Assembling granitoid batholiths: the petrogenesis of the Donegal batholith, Ireland

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Granitoid rocks (*sensu lato*) are the crustal legacies of thermal disturbances that initiate melting in the mantle and along the base of the crust. Buoyancy contrasts and the exploitation of favorable structures facilitate the upward transport of magma and the assembly of large, composite batholiths. Despite more than a century of research, their origin, melting duration, influence of magma source(s), mode(s) of emplacement, and the relationship to orogenic events remain poorly understood. Traditionally, the study of granitoid batholiths used a combination of field relationships, whole-rock geochemistry, and entire-mineral dating. However, important petrogenetic questions were not resolvable with the techniques available. The advent of new petrochronological (determination of how rocks or minerals grow with time) and micro-beam analytical techniques provide data with a high spatial resolution for unravelling the evolution of complex igneous systems. Micro-beam methods permit the rapid collection of "timestamped", isotopic and geochemical datasets with the ability to document geological variability at the micron scale in minerals. Evaluating how the isotopic and trace element compositions evolve will elucidate the sources and processes operating during batholith emplacement. The Silurian to early Devonian Donegal batholith is a classic example in Ireland of a composite batholith emplaced over ca. 30 myr. Emplacement of the batholith resulted from episodic magma pulses following oceanic slab failure (break-off) after the Iapetus Ocean closed during the Ordovician. New in-situ LA-ICP-MS zircon U–Pb geochronological data and in-situ LA-ICP-MC-MS zircon hafnium isotopic data, in addition to complementary whole-rock geochemical and petrographic data, provide important petrogenetic information about the magma sources and processes that were active during the assembly of the Donegal batholith.

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