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# Eoarchean TTGs derived from thickened mafic arc crust

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Earth's first continental crust is largely composed of magmatic rocks with tonalitic-trondhjemitic-granodioritic composition (TTGs). TTGs are seen as originating either from melting of hydrated MORB-like oceanic crust in subduction zones similar to modern adakites or alternatively from melting within thickened mafic arc crust. To simulate formation of Eoarchean TTGs in different tectonic regimes we combine thermodynamic calculation of partial melting in mafic host rocks with subsequent modeling of trace element partitioning between residual assemblages and coexisting tonalitic melt. We compare water-absent partial melting of two hydrated starting compositions, a modern MORB and a typical Eoarchean arc tholeiite from the Isua Supracrustal Belt. The latter represents the country rock of World's oldest and arguably best-preserved TTGs, the Itsaq Gneiss Complex of SW Greenland. Isua tholeiites contain less Al and Na and more Fe and Mg as compared to present day MORB and are predicted to form amphibole-rich and plagioclase-free residues even at low pressures. At 10 kbar, modeled tonalitic partial melt of MORB displays a trace element composition very different from the ones observed in TTGs. At higher pressures (14 and 18 kbar), with an eclogite as residue, the modeled trace element compositions become more similar to natural ones, but several parameters are still amiss. Perfectly-fitting trace element patterns are achieved by using Isua tholeiite as host rock and melting pressures of 10 and 14 kbar. Some key observations in TTGs can only be reproduced using Isua tholeiite as protolith. These are, for instance, the pronounced negative Ti anomalies, the positive anomalies of Zr and Hf relative to Sm and Nd, and the variation in the Nb/Ta ratio. For some elements, e.g., Th and Ti, the better fit for the tholeiite protolith is partly inherited from the host rock, yet an appropriate fractionation by the residual phase assemblage is paramount. Formation of the Earth's oldest continental crust is therefore best explained by melting within tectonically thickened mafic island-arc crust.