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Geochemical and petrochronological investigation of >3.5 Ga orthogneisses from the East Pilbara Terrane

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In Archean granite-greenstone terranes, domes represent multiple granitic magmatic emplacement events preserved as variably deformed granitic gneisses. Commonly, the oldest granitic components occur as slivers of deformed gneisses along the interface between domes and adjacent greenstone keels.

The Callina Supersuite represent the first craton wide voluminous juvenile granitic magmatism in the Pilbara Craton between 3.49-3.45 Ga. However, rare pre-Callina orthogneiss complexes and detrital and inherited zircon attest to older Eoarchean to early Paleoarchean granitic crust. The extent of this early granitic crust is unclear. Thus, investigating rare pre-Callina granitic gneisses will yield valuable information on the initial formation of the Pilbara Craton.

Here, we present an integrated geochemical and petrological study on 3.5-3.6 Ga granitic orthogneisses from the southern margin of the Muccan Granitic Dome [1]. We show that these gneisses have no resolvable ^{142}Nd anomalies and yield $\varepsilon_{Hf(t)}$ of +1 to -3. The gneisses are petrologically and geochemically diverse, including epidote-bearing samples, and have been intensely deformed and migmatised during exhumation from >6 kbars at 3.4 Ga [1].

We propose that the pre-Callina gneisses formed from mafic precursor crust with chondritic to sub-chondritic ε_{Hf} without preserved Hadean components, which is consistent with previous studies that the Pilbara Craton does not contain evidence of contributions from Hadean enriched or depleted components. The paucity of pre-Callina gneisses in the Pilbara Craton indicates that these gneisses represent remnants of low volume felsic bodies that formed in proto-Pilbara thick mafic crust (>20km) over >100Ma by localised melting of hydrated mafic crust.

We hypothesise that the pre-Callina components mark the onset of continental crust formation in the Pilbara. Initially low volume granitic bodies remained trapped at depth with insufficient volume to overcome confining pressure. Thus, the earliest granitic magma bodies were emplaced at depth and only exhumed together with the subsequent voluminous Callina and Tambina Supersuite magmatic events.

[1] D. Wiemer, C. E. Schrank, D. T. Murphy, L. Wenham, and C. M. Allen, Nature Geoscience, vol. 11, pp. 357-361.