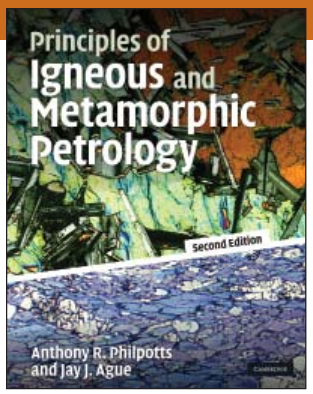
PRINCIPLES OF IGNEOUS AND METAMORPHIC PETROLOGY[2]



Principles of Igneous and Metamorphic Petrology, second edition, is a welcome update of the volume originally published in 1990, authored by Anthony Philpotts alone, which became the definitive reference for petrologists. The term "principles" in the title is the key here. The second edition covers nearly all aspects of petrology; there are thorough, in-depth treatments of everything from thermodynamics, heat transfer, kinetics, crystal growth and emplacement mechanisms to phase diagrams, petrography and isotopes. The flow is fairly logical – the chapters "Magmatic Processes" and "Igneous Rock Associations" build on material covered earlier in "Thermodynamics," "Phase Equilibria" and "Crystal Growth." What there is less of is geochemistry. Of course this is a separate topic in itself, and there are plenty of excellent geochemistry texts available. Nevertheless, modern petrology does rely heavily on geochemistry, and although isotopes, for instance, warrant a separate chapter, the application of trace elements to magmatic processes is limited. I don't recall seeing a single normalised trace element (or REE) diagram, although for many, that may not be such a bad thing!

The real quality of this book lies in its authoritative character and depth of coverage. This is enhanced by the integration of research-based information from journals. There are 26 pages of carefully selected references, as up to date as 2007. The text is complemented by crisp, clear diagrams and photographs, including some taken from publications. These are all in black and white, but this detracts little from the quality and doubtless saves some cost. After all, this is not a coffee table book, but rather a volume which will likely be well thumbed and littered with "stickies" and other place markers by students and professors alike. The copious use of photomicrographs is an important feature, and they are a reminder of the critical need for careful microscope examination before time and resources are diverted to quantitative analyses and modelling. The photomicrographs are complemented by colour versions on the book's website and by a companion petrographic guide by the main author. The text does not shy away from quantification and includes some challenging end-of-chapter numerical problems (sufficiently challenging that I would like to have had access to *all* the solutions!). The introduction of now widely used computational tools, such as MELTS and THERMOCALC in igneous and metamorphic petrology, respectively, adds to the rigour of the book.

For me, one of the excellent aspects of the book is the clever integration of different perspectives of petrology – for instance, the illustration of alkali feldspar phase relations, which is typically simply achieved through an *X*–*T* section, is shown as a three-dimensional sketch with *X*–*T* sections along varying X_{H2O}. These diagrams are accompanied by two photomicrographs to show how hypersolvus and subsolvus textures relate to the phase diagrams. Similarly, the Di–Ab–An phase diagram is accompanied by a photomicrograph showing how the curved plag–cpx grain boundary formed by progressive crystal growth reflects the phase diagram. This is typical of the innovative approach in many of the diagrams. Double-diffusive convection, for instance, is illustrated by combining cartoon magma chambers with photos of appropriate tank experiments, and the finger-like protrusions along the periphery of the Shonkin Sill are illustrated by analogy with a photo of a fried egg (along with an explanation of the viscosity control, lest this seem simply frivolous!).

Compared with the first edition of *Principles*, the main change (other than the addition of author Jay Ague) is in the physical quality of the book itself, which is perhaps related to the change of publisher to Cambridge University Press. The pages are of thicker, better quality paper (my copy of the first edition is impressively yellowed despite being less than 20 years old). The basic structure is quite similar – the chapter titles in the igneous section are unchanged, while those in the metamorphic section are restructured, reflecting the addition of Ague's expertise and perspectives. The metamorphic section (which, as an igneous petrologist, I am less qualified to assess) is markedly enhanced by a wealth of additional images – field photographs, photomicrographs and line drawings – compared with the first edition. Overall there are an additional ~170 pages compared with the first edition, and the updates certainly make the second edition a worthwhile purchase. These updates include, for instance, Wark and Watson's 'Ti in quartz' geothermometer, an updated compilation of diffusivities, crystal size distributions (CSDs) backed up with all the necessary theory, a 2005 InSAR image of the East African Rift showing the spectacular deformation accompanying recent eruptions, and the recently discovered ultrahigh-pressure terranes.

The book is designed as an advanced text and will certainly succeed in challenging even the brightest graduate students. The fact that it covers both metamorphic and igneous petrology may not increase its chances of adoption, as few instructors will be as competent in both subjects as the advanced level of presentation requires. Even at schools where advanced igneous and metamorphic petrology are taught as a single course, it is usually done by more than one instructor, each of whom has his or her own favourite texts. That won't stop this volume from being an essential reference for professional/academic petrologists and geochemists.

Are there weaknesses in the book? In a sense it is a "classical" petrology text. The description of rock classifications and associations harks back to the era of Carmichael, Turner and Verhoogen, and the authors miss the opportunity to fully integrate the excellent fundamentals presented with plate tectonic environments, which, as we now recognise, dictate nearly all aspects of magmatism. Igneous practitioners will need to keep a copy of Wilson's *Igneous Petrogenesis* (unfortunately now quite dated) alongside Philpotts and Ague to achieve the ideal mix of modern petrology–geochemistry–plate tectonics. Nevertheless, at less than $100, *Principles of Igneous and Metamorphic Petrology* is a "must-have" for any self-respecting petrologist.

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2 Philpotts AR, Ague JJ (2009) Principles of Igneous and Metamorphic Petrology, Second Edition. Cambridge University Press, New York, 667 pp, ISBN 978-0-521-88006-0, US$90