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New constraints on African and North American kimberlite emplacement and their connection to LLSVPs

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Kimberlites are relatively rare ultramafic igneous rocks commonly emplaced on Archean cratons. They are widely distributed, and several hypotheses have been proposed to explain their emplacement. In this study, we provide new constraints on the emplacement of African and North American kimberlites by backtracking their locations using the free GPlates software, as well as a kinematic model that allows us to go as far back as 1,800 Myr.

By considering several new, state of the art tomography models, we quantitatively assess the correlation between the present-day LLSVPs (Large Low Shear Velocity Provinces) location and backtracked kimberlite locations.

We show that most of the kimberlites with ages between 120 and 680 Ma occurring on the North American continent were located over LLSVPs when they were emplaced. More importantly, we show that quiet periods, during which few kimberlites were emplaced, can occur when the North American plate drifted between the Pacific LLSVP and the African LLSVP (Adam and Kempton, 2025). This indicates that LLSVPs have remained stable for at least 680 Ma and therefore play an essential role in creating and stabilizing global mantle flow.

Most kimberlites emplaced over the African continent were generated during the 260-0 Ma period (78%). During this period, 87% were generated over LLSVPs. This shows that deep mantle significantly controlled periods of intense kimberlitic magmatism during this period. Only 26% of the kimberlites older than 260 Ma were located over LLSVPs at the time they emplaced. This may indicate that (i) either the LLSVPs pattern around the African continent changed throughout time or (ii) that other phenomena such as rifts or edge driven convection facilitated the kimberlites emplacement.

Adam, C., & Kempton, P. D. (2025). Secular variation in the North American kimberlite formation: The variable connection to LLSVPs. Geochemistry, Geophysics, Geosystems, 26, e2025GC012528. https://doi.org/10.1029/ 2025GC012528