Resolving Lower Crustal Thermal Histories with U-Pb Thermochronology

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Geophysical processes impart characteristic thermal signatures to the lithosphere. Traditionally, the thermal evolution of the lithosphere is recovered through the interpolation of discrete temperature-time points, generated by assigning estimates of nominal closure temperatures to volume-averaged radiometric ages. Whilst informative, bulk thermochronology results in low-resolution thermal history information. Rather, the highest resolution record of thermal history information is captured by intracrystalline concentration profiles [1, 2, 3]. Here we present the results of a combined LA-ICPMS and ID-TIMS U-Pb study on rutile grains from two garnet-bearing mafic granulites from a kimberlite in the Archean Slave province [4]. Interpreted using numerical models, we show that the rutile U-Pb isotope systematics are consistent with slow-cooling following crystallization at ~1.2 Ga, contemporaneous with the Mackenzie dike swarm. Inversion of rutile U-Pb age gradients is complicated by the ubiqutous presence of ilmenite lammellae. We suggest that these lamellae act as fast diffusion pathways for Pb and High Field Strength Elements. The effect of lamellae on rutile U-Pb closure temperature is explored using numerical models and EPMA characterization. Results serve to improve current understanding of how rutile U-Pb thermochronology can be applied to trace the thermal evolution of the lower crust – a critical charge to addressing the processes that stabilize continental lithosphere.

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