BOOK REVIEWS

Barber, D. J. and Meredith, P. G. (Eds.). *Deformation Processes in Minerals, Ceramics and Rocks* (The Mineralogical Society Series, Vol. 1). London and Boston (Unwin Hyman), 1990. xviii + 423 pp. Price £65.00.

This monograph resulted from a two-day meeting of the Mineralogical Society of Great Britain and Ireland held in 1987. It consists of sixteen chapters by Earth and materials scientists on the deformation processes in minerals, ceramics and rocks. The book surveys the current state of knowledge about the micro-deformation processes and mechanics in non-metallic systems. The topics covered fall into two groups—brittle deformation microprocesses and micromechanics, chapters 1–5; and ductile/plastic deformation processes, chapters 6–16. Topics covered include single-crack behaviour, fracture of polycrystals and ceramics, failure maps, brittle-ductile transition, plastic deformation, experimental studies, studies of natural microstructures, fluid-phase assisted creep, and dynamic recrystallisation [M.A.91M/3660–3675].

Chapter 1 by P. Meredith on fracture and failure of brittle polycrystals is an overview of recent developments in the understanding of the micromechanics of fracture and brittle failure in polycrystalline materials This review encompasses fracture mechanics, failure prediction, damage mechanics and brittle–ductile transitions. It is an excellent summary of the current state of knowledge. Chapter 2 on single-crack behaviour and crack statistics by Y. Guegen *et al.* reviews fracture mechanics and fracture interactions and proposes that for multiple cracks and crack interaction a statistical approach using anisotropic correlated percolation theory is appropriate for understanding the localisation of fracture processes.

Chapter 3, fracture of polycrystalline ceramics by S. W. Freiman and P. L. Swanson is a short but informative review on brittle deformation in cereamic polycrystals and introduces the newly recognised phenomenon of crack surface tractions—frictional interlocking and ligamentary bridging. S. D. Hallam and M. F. Ashby in Chapter 4 discuss compressive brittle-failure and the construction of multi-axial failure maps. Chapter 5 by S. Murrell is a wide-ranging review of brittle–ductile transitions in polycrystalline non-metallic materials. Murrell concludes that much more experimental data is required for the transition between fracture and flow in geological materials.

The regimes of plastic deformation are excellently reviewed by D. J. Barber in Chapter 6 which is followed in Chapter 7 (J. P. Poirier *et al.*) by an overview of the methods of experimental data analysis. They propose a new technique of global inversion for the correct determination of the appropriate flow laws from deformation experiments.

Chapter 8 by J. Tullis reviews the results of experimental deformation of polycrystalline aggregates of quartz, feldspar and quartz–feldspar mixtures. Successful high-temperature experiments (900 °C) show textural development in quartz and feldspar polycrystals that closely simulates natural deformation textures. The microstructural and textural evolution of natural tectonites from the Moine thrust zone at Assynt are described by R. Knipe in Chapter 9. He demonstrates that complex polycyclic textural and microstructural development can be explained in terms of P–T–t–ε paths and recognises the importance of diffusive mass transfer processes (pressure solution) during deformation in the thrust zone.

Chapter 10, Mechanisms of reaction-enhanced deformability in minerals and rocks by D. Rubie is a review of field and experimental evidence for this process.

Deformation by pressure solution mechanisms is analysed theoretically by F. Lehner in Chapter 11 and demonstrated experimentally by C. Spiers *et al.* in Chapter 12. These two companion chapters demonstrate the progress made in understanding the theory and in developing experimental proof of the phenomena first documented by Sorby in 1851. Chapter 13 by B. Darby reviews the state of knowledge on dynamic recrystallisation and grain-size. He develops a theoretical analysis to explain that for a wide range of materials, a narrow band of stress–grain size relationships can be predicted. T. Takeshita *et al.* in Chapter 14 use a generalised description of anisotropic plastic flow which takes into account the deformation history to simulate dislocation-assisted plastic deformation in olivine

polycrystals. Chapter 15 by A. Hever *et al.* describes the slip systems in uranium dioxide and Chapter 16 (C. Hennig-Michaeli and J.-J. Couderc) describes dislocation rections in experimentally deformed chalcopyrite singel crystals.

In summary this book is a mixture of reviews of the state of knowledge on micro-deformation processes in non-metallic materials together with new data. It is well presented, well edited and indexed. The volume contains a wealth of information and up-to-date references that will be invaluable to the reader. To those unfamiliar with the fields of brittle micro-mechanics this volume will be a useful high-level introduction. The chapters on plastic deformation processes also provide a valuable review of the current theories and level of knowledge. At £65 it is perhaps a little expensive for individual libraries but is a must for all departmental and University/College libraries. It is highly recommended for any Earth scientist who needs to understand deformation processes in the lithosphere.

K. R. McClay

Mason, R. *Petrology of the Metamorphic Rocks* (2nd edn.). London (Unwin Hyman), 1990. x + 230 pp. Price £35.00 hardback; £14.95 paperback.

The First Edition (1978) of Roger Mason's textbook on metamorphic petrology was presented as the third volume in the series published by Allen & Unwin covering the main classes of rocks—igneous, sedimentary and metamorphic. This pretence was never convincing and has been dropped in the present edition. Mason's approach is entirely different from those adopted in earlier texts. Instead of a systematic classificatory framework, metamorphism and metamorphic rocks are presented through a series of case histories drawn from the author's own research experience in Britain, Ireland, other parts of Europe, Turkey, the United States and China.

This original approach has been retained in the Second Edition, although the subject matter has been updated and rearranged so that it is now more overtly related to the plate tectonic environments in which the different types of metamorphic rocks have been formed.

After introductory chapters dealing with the definition of terms, schemes of classification, methods of study and the chemical and thermodynamic aspects of metamorphism, the main body of the text covers the einvironments of contact metamorphism related to intrusion, dynamic metamorphism in thrusts and shear zones, metamorphism on the ocean floor and in zones of subduction and collision of tectonic plates. An account is given of high-grade granulite facies terrains, found in the stable continental cratons, and of metamorphisms of mantle materials seen in ophiolite complexes and mantle xenoliths, brought up in kimberlite pipes and basaltic lava flows. The final chapter introduces 'extra-terrestrial metamorphism', as seen in meteorite impact craters on earth, represented by the Nordlinger Ries crater in Southern Germany, and the Moon rocks brought back from the Apollo missions. The text is well illustrated by clear line drawings of maps, graphs and thin sections of metamorphic rocks.

The book originated as a Second Year University course in metamorphic petrology and it certainly provides a valuable and stimulating introduction to metamorphism for students at this level. It will also provide a readable and useful update in current methods and concepts in metamorphic petrology for teachers and professional geologists. The personal and anecdotal approach in spite of a Glossary of terms and an Index, will limit its value as a standard course textbook, as the author has not attempted to provide a comprehensive coverage of the whole range of metamorphism and metamorphic rocks.

A. J. Barber

Poirier, J.-P. *Introduction to the Physics of the Earth's Interior*. Cambridge (Cambridge University Press), 1991. Price: hardback £40.00, paperback £17.50.

This is an excellent soft-bound book, packed with essential mathematical models and physical explanations for current research through mineral physics and geophysics, to determine the structure, composition and temperature of the deep Earth. In the first two chapters, the book presents a succinct review of the fundamentals of thermodynamics of solids, and elastic moduli. The next chapter provides a fairly rigorous review of the fundamentals of lattice vibrations, including, for example, recent observations on Gruneisen parameters. The next two chapter explain the origins and applications of the equations of state for solids at high temperatures and pressures, and examine the thermodynamics and theoretical models of melting with, for example, specific application to our current understanding of the Earth's core. Dynamic processes in the Earth, including mechanisms of diffusion and viscosities of solids and liquids are linked with the principles of electrical and thermal conduction in a longer chapter 6, under the title of transport properties. Finally in Chapter 7, the three major types of