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Plume-driven recratonization of deep continental lithospheric mantle - 2022 Shen-Su Sun Award

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Cratons are Earth's ancient continental land masses that remain stable for billions of years. The mantle roots of cratons are renowned as being long-lived, stable features of Earth's continents, but there is also evidence of their disruption in the recent and more distant past. Despite periods of lithospheric thinning during the Proterozoic and Phanerozoic eons (the past 2.5 billion years), the lithosphere beneath many cratons seems to always 'heal', returning to a thickness of 150 to 200 kilometres; similar lithospheric thicknesses are thought to have existed since Archaean times (the past 4 billion years). Although numerous studies have focused on the mechanism for lithospheric destruction, the mechanisms that recratonize the lithosphere beneath cratons and thus sustain them are not well understood. Here we study kimberlite-borne mantle xenoliths and seismology across a transect of the cratonic lithosphere of Arctic Canada, which includes a region affected by the Mackenzie plume event 1.27 billion years ago. We demonstrate the important role of plume upwelling in the destruction and recratonization of roughly 200-kilometre-thick cratonic lithospheric mantle in the northern portion of the Slave craton. Using numerical modelling, we show how new, buoyant melt residues produced by the Mackenzie plume event are captured in a region of thinned lithosphere between two thick cratonic blocks. Our results identify a process by which cratons heal and return to their original lithospheric thickness after substantial disruption of their roots. This process may be widespread in the history of cratons and may contribute to how cratonic mantle becomes a patchwork of mantle peridotites of different age and origin [1].

[1] Liu et al., 2021 Nature, 592, 732-736.