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Two-sided accretion and plateau-scale reworking of the Rae craton during Nuna assembly

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The Rae craton, one of the principal building blocks of the Canadian Shield, occupied an upper-plate position within an oppositely verging, double-sided subduction system during the assembly of the supercontinent Nuna (<1.96 Ga). It therefore provides a natural laboratory for examining the dynamics of two-sided accretion systems in the Precambrian.

Along its northwestern margin, the Boothia-Somerset region preserves a complex poly-cyclic tectono-metamorphic history, the latter stages of which are associated with the Thelon orogeny, which involved east-dipping subduction, arc magmatism, back-arc extension, and crustal thickening. This evolution is recorded in two metamorphic stages that postdate deposition of <1.96 Ga carbonate-clastic strata (Sequence 3). Integrated LA-ICP-MS trace-element mapping and phase equilibria modelling of metaplutonic and metasedimentary units document an initial ultra-high-temperature event at ca. 1.945 Ga (≥1000°C at mid-crustal pressures), followed by renewed burial and high-grade metamorphism at ca. 1.94-1.93 Ga, with a subsequent high-temperature overprint at ca. 1.87 Ga.

The eastern Rae records a post- ca. 1.95 Ga tectono-metamorphic evolution (Snowbird and Trans-Hudson orogenies) involving west-dipping subduction, rapid cooling, regional-scale extension, lithospheric thinning, and syn- to post-collisional ultrapotassic magmatism. These features are interpreted to reflect gravitational collapse of a previously thickened orogenic crust. The spatial continuity of granulite- to locally eclogite-facies (>14 kbar) assemblages, the scale of deep-crustal uplift (>400,000 km²), and subsequent extensional reactivation, constrained by thermodynamic modelling coupled with geochronology and thermochronology, support the development of a large Paleoproterozoic orogenic plateau within the composite upper plate during Trans-Hudson convergence. The style of crustal thickening, high-grade metamorphism, and subsequent decompression melting at ca. 1.83 Ga, is comparable to the complex regional distribution of deformation and magmatism preserved in the upper plate region of the Himalayan-Tibetan system.

Collectively, these integrated mineral-scale trace-element data and quantitative P-T-time constraints demonstrate that the Rae craton preserves evidence for one of the earliest large-scale, modern-style orogenic plateau collapse systems developed within a two-sided accretionary framework during the assembly of Nuna.