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Geothermometry and Geobarometry —introduction

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THE following four papers are a representative subset of the talks that were given during a lively session at the 1989 Winter Meeting of the Mineralogical Society (19 and 20 December), organised by us on behalf of the Metamorphic Studies Group on the theme of 'Geothermometry and Geobarometry'. The talks at the meeting fell broadly into three groups: those dealing with fundamental problems of obtaining the requisite compositional and thermodynamic data, case studies of the applications of thermometers and barometers, and discussions of the limitations of the approach imposed by kinetic factors.

The first group of talks included contributions by T. J. B. Holland and J. Lieberman (co-authors M. Engi and R. G. Berman) dealing with perhaps the major hurdle in the way of reliable geothermometry and geobarometry: the question of activity–composition relationships for natural minerals. Holland took the examples of the pyroxenes and the plagioclase feldspars and showed, respectively, how Landau theory could be utilised to take account of ordering, and how Darken's quadratic formalism can take account of a structural break. Lieberman's contribution was based on the use of the PTX-system software (Perkins *et al.*, 1986) and showed that activity–composition models could be refined to minimise the discrepancies between different equilibrium curves calculated from a single set of mineral compositions from a given sample. There was further discussion on the use of internally-

consistent data bases, and most participants were impressed by the similarity of the results obtained from both the PTX-system and the THERMOCALC (Powell and Holland, 1988) software; their convergence provides grounds for optimism. Readers might like to note the recent review of such software systems by Bucher-Nurminen (1990).

In contrast to this general view, D. M. Kerrick showed that discrepancies in detail remain between different experimental studies of the Al-silicate polymorphs, and that these can be due to differences in starting materials. Schumacher, in the first paper of this published set, shows that calculations involving iron-bearing minerals require careful consideration of the oxidation state of iron when microprobe analyses are recalculated, a point also emphasised by B. J. Wood and L. T. Bryndzia in the context of upper-mantle oxygen fugacities. The value of the specific thermobarometer as a complement to the data sets is also clear from the careful analysis of the garnet-orthopyroxene barometer by D. A. Carswell which is published here, and which reiterates both the importance of careful recalculation of analyses of iron minerals and of good activity models.

The paper by Faulhaber and Raith in this set is an excellent example of several case studies that were presented. At a time when rather preliminary studies, based on brief investigations of a few samples, sometimes appear in print, this paper

demonstrates that a significant amount of additional information can be obtained by careful study.

A number of speakers at the meeting dealt with aspects involving diffusion, a subject which was introduced with great clarity in a keynote talk by J. Brady. The paper here by Crowley is an example, and demonstrates that, although diffusion is not important in the more refractory minerals over much of the metamorphic temperature spectrum, it does become significant at high grades and eliminates any information about a mineral's prograde history that might have been preserved in its zonation. An additional factor pointed out by E. McLellan is the role of deformation in promoting recrystallisation and hence readjustment of mineral chemistry.

The meeting ended on an optimistic note. The basic thermodynamic data for many minerals are now well known, and some progress is being made with the vast task of evaluating activity models for metamorphic minerals. Consequently, our ability to make sense of the complex textural and chemical information in metamorphic rocks is advancing apace. While the uncritical application of published thermometers and barometers is fraught with pitfalls, careful studies based on critical evaluation of all the data are adding considerably to our understanding of metamorphism. Kinetic effects determining the compositions of phases now available for us to observe

and analyse are becoming amenable to quantitative analysis. Geothermometry and geobarometry have held out the promise to the earth science community of a simple and rapid approach to determining many of the basic parameters that will help in the understanding of orogenic processes: that promise is rapidly being fulfilled.

This session was only possible through the efforts of the convenor of the 1989 Winter Meeting, David Price, and his colleagues at University College, and we would like to express our thanks to all of them for their hard work that made our session possible.

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