

The petrogenesis of late-stage K-rich granites in Archaean crust

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Archaean felsic crust commonly contains sequences of granitoid rocks that exhibit a temporal increase in bulk K_2O/Na_2O , documenting a transition from juvenile crust towards Late Archaean granite (*sensu stricto*). The emplacement of late-stage K-rich granite also marks the first appearance of rare lithium-bearing intrusions in most cratons; however, it is unclear whether low K_2O/Na_2O tonalite–trondhjemite–granodiorite (TTG) and/or “transitional TTG” rocks, which volumetrically dominate Archaean terranes, are involved in the formation of these Li-rich melts. In particular, the source composition (X), pressure (P), temperature (T), and water content (H_2O) that drive the transition from TTG to K-rich granites in the Archaean remain enigmatic.

Here, we use petrological modelling [1] to explore P-T-X- H_2O parameter space relevant to crustal melting in Archaean terranes, with particular reference to the sequence of TTGs (~3.5–3.2 Ga), transitional TTGs (~3.1 Ga), and late-stage granites (~2.8–2.7 Ga) preserved in the well-exposed Eastern Kaapvaal craton of Southern Africa. We find that anatexic melting of TTG-like protoliths can reproduce the average major-element composition of K-rich granites, particularly the shift from low (<0.5) to high (>1.5) K_2O/Na_2O . We then examine melting behaviour along likely metamorphic P-T paths related to orogenic deformation and contextualise our results within an assumed geodynamic framework relevant to the Neoarchaeon. Importantly, we also track trace element evolution to identify P-T-X- H_2O conditions that allow some late-stage K-rich granitic melts to become anomalously Li-rich. Our findings have implications for both the progressive chemical modification of Archaean crust, as well as fundamental mineralisation processes.

[1] Riel, N., Kaus, B. J., Green, E. C. R., & Berlie, N. (2022), *Geochemistry, Geophysics, Geosystems*, 23(7), e2022GC010427