper in which Ohtake and his associates predicted that a $M = 7\frac{1}{2} \pm \frac{1}{4}$ earthquake would occur within a seismic gap they had recognized in Mexico. It was their misfortune that their work was misreported in a letter to the President of Mexico written by two non-seismologists, and that following receipt of this letter there were several misleading press releases. The earthquake did not occur on the day prophesied by the letter writers, but the panic created caused property value losses comparable to those anticipated for an actual earthquake. Garza and Lomnitz carry out a statistical reassessment of the original seismic data used to detect the gap and conclude that the evidence is inconclusive. A note added in revision reports that on 29 November 1978 a $M7.5$ earthquake occurred on the Oaxaca coast close to the originally predicted epicentre location. Ironically, it caused little damage and no significant economic disruption.

M. Wyss and R. E. Habermann in a paper on 'Seismic quiescence precursory to a past and a future Kurile Island earthquake' predict that a $M > 8$ earthquake "... will occur along the north Kurile island arc between latitude 45.5°N and 49.2°N at a time between now and 1994". In addition to their excellent account of the seismicity of the Kurile region the authors also provide the reader with some much needed definitions for use in this expanding branch of earth science.

Seismicity variations along the Makran coastal region of Pakistan and Iran are analysed by R. C. Quittmeyer who concludes that a future large earthquake will occur within the western part of the region.

W. H. K. Lee and D. R. Brillinger in a thoughtful review of Chinese earthquake history use 'Point Process Analysis' to detect recurrence intervals. They point out that only China and the Middle East possess recorded histories of 3000 years which may be used for assessments of historical seismicity.

The well-known sequence of post-1938 earthquake epicentres and fault breaks along the North Anatolian fault zone is re-analysed by M. N. Toksöz, A. F. Shakal and A. J. Michael in the eighth article. They detect a two-directional migration of epicentres away from a central region near longitude 39°E, the westward migration at 50 km/yr being five times faster than the eastward. They conclude that there are major seismic gaps at the western and eastern ends of the fault zone. The reproduction of their fig. 1, from an earlier paper by Toksöz and coworkers, is so poor that critical detail is not visible.

The paper by J. Delsemme and A. T. Smith on 'Spectral analysis of earthquake migration in South America' will be of interest to seismologists but its tectonic content is limited.

The penultimate article by Li-Sheng Huang, J. McRaney, Ta-liang Teng and M. Prebish establishes some correlation between twelve $M \geqslant 6$ events on the San Andreas fault system in southern California and rainfall patterns in that semiarid region.

The final paper, by Y. Fujii and K. Makane is on 'Anomalous crustal strain prior to the 1923 Kanto, Japan, earthquake as deduced from analysis of old triangulation data'; it seems somewhat out-of-place in this book.

With the exception of the quality of a few illustrations and a very few typographical errors, the book is well produced and edited. On the basis of the topics discussed in the first eight articles it is worthy of a place on the library shelves of geology departments, but remember it has appeared as Vol. 117, No. 6 of *Pageoph* if your institution subscribes to that periodical.

Whereas *Earthquake Prediction and Seismicity Patterns* is a collection of original research papers *Earthquakes and Volcanoes* is a book intended for earth science students or scientists from other disciplines. In common with other books in the series 'Readings from Scientific American', *Earthquakes and Volcanoes* is a selection of offprints held together by introductory linking passages, in this instance by Bruce Bolt. The book comprises 154 pages, the majority of them containing one or more illustrations (some in colour), and all of them of the customary high standard maintained by *Scientific American*. The clarity of the writing is so uniformly excellent that I can only assume that professional subeditors are involved in the production of each article.

The book contains eleven short articles divided into three sections (dates of original publication in parentheses).

I. *Earthquake Properties*

1. D. M. Boore, 'The motion of the ground in earthquakes' (1977).
2. F. Press, 'Resonant vibrations of the Earth' (1965).
3. F. Press, 'Earthquake prediction' (1975).
4. D. L. Anderson, 'The San Andreas Fault' (1971).

II. *Earthquakes and Earth Structure*

5. P. Molnar and P. Tapponnier, 'The collision between India and Eurasia' (1977).
6. B. A. Bolt, 'The fine structure of the earth's interior' (1973).
7. T. H. Jordan, 'The deep structure of the continents' (1979).

III. *Volcanoes and Heat Flow*

8. H. Williams, 'Volcanoes' (1951).
9. H. N. Pollack and D. S. Chapman, 'The flow of heat from the earth's interior' (1977).
10. M. N. Toksöz, 'The subduction of the lithosphere' (1975).
11. D. P. McKenzie and F. Richter, 'Convection currents in the earth's mantle' (1976).

In addition to all the articles having appeared in monthly issues of *Scientific American* some of them have also been included in previously published 'Readings' on other but related themes. Because the articles were originally published in a separate issue of the parent periodical the authors of each post-1968 paper were obliged to introduce the reader to the broad outlines of plate tectonics before passing to their special topics. Inevitably this has resulted in some repetition now that the papers have been collected together in a book. A few minor but irritating errors may be a consequence of over-hasty compilation when the articles were assembled for reprinting in book form. For example, in the extreme right-hand part of the figure on page 48 two points on the map are labelled D^1 and D^1 although in the caption they are referred to as D^1 and D. In addition B^1 and B which appear on the same map are not mentioned in the caption. In the table of subduction zones in Toksöz's article the page number of a related figure is given as 8, whereas in this collected edition it is 130. Jordan's otherwise excellent article is slightly marred by some barbarous jargon.

Perhaps the least satisfactory parts of the book are Bolt's introductions to the three sections. They are in the form of a series of questions posed by a hypothetical enquirer, and a series of answers largely derived from the following articles. Although the answers are admirably concise and up-to-date, the questions are somewhat contrived. They read more like examination questions than the type of query which an interested layman might ask of a seismologist.

On the basis of the authority of the contributors, the clarity of their accounts and the generally high standard of book production, I have no hesitation in recommending this modestly priced book to students and to scientists not involved with earthquake research.

P. L. Hancock

An Unconventional View of Cleavage Genesis

Davies, W. 1980. *On Slaty Cleavage and Structural Development in Lower Palaeozoic Wales.* University College of Wales, Department of Geology Publications, No. 8. 26 pp., 11 plates. Price: soft-cover £1.00 (free to libraries and persons known to be interested).

The series of publications from the Geology Department of the University College of Wales at Aberystwyth, commenced in 1972 with a long paper by Nancy Kirk on her then heretical views about graptolites, which at the time were unacceptable to the editors and referees of many journals. Davies' paper is the 8th publication in the series but the first on a structural topic; it is likely to be as controversial as its forerunners. Davies presents his own completely revolutionary ideas on the development of Wales during the Early Palaeozoic and integrates them with some novel notions on slaty cleavage genesis in Caledonian Wales. The author invites comments and questions from readers in the hope that their contributions will form the basis of a published discussion of his ideas.

In the first part of his paper Davies critically examines currently held views about the structure of Caledonian Wales and the value of the classical hypothesis of its geosynclinal evolution. He refers to the difference between observed and inferred thicknesses of Lower Palaeozoic successions, stating that whilst a thickness of at least 10000 m was suggested by O. T. Jones only 600 m can be observed at any one point. Thus he questions concepts based on what he believes was Jones' thickness over-estimate, and attempts to explain the evolution of an Early Palaeozoic basin containing no more than 1000 m of strata (excluding volcanic rocks). Unlike O. T. Jones, who attributed the low metamorphic grade of the rocks to burial during the Early Palaeozoic, Davies proposes that the metamorphism could be related to burial beneath between 2.5 and 5 km of Carboniferous, Triassic and Jurassic strata. This is where I believe the author introduces an inconsistent approach. Although he wishes to reduce the thickness of the Lower Palaeozoic succession to that which can be observed he is nevertheless content to postulate burial beneath successions for which there is no *direct* evidence of their ever having been deposited.

In place of the classical geosynclinal hypothesis and modern plate tectonic models for the sedimentary and deformational evolution of the basin, Davies suggests that the sediments were deposited in an intracratonic basin some 200–400 km wide with a palaeoslope of not more than 1°. He also proposes that the structures can be better explained by a general uplift of the Precambrian basement. It might have added to the author's argument if he had explained how he thinks the thick, dominantly andesitic and rhyolitic pile of the Snowdonia Volcanics came to be erupted in an intra-cratonic environment, since most other workers regard such volcanics as being characteristic of an island arc environment.

Davies continues his argument by analysing the geology of several subareas and proposes penecontemporaneous gravitational sliding of sediments, rather than orogenic deformation, as the origin of the Caledonian structures. He regards the structures as being the result of large-scale sheet sliding of sediments down basin slopes; folds and cleavage developing where the leading edge of the sliding mass came to a halt. In these circumstances, he argues, the attitudes and styles of the folds would depend on whether movement was checked in a severe (his word) or uneven manner. He postulates that cleavage formed in a stress field generated by the sliding and assisted by dewatering of the sediment pile. The wide variation in cleavage trend in North and Mid Wales he attributes to different directions of mass sliding. Davies also discusses the possible effect of the Snowdon Volcanics on cleavage attitude, and concludes that the weight of the volcanics forced the soft sediments concentrically outwards from beneath the volcanic pile.

In the second part of his paper Davies discusses a possible mechanism of slaty cleavage formation in Wales, again emphasising the role of soft sediment deformation. He describes the variety of cleavage styles and presents some comments on strain values as determined from deformed fossils and reduction spots. This section of the paper is well illustrated by stereopairs of scanning electron micrographs showing examples of cleavage textures in Welsh Lower Palaeozoic slates, and in a slate from the French Alps. Davies again concludes that deformation occurred before lithification and considers that his concepts could be applied outside Wales. However he does not tackle the problem of explaining the genesis of cleavage in some of the retrogressively metamorphosed minor intrusions which are referred to in the older literature as "greenstone schist" or "chlorite schist". It is difficult to envisage dewatering or soft sediment sliding as a significant mechanism of cleavage formation in these settings.

Judging from the quantity of papers published about the dewatering hypothesis, many, if not most, structural geologists, will disagree with Davies' conclusions. His interpretation of the Welsh Lower Palaeozoic sequence is also likely to meet with substantial opposition. Nevertheless both he and his department must be congratulated for their courage in