Deciphering the burial and unroofing history of the Slave craton from apatite (U-Th)/He thermochronometry

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Archean cratons are unique in that are considered qualitatively stable and immune to tectonism. However, many continental interiors are characterized by repeated episodes of burial and unroofing, as recorded by thick sequences of Phanerozoic strata interspersed with widespread unconformities. Phases of denudation and aggradation may thus reflect low amplitude, long wavelength vertical motions of cratons through time and signal a more dynamic history to cratonic regions that traditionally recognized. Kimberlites, dike swarms, and mantle plumes represent deep-seated thermal and mechanical perturbations to the cratonic lithosphere and may be intimately linked with patterns of subsidence and surface uplift, superimposed on the record of eustatic sea level change. The discrete lithotectonic blocks of differing age and architecture that make up cratonic regions introduce additional complexity into these patterns, owing to the possibility of these distinct blocks responding differently to younger perturbations.

The Archean Slave craton in the Canadian shield provides an exceptional opportunity to examine the low temperature cooling patterns and burial and unroofing history of such cratonic regions because it is pierced by kimberlites ranging from Cambrian to Cretaceous in age. Although the craton is currently devoid of Phanerozoic cover, some kimberlites contain sedimentary xenoliths that record snapshots of the extent and, in some cases, the thickness of strata across the craton during Phanerozoic time. We acquired apatite (U-Th)/He thermochronometry data on a suite of nine samples along an E-W transect from the interior of the Slave craton into the adjacent Paleoproterozoic Wopmay orogen to more fully constrain the magnitude, extent, and timing of past burial and unroofing episodes and to assess whether differential unroofing occurred across this major lithospheric boundary.

Archean rocks from the craton yielded mean dates of 242 to 296 Ma and Paleoproterozoic rocks of the Wopmay orogen yielded mean dates from 212 to 231 Ma. We use these results, combined with geologic and stratigraphic constraints, to decipher minimum burial temperatures and corresponding burial depths during the Phanerozoic. These data require a thermal history characterized by burial to depths >2 km between 400 and 225 Ma, followed by unroofing to near-surface conditions by ~145 Ma with minimal reheating during the Cretaceous and early Tertiary. The uniformity of the apatite (U-Th)/He dates indicates that there was no major differential unroofing across the boundary between the Slave craton and Wopmay orogen in Phanerozoic time, and suggests that these lithotectonic blocks responded to lithospheric perturbations as a cohesive unit.