Early Earth evolution of the Pilbara Craton, with implication for continental growth

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The granite greenstone terrains in the Pilbara Craton are some of the best-preserved Archean terranes on Earth making them ideal for tackling questions regarding growth of the continental crust during the early stages of Earth's history.

The Pilbara Craton has been suggested to have developed on a >3.8 Ga substrate of continental crust. Although gneisses with inherited 3.65 Ga zircon has been identified, no unambiguously igneous rocks older than 3.59 Ga has ever been identified in an outcrop.

Here we identify several new 3.59–3.58 Ga magmatic intrusions within the East Pilbara Terrane, the Mount Webber event, to date the oldest identified rocks in the Pilbara Craton. Furthermore, newly identified ~3.5 Ga intrusions in the Muccan and Carlindi Granitic Complexes identify the "lost supersuite", an intrusive contemporaneous equivalent to the extrusive Coucal Formation of the Counterunah Subgroup.

Collectively zircon U–Pb-O-Hf isotopes from the earliest igneous suites in different granitic complexes around the East Pilbara Terrane suggest the generation of a basement from a chondritic mantle source at ~3.7–3.5 Ga. Homogeneously chondritic zircon Hf signatures of >3.5 Ga intrusions and more heterogeneous isotopic signatures post 3.5 Ga suggest a ~3.5 Ga tectonic shift subsequently leading to differentiation of the upper mantle with respects to Lu–Hf. Zircon $\delta^{18}O$ indicates increased reworking incorporating supracrustal components post- 3.5 Ga, corroborating the zircon Hf isotopes. The shift in isotopic signatures coincide in time with the emplacement of the Warrawoona group and suggests a ~3.5 Ga change in tectonic regime within the East Pilbara Craton. Furthermore, the collective zircon U–Pb-Hf-O isotopic signatures of the oldest gneissic components in the Pilbara Craton do not support the existence of an older underlying basement (proto-crust).