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Using quantitative phase petrology to understand metamorphism

Richard White
Institute for Geoscience, University of Mainz, Germany (rwhite@uni-mainz.de)

Quantitative phase petrology has become one of the mainstay methods for interpreting metamorphic rocks and processes. Its increased utility has been driven by improvements to end-member thermodynamics, activity–composition relationships and computer programs to undertake calculations. Such improvements now allow us to undertake calculations in increasingly complex chemical systems that more closely reflect those of rocks. Recent progress in activity–composition (a–x) relationships is aimed at developing suites of a–x relationships in large chemical systems that are calibrated together, which will allow a more direct application of the method to metamorphic rocks. In addition, considerable progress has been made in how quantitative phase diagrams can be used to understand features, including chemical potential diagrams for reaction textures, methods for fractionating bulk compositions and methods for modelling open system processes.

One feature of calculated phase diagrams is that they present us with a great amount of information, such as mineral assemblages, mineral proportions, phase compositions, volume or density etc. An important aspect to using this information is to understand the potential uncertainties associated with these, which are significant. These uncertainties require that calculated phase diagrams be used with caution to interpret observed features in rocks. Features such as mineral zoning and reaction textures should still be interpreted in a semi-quantitative way, even if based on a fully quantitative diagram. Exercises such as the interpretation of reaction overstepping based on relating phase diagrams to observed mineral core compositions are likely to give spurious results given the infelicities in existing a–x models.

Despite these limitations, quantitative phase petrology remains the most useful approach to interpreting the metamorphic history of rocks in that it provides a theoretical framework in which to interpret observed features rather than a literal truth