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Has the Thermal Structure of the Cratonic Lithosphere Changed Over Time?

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Secular variations in the temperature, thickness, and composition of the cratonic lithospheric mantle remain widely debated due to their influence on low-volume magmatism, ore deposit formation, and lithospheric geodynamics. Previous studies have inferred these changes using whole-rock compositions of volcanic rocks (e.g., basalts and komatiites), thermal modeling, and other mantle-derived samples (Herzberg et al., 2010). In this study, we analyse long-term trends in the thermal structure of the cratonic lithospheric mantle using a database of >10,000 mantle xenoliths and xenocrysts from kimberlites and related volcanic rocks, spanning emplacement ages from the Miocene to the Paleoproterozoic. We integrate sample compositions with geothermobarometry and new paleogeotherm modeling techniques to estimate the depth of the lithosphere-asthenosphere boundary (LAB) over time. Our results indicate that the thermal structure of most cratons have remained largely unchanged since at least the Mesoproterozoic. We infer that mantle potential temperature (Tp) has decreased by less than 100°C over the past 1.3 Gyr for most cratons (Sudholz and Copley, 2025) Future work should explore the implications of these findings for volatile storage in the mantle and the generation of mantle-derived magmas, including kimberlites and lamprophyres.

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Sudholz, Z. J., & Copley, A. (2025). Xenolith constraints on the mantle potential temperature and thickness of cratonic roots through time. *Geophysical Research Letters*, *52*(2), e2024GL112851.