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Metasomatism and metallogeny of A-type granites of the Mt Painter–Mt Babbage Inliers, South Australia

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ABSTRACT

The Mount Painter and Mount Babbage Inliers (South Australia) are largely composed of Mesoproterozoic A-type granitoids that intruded marginally older metasediments. Metasomatic activity has had a pronounced influence on the granites in the southerly Mt Painter Inlier. U–Pb dating and Hf isotope ratios of zircons from granites and hyperaluminous rocks show the latter to be heavily metasomatised equivalents of the granitoids. Similar metasomatic processes are likely to have been responsible for the formation of Fe-oxide–U–REE ores. These ores formed more than 1100 Ma after intrusion of the Mesoproterozoic A-type granites, and elemental remobilisation may have been associated with a new phase of granitoid magmatism around 455 Ma. The ferroan and incompatible element-rich nature of A-type granites makes them a suitable source for ores that can be tapped whenever thermal and fluid conditions are favourable.

1. Introduction

The most common mineralisation associated with the broad class of granites denoted as 'A-type' (ferroan) is tin, tungsten and beryllium (Haapala et al., 2005). However, iron oxide–copper–gold (IOCG) plus uranium and rare earth elements (REE) constitute another economically important class of ores that show a spatial and temporal relationship to such granites (Haapala, 1995). A prime example of this type of mineralisation is the giant Olympic Dam deposit, located on the South Australian Gawler Craton, associated with ca. 1590 Ma A-type granites (Creaser and Cooper, 1993). The association between A-type granites and IOCG mineralisation is logical as one of the defining characteristics of A-type granites is their iron enrichment (Loiselle and Wones, 1979); it has therefore been suggested that A-type granites should better be called ferroan granites (Frost and Frost, 2011).

As ore-forming processes necessitate the mobilisation of elements from their source, followed by their concentration and deposition, ore formation is always associated with changes in whole rock composition. Therefore, the chemical composition of granites affected by ore formation can be unrepresentative of their magmatic signature, hampering efforts to fit them into existing classification schemes.

Apart from the well-known occurrence on the Gawler Craton, Mesoproterozoic A-type granites are also found in other parts of South Australia, such as the Curnamona Province (Fig. 1). In this contribution, we provide new data for A-type granites from the Mount Painter and Mount Babbage Inliers on the northwestern side of the Curnamona Province, focussing on the metasomatic and metallogenetic processes that have affected the granitoids. Our data indicate that deformation and metasomatism can alter granitoid rocks almost beyond recognition, whereby only resistant minerals such as zircon can potentially give clues to the identity of the protolith. Recognition of the protolith allows quantification of metasomatic processes, which is a prerequisite to investigate a potential link with ore formation. For the A-type granites described here, a variety of metasomatic processes seem to have played a role, including albitisation and Mg-metasomatism, with concomitant mobilisation of iron. The latter element now makes up the bulk of the U and Cu-bearing ores in the area. The intrusion of Palaeozoic granites, with I–S type affinities, may have acted as the heat source for at least some of the metasomatic activity.

2. Regional setting and field data

The Mount Painter and Mount Babbage Inliers belong to the Moolawatana Domain (Conor and Preiss, 2008) of the Curnamona Province, which straddles the boundary between South Australia and New South Wales (Fig. 1). Large parts of the province are covered with (meta)sediments of Neoproterozoic to Recent age; other exposed Meso- to Paleoproterozoic areas are the Olary and Broken Hill Domains in the south. The first comprehensive work on the geology of the Mount Painter and Mount Babbage Inliers, including their Neoproterozoic–

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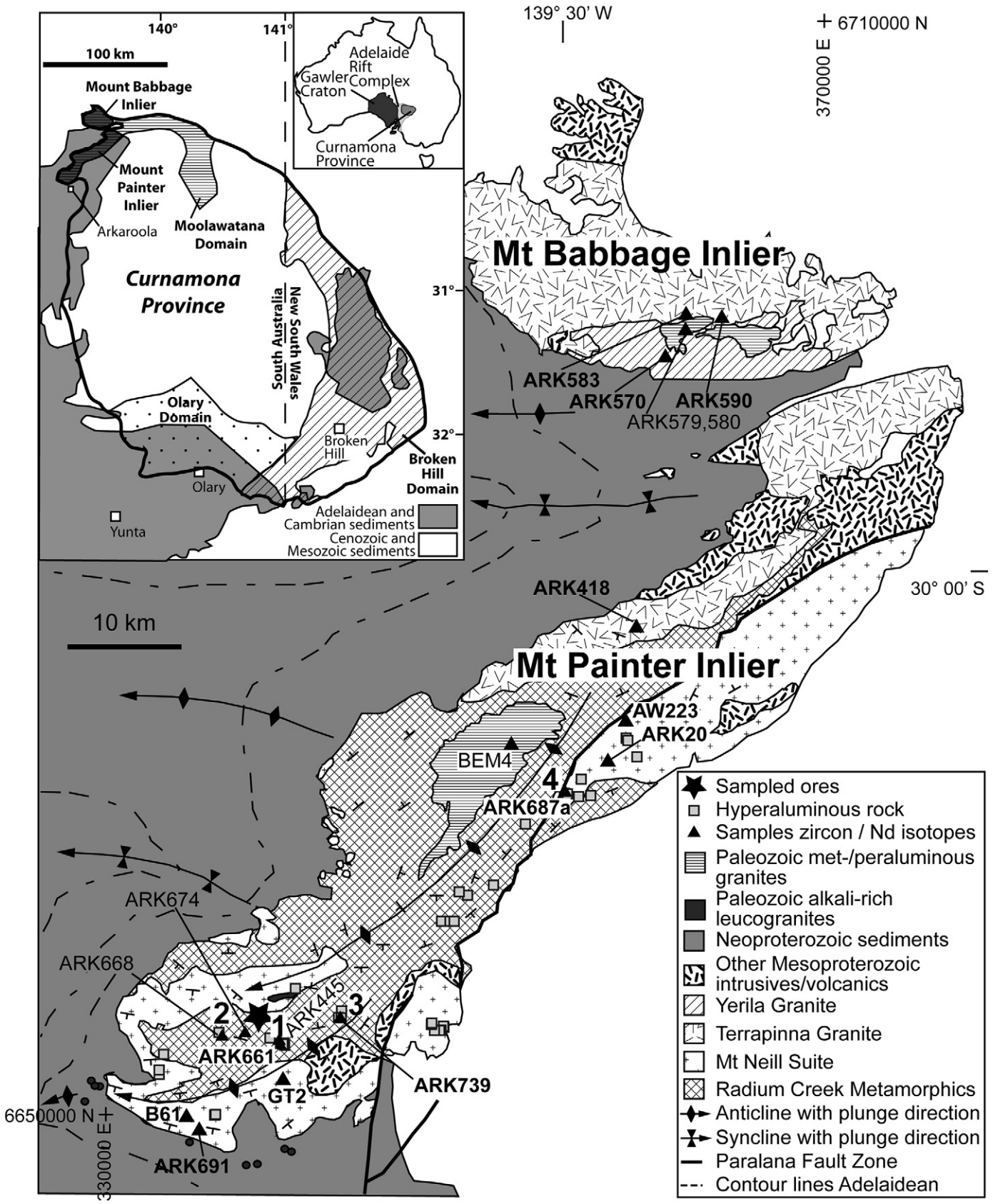

Fig. 1. Lithological map of the Mount Painter and Mount Babbage Inliers after Coats and Blisset (1971) and Stewart and Foden (2001). The distribution of the Radium Creek Metamorphics is taken directly from Coats and Blisset (1971), but more detailed mapping shows that some parts represent heavily deformed granitoids. Samples used for zircon studies are indicated with a triangle; samples yielding Precambrian ages only in bold face. Inset: Curnamona Province with discussed Domains, after Conor and Preiss (2008). The Mount Painter and Mount Babbage Inliers belong to the Moolawatana Domain. The overview map of Australia shows the location of the Curnamona Province and Gawler Craton.