BOOK REVIEWS

Johannes, W. and Holtz, F. *Petrogenesis and Experimental Petrology of Granitic Rocks.* Heidelberg (Springer), 1996. xiii + 335 pp. Price DM163.00 ISBN 3-540-60416.2

This book is essentially an annotated collection of experimental data that bear on the origins and evolutionary paths of granitic magmas. The focus is on crystal–liquid phase equilibria and the effects of volatile components on the physical and chemical properties of the melts and magmas. The topics of pegmatites and silicic volcanic processes are not covered. The writers are two experimental petrologists who have contributed substantially to the body of knowledge on the formation of granitic magmas. Written mainly for the specialist, this work assumes familiarity with the use and interpretation of phase diagrams and with the meanings and relationships between some basic thermodynamic variables. The 335 pages are packed with 184 illustrations — phase diagrams, photographs of experimental run products and various graphs, mostly borrowed from the scattered literature. It is very useful to have all of this information in one place. Indeed, some of the work is not all that 'previous', since a good number of the references (chiefly by the authors of the book) are dated 1996 and were 'in press' at the time of this review. In a very few cases, unattributed, unpublished results are presented. One assumes that this work is also by the authors.

The book is well written. It does contain a few English errors, but these are minor. Typographical errors are rare, though page 189 refers to the use of AgPt capsule alloys, where AgPd is probably meant. Spellings are American throughout the work, but there is some inconsistency in the use of units; some are in cgs and others in mks. This has been inherited from the previous work, no doubt. There is also some slight inconsistency in the use of mathematical symbols, with '×' replaced by '*' occasionally. One might also quibble over the use of 'water' when H_2O is meant, and the occasional use of 'unstable' instead of 'metastable'.

There are nine chapters and an appendix of abbreviations. Full references are given in the back of the book — by far the best place for them. Chapter 1 gives a brief geological background, placing granites in their context, emphasizing the critical role played by H_2O in their genesis.

Chapter 2 covers the Qtz–Ab–Or $\pm$ H_2O $\pm$ CO_2 system, and its subsystems. Melt compositions are dealt with in terms of both silicate and volatile components. H_2O solubility and the effects of the H_2O budget on melt proportion are covered.

In chapter 3 the properties of hydrous haplogranitic melts are summarized. H_2O solubility and its temperature, pressure and compositional dependences are explored. The speciation of H_2O in aluminosilicate melts is discussed, in the context of the authors' view that "molecular H_2O is an important component in silicate melts, besides OH groups". We may argue that this is an invalid assumption, since the assignment of vibrational spectroscopic bands to molecular H_2O is uncertain. Though we know that clustering occurs, from NMR spectroscopy, the interpretation of 4H as $2H_2O$ is on shaky ground. Models for the incorporation of 'H_2O' into silicate melts are summarized. The latter part of the chapter deals with the viscosities, densities, diffusivities and rheological properties of granitic magmas. The last section echoes the current debate over the ascent mechanism for granitic magmas, and how the magma properties affect such modelling.

Chapter 4 concerns the effects of excess Al and the presence of P, F, B and Li on the phase relations and physical properties of melts in the haplogranite system. Great emphasis is placed on Al. Data on the solubilities of various accessory minerals are summarized. The reader should be especially careful if inspired to do any zircon solubility calculations, since the 'M' compositional parameter of Watson and Harrison (used in equation 4.6) is not as simply calculated as it may appear. Chapter 4 does not deal with CO_2 as a minor component, or with the strange and unverified results of Swanson (*Amer. J. Sci.*, **279**, p. 703–20, 1979) who found calcite coexisting with granitic liquids in the system Qtz–Ab–Or–An–H_2O–CO_2. This must be because the chapter is supposed to be limited to the anorthite-free system. Nevertheless, this work also goes uncited in chapter 7, which specifically deals with Qtz–Ab–Or–An–H_2O. One supposes that this work simply failed to fit any of the system categories into which the book has been divided. The chapter contains a sampling of case studies in which experimental petrology has been used to elucidate the petrogenesis of peraluminous leucogranites. However, no mention is made here of similar studies on the more normal granitic to granodioritic rocks; these are found scattered through various other chapters. Perhaps the amount of attention paid to leucogranites reflects the emphasis on such rocks by the European petrological community. Such emphasis is wholly unjustified, given the relative scarcity and general unimportance of such rocks.

The effects of the presence of Fe and Mg in granitic systems is covered in chapter 5. This chapter begins with a section on the role and control of oxygen fugacity in experiments. Page 190 misattributes the invention of the H_2 diffusion membrane to Shaw who, apparently, adapted its use from the chemical industry. It then summarizes important results of experiments on synthetic granitic systems to which Fe and/or Mg have been added. Curiously, this chapter does not discuss the stability of epidote, a phase encountered in some of the work referred to. However, epidote is mentioned in the final pages of the next chapter. Experimental petrologists would do well to heed the warning on page 189 that "results from... studied performed with different pressure vessels in which f_{O_2} inside the vessel ... is unknown cannot be compared,". Page 191 completely misinterprets the results of Clemens and Wall (*Canad. Mineral.*, **19**, p. 111–32, 1981), wrongly stating that their starting materials were metaluminous. As recognized later in the book, the rocks were actually peraluminous and the low-pressure stability of garnet in such magmas was a major finding of this early work. Five times in this chapter, the authors rather uncritically endorse a restite origin for the cores of zoned plagioclase crystals and the restite unmixing theory of the origin of chemical variation in granitic rock suites. The authors also mention the concept of mobilization of magmas with 50% entrained restitic crystals and seem to regard most tonalites as magmas, rather than cumulates from granodioritic magmas.

Thinking of tonalites in more detail, chapter 6 summarizes what is known about phase relations and kinetics in the system Qtz–Ab–An–H_2O, with and without excess Al_2O_3. There is plenty of comment on the formation of tonalites and their role in the Archaean crust. Fluid-absent partial melting of natural tonalitic rocks is also dealt with here.

The effects of addition of anorthite component to the haplogranite system are presented in chapter 7. Kinetic studies are also included, along with element partitioning data and the hypersolidus and subsolidus phase relations and kinetics.

Natural granite experiments are mostly dealt with in chapter 8, with the great variety of experimental techniques and conditions summarized. Here the reader will also find a discussion of partial melting experiments on greywackes and pelites. The Clemens *et al.* (*Amer. Mineral.*, **71**, p. 317–24, 1986) experiments on an A-type granite are misclassified here as carried out with various amounts of H_2O added to the charges. In fact this work used H_2O-CO_2 fluids to indirectly control melt H_2O content. However, this does not detract from a very useful and interesting chapter.

In the ninth and final chapter the authors discuss the formation of granitic magmas by fluid-absent (dehydration) melting. This is a thorough exploration of the various studies, but one might ask why the tonalite, greywacke and pelite work was not included here, instead of in chapters 6 and 8. The authors conclude that there is a need to more systematically investigate the compositional variables at work in these melting reactions. One could not agree more.

Each of the chapters contains a final section on the interpretation and geological applications of the experimental results, and suggestions as to how gaps in the knowledge may be filled. Overall, this is an extremely valuable reference work for the specialist granite petrologist. Basalt people and granulite petrologists could also profit by reading it. This book belongs in institutional libraries and on the bookshelves of those crazed individuals who dedicate their academic lives to solution of the greatest puzzle in crustal petrogenesis. J.D. Clemens

Craig, J.R. and Vaughan, D.J. *Ore Microscopy and Ore Petrography*, 2nd Edition, Chichester and New York (John Wiley and Sons, Ltd). 1995 xiv + 434 pp. Price £18.95. ISBN 0-471-115991.

Some geology textbooks prove to be invaluable as sources of information or handy reference books whereas others, for no apparent reason, lie in nearly mint condition on the bookshelf, read through once then consulted very occasionally for a very limited range of points. It is often not obvious why books fall into the former category; ease of use, logical layout of topics and information so that data may be found without recourse to the index may all contribute, or it may just be a personal response conditioned in the formative stages of one's training. Craig and Vaughan's *Ore Microscopy and Ore Petrography* has been in constant use, readily accessible for reference, lying beside my reflected light microscope. For a paperback book it has lasted very well considering the amount of use it has had. However, age and hard use have taken their toll and the cover has become raggy and, despite several running repairs with parcel tape, blocks of pages threaten to escape unless carefully looked after. The publishing