New insights into the geological evolution of the west Musgrave Complex

by

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The Musgrave Complex, in central Australia, is perhaps the least-understood exposed piece of Proterozoic Australia. It has a complicated late Meso- to Neoproterozoic igneous, structural, and metamorphic history, which is coupled with geographical isolation and cultural sensitivity. Here, we update the progress of the Geological Survey of Western Australia's west Musgrave mapping project, and show how these results are rapidly providing new insights into the geological evolution of this region.

Oldest exposed rocks

In the eastern part of the Musgrave Complex, locally exposed basement rocks are as old as c. 1600 Ma (e.g. Edgoose et al., 2004). However, in the west Musgrave Complex, the oldest rocks belong to the Wirku Metamorphics (Fig. 1) and are gneisses of sedimentary, volcaniclastic, and volcanic origin. Their zircon age spectra include detrital peaks that indicate maximum depositional ages of between c. 1360 and c. 1307 Ma, and define at least four geographically separate groups (BATES* region, Tjuni Purlka Tectonic Zone, Latitude Hills area, and the southern BLACKSTONE region; Fig. 1) dominated by various age peaks between c. 3200 and c. 1410 Ma. It is possible that the four groups represent slightly different stratigraphic packages within a single depositional basin.

The 1336–1293 Ma Mount West Orogeny and the Wankanki Supersuite

It is now clear that c. 1300 Ma granites, first identified by Gray (1971), form a significant component within the Tjuni Purlka Tectonic Zone, a northwest-trending zone of extensive faulting (Fig. 1 inset), and represent the most voluminous felsic component to the southwest of that zone (Fig. 1). These rocks form the Wankanki Supersuite and are a result of the Mount West Orogeny. Crystallization ages range from c. 1336 to c. 1293 Ma, with most between c. 1326 and 1312 Ma (Fig. 2). Volcanic equivalents are present, and detritus of this age contributed to units within the Wirku Metamorphics. Intrusive rocks of this age have not been found in either the BATES region or the Latitude Hills area.

The Wankanki Supersuite comprises calc-alkaline, I-type granites and differs in this respect from all other granites in the west Musgrave Complex. The granites might reflect magmatism within a continental arc, or be remelts of earlier (?arc-related) crust.

The c. 1219–1155 Ma Musgravian Orogeny and the Pitjantjatjara Supersuite

The Musgravian Orogeny involved intense deformation and widespread high-grade crustal reworking, including the production of the voluminous granites of the Pitjantjatjara Supersuite. These granites fall into the within-plate granite and A-type fields on discrimination diagrams and most likely reflect extensive basement reworking in an intracratonic setting.

In the BATES region, the granites of the Pitjantjatjara Supersuite can be divided into two distinct age groups: an older group reflecting magmatism and metamorphism between c. 1219 and 1200 Ma (early Musgravian), and a younger group (late Musgravian) reflecting magmatism and metamorphism between c. 1190 and 1155 Ma (Fig. 2). Early Musgravian granites are restricted to the western part of the BATES region, and range in composition from quartz monzodiorite and granodiorite to monzogranite. Late Musgravian granites occur throughout, and range in composition from monzogranite to syenogranite.

Granites of the Pitjantjatjara Supersuite are less common in other areas of the west Musgrave Complex (Fig. 1). In the Tjuni Purlka Tectonic Zone, dating still identifies distinct early-Musgravian and late-Musgravian granites, but metamorphism was almost continuous from c. 1219 to c. 1175 Ma, and suggests that this zone was tectonically active throughout the entire Musgrave Orogeny.

* Capitalized names refer to standard 1:100 000 map sheets, unless otherwise indicated

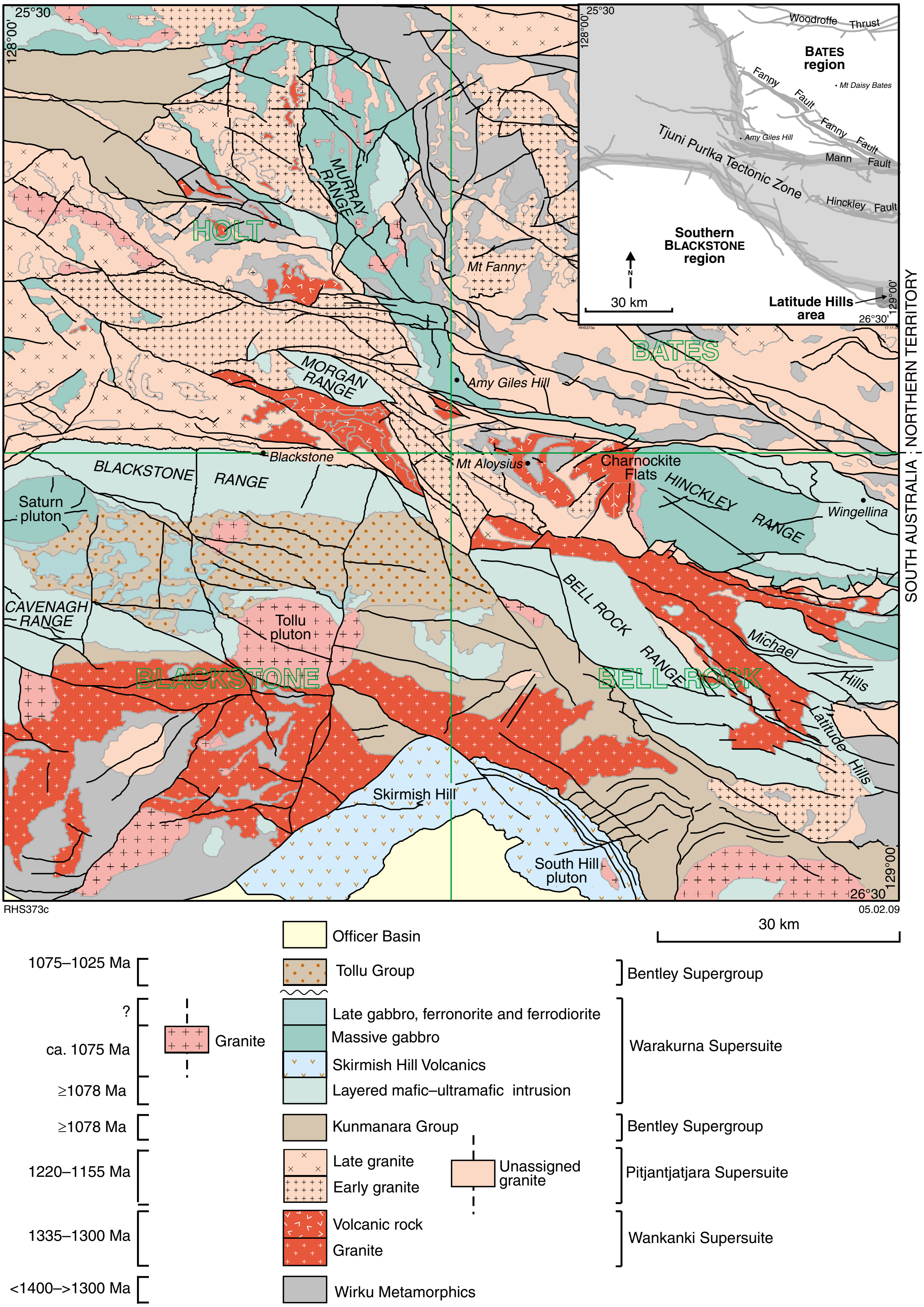

Figure 1. Interpretation of the solid geology of the eastern portion of the west Musgrave Complex. Inset shows major faults and tectonic regions. The four 1:100 000 sheets are named

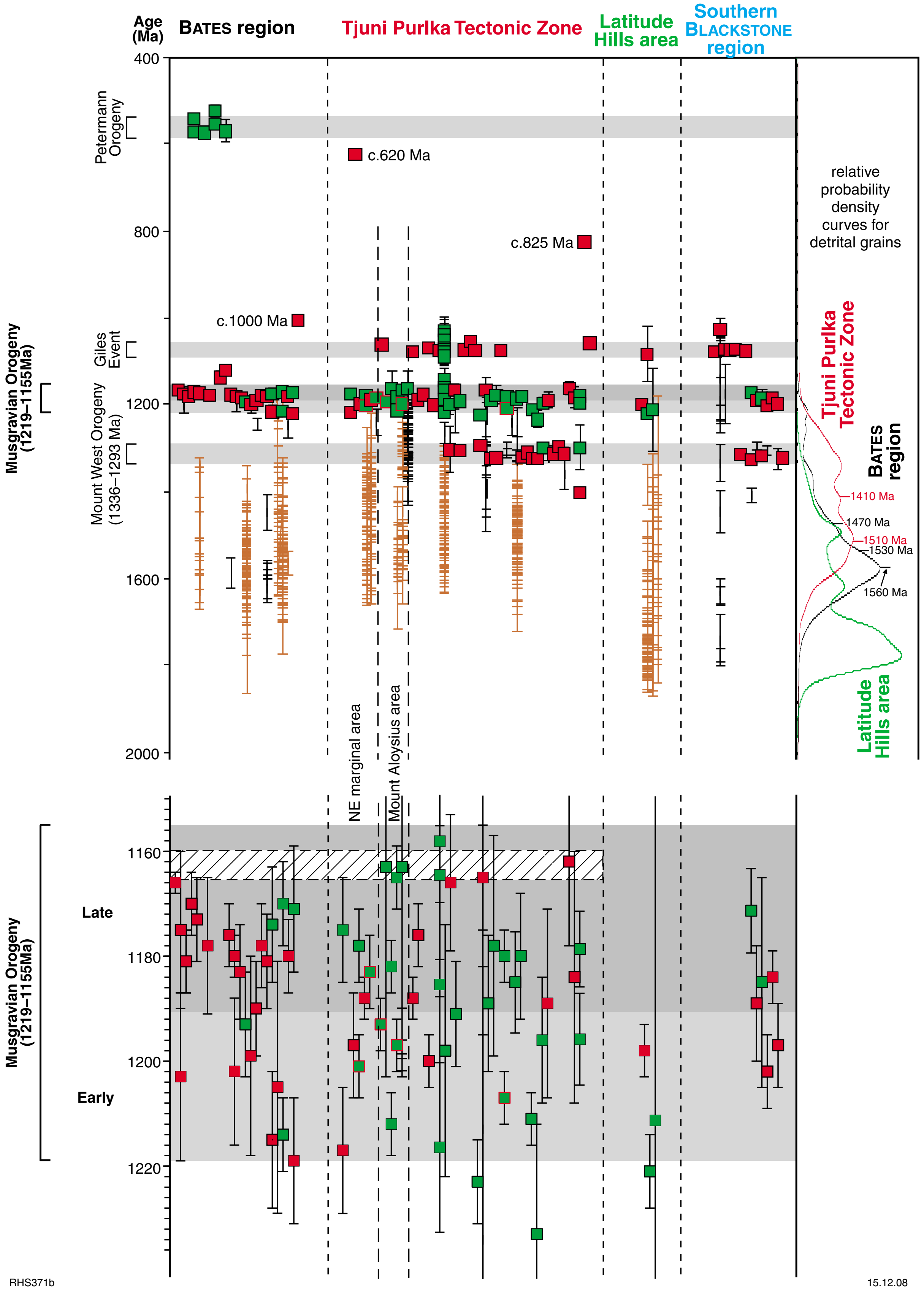

Figure 2. Time–space plot of SIMS (U–Pb) zircon ages. Red squares denote igneous crystallization; green squares denote an age interpreted as metamorphic; green squares with red borders denote an age interpreted as local migmatization; unfilled (no squares) black error bars denote inheritance; unfilled brown error bars denote detrital ages. Source: Geological Survey of Western Australia (2008)

The Giles Event and the Warakurna Supersuite

The Warakurna Supersuite groups all igneous rocks thought to be related to the c. 1075 Ma Giles Event. Layered mafic–ultramafic intrusions form the west-northwest spine of the west Musgrave Complex. Their age is poorly constrained. Glikson et al. (1996) quote an age of 1078 ± 3 Ma from a leucogranite within the Bell Rock intrusion, but this date is identical to the age of felsic dykes that truncate magmatic layering and that were comagmatic with massive gabbros that engulf the layered intrusions. The age is a *minimum* age for emplacement of the layered intrusions, which might be as old as the latest Musgravian (c. 1170 Ma), as suggested by Gray (1971).

Unlayered gabbro intrudes the layered intrusions, forming a regionally extensive feature offset by sinistral movement along late west-trending faults. Comagmatic leucogranite is dated at between c. 1075 and c. 1078 Ma, which defines a period of mafic and felsic magmatism, upright folding, and northwest to north-northwesterly trending shearing. Like the Pitjantjatjara Supersuite, the Giles granites show strongly developed A-type compositional characteristics and fall into the within-plate granite field, reflecting high-temperature reworking of dry lower crust. Notably, Pitjantjatjara and Giles granites are rarely present in the same region.

Volcanic and sedimentary rocks of the Tollu Group form part of the regionally extensive Bentley Supergroup. We have split the Tollu Group into two groups, for reasons outlined below. The layered mafic–ultramafic Blackstone intrusion was emplaced into the lower part of the Tollu Group, but volcanic rocks in the upper part of the group conformably overlie the layered intrusion and feeder dykes to the volcanic rocks cut the layered intrusions. Age constraints on the Tollu Group have hinged on the 1078 ± 5 Ma date of Glikson et al. (1996; see above). However, the dated outcrop is not volcanic, as previously thought, but is instead fine-grained leucogranite identical to c. 1075 to c. 1078 Ma Giles leucogranites. A dacite from the upper Tollu Group yielded a preliminary age of 1026 ± 26 Ma, which is more consistent with the field relationships established within the region. Thus, deposition of the lower and upper Tollu Group is likely separated by a minimum of 50, and possibly up to 150 m.y — a hiatus that saw emplacement of layered mafic–ultramafic intrusions, uplift, erosion, and possibly folding. We have accordingly subdivided the sequence into the (lower) Kunmanara Group and the overlying redefined Tollu Group. This complex history of volcanism, emplacement of large layered mafic–ultramafic intrusions, felsic magmatism, and deformation over a time period of at least 50 m.y. is more akin to the evolution of a failed intracontinental rift than classic plume-related Large Igneous Provinces.

References

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