Generation of Palaeoproterozoic Tonalites and Associated High-K Granites in Southwestern Tanzania by Partial Melting of Underplated Mafic Crust in an Intracontinental Setting: Constraints from Geochemical and Isotopic Data

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Abstract
The southwestern part of the 2.0–1.8 Ga Palaeoproterozoic Usagaran Belt in the Njombe area of SW Tanzania is intruded by two types of synchronous granitic rocks with different chemical and petrological characteristics. The first type consists of hornblende-rich tonalites that have major element compositions similar to those of Archaean TTG but differ significantly in their trace element composition. The tonalites are spatially and closely associated with felsic, high-K, I-type granites, some of which are gneissic and/or aplitic. U–Pb zircon geochronology shows that the emplacement of tonalites at 1887 ± 11 Ma was largely contemporaneous with emplacement of high-K granitic gneisses at 1877 ± 15 Ma and aplitic granites at 1857 ± 19 Ma. The data also reveal the presence of Archaean crust of 2648 ± 25 Ma in the zircon cores of some samples in the otherwise Palaeoproterozoic terrane.
The tonalites are characterized by MgO contents of 1.60–4.11 wt.% at a SiO2 range of 58.1–67.9 wt.%, the Mg# of 34–55, lower Sr contents (220–462 ppm) and less fractionated REE patterns (La/YbCN = 3.55–12.9) compared to Archaean TTG (Sr > 500 ppm, La/YbCN > 20). These features, coupled with the εNd (1887 Ma) values of + 0.37 to − 0.66 as well as the associated mafic enclaves are suggestive of derivation of the tonalites by low pressure (below the garnet stability) partial melting of a mantle-derived mafic underplate that was subsequently contaminated with small amounts of pre-existing igneous crustal rocks. The evolved nature of the high-K granites (MgO = 0.20–1.30 wt.%, SiO2 = 65.5–73.9 wt.%, Mg# = 25–42, εNd = − 3.20 to − 4.75) coupled with old TDM ages which are 200–1000 Ma older than their emplacement age requires a higher degree of assimilation of older crustal material by the magma derived from partial melting of the underplated mafic crust which was subsequently followed by crystal fractionation involving plagioclase, pyroxene and amphibole.

The close spatial and temporal association of the tonalites, mafic enclaves and the high-K granites and gneisses in the Njombe area provides the first direct evidence of the role of magmatic underplating for the regional thermal anomaly that caused widespread crustal anatexis leading to the generation of the 1.8–1.9 Ga granitic rocks (in Njombe area) and/or associated felsic volcanism in the Usagaran (in Ndembera) and Ubendian (in Ngualla) Belts of SW Tanzania.

Keywords
Usagaran Belt;
Makambako–Njombe traverse;
Msusule tonalites;
High-K granites;
Palaeoproterozoic