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Comparison of the Lake Inari and Lewisian terrains: Could both have formed in a prolonged Archean plume setting?

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The transformation of basaltic crust into thick, buoyant felsic crust with a tonalite-trondhjemite-granodiorite (TTG) composition was a key process in Earth's evolution during the Archaean Eon (4.03–2.50 Ga). Geochemical modelling and experimental studies strongly support TTG formation through the partial melting of hydrated mafic rocks, while growing field evidence continues to provide crucial insights into this process. Archaean terrains commonly preserve basaltic fragments of varying sizes interspersed with TTGs. In this study, we compare the ages and compositions of two Archaean terrains—the Lewisian gneisses of Scotland and the Lake Inari terrain of Finland—both of which exhibit a bimodal TTG-metabasalt association and diverse migmatite structures, including metatexites, metatexite-diatexite transitions, and massive diatexites. The Lake Inari terrain TTGs range in age from 2900 to 2600 Ma, while the Lewisian gneisses of the Scottish mainland and the Outer Hebrides date from 3100 to 2700 Ma. These age distributions suggest a prolonged phase of migmatization spanning hundreds of millions of years, during which partial melting led to the accumulation of melts—first in isolated patches, then in melt bands, and eventually across larger regions. This prolonged melting may have been driven by sustained heat from a stationary mantle plume. The intermingling of partial melts from high- and low-HREE TTGs suggests a common source material rather than distinct tectonic settings. We interpret both complexes as evidence of extensive migmatization in the deeper layers of an overthickened basaltic plateau, driven by a mantle plume and aligned with a stagnant or sluggish lid tectonic regime. Our findings suggest that the partial melting of plateau basalts, leading to the production of buoyant TTGs, may have played a crucial role in the initiation of continental evolution.