BOOK REVIEWS

Barker, A.J. *Introduction to Metamorphic Textures and Microstructures*. (Second Edition). Cheltenham, U.K. (Stanley Thornes (Publishers) Ltd), 1998. xiii+264 pp. Price £29.95. ISBN 0-7487-3985-8.

This book is a substantial improvement on the first edition, published in 1990 with 162 pages and reviewed in *Mineralogical Magazine*, **55**, 144–5. It has been expanded by 100 pages, has an improved format and an attractive softback cover, and yet the price is still reasonable. The strength of the book is its emphasis on aspects students can observe for themselves in metamorphic rocks and thin sections and the interpretations that follow from these observations. It is not given to ACF diagrams or too much chemical and mineralogical theory, although the basis of the metamorphic facies, petrogenetic grids and the major metamorphic changes with increasing metamorphism in a range of common rock types, are summarized perfectly adequately for an undergraduate. It is, as the title states, a book about metamorphic *textures*, not a text about metamorphism in relation to mineral assemblages, or the history of the recognition of metamorphic zones, so Barrow and the Dalradian, and Rosenbusch and Barr-Andlau are excised, although 'Barrovian' metamorphism survives. There is a strong emphasis on the role of deformation in promoting and controlling metamorphism, but due recognition is also made of the crucial role of fluids; without one or both, most rocks would remain little changed by *P-T* changes.

The three-fold division of the book and the chapter headings bring out these emphases: Part A, Introduction to metamorphism and metamorphic rocks, 37 pp: (1) environments and processes of metamorphism; (2) facies concept and petrogenetic grids; (3) compositional groups of metamorphic rocks. Part B, Introduction to metamorphic textures and microstructures, 73 pp: (4) layering, banding and fabric development; (5) crystal nucleation and growth; (6) mineral inclusions, intergrowths and coronas; (7) replacement and overgrowth. Part C, Interelationships between deformation and metamorphism, 106 pp: (8) deformed rocks and strain-related microstructures; (9) porphyroblast-foliation relationship; (10) shear-sense indicators; (11) veins and fluid inclusion; (12) deciphering polydeformed and polymetamorphosed rocks. There is a glossary defining terms used, and a list of key mineral assemblages in each metamorphic facies.

The eight plates comprise 44 coloured photographs of thin sections, are excellently reproduced and are much easier to see than the cramped versions in the first edition, because they are larger, reflecting the larger format of the book, although the content is the same. The publishers clearly let the author down by omitting the written explanations to the plates and these are pasted onto the last two pages as a post-printing addition although the plates are located in the centre of the book. The text is lavishly illustrated with 156 black-and-white figures, most of which are commendably clear, e.g. those showing symplectites. I was, however, disappointed with Fig. 1.5, its explanation and that in the accompanying text. This deals with D.M. Carmichael's ionic exchange mechanism; a great opportunity to show how minerals can act as catalysts and to explain that all too common puzzling observation that in one part of a thin section a mineral has clearly been arrested in replacing another, while elsewhere in the same slide the reverse replacement is evident.

The book is excellent. There is no other comparable undergraduate text and it will be used by those who wish to integrate structural geology, microtectonics, and metamorphism. Parts of C.W. Passchier and R.A.J. Trouw's *Microtectonics* (Springer, 1996, pp 289) overlap in context, but the latter is much more specialized, incomparably more expensive and the authors do not like the word schistosity, which is subsumed into 'continuous foliation' but confusingly still retained in the rock term, schist. The terminological problems of continuous and spaced cleavage, schistosity and foliation are adequately recognized in the present book. I liked the objective discussions of the various unresolved problems, e.g. those of porphyroblast growth, particularly in relation to garnets and T.H. Bell's concepts. I have recently been surprised by the

constant orientation of the internal S_i of some garnets across tens of cm even with a completely re-made S_e. This is a good teaching book, greatly improved by revision, and strongly recommended.

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Parnell, J. (Ed.). *Dating and Duration of Fluid Flow and Fluid-Rock Interaction*. London (Geological Society Special Publication 144). 1998. vi+284 pp. Price £69.00. ISBN 1-86239-019-3.

In 1997, the Geofluids conference in Belfast included an international seminar entitled 'Dating of Fluid Flow'. This volume contains 18 papers from that seminar, and an overview by the editor. There are five sections: (1) Specific techniques for dating of fluids and fluid flow (five papers); (2) Isotope techniques for dating of fluid flow (four papers); (3) Case studies assessing timing of fluid flow events (four papers); (4) Timing, duration and speed of oil migration (three papers); (5) Dating of Quaternary fluid flow events (two papers).

Within this overall structure, there is a limited number of review papers; most contributors appear to have used the seminar as an opportunity to update presentations of their research. Consequently there are substantial summaries of data, often tabulated and so suitable for creative use by the reader.

Specific techniques addressed by the first five papers include palaeomagnetism, apatite fission track dating, helium isotopes and fluid inclusions. Elmore *et al.* and Symons *et al.*, respectively present detailed palaeomagnetic data for hydothermally altered rocks from the Arbuckle Mountains, S. Oklahoma, and for MVT deposits, Viburnum Trend, SE Missouri, supported by substantial bibliographies. Similarly, indirect evidence for timing of fluid–rock interaction is considered for apatite fission track dating coupled with vitrinite reflectance data and thermal histories in general terms and for three case studies: west of Shetland, an unspecified well somewhere in Asia and for NW Australia (Duddy *et al.*). This papers focuses on the identification of anomalies attributable to the influx of fluids hotter than the geotherm. Pinti and Marty give a detailed review of the use of helium and noble gas isotopes in dating very old groundwaters (104–107 years), giving copious data for the Paris Basin. Finally, Wilkinson *et al.* present fluid inclusion data for Brent Group reservoir sandstones from the Columba Terrace, northern North Sea, constraining the timing of quartz overgrowths by reference to regional burial histories.

Isotopic methods of dating are addressed specifically by Zwingmann *et al.*, who use K-Ar dating of 'hydrothermal' illite to determine the timing of fluid flow in Rotliegend reservoir sandstones. Abundant data are provided, and relationships between K-Ar results and illite morphology are discussed. Spötl *et al.* use ^{40}Ar-^{39}Ar techiques to date authigenic K-feldspars from veins in Permian carbonates from the Austrian Alps. Data for $\delta^{18}O$ and Rb/Sr isotope ratios are also given, together with feldspar compositions (microprobe), which are critically interpreted to identify some of the limitations of the use of feldspars as well as their evident potential. In a very brief paper, Wayne and McCaig use Rb-Sr and U-Pb data for separated minerals to date shear zones in the Néouvielle Massif, central Pyrenees. Importantly, the lack of isotopic equilibrium for both systems is described. Moving back to MVT ore deposits, Walshaw and Menuge review the use of Rb-Sr techniques to date sphalerite, providing data for deposits from the Mississippi Valley, Pine Point, Polaris and the Lennard Shelf. Again, the limitations of the technique are addressed, and summary data from other sources are presented.

There are four case studies. Pagel *et al.* describe the results of a multidisciplinary study of the Ardèche passive margin (SE Massif Central). Summary data are presented for fluid inclusions, apatite fission track analysis, vitrinite reflectance, Rock-Eval pyrolysis and stable and radiogenic isotope studies, together with a thermal history. Hollis addresses the timing of fluid expulsion and migration associated with the formation of the South Pennine Orefield, using fluid inclusion data, mineral parageneses and burial histories. Morris and Nesbitt provide substantial geological information concerning fluid-rock interaction in the MacKenzie Mountains, Northwest Territories, with stable isotope data for C, O and H presented in summary form. Qing then provides a focused study of the Presqu'ile reef (Pine Point), with stable isotope data of O and C, some $^{87}Sr/^{86}Sr$ data and some summary fluid inclusion data (T_h), acknowledging the difficulties involved in estimating an age for the Pine Point mineral deposits.

The problem of timing petroleum migration is addressed by Lisk *et al.*, who describe fluid inclusion work on the Australian NW Shelf,