Preface

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The Sixth Hutton Symposium on the Origin of Granites and Related Rocks was held on July 2–6, 2007 at the University of Stellenbosch, South Africa, founded on granite, nestled at the feet of towering mountains and fringed by the rolling wine-lands of the Western Cape. This Special Issue opens with Master's historical account of how the Cape granites influenced 18th and early 19th century thinking on the origins of these rocks. The fascinating fact is that the granites of the Western Cape were apparently the first intrusive granites recognised outside Britain. The balance of the volume contains a collection of research papers derived from the meeting and illustrates some of the important directions in which granite research may be evolving. One of the characteristics of the papers and talks presented at the meeting was that there seemed to be some shift in interest, away from the crust as a source of granitic magmas and towards mantle rocks that have been metasomatised by subduction-zone fluids or melts. Nevertheless, the crust still holds pride of place as the cradle of granite genesis.

The next 15 papers fall into four groups. Those concerning the origins of the magmas themselves include Martin *et al*., Moyen *et al*., Turner & Rushmer, Longridge *et al*. and Bédard. Martin and his co-workers deal with sanukitoids and Closepet-type magmatism. Both these kinds of magmas are effectively unique to the period of time that marks the transition between the Archaean and the Proterozoic, and both are believed to be produced by partial melting of enriched mantle, rather than the crust. Martin *et al*. present their ideas on how the Archaean mantle was enriched, and they correlate the production of these distinctive magmas with the temporal evolution of heat production in the planet. The enrichment theme is continued in the paper by Moyen *et al*., who describe geochemical differences among Archaean TTG rocks (tonalites, trondhjemites and granodiorites) that lead them to recognise three subgroups whose chemistry they interpret as reflecting the degree of source enrichment and the depth of melting. Turner & Rushmer draw a parallel between the continental flood basalts and some A-type granites that they interpret as being mantle-derived. They note the geochemical similarities between rhyolitic rocks that cap flood basalt sequences and some kinds of A-type granites. They suggest that these A-type granitic rocks were produced by fractionation of basaltic parent magmas. Staying with the theme of mafic magmas, Longridge *et al*. examine the thermal effects of the Bushveld Complex on underlying metapelites. They show how partial melt from the metapelites was segregated, and they describe structures that indicate slow, buoyant diapiric ascent of the felsic magma, attended by ductility enhancement that allowed the formation of marginal shear zones. Bédard presents a model for the production of different types of anorthositic magmas by partial melting either of basaltic arc crust or of mantle enriched by subduction-derived fluids. He goes on to speculate as to why anorthositic magmas may or may not be present in a terrane, depending on temporal changes in lithospheric heat-production.

The papers dealing with the construction of plutons and emplacement include Bons *et al*., Horsman *et al*., Razanatseheno *et al*. and Benn. Considering the mechanisms of melt transfer from partially molten source to pluton, Bons *et al*. challenge the idea of a continuum model, with small veins progressively feeding ever-larger veins and dykes. Instead, they outline the features of, and evidence for, a model involving stepwise accumulation of melt volumes, arguing that the full range of vein/dyke sizes never coexists in nature. Horsman *et al*. describe evidence for the multi-pulse assembly of some shallow-level plutons in a tectonically-quiescent regime. They describe a progression from sill to laccolith to piston-type emplacement as the magma systems increase in volume. Focusing on a crudely-zoned pluton in Madagascar, Razanatseheno *et al*. provide structural and AMS (anisotropy of magnetic susceptibility) evidence of steeply-inclined magmatic foliations and lineations reflecting upward flow of the magmas, to fill the pluton in pulses of different composition. Benn continues the theme of AMS as a tool to study the structural evolution of plutons during and after their magmatic histories. He demonstrates that fabrics formed during the emplacement of syn-tectonic plutons can be distinguished from the effects of post-emplacement deformation, and that the post-emplacement fabrics can be used to shed light on regional bulk kinematics.

Several of the papers are concerned with the mechanisms by which granitic plutons acquired their internal compositional diversity. Clemens *et al*. review the evidence from a broad range of granitic bodies and find a common lack of evidence for significant degrees of differentiation. Departing from conventional wisdom, they conclude that the heterogeneities in most granitic bodies were not brought about through crystal fractionation, magma mixing, restite unmixing or any other differentiation mechanism, but were inherited from the magma sources and only slightly modified thereafter. In contrast, Economos *et al*. examine the causes of compositional diversity in the Tuolumne batholith, taking the Half Dome granodiorite as their example, and conclude that fractionation was the dominant process. Taking a less conventional approach to these kinds of problems, Müller *et al*. review the evolution of Late Hercynian felsic magmas through the study of quartz crystals in the rocks. They use cathodoluminescence imaging, Fourier-transform infrared spectroscopy and electron probe microanalysis to reveal the growth and alteration features that reflect the changes in magma compositions (including dissolved H_2O content) and crystallisation conditions. Features such as adiabatic and non-adiabatic magma ascent, temporary storage of magma and mixing with more mafic magma can all be discerned, illustrating the utility of this technique for tracing a magma's history.

The balance of the volume consists of three papers presenting specific case studies that range from work on prospective protoliths for granitic magmas and the processes of melting and magma migration to a study of the genesis of some anorthositic magmas. Jung *et al*. use garnet REE zoning patterns to reveal the intricacies of chemical equilibrium and disequilibrium during partial melting of metasedimentary rocks in the Damara orogen of Namibia. The results have importance for the understanding of REE patterns in

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crustally-derived granitic magmas. In the context of granitic magmatism in continental collision zones, Searle *et al*. investigate the formation of Himalayan granites. They find that, here, fluid-absent, mid-crustal melting of the Proterozoic protolith was due to a combination of thermal relaxation and high rates of internal heat production. Both mantle heat sources and the oft-cited shear-heating mechanism are ruled out. Finally, in a return to the mantle whence, it has been claimed, all good things come, Hoshide & Obata describe the fractionation mechanisms, in the Murotomisaki gabbro (Japan), that led to the production of layers of felsic magma. Surprisingly, it seems that flushing by aqueous fluids led to preferential remelting of plagioclase, and the formation of anorthositic layers that spawned diapiric upwellings within the magma body.

From the above it will be apparent that there is a great degree of variety here, and something for nearly every taste. If these papers represent the present thrust of granite-related research, it would seem that we can expect future progress particularly in understanding (1) the melting processes that lead to the formation of granitic magmas; (2) the physical, chemical and kinetic controls on the compositions of granitic magma; and (3) the relationships between the production of magma pulses and the mechanisms and time-scales of pluton construction and magma flow within plutons. As with most predictions, this is probably incorrect. In any case, it will be fascinating to see what themes dominate in the next Hutton Symposium.

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