TTG formation: water-present melting as an alternative to high-pressure melting

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Chemical diversity in Archaean tonalite–trondhjemite–granodiorite (TTG) rocks has been commonly proposed to reflect variable depth of melting [1]. TTGs preserving 'high-pressure' signatures have been associated with deep subduction to >70 km depth [2,3] or overthickening of mafic plateaus [4]. However, the residual TTG source rocks are mostly absent and independent constraints on the Archaean tectonic regime(s) remain contentious. Despite more sporadic occurrence since 2.4 Ga, TTG suites are still present in the global Proterozoic record, and might serve as analogues for petrogenetic studies.

Here we demonstrate that a 1.56 Ga TTG plutonic suite from the Proterozoic Georgetown Inlier, NE Australia was derived from nearby partially melted metamafic rocks during the waning stage of a ~1.6 Ga continental collision. The TTG rocks have elevated Sr and low heavy rare earth element (HREE) and high field strength element (HFSE) contents and thus are comparable to Archaean 'high-pressure' TTGs. Field relationships, zircon geochronology and thermometry, phase equilibrium calculation, and trace element modelling collectively reveal that the 'high-pressure' TTG signature in the Georgetown Inlier was generated at relatively shallow depths (25–35 km). Enrichment in Sr over HREE and HFSE in the TTG melts resulted from plagioclase breakdown induced by the presence of a free water phase. TTG formation may be unrelated to a specific geodynamic environment, suggesting that the compositional variability of Archaean juvenile felsic rocks might need to be profoundly re-assessed.

[1] Moyen and Stevens, 2006, *GMAGU*, 164
[2] Martin, 1986. *Geology*, 14(9)
[3] Rapp, et al., 2003, *Nature*, 425(6958)
[4] Condie, 2005. *Lithos*, 80(1-4)