

From Field Evidence to Geochemical Insights: The Generation of Archaean TTGs

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Balz Kamber, a distinguished researcher in Earth Sciences, has significantly advanced our understanding of Archaean crustal evolution. This study contributes to research on early crust formation by linking field evidence on tonalite-trondhjemite-granodiorites (TTGs), recognised as products of hydrated mafic rock melting and contributors to new continental crust, to petrogenetic models applicable to Archaean terranes worldwide. The Lake Inari migmatite-granitoid terrain in northern Finland provides a natural laboratory where the bimodal association of felsic TTGs and their basaltic precursors is spatially and genetically linked, as evidenced by leucosomes within the basalts. This physical relationship suggests that TTGs may form directly through basalt melting, making Lake Inari a valuable test case for geochemical modelling. The data from Lake Inari (Halla et al., 2024) confirm systematic trends supporting partial melting as the dominant TTG formation process. La/Sm increases from mafic rocks to TTGs, indicating progressive differentiation, but decreases at higher melting degrees, defining a specific melting range. Th/Nb increases with La/Sm suggesting that negative Nb anomalies result from partial melting and differentiation. On average, Th/Nb increases from 0.17 in basalt to 0.96 in TTG ($K_2O/Na_2O < 0.5$). The average TTG was modelled as an 18% partial melt of basalt, assuming a bulk D-value of 0.01 for highly incompatible Th. The source mineralogy follows the thermodynamic model of Palin et al. (2016) for 20% melting at 12 kb (~40 km depth). While 20% represents an upper estimate, an 18% melting estimate yields bulk D-values of 0.4–0.5 for Rb, Sr, U, and Th; 1.37 for Nb and Ta; and 3.4–2.7 for Lu, Yb, and Y. Th/Nb increases with La/Sm in TTGs worldwide, demonstrating its reliability as a geochemical indicator. The Lake Inari model is applied to other TTGs, allowing the distinction between TTGs derived from relatively high Th/Nb subduction-related sources and those formed in non-subduction settings, offering new insights into early continental growth. By linking field evidence with geochemical modelling, this study refines our understanding of Archaean crustal evolution. It exemplifies the interdisciplinary approach championed by Balz Kamber, whose legacy lies in bridging geochemical methodologies to address fundamental geological questions.