BOOK REVIEWS

Mysen, B. O. (ed.) *Magmatic Processes: Physicochemical Principles.* Pennsylvania State University (Geochemical Society, Special Publication no. 1), 1987. x + 500 pp., 13 maps. Price $65.00.

In honour of the retirement of Hatten S. Yoder, Jr., as Director of the Geophysical Laboratory of the Carnegie Institution of Washington, an international conference and field study was held in Hawaii during June 1986. The first Special Publication of the Geochemical Society contains the extended papers presented at the conference. The 30 papers in the volume have been subdivided into 5 sections: Structure and Properties of Source Regions; Upper Mantle Partial Melting and Fractionation; Continental Margin Processes; Magma Ascent, Emplacement and Eruption; and, Crustal Felsic Magma Properties and Processes. One of the objectives of the meeting was to stimulate cooperation across scientific boundaries, and the resultant specialist papers cover topics in theoretical geophysics, fluid dynamics, observational geochemistry and petrology, and experimental studies. The net result is a volume which is of an exceptionally high scientific standard, and which should hold the attention of many earth science researchers and students.

The first section, under the broad heading of structure and properties of source regions, leads with a discussion of the depths of mantle reservoirs by Don Anderson, which emphasises the cross-fertilization between seismology and petrology. Low- and high-temperature peridotite nodules from the Kaapvaal craton are discussed by Boyd and Mertzman, with speculation that the high-temperature peridotites originated from oceanic plate subduction beneath the southern margins of the craton during the formation of the Namaqua–Natal mobile belt. In the remainder of the first section, Scarfe, Mysen and Virgo discuss the pressure dependence of the viscosity of silicate melts, and two papers by Herzberg are addressed towards the geological possibility of silicate melts becoming neutrally buoyant, with the occurrence of olivine flotation. Finally, a paper by Turcotte discusses the mechanisms and physics of magma segregation processes, starting with melting along grain boundaries, and progressing to diapirism and magma fracturing.

In the second section, dealing with upper mantle partial melting and fractionation, two papers consider with the petrogenetic role of methane and variable C–H–O fluid compositions. The first, by Taylor and Green, discusses experimental data from the nepheline–forsterite–silica system, with speculations on the CH_4 solution mechanism. The second, by Green, Fallon, and Taylor, discusses the geological applications of the experimental data to mantle-derived magmas, and the effects of variable C–H–O fluid compositions, with a consideration of the f_{O_2} controls. The role of carbon is similarly considered by P. J. Wyllie in a discussion of nephelinitic volcanism and carbonatites. Additional papers in the section are by Presnall and Hoover on high-pressure constraints on the origin of mid-ocean ridge basalts, and Bailey and Macdonald on dry peralkaline felsic liquids and CO_2 flux through the Kenyan rift zone.

The section dealing with continental margin processes starts with a petrographic study and discussion of the Dora Maira pyrope–coesite–kyanite–talc–phengite–jadeite suite, and suggest that the suite represents subduction of the continental crust to depths near 100 km. The paper extends implications to the genesis of lamproites. The Japanese island arcs are discussed by Kushiro on the evidence of inclusions, melting relationships, and combines experimental with observational seismic velocities. Yagi and Takeshita follow with a discussion of the role of hornblende crystallization and segregation from proposed hydrous high-alumina basalt magmas as part of the genesis of calc-alkali andesites. The remaining papers in the section are by Ernst on a petrological study of mafic meta-igneous rocks of possible komatiitic affinities in northern California, and a semi-empirical study of volcanic series by Perchuk.

The fourth section dealing with magma ascent, emplacement and eruption, starts with two papers on Hawaii. The first are the annotated bibliographies from the workshop held during the conference, collected by Wright and Swanson, and covering aspects of observations on active volcanoes. The second paper, by Rosalind Helz, provides an excellent overview of differentiation processes in the Kilauea Iki lava lake. The situation of neutral buoyancy in magma systems is again evaluated, in this section by Ryan, and applied to Hawaii, Krafla, and the East Pacific Rise. Other papers in the section include an excellent discussion

of the processes involved in steady state double-diffusive convection in magma chambers by Clark *et al.*, constraints on crystal sizes in intrusions imposed by the cooling regime and crystallization kinetics (by Brandeis and Jaupart), application of Legendre transforms to construct thermodynamic potentials which are minimal at thermodynamic equilibrium, and the testing of the equations by simulations of isothermal and isenthalpic assimilation (by Ghiorso and Kelemen). Lastly, Taylor discusses differences in the style of hydrothermal alteration between layered gabbros and granites on the basis of stable oxygen isotope studies.

The last section deals with crustal felsic magma properties and processes. Initially, Pichavant *et al.* provide evidence for fractionation in peraluminous magmas using chemical evidence from the Macusani glasses contained in ash-flow tuffs. Mysen uses the RKNFSYS rock file data of Chayes to gain insights into relationships between bulk, elemental compositions, structures and properites of magmatic silicate melts. In the third paper of the section, Fraser and Rammensee indicate the use of the Knudsen Cell mass spectrometer to determine the mixing properties of granitic and other aluminosilicate melts, by mass spectral analyses of the vapour phase coexisting with melts. Navrotsky then discusses calorimetric techniques to obtain thermodynamic data for hydrous minerals, melts, and glasses. The effect of fluorine species on melt viscosities is discussed by Don Dingwell. The following paper, by Nekvasil and Burnham, is an application of a revised quasi-crystalline model to the calculation of pressure and water content effects on granitic phase equilibria.

As can be seen from the brief indications of the paper contents, the volume is truly interdisciplinary, with contributions from leaders in the various fields. Apart from the scientific standards, the editor and the Geochemical Society deserve commendation for the introduction preceding the main topic of the paper. In every case, care has obviously been taken to lead the interested non-specialist into the main topic. The volume is recommended not only for specialists, and interested non-specialists, but also for final year undergraduates for excellent examples of scientific argument and approach. The reviewer would give the paper by Taylor and Green, on the petrogenetic role of methane as an example. Following a lucid discussion and evaluation of the roles of volatiles and f_{O_2} in petrogenesis, the authors discuss the theory and techniques involved with the use of Fourier transform infrared spectroscopy as an analytical tool to study the behaviour of methane in silicate melts. The spectral data are presented, models evaluated, and conclusions drawn. Together with most of the papers in the volume, communication has been emphasized. With only a couple of exceptions, all the diagrams are clear and sufficiently labelled.

A major trend in the volume is the discussion and evaluation of the roles of volatile species, both in interaction with the silicate melt, but also as controlling f_{O_2} druing melt differentiation. The physics of melt fluidity was another major trend. However, as P. J. Wyllie ended in his paper, 'there is as yet no concensus about the rheology of mantle-fluid systems'. Although it is not in any way a derogatory opinion of the reviewer, notable absences in the volume lie in stable isotope contributions (apart from that of Hugh Taylor), and in contributions from the sister laboratory of the Department of Terrestrial Magnetism. In spite of the pioneering work in ^{10}Be, the exciting data from these studies were not mentioned in the volume. The net result however, is a very high quality volume from the Geochemical Society, remarkable both for the scientific quality and the effort expended in communicating to the non-specialist.

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Levinson, A. A., Bradshaw, P. M. D. and Thomson, I. *Practical Problems in Exploration Geochemistry*. Wilmette, Illinois (Applied Publishing Ltd), 1987. xii + 269 pp. Price $80.00.

The publication of textbooks on the principles and practice of exploration geochemistry spans the last 25 years, but this, the latest of the genre, breaks new ground with its highly innovative approach. The authors, one a senior academic with a pedigree which already includes an invaluable textbook on exploration geochemistry, the other two top mineral exploration managers in Canada, have assembled a compendium of exploration geochemistry case histories. But in their book each case history is divided into two parts: the first part comprises a thought-provoking problem to stimulate the mind of the inquisitive student of exploration geochemistry; later the solution to the problem is presented and its wider implications for the routine application of exploration geochemistry are discussed.

The first 160 pages are devoted to the 40 problems that the book contains. Each has been contributed by a geologist and is drawn from his or her practical experience of exploration geochemistry. The problem is positioned with details of geographical location, climate, physiography, local geology, sampling patterns, analytical methods and whatever further information may be appropriate to leading the reader into attempting a reasoned interpretation of geochemical data that are then