Alternative ways to produce TTGs: Insights from the 3.43-3.48 Ga Tsawela gneisses, Ancient Gneiss Complex (Swaziland)

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It is widely accepted that the Archaean tonalite-trondhjemite-granodiorite (TTG) suite formed substantial by partial melting of hydrated mafic crust in the stability field of garnet-amphibolite and rutile-bearing garnet-pyroxenite. Yet, there is no consensus regarding the geodynamic setting in which these rocks formed and contributed to cratonic stabilization.. In Eo- and Palaeoarchean high-grade gneiss terranes deformation and migmatization have often obliterated the primary magmatic relationships, making it impossible to place constraints on the magmatic history of single intrusive granitoid suites.

We investigated the well-preserved, non-migmatitic 3.43-3.48 Ga dioritic to tonalitic Tsawela gneiss (TG) suite of the Ancient Gneiss Complex (AGC, Swaziland), that intruded the >3.5 Ga Ngwane Gneiss which represents the oldest compontent of the AGC. We used a combination of major and trace element chemistry, Hf-Nd whole-rock isotope systematics, Pb-Pb zircon geochronology and Hf-in-zircon isotope analyses to infer the magmatic evolution of these rocks. Geochemical modelling using major and trace elements suggests that the TG formed by mixing of partial melts of the Ngwane Gneisses and juvenile melts from mafic tholeiitic sources that do not show negative Nb-anomalies. Initial εHf and εNd values are +0.1 - +3.7 and -0.1 to +0.6, and initial εHf values of the zircons are +0.4 to +2.0, respectively, indicating that the isotope systems were efficiently homogenized during magma mixing of approximately equal amounts of tholeiitic magma and magma derived from partial melts of >3.5 Ga Ngwane Gneiss crust. Underplated and intraplated tholeiitic melts were possibly triggered by a mantle plume, which also triggered partial melting of the >3.5 Ga crust. Alternalitvely, fractional crystallization of wet mantle-derived melts could account for the compositional variability of the TG and its isotopic homogeneity. We propose that magma mixing and assimilation-fractional crystallization must be taken into account when crustal evolution models are derived based on Hf-Nd isotope compositions.