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Low temperature Phanerozoic history of the Northern Yilgarn Craton, Western Australia

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Abstract

The Phanerozoic cooling history of the Western Australian Shield has been investigated using apatite fission track (AFT) thermochronology. AFT ages from the northern part of the Archaean Yilgarn Craton, Western Australia, primarily range between 200 and 280 Ma, with mean confined horizontal track lengths varying between 11.5 and 14.3 μm. Time–temperature modelling of the AFT data together with geological information suggest the onset of a regional cooling episode in the Late Carboniferous/Early Permian, which continued into Late Jurassic/Early Cretaceous time. Present-day heat flow measurements on the Western Australian Shield fall in the range of 40–50 mW m^{-2}. If the present day geothermal gradient of $\sim 18 \pm 2$ °C km^{-1} is representative of average Phanerozoic gradients, then this implies a minimum of ~50 °C of Late Palaeozoic to Mesozoic cooling. Assuming that cooling resulted from denudation, the data suggest the removal of at least 3 km of rock section from the northern Yilgarn Craton over this interval. The Perth Basin, located west of the Yilgarn Craton, contains up to 15 km of mostly Permian to Lower Cretaceous clastic sediment. However, published U–Pb data of detrital zircons from Permian and Lower Triassic basin strata show relatively few or no grains of Archaean age. This suggests that the recorded cooling can probably be attributed to the removal of a sedimentary cover rather than by denudation of material from the underlying craton itself. The onset of cooling is linked to tectonism related to either the waning stages of the Alice Springs Orogeny or to the early stages of Gondwana breakup.

Keywords: Apatite; Fission track dating; Thermochronology; Denudation; Tectonics; Yilgarn Craton; Western Australia; Gondwanaland; Supercontinents

1. Introduction

The antiquity of rocks in the Western Australia shield combined with its relatively subdued topography has led to the notion that this continental

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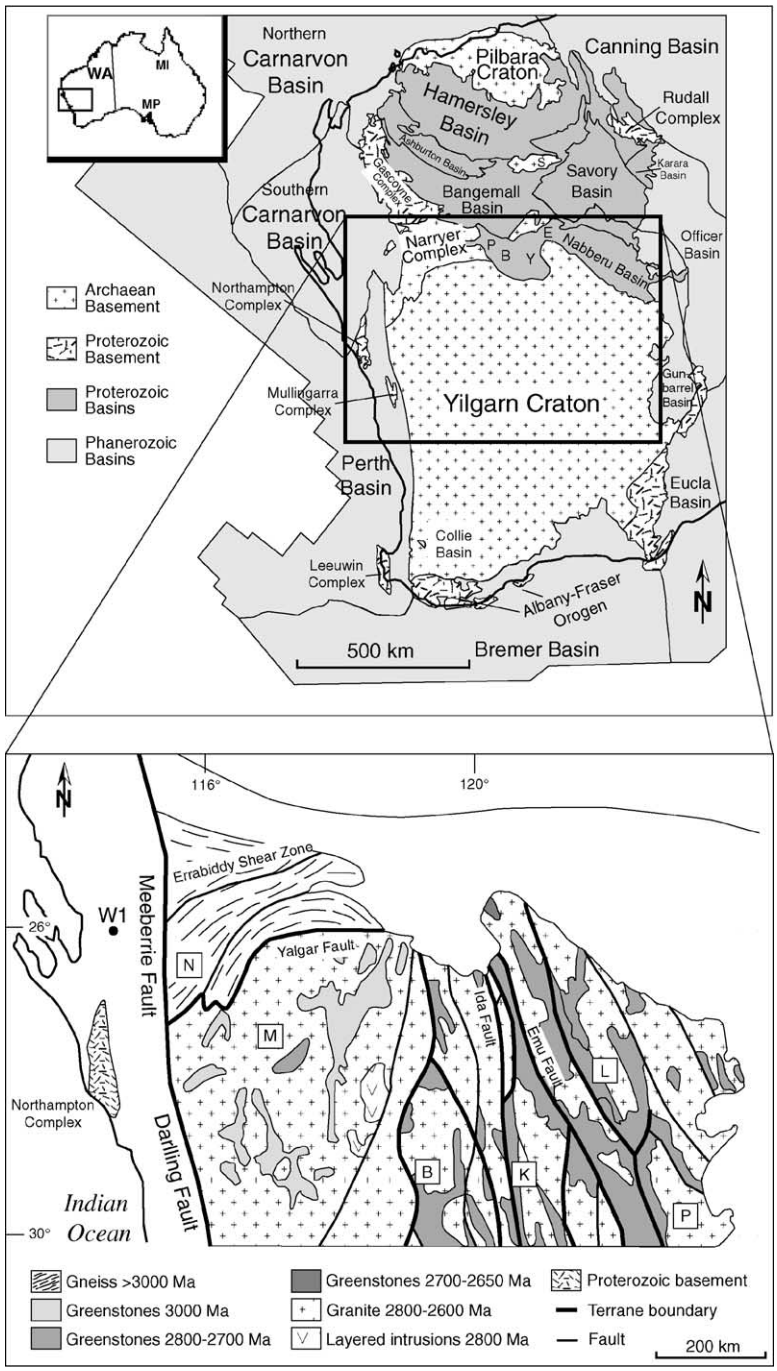

Fig. 1. Upper map: Location of study area (box) and regional geology. MI=Mount Isa, MP=Mount Painter, WA=Western Australia State; Proterozoic basins: B=Bryah, E=Earaheedy, P=Padbury, Y=Yerrida. Lower map: Tectonic terranes with rock types and their age relationships comprising the northern Yilgarn Craton (modified after Myers, 1993; Wilde et al., 1996). Terranes: B=Barlee, K=Kalgoorlie, L=Laverton, M=Murchison, N=Narryer, P=Pinjin. W1=Woodleigh1 well location.