

**Early Archaean crustal evolution:
evidence from ~3.5 billion year old greenstone
successions in the Pilgangoora Belt, Pilbara Craton,
Australia**

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ABSTRACT

In the Pilgangoora Belt of the Pilbara Craton, Australia, the ~3517 Ma Coonterunah Group and ~3484-3468 Ma Carlindi granitoids underlie the ≤ 3458 Ma Warrawoona Group beneath an erosional unconformity, thus providing evidence for ancient emergent continental crust. The basalts either side of the unconformity are remarkably similar, with N-MORB-normalised enrichment factors for LILE, Th, U and LREE greater than those for Ta, Nb, P, Zr, Ti, Y and M-HREE, and initial $\epsilon(\text{Nd}, \text{Hf})$ compositions which systematically vary with Sm/Nd, Nb/U and Nb/La ratios. Geological and geochemical evidence shows that the Warrawoona Group was erupted onto continental basement, and that these basalts assimilated small amounts of Carlindi granitoid. As the Coonterunah basalts have similar compositions, they probably formed likewise, although they were deposited >60 myr before. Indeed, such a model may be applicable to most other early Pilbara greenstone successions, and so an older continental basement was probably critical for early Pilbara evolution.

The geochemical, geological and geophysical characteristics of the Pilbara greenstone successions can be best explained as flood basalt successions deposited onto thin, submerged continental basement. This magmatism was induced by thermal upwelling in the mantle, although the basalts themselves do not have compositions which reflect derivation from an anomalously hot mantle. The Carlindi granitoids probably formed by fusion of young garnet-hornblende-rich sialic crust induced by basaltic volcanism.

Early Archaean rocks have Nd-Hf isotope compositions which indicate that the young mantle had differentiated into distinct isotopic domains before 4.0 Ga. Such ancient depletion was associated with an increase of mantle Nb/U ratios to modern values, and hence this event probably reflects the extraction of an amount of continental crust equivalent to its modern mass from the primitive mantle before 3.5 Ga. Thus, a steady-state model of crustal growth is favoured whereby post ~4.0 Ga continental additions have been balanced by recycling back into the mantle, with no net global flux of continental crust at modern subduction zones. It is also proposed that the decoupling of initial $\epsilon(\text{Nd})$ and $\epsilon(\text{Hf})$ from its typical covariant behaviour was related to the formation of continental crust, perhaps by widespread formation of TTG magmas.