BOOK REVIEWS

Ashworth, J. R., ed. *Migmatites*. Glasgow and London (Blackie & Son Limited), 1985. x + 302 pp., 104 figs. Price £27·50.

The eight chapters in this well-produced book comprise a series of contributions to the origin of migmatites by eight researchers prominent in this field. It has been published at a time when anatexis is much more readily accepted, certainly by English-speaking geologists, than eighteen years ago when the now-classic book by K. R. Mehnert (*Migmatites and the origin of granitic rocks*) first appeared. Indeed, in the view of some, anatexis as a mechanism for migmatite formation is now too uncritically accepted! This book follows closely on the heels of the volume edited by M. P. Atherton and C. D. Gribble (*Migmatites, melting and metamorphism*) which contains the papers presented at a Geochemistry Group Meeting in Glasgow in 1982. In spite of some overlap of contributors and the short time interval between the two books, significant overlap has been avoided and the 'state of the art' chapters in this new book are extremely good scientifically. Four mechanisms are still regarded as possible processes for the formation of migmatites: partial melting and segregation of the initial melt; sub-solidus metamorphic differentiation by mechanical and/or chemical processes; *lit-par-lit* injection of a granitic magma along foliation planes; and, metasomatism, with the introduction of fluid and possibly potassium, or less commonly sodium. There is also the problem of 'closed' system versus 'open' system behaviour, the former favouring the processes of partial melting and/or metamorphic differentiation, the latter favouring metasomatism or igneous injection as the migmatite-forming process. Finally, two or more of these processes may operate together rather than independently in the formation of a particular migmatite terrain or outcrop and generalizations about migmatite-forming processes, even at outcrop scale, are a thing of the past.

Ashworth himself has written the introduction and in a mere thirty-five pages (including references) he has provided as good a review as I can imagine possible—well worth a read, especially by final-year students in petrology option classes seeking a way into the theories and voluminous literature of migmatites. The problem of the composition of allegedly anatectic leucosomes (i.e. the problem of incomplete segregation of melts which are mixtures of melt and residue, and the scarcity of K-feldspar in some migmatites) are introduced in this chapter and picked up elsewhere, e.g. in the case of the melt segregation problem by Johannes and by Olsen. Textures and structures as possible indicators of melt presence are introduced here and taken in depth in Chapter 5 by Ashworth and McLellan. Open and closed system behaviour are introduced but left to Olsen in Chapter 4 to deal with in depth.

An assessment of the experimental work in granitic systems as it relates to the origin of migmatites is provided by Johannes. This chapter contains a thorough critical review of the experimental work and, in particular, Johannes discusses the work of Winkler and Brietbart which may have been accepted too uncritically by some authors. Johannes also provides a series of suggestions for future research. These include the establishment of the protolith in each case (i.e. an assessment of the layer-by-layer transformation model of Johannes and Gupta versus the isochemical partial melting model of Mehnert); due consideration of the role of metasomatism (reflecting the realization of the polygenetic origin of many migmatites); the question of actual mineral compositions and their compatibility with the various possible models; the potential contribution from a study of fluid inclusions, a field pioneered by Touret and the subject of Chapter 8; the role played by deformation in migmatite formation, a feature touched upon by many of the contributors including Tracy; detailed geothermobarometry to determine the P-T-X_{H_2O} conditions during migmatization; and, further experimental work (e.g. on the solubility of mafic components in granitic melts and the composition of fluids in equilibrium with felsic phases). Johannes articulates what we already know; there is still much research to be done and still much to be learned about migmatites.

In Chapter 3 Grant reviews phase equilibria in partial melting of pelitic rocks, a topic fundamental to modern metamorphic petrology. This review considers sub-solidus equilibria, partial melting, melting under conditions where $P_{H_2O} = P_{total}$, melting where P_{H_2O} is less than P_{total}, vapour-absent melting and other problems related to the partial melting model such as the segregation of the liquid from the solid and the problem of high-temperature recrystallization after segregation and freezing of the melt. In the following chapter, Olsen considers the question of mass balance in migmatites and the problem of 'closed system', isochemical production of the leucosome except for the introduction of volatile components, and 'open system', non-isochemical production of the leucosome, behaviour. Local mass transfer, as might be

expected, occurs perpendicular to the leucosome–melanosome interface, whereas any external introduction of material along the strike of the leucosome becomes fairly uniformly distributed through the leucosome.

Ashworth and McLellan, in Chapter 5, argue that important information on migmatization processes may be gained from textures and an understanding of processes involved in the development of particular textures in spite of frequent subsequent modification of primary migmatization textures by post-migmatization events. Textural characteristics which have figured in the migmatite debate include grain size (pegmatitic *versus* aplitic), features regarded as resulting from crystallization of a melt (idiomorphic zoning in plagioclase feldspar, replacement textures such as myrmekite), grain shape, grain orientation, and grain contact relations (in which both Ashworth and McLelland themselves, together with Dougan, have built upon the early work of Kretz). Touret and Olsen, in Chapter 8, which might have been placed better before the regional examples of migmatite terrains, consider what might be gained from a study of fluid inclusions, a field pioneered in high-grade metamorphic rocks by Touret during the past fifteen years. It is axiomatic that some kind of fluid is necessary for the generation of migmatites, whatever the actual process of migmatization might have been, a fact reflected in the increased abundance of inclusions in the leucosome minerals, and in spite of the argument about whether or not the fluid preserved in the inclusions represents a sample of the fluid in equilibrium with the leucosome at the time of formation. In any case, the fluid in inclusions represents the only samples we have of the fluids associated in general terms with migmatites (although the methods of thermodynamics may allow the calculation of the fluid composition which must have been in equilibrium with the solid phases). The debate continues, however, over the source of the fluids now preserved as inclusions, especially the CO_2 in leucosomes and the late-stage H_2O in leucosomes. This topic relates to the current controversy in metamorphic geology over the origin of granulite facies mineral assemblages and variably LILE-depleted bulk rock chemistries—partial melting versus CO_2-flushing.

Finally, in Chapters 6 and 7, Tracy and Barr consider the development of migmatites in New England and the Moines, respectively; both of which are polyorogenic and polygenetic migmatite terrains. The New England region has become well known to metamorphic geologists during the last ten years through the work of Robinson and his co-workers and prominent among these has been Tracy who has written this comprehensive and instructive review. In contrast, Barr's work in the Moines brings fresh views to neglected migmatites in a classic part of British Isles geology. Unfortunately, the regional examples are restricted to these two migmatite terrains. Chapters on Scandinavian migmatites (where the great controversy originally started through the works of Sederholm and Holmquist, the famous 'arterite' versus 'veinite' debate) and Australian examples (e.g. Broken Hill or Arunta) would have been welcome and instructive.

In conclusion, this is an extremely useful book as an up-to-date review of and introduction to the subject of migmatites which is reasonably priced, especially considering that the market will be limited to final year undergraduate students and post-graduate research workers with an interest in petrology.

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Glover, J. E., and Harris, P. G., eds. *Kimberlite Occurrence and Origin: a Basis for Conceptual Models in Exploration.* Geology Department and University Extension, the University of Western Australia, Perth, 1984. 298 pp. Price (post free) $ (Australian) 26.

The discovery of diamond-bearing lamproite in Australia in 1976 meant that by 1985 Australia was a major producer of diamonds. A two-day seminar held at the UWA dealt with the origin of diamond-bearing lamproites and kimberlites. In the proceedings kimberlite terminology (Smith); geology (Janse, Sobolev); emplacement and volcanism (Dawson, Harris, Ferguson, and Jacques) are dealt with most succinctly as is the geochemistry of the lithospheric mantle based on xenolith studies (O'Reilly). A section on garnet inclusions in diamonds as genetic indicators (Gurney) summarizes much of the recent isotopic data on diamond inclusions. Using a similar technique the complexities of east Australian grossular–coesite-bearing diamonds are discussed (Sobolev). A well-illustrated section (Hall and Smith) reviews the recent diamond discoveries of Australia, and Jacques, Ferguson, and Smith describe the geology, petrography, and heavy mineral–nodule characteristics of the Australian lamproites. Although this meeting could have provided much more information on the unique Australian localities, it does provide a much-needed introduction to the Australian lamproites and their diamonds. A must for all those interested in 'keeping-up' with the kimberlite–lamproite literature [MA 86M/2327–2339].

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