



Reinterpretation of high-temperature metamorphism within a continental back-arc setting for the Broken Hill Block, NSW, Australia

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Accounting for mid-crustal high-temperature/low-pressure metamorphism where contemporaneous, voluminous magmatism is absent, and where peak metamorphism appears synchronous with crustal shortening is difficult, as this regime is typically associated with mid- to high-pressures, and also calls for introduction of an anomalously high heat source at shallow crustal levels. An example of such a metamorphic regime is the Broken Hill Block (BHB), central western New South Wales, Australia, where regional peak high-temperature/low-pressure granulite facies metamorphism is associated with crustal shortening during the Olarian Orogeny ~ 1.6 - 1.58 Ga. Contemporaneous, voluminous magmatism is absent. We have reinterpreted the pre-Olarian history of the BHB, and suggest that peak high-temperature metamorphism was the result of burial of anomalously hot rock packages, and involved at least two episodes of extension closely followed by shortening.

Early rifting and deposition of the lower BHB sedimentary sequences ~ 1.71 - 1.67 Ga (e.g. Page et al., 2005, *Economic Geology*, v. 100, p. 633) resulted in initial elevation of lithospheric geothermal gradients. These sequences then underwent burial to ~ 10 - 15 km depth during sag-phase sedimentation. A second, transient, mid-crustal extensional event occurred at ~ 1.62 Ga (Forbes et al., 2007, *J. Geology*, v. 115, p. 691) and was associated with elevated geothermal gradients (~ 41 - 61°C km^{-1}). This event maintained the elevated geotherm that was inherited from the earlier rifting event. The

BHB then underwent further burial to ~ 17.5 km (~ 5 kbar). Burial of the hot rock packages resulted in an increase in temperatures to conditions of peak, low-pressure granulite facies metamorphism (at least 740°C , ~ 5 kbar) at ~ 1.60 Ga. At this time, high-temperature shear zones were active. The BHB subsequently underwent intense shortening during the Olarian Orogeny ~ 1.6 - 1.58 Ga.

Tectonic switching has often been associated with a back-arc environment, where extension may be a response to slab roll-back, and a switch to shortening is caused by arrival of anomalously buoyant material at the subduction site (e.g. Collins, 2002, *Geology*, v. 30, p. 535). The interpreted tectonic environment for the BHB during the Palaeo- to Mesoproterozoic is a continental back-arc setting within the over-riding plate of a subduction zone located along the southern margin of Australia.