Paper Number: 5154

New apatite U-Pb thermochronological constraints on the development of granite-gneiss domes in the Mesoarchean eastern Pilbara craton

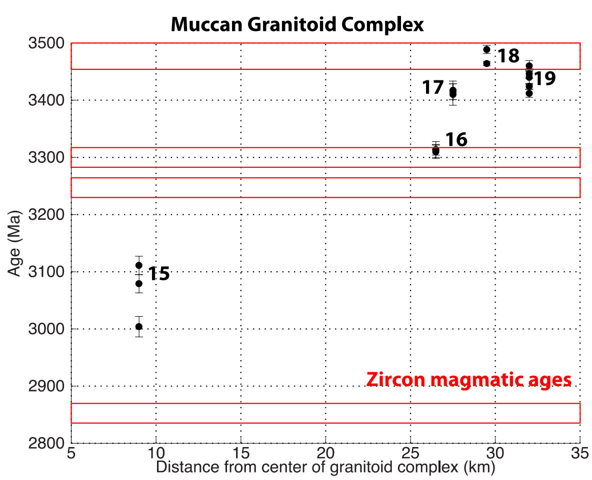
MacLennan, S.A.[1], Schoene, B.[1]

[1]Princeton University, Department of Geosciences, NJ, 08544, corresponding author: sam7@princeton.edu

---

Due to a scarcity of Paleo- and Mesoarchean crust, the Pilbara craton in northwestern Australia contains a unique record of the tectonic and environmental conditions on early Earth. A key lithotectonic aspect of this craton is the presence of "dome and keel structures", which refer to granite-gneiss domes flanked by greenschist facies metavolcanics and sediments. These structures are frequently found in Archean crustal fragments, a fact that has been used to argue for significant changes in tectonic style through Earth history.

Despite rigorous field mapping, geochemistry and geochronology, aspects of the thermo-tectonic evolution of the craton remain poorly understood. For this reason we have obtained apatite U-Pb ages (with a nominal closure temperature of 400°C) from three of the most prominent granite-gneiss domes to better understand their cooling and exhumation histories from the middle or lower crust.



Existing models for the formation of these granite-gneiss domes predict that exhumation of the felsic middle to lower crust occurred at ~3.3 Ga, coeval with felsic magmatism and structural doming. These models often invoke thermal incubation of the felsic middle crust after deposition of a ~15km thick pile of metavolcanics, leading to gravitational instability. Apatite dates from the three gneiss domes are generally distinct, with some showing considerable variability within single domes.

Figure 1: Apatite U-Pb ages from the Muccan gneiss dome

The Corunna Downs dome shows radial cooling patterns, where the center cooled ~15 Ma after the outer rim at ~3.31 Ga. This can be explained by cooling after diapiric or magmatic emplacement.
The Mt Edgar dome shows a larger range in ages from 3.3 to 2.95 Ga, that may indicate that portions of this dome were above ~400°C after 3.3 Ga. This could be explained either by late exhumation from the middle crust, or partial resetting of the U-Pb system by nearby 2.83 Ga post tectonic intrusions. Preliminary Pb diffusion forward models that incorporate the current locations of late intrusions indicate that their ability to disrupt the U-Pb system seems unlikely. Finally, the Muccan dome records ages between ~3.1 and 3.45 Ga. The ~3.45 Ga apatite ages on its southern margin necessitate exhumation of

this gneissic material during deposition of the overlying volcanic sequences, indicating these two units may not have been structurally coupled at the time; these data also exclude the Muccan dome from a regional doming event ca. 3.3 Ga.

These new additions to the thermo-tectonic record of the Pilbara craton indicate that the formation of dome and keel structures may have been polyphase, and have a longer history of development than previously expected. Further expansion of this dataset will allow for a more nuanced understanding of dome and keel structures and the thermal state of the crust during the Archean.