Ultramafic rocks at the Isua supracrustal belt and East Pilbara Terrane are crustal cumulates, not slices of early mantle

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The initiation of plate tectonics remains enigmatic, with the proposed onset timing ranging from Hadean to Proterozoic. Recently, many mineralogical, petrological and geochemical studies suggest onset of plate tectonics at ~3 Ga. For example, the geology of East Pilbara Terrane (~3.55 to 2.70 Ga; Australia) is widely interpreted as representing Paleoarchean non-plate tectonics, followed by plate tectonics after a ~3.2 Ga transition. In contrast, Isua supracrustal belt (3.85 to 3.55 Ga; Greenland) has been dominantly interpreted via plate tectonics. There, two ultramafic lenses have been interpreted as depleted mantle slices, emplaced via thrusting in an Eoarchean subduction zone, implying early plate tectonics. We present new petrological and geochemical data of ultramafic samples from the Isua lenses and from the East Pilbara Terrane to explore their origins. Pilbara samples appear to preserve cumulate textures; protolith textures of Isua samples are altered beyond recognition. Samples with low chemical alteration show similar whole-rock chemistry, including up to 5.0 wt.% Al₂O₃ and up to 0.25 wt.% TiO₂ that both covary negatively with MgO (37.1 to 47.5 wt. %); these variations suggest cogenetic relationships with local lavas. Flat trace-element fractionation trends parallel those of local lavas in the primitive-mantle normalized spider diagram. Spinel crystals from Pilbara samples yield ~20-60 Mg#, relatively constant Cr# at ~70, and 0.61-4.81 wt.% TiO₂. Our data are consistent with crustal cumulate emplacement. In contrast with depleted mantle rocks, our samples have higher whole-rock Al₂O₃ and TiO₂, flat (vs. upward) trace-element fractionation trends from less to more compatible elements, and spinel crystals with higher TiO₂ and relatively constant (vs. varied) Cr#. Therefore, Isua and Pilbara ultramafic rocks may have similar, non-plate tectonic origins, and the Isua record allows a ~3 Ga onset of plate tectonics.