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Building the earliest preserved crust in the Pilbara Craton

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Granitoids from the Pilbara Craton in Western Australia are one of the most ancient and best-preserved records of early processes of continental crust generation. No consensus has been reached on whether this early crust originated from a chondritic or depleted mantle reservoir in the Eo/Palaeoarchaean. Zircon U-Pb and Lu-Hf isotopes data for granitoids sampled across the Mount Edgar Dome record four main magmatic events between 3.47 and 3.23 Ga. Whole-rock major and trace element analyses suggest that the samples belong to two distinct petrogenetic groups. The first group is part of the Tonalite-Trondhjemite-Granodiorite (TTG) suite, representing highly fractionated magmas initially formed by partial melting of a basaltic source. The second group, here classified as granites, is best interpreted by the remelting of a more felsic source. Strikingly, TTG-like and granitic magmas occurred coevally in time and space while showing a clear change from superchondritic to subchondritic Hf isotope compositions between 3.47 and 3.23 Ga. The superchondritic Hf isotope composition of the 3.47 Ga granitoids substantiates derivation from a depleted mantle source that separated from the chondritic mantle prior to 3.8 Ga. The presence of ca. 3.5 Ga inherited zircons in 3.3 and 3.23 Ga magmas suggests that crustal remelting processes were involved in their generation. We propose that all granitoids investigated in this study originated from a single mantle–crust differentiation event. This event resulted in the separation of two distinct crustal reservoirs from the depleted mantle, i.e., a mafic crust and a more felsic crust. Overall, our data suggest that protracted intra-crustal remelting processes and differentiation have played a key role in the formation, evolution and maturation of the building blocks of continents during the Palaeoarchaean.