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Constraining the thermal architecture and structural evolution of the late Mesoproterozoic Grenville orogen in Canada

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The c. 1.1–1.0 Ga Grenville orogen is thought to be analogous to the Himalayan-Tibetan orogen in terms of featuring double-thickness crust (70-80 km), high-temperature metamorphism (>800 ˚C) and a plateau-like architecture [1]. The wide range of recorded peak *P-T* conditions and metamorphic ages (~3–19 kbar, 500–1000 ˚C, and 1090–980 Ma [2]) provide an extensive dataset with which to understand the evolution of the middle and lower crust during orogenesis. Furthermore, the range of accessible structural levels allows orogen-scale temperature-deformation feedbacks to be studied, as temperature exerts a strong control on crustal rheology [3].

We integrate field observations with phase diagram modelling and U-Pb monazite geochronology of samples collected along a 170 km transect of the Grenville orogen parallel to Georgian Bay in Ontario, Canada, that starts in the footwall of the sole thrust ("Grenville Front") and crosses two structurally overlying thrusted domains. The constrained *P-T* array increases up-temperature along the kyanite-sillimanite transition to peak conditions of ~10 kbar at 800 ˚C, documenting a slightly higher *P/T* gradient than that typically found in collisional orogens (i.e. "Barrovian" metamorphic sequences [1]). A steep thermal gradient is observed in the proximal hanging wall of the sole thrust, with consistent peak metamorphic conditions of 8–9 kbar and 700–800 ˚C documented in the two overlying thrusted domains, consistent with the syn-metamorphic nature of deformation fabrics. Dating results indicate that these conditions were attained at *c.* 1060–1050 Ma in the lower thrusted domain. A broader age bracket for the upper domain (1100–950 Ma) is consistent with greenschist-grade overprinting of older high-grade metamorphic fabrics.

We combine the *P-T* results with an available crustal seismic reflection profile [4] to inform thermal modelling. Collectively, these data provide insights into the orogen's thermal and structural evolution, with implications for the evolution of the lower and middle crust during collisional orogenesis.

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