BOOK REVIEWS

Brown, M., Candela, P.A., Peck, D.L., Stephens, W.E., Walker, R.J. and Zen, E-an (eds.) *The Origin of Granites and Related Rocks*. Edinburgh (Trans. R. Soc. Edinburgh, Earth Sciences, vol. 87, parts 1 and 2), 1996, vi + 361 pp. Price £47.00 (incl. p + p).

The volume begins with a preface by Prof. Mike Brown, summarizing current debates and controversies, and concludes with Prof. Barrie Clarke's views on where we stand after two hundred years of granite studies since Hutton's *Theory of the Earth* was published. As is always unwise, in what may be a chaotic oscillation about 'truth', Clarke has succumbed to the temptation of predicting the future of granite science. Between these two papers lie some 32 papers (352 pages) embodying the most up-to-date views of more than 50 of the worlds leading granitologists on a wide variety of subjects.

Papers are grouped into blocks dealing with partial melting and the fertility of magma sources, melt segregation, magma ascent and emplacement, the compositional evolution of magmas, regional case studies, magma dynamics and chamber processes, fluid evolution and metallogeny, and implications of granites for the nature of unexposed source rocks.

It is impossible to comment in detail on all of these contributions [M.A. 97M/0898–0930]. However, the following list will give a flavour of the contents of this volume.

Thompson discusses the melt-producing capacity of crustal rocks and shows that greywackes are the most fertile magma sources.

Patiño Douce examines the effects of pressure and H_2O activity on the compositions of crustal melts, finding a sympathetic relationship between a_{H_2O} and Fe + Mg in the melt.

Barboza and Bergantz develop a dynamic physical model for fluid-absent partial melting of crustal rocks. They conclude that buoyant forces alone may be insufficient to trigger melt extraction.

Bea warns geochemical modellers that equilibrium element partitioning between accessory phases and melts may be uncommon and that effective partition coefficients will approach unity.

Watson uses finite difference simulations to characterize diffusion-controlled dissolution and growth of zircon in granitic melts. In the absence of extreme deformation, these processes are found to be controlled simply by the diffusion coefficient of Zr. Only inherited zircons larger than 120 μm will survive magmatic events at > 850°C.

Holtz, Scaillet, Behrens, Schulze and Pichavant describe new determinations of H_2O solubility in granitic melts. They use these data with viscosity measurements to predict the evolution of melt viscosity along magma ascent paths.

Dingwell, Hess and Knoche present new experimental determinations of the compositional and temperature dependence of densities and viscosities of granitic melts, demonstrating the non-Arrhenian temperature dependence of viscosity.

Rushmer describes experimental data on partial melting in rock cores under both static conditions and during deformation. Fluid-absent melting produces melt-filled cracks at extremely low melt fractions. She concludes that models for melt migration cannot assume constant, ideal melt-crystal interfacial angles or the existence of a critical melt fraction. Melt migration is probably dependent on the tectonics of the system.

Sawyer examines the segregation of melt in migmatites, concluding that only mobilization of diatexites (melt plus residue) can produce the observed compositions of granitic magmas. He does not comment on the origins of layered restitic granulites.

Weinberg suggests that near-source dykes may be unable to grow large enough to allow their propagation and presents his model for the ascent of granitic magma as diapirs. His granitic dykes are only late features, sprouting from the heads of supposed diapirs.

Petford asks the question "dykes or diapirs?" and answers firmly "dykes!", suggesting that most granitic plutons are relatively thin, sheet-like bodies, dyke-fed with pulses of magma.

Paterson, Fowler and Miller describe what they interpret as exposed roofs and walls of granitic magma chambers in what are believed to be exposed sections through the Sierra Nevada crust. They conclude that batholiths are vertically extensive, with roots deep in the crust and volcanic edifices above. They view material transport as dominated by wall-rock flow down the sides of buoyant diapirs.

Anderson shows that many granites contain low-variance mineral assemblages that can be used to calculate magmatic P–T–f_{O_2}–a_{H_2O} conditions. He examines the status of several of these thermometers and barometers and discusses their use in constraining tectonic histories of regions.

Nekvasil and Carroll use recently determined phase equilibria in haplogranite–H_2O–CO_2 systems to predict melt differentiation paths during magmatic crystallization.

Hogan examines granitic melt crystallization in complex multi-dimensional reaction space using three-dimensional vector plots of reactions deduced from natural rocks. He uses these to infer the nature of the reactions that control mineral compositions and phase assemblages in particular magmatic systems.

Chappell presents his views on the causes of chemical variation within granite suites and examines their implications for the physical state of the magmas, the mechanisms of magma ascent, the relative contributions of crust and mantle to the magmas, the chemical fractionation of the crust, the compositions of the melts and magmas, and for the occurrence of economic mineral deposits.

Collins takes an approach (to the modelling of the chemical variations in the granites of the Lachlan Fold Belt of southeastern Australia) that is in sharp contrast to that of Chappell. He advocates a three-component mixing model (mantle plus two crustal components) and discusses its tectonic implications.

Nakajima describes the Cretaceous granitoids of southwestern Japan and discusses their bearing on crustal growth in the region. In a similar vein, Rapela and Pankhurst discuss the monzonites of the innermost cordillera of Patagonia inferring their origin by remelting of underplated mafic source rocks.

Drummond, Defant and Kepezhinskas present their geochemical arguments for derivation of tonalite–trondhjemite–dacite and 'adakite' magmas through partial melting of subducted slabs in arc settings.

Flinders and Clemens argue that, in common with a great number of natural physical systems, enclave-bearing granitic magmas also demonstrate features typical of chaotic dynamics, coupled with complex chemical and isotopic variations that are incompatible with simple mixing models.

Poli, Tommasini and Halliday also examine the mafic-felsic magma interactions, producing a multi-stage differentiation-'contamination'-mixing model for the Sardinia-Corsica batholith.

Wiebe deals with composite mafic-felsic layered intrusions, invoking double-diffusive convection as a mechanism for the conversion of a magma of one chemical type into another chemical type. He suggests that such processes may operate in the deep crust but not be evident in some of the granitic products emplaced at shallower levels.

Baker and Rutherford discuss experimental data bearing on the crystallization of anhydrite and sulphate apatite in oxidized, sulphur-rich silicic magmas. They calculate the compositions of fluid phases coexisting with such melts and speculate that intrusive equivalents of these rocks should exist in arc plutonic complexes.

Hanson uses numerical modelling techniques to analyse the hydrodynamics of magmatic and meteoric fluids around cooling granitic intrusions. The calculated flow and mixing patterns are consistent with the distribution and evolution of granite-related skarns and hydrothermal ore deposits.

Barton describes the relationships between the chemistry of granitic intrusions and metallogeny in southwestern North America. He emphasizes the magmatic control on the nature of ore deposits and the lack of any apparent regional control.

Blevin, Chappell and Allen make a similar sort of study, focusing on eastern Australia. They emphasize the occurrence of the magma compositional control on the nature of ore deposits, but also recognize a regional geological control and an influence of the depth of granite emplacement.

Lowenstern and Sinclair describe the influence of exsolved magmatic fluids on the formation of comb-layered quartz in a W-Mo vein deposit in Canada, inferring repeated vapour evolution episodes.

London provides us with a review of the P–T–fluid conditions of formation and textural evolution of granitic pegmatites. He deals briefly with the issues of the sources of pegmatite magmas and extents of magma-wallrock interactions.

Pichavant, Hammouda and Scaillet describe experimental evidence for the influence of protolith composition on the redox state and Sr isotopic composition of granitic magmas. They conclude that the isotopic compositions of partial melts may not necessarily reflect those of their source rocks.

Krogstad and Walker use Sm–Nd and Pb–Pb isotopic systematics to infer the existence of heterogeneities in the crustal sources of the Harney Peak granite in South Dakota. They caution against the use of small sample sets in mingled/mixed magma series to infer the ages and characters of granite protoliths.

Johnson, Shirey and Barovich introduce granite petrologists to the use of Lu–Hf and Re–Os isotopic systems in studying crustal evolution and the origins of granitic magmas. They conclude that Os isotopes show great promise for uncovering otherwise undetectable juvenile mafic crustal influences in granite protoliths.

The volume is a granitic tour de force and a must-buy for any geoscientist working on granite problems. Some of the ideas presented in it will undoubtedly wither and pass from sight in future years but the volume will remain an historical record of the state of our knowledge on matters granitic. As such it has a place in any good geological library.

J.D. CLEMENS

Cawthorn, R.G. (ed.) *Layered Intrusions*. Amsterdam (Elsevier Science BV). 1996, x + 531 pp + 1 map. Price $93.75 (softback), $200.00 (hardback). ISBN 0-444-81768-9 (hardback) 0-444-82518-5.

Layered plutonic igneous rocks remain one of the most contentious and fascinating aspects of igneous geology. Layering phenomena are an important clue to processes occurring during the crystallization of igneous bodies. This book represents a valuable attempt to bring together a variety of experts on different layered igneous intrusions into a single monograph, and will undoubtedly be embraced as an important reference for studies on layered rocks. It is now ten years since the publication of *Origins of Igneous Layering*, edited by I. Parsons, which many will consider an important contribution to research into layered igneous rocks. *Layered Intrusions* updates much of that work, but the style is more of a review, and will appeal to a wider audience.

The format of the book is as a series of 14 chapters, each tackling a different aspect, with a foreword by G.M. Brown. The first four chapters consider the origins and development of layered igneous rocks, whilst the remaining seven are descriptive reviews of some key intrusions or provinces (including Skaergaard) which have provided some of the most important clues to our understanding of layered processes. A colour pull-out map is provided with the Skaergaard review. The chapters' titles and authors are: 1. H.R. Naslund and A.R. McBirney, Mechanisms of Formation of Igneous Layering; 2. I.H. Campbell, Fluid Dynamic Processes in Basaltic Magma Chambers; 3. R.H. Hunter, Texture Development in Cumulate Rocks; 4. C.A. Lee, A Review of Mineralization in the Bushveld Complex and some other Layered Mafic Intrusions; 5. A.R. McBirney, The Skaergaard Intrusion; 6. H.V. Eales and R.G. Cawthorn, The Bushveld Complex; 7. J.R. Wilson, B. Robins, F.M. Nielsen,, J.C. Duchesne and J. van der Auwera, The Bjerkreim-Sokndal Layered Intrusion, SW Norway; 8. J.D. Miller Jr and E.M. Ripley, Layered Intrusions of the Duluth Complex, Minnesota, USA; 9. J.R. Wilson and H.S. Sørensen, The Fongen-Hyllingen Layered Intrusive Complex, Norway; 10. B.G.J. Upton, I. Parson, C.H. Emeleus and M.E. Hodson, Layered Alkaline Igneous Rocks of the Gardar Province, South Greenland; 11. A.H. Wilson, The Great Dyke of Zimbabwe; 12. C.H. Emeleus, M.J. Cheadle, R.H. Hunter, B.G.J. Upton and W.J. Wadsworth, The Rum Layered Suite; 13. I.S. McCallum, The Stillwater Complex; 14. C.I. Mathison and A.L. Ahmat, The Windimurra Complex, Western Australia.

The foreword stresses the importance of the book to researchers, but the book will have another role as a one-stop reference for final-year undergraduate students of igneous petrology. Naslund and McBirney's condensed but readable review of magma chamber processes and the reviews of key intrusions such as Skaegaard, will be an invaluable teaching aid. My only criticism of the book lies not with the content but with the cost. With a price tag of US$200 for a hardback, there are few individuals who will be able to purchase this book. In times of increasing financial restraint in higher education, it will also be outside the price range of many institutions and university libraries. It is a pity that such an important contribution will not reach a wider audience.

A.A. FINCH

Hoefs, J. *Stable Isotope Geochemistry: (fourth completely revised, updated and enlarged edition)*, 4th Edition, Berlin, Heidelberg and New York (Springer-Verlag), 1996, xi + 201 pp. Price DM78.00. ISBN 3-540-61126-6.

This book of 168 pages provides a synopsis of some stable isotopic concepts and data relevant to the Earth Sciences. The book comprises three main parts *viz.* Chapter 1: Theoretical and Experimental Principles (26 pages); Chapter 2: Isotope Fractionation Mechanisms of Selected Elements (34 pages); Chapter 3: Variations of Stable Isotope Ratios in Nature (103 pages), with this last chapter being divided into 12 sections, each dealing with isotopic variations in particular geospheres. Chapter 3 devotes 51 pages to stable isotopes in low-temperature systems (e.g. 15 on Section 3.11: Sedimentary Rocks) and 38 pages to stable isotopes in high-temperature systems (e.g. 5 pages to Section 3.3: Magmatic Rocks).

The book is useful as a source of information, but it is not for the non-specialist, despite the claim made in the preface that "The book is written.....more for the non-specialist and graduate student, who needs practical knowledge of how to interpret stable isotope ratios." This is a book for reference into which those with some acquaintance with isotopic techniques can delve to widen their understanding of isotope systematics and pick up hints and information that might be useful or lead them down new paths. There are several books (e.g. E. Mazor, *Applied Chemical and Isotopic Groundwater Hydrology* and G. Faure,