Modelling TTG petrogenesis: Recent Advances and a Case Study from the Kapuskasing Uplift, Ontario

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Abstract:

Tonalite-trondhjemite-granodiorite (TTG) suites are the dominant component of Archean continental crust, but their origin remains debated. The trace element composition of TTGs is commonly used as a proxy of the tectonic setting of their basaltic source; elevated Sr/Y and La/Yb ratios are interpreted as evidence of high-pressure anatexis of subducted oceanic crust. However, non-subduction models for TTG genesis have also been proposed. Investigating the petrogenesis of TTGs can therefore provide crucial insight into the tectonic regime that operated on early Earth and gave rise to the first continents. Increasingly sophisticated thermodynamic models have become powerful tools in this field of research, as they allow for forward modelling of the metabasite source and calculation of expected TTG chemical compositions. Different scenarios may be tested, including the general effects of petrological processes on TTG composition and regional studies linking TTGs to possible sources.

I will discuss two TTG modelling studies that form part of my PhD thesis. The first tests the effect of three factors that may influence the composition of TTGs at their source: progressive loss of anatectic melt, fractionation of garnet cores from the system, and source metabasite composition. The results illustrate that the trace element signatures of TTGs can be linked to variables other than depth of melting. In the second study, thermodynamic modelling is used to test the genetic connection between TTGs and granulites in the Kapuskasing Uplift in the Superior Province. Two geochemical groups of TTGs are found, and preliminary modelling results indicate that the associated granulites may represent the source of one group. The other group, however, appears to be most consistent with a lower-T, higher-P eclogite-facies source. Integrating these results with geochronological data will be key to determining the significance of the TTG groups to the tectonic history of the Kapuskasing Uplift. As thermodynamic models are further refined, this technique will continue to provide valuable insights into the genesis of crustal rocks on Earth.

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