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Detrital zircon provenance constraints on the evolution of the Harts Range Metamorphic Complex (central Australia): links to the Centralian Superbasin

IAN S. BUICK[1], MARTIN HAND[2], IAN S. WILLIAMS[3], JO MAWBY[2], JODIE A. MILLER[4] & ROBERT S. NICOLL[5]

[1]*School of Geosciences, Monash University, Melbourne, Vic. 3800, Australia (e-mail: Ian.Buick@sci.monash.edu.au)*

[2]*Department of Geology and Geophysics, University of Adelaide, Adelaide, S.A. 5005, Australia*

[3]*Research School of Earth Sciences, Australian National University, Canberra, A.C.T. 0200, Australia*

[4]*Department of Geology, University of Stellenbosch, Stellenbosch 7600, South Africa*

[5]*Department of Earth and Marine Sciences, Australian National University, Canberra, A.C.T. 0200, Australia*

Abstract: Until recently it has been widely accepted that protoliths to metasediments of the Harts Range Metamorphic Complex (central Australia) were deposited prior to *c*. 1.75 Ga and form part of the Palaeoproterozoic Arunta Inlier. However, new sensitive high-resolution ion microprobe U–Pb analyses of detrital zircon, together with recently published data, suggest that they were deposited coeval with *c*. 545–520 Ma sediments from the adjacent, little metamorphosed Neoproterozoic to Palaeozoic Centralian Superbasin. Protoliths of the Harts Range Metamorphic Complex were deposited in the Irindina sub-basin, an early- to mid-Cambrian rift located between the present-day Amadeus and Georgina Basin remnants of the Centralian Superbasin. Deposition occurred during a widespread and long-lived interval of extension in parts of central Australia associated with eruption of the voluminous Kalkarinji Continental Flood Basalts. The Harts Range Metamorphic Complex was metamorphosed to upper amphibolite- to granulite-facies conditions within *c*. 40 Ma of deposition of its sedimentary protoliths.

Keywords: SHRIMP, zircon provenance, central Australia, metamorphism, tectonics.

The Arunta Inlier (Fig. 1a and b) is an extensive east–west-trending, polyphase, high-grade, predominantly Palaeoproterozoic metamorphic complex (Collins & Shaw 1995). It is overlain unconformably by Neoproterozoic to mid-Palaeozoic intracratonic sedimentary basins (the Amadeus, Ngalia and Georgina basins; Fig. 1b) that are structural remnants of the formerly more extensive *c*. 900–300 Ma Centralian Superbasin (Shaw *et al*. 1991). The Arunta Inlier was exhumed and interleaved with overlying Centralian Superbasin cover sequences during the polyphase *c*. 440–300 Ma Alice Springs Orogeny (Haines *et al*. 2001).

Notwithstanding recent geochronological studies having shown that some high-grade metamorphism in the easternmost Arunta Inlier (Harts Range area; Fig. 1b and c) is Palaeozoic in age (Hand *et al*. 1999*a*; Mawby *et al*. 1999; Buick *et al*. 2001), it has generally been accepted that (1) all high-grade metamorphic rocks within the Arunta Inlier have Palaeo- to Mesoproterozoic sedimentary or igneous protoliths, and (2) metamorphism of the Centralian Superbasin sediments reached only (at most) greenschist-facies grades (see Shaw *et al*. 1984, 1991; Sivell & Foden 1985; Cooper *et al*. 1988; Collins & Shaw 1995). This assumption, which underpins conceptual models for the tectonic (Shaw *et al*. 1984; James & Ding 1988; Collins & Shaw 1995) and geochemical (Sivell & Foden 1985; Sivell & McCulloch 1991) evolution of the Arunta Inlier, has recently been challenged by the discovery of detrital zircon in granulite-grade metamorphic rocks from a small area of the Harts Range Metamorphic Complex (Fig. 1c), and inherited zircon in a granite intrusive into these rocks, that have yielded concordant sensitive high-resolution ion microprobe (SHRIMP) U–Th–Pb ages as young as *c*. 520 Ma (Buick *et al*. 2001).

In this study, we combine new SHRIMP age determinations on detrital zircons from the Harts Range Metamorphic Complex and apparent time-equivalent sediments from the Amadeus Basin with data from Buick *et al*. (2001) to argue that the protoliths to the Harts Range Metamorphic Complex were not Proterozoic rocks of the Arunta Inlier, but Cambrian sediments deposited as part of the Centralian Superbasin.

Regional geology

The Harts Range can be divided into the Harts Range Metamorphic Complex and the structurally underlying Entia Gneiss Complex, which occupies the core of a major domal structure (Fig. 1c). The Harts Range Metamorphic Complex consists of metasedimentary rocks and the Harts Range Meta-Igneous Complex (Sivell & Foden 1985), which together have a present-day structural thickness of *c*. 6–7 km. The metasediments can be subdivided into several units (Ding & James 1985). The structurally lowermost comprises the metapelite-dominated Irindina Gneiss, which additionally contains horizons of quartzite and marble (Naringa Calcareous Member). The structurally higher levels comprise the Brady Gneiss, which can itself be divided into structurally lower and upper sub-units of predominantly metapelite and calcsilicate rock, respectively (Fig. 1c).

Mafic rocks of the Harts Range Meta-Igneous Complex occur within the Irindina Gneiss at a structural level above the Naringa Calcareous Member. Their precursors were basaltic flows or volcaniclastic sediments, gabbros and anorthosites (Sivell & Foden 1985; Sivell 1988). The major and trace element geochemistry of these rocks is consistent with a rift setting (Sivell & Foden 1985; Sivell 1988), as is their association with a lithostratigraphic protolith package of carbonates, shales and greywackes (Friedmann & Burbank 1995). Harts Range Meta-