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An abrupt change in Nd isotopic composition in Australian basins at 1655 Ma: Implications for the tectonic evolution of Australia and its place in NUNA

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ABSTRACT

Late Paleoproterozoic sedimentary basins across eastern Australia record a significant change in their neodymium isotopic composition at ca. 1655 Ma. Prior to ca. 1655 Ma, detritus was derived from comparatively evolved sources generating bulk $\varepsilon_{Nd(1650\,Ma)}$ values of generally −8 to −6. Subsequent sedimentary successions, which accumulated between ca. 1655 Ma and 1600 Ma, have bulk $\varepsilon_{Nd(1650\,Ma)}$ values of −2 to −1. This change is interpreted to reflect the input of sediments from a new, probable felsic volcanic source, corresponding to a fundamental change in tectonism and/or tectonic drivers for basin evolution in northern Australia. One possible driver for the change in sedimentary source is the initiation of renewed rifting from 1655 Ma along the eastern margin of Paleoproterozoic Australia. As the 1655–1600 Ma sedimentary successions that record the isotopic change are voluminous, a large, juvenile source of volcanic detritus must have been present, either within Paleoproterozoic Australia or in the cratonic block immediately to the east of Australia in the NUNA supercontinent. Although voluminous juvenile felsic magmatic sources are known in eastern and central Australia (e.g. 1639–1631 Ma volcanics in the Warumpi Province; 1620–1610 Ma granites of the St. Peter Suite in the Gawler Province), these sources are too young to have acted as a source for the juvenile detritus. Felsic intrusions of ∼1650 Ma age are present in the Mount Isa Province, but the known exposed volume is very small. Of these possible sources, we favour either a buried or eroded eastern Proterozoic Australian source or an outboard Laurentian source.
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1. Introduction

It is well established that the fill of sedimentary basins preserves a record of tectonism and uplift within their hinterlands even though the source rocks themselves may have long been removed through erosion or tectonic divergence. This statement is no less true for modern sedimentary basins as it is for much older ones of Proterozoic age preserved within the Mt Isa Province and Coen and Georgetown Inliers of northern Australia, and within the Curnamona Province of south-central Australia (Fig. 1). Although now variably deformed and metamorphosed, these basins still retain important information about tectonic events affecting large tracts of Proterozoic Australia, including evidence for intermittent ongoing magmatism from ca. 1690 to 1640 Ma as the basins evolved.

These magmatic rocks, particularly felsic tuffaceous rocks and peperites within basin fill, have been used to establish detailed correlations of sedimentary successions within individual geological provinces (e.g. Southgate et al., 2000; Jackson et al., 2005; Neumann et al., 2009). These and other geological data have also been used to propose correlations between Proterozoic provinces (e.g. Laing, 1996; Giles et al., 2002; Page et al., 2005; Betts and Giles, 2006; Cawood and Korsch, 2008; Gibson et al., 2008) across Australia, but because of the large distances involved and because large areas within and between provinces are under cover, these correlations are not as definitive. Here we present Sm–Nd characteristics and U–Pb geochronology of basin fill for late Paleoproterozoic successions in the Mount Isa Province and Georgetown Inlier. This paper reports these new data in the context of existing data for the Curnamona Province (Barovich and Hand, 2008) and Coen Inlier (Blewett et al., 1998) to record a major influx of juvenile magmatic detritus at ca. 1655 Ma, which supports intra-province correlation. Based on these data, we discuss possible sources and processes that could have provided this detritus, and then speculate on possible tectonic implications.

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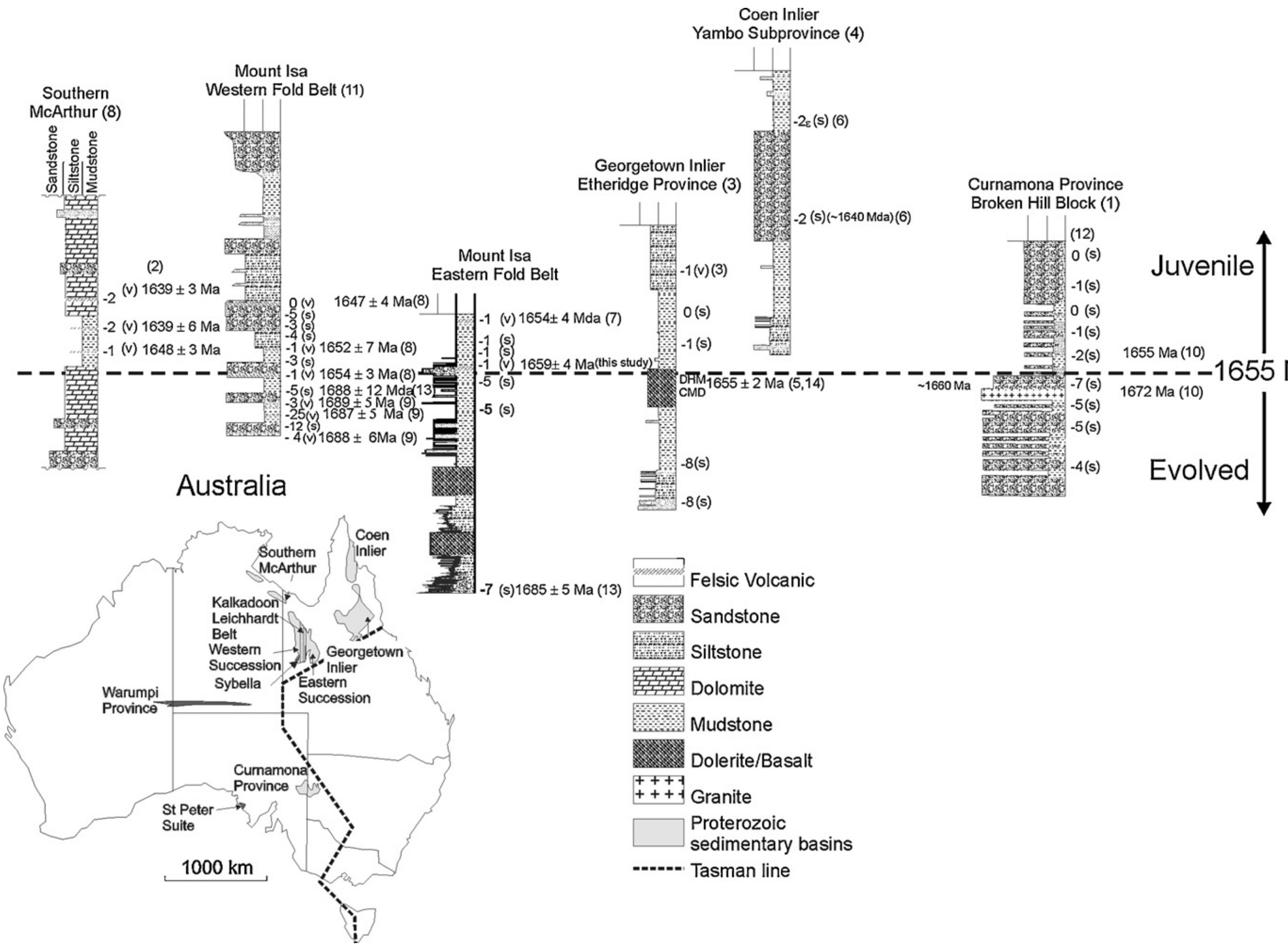

Fig. 1. Regional chronostratigraphic columns in Precambrian eastern Australia showing juvenile felsic input at ca. 1655 Ma. Detrital zircon U–Pb, inferred maximum depositional ages (Mda) and stratigraphic ages (Ma) derived from magmatic rocks, rhyolite and dolerite. Epsilon Nd data on bulk volcanics (v) and bulk sediments (s). DHM = the Dead Horse meta-basalt and CMD = the Cobbold meta-dolerite as described in Black and McCulloch (1984), Black et al. (1998) and Baker et al. (2010). Regional stratigraphic data are from this study and following references marked on figure in brackets; Stevens (1980) (1), Page (1981) (2), Withnall et al. (1988) (3), Blewett and Trail (1995) (4), Black et al. (1998) (5), Blewett et al. (1998) (6), Page and Sun (1998) (7), Page et al. (2000) (8), Jackson et al. (2005) (9) Page et al. (2005) (10), Southgate et al. (2006) (11), Barovich and Hand (2008) (12), Neumann et al. (2009) (13), Baker et al. (2010) (14). Data from the Sybella Granite and Carters Bore Rhyolite are in Supplemenatry data 2.

1.1. Geologic setting

The evolution of the interior of the eastern part of the proto-Australian continent between 1800 and 1600 Ma is characterised by the development of numerous intracratonic volcano-sedimentary basins (e.g. Plumb et al., 1990; Eriksson et al., 1993; Southgate et al., 2000; Giles et al., 2002; Betts et al., 2008). A dominantly extensional setting (possibly backarc) for basin development is generally inferred with syn-extensional magmatism, deformation and low-pressure/high-temperature metamorphism linked at higher crustal levels to normal growth faulting and sedimentation (Giles et al., 2002; Betts and Giles, 2006; Gibson et al., 2008). Basin fill is dominated by clastic sequences deposited at variable depths (e.g. Southgate et al., 2000; Neumann et al., 2009). Below we describe the geology of individual basins of proto-Australia.

Although the Queensland Geological Survey (2011) has further subdivided and redefined geological domains within the Mount Isa Province, we retain the older tripartite division (Day et al., 1983; Blake and Stewart, 1992) for the sake of simplicity. The Western Fold Belt and the Eastern Fold Belt are both predominantly made up of sedimentary rocks whereas the third unit (Kalkadoon–Leichhardt Belt) is older and comprises mainly felsic volcanic and plutonic rocks that are older than 1850 Ma (Blake and Stewart, 1992; Bierlein et al., 2008, Fig. 1).

The sedimentary rocks have been split into three superbasins, the Leichhardt, Calvert and Isa Superbasins (Southgate et al., 2000). The 1790–1740 Ma Leichhardt Superbasin formed in an east-west-directed extensional environment (Eriksson et al., 1993; Jackson et al., 2000; Gibson et al., 2008), and is characterised by tholeiitic basalt and fluvial to shallow marine sedimentary rocks. The 1720–1670 Ma Calvert Superbasin also formed in an extensional environment and involved the extrusion of bimodal volcanic rocks (Fiery Creek Volcanics) followed by deposition of fluvial to deep marine sedimentary rocks. Both ENE-WSW (Gibson et al., 2008) and N-S (Betts et al., 2008) extensional directions have been proposed for formation of this superbasin. The 1660–1575 Ma Isa Superbasin initially involved extension along NNE-SSW trending axes followed by sag-phase sedimentation and then renewed extension in the northwest (Queensland Geological Survey, 2011).

In the Eastern Fold Belt, the Calvert Superbasin comprises mainly deep-water sedimentary facies with intercalated mafic sills that are interpreted to have developed in a rift environment as part of an extensional system active from ca. 1690 to 1660 Ma (Page and Sun, 1998; Gibson et al., 2008; Rubenach et al., 2008). In contrast, deposition in the Western Fold Belt during this same period occurred under fluviatile to near shore to shallow marine conditions, and mainly gave rise to quartzite-and sandstone-dominated

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