Timing and geochemistry of felsic magmatism in the west Musgrave Complex

by

R. H. Smithies, H. M. Howard, S. Bodorkos, P. M. Evins, and F. Pirajno

In conjunction with geochronological data, the geochemistry of felsic rocks has proved a vital tool in mapping the west Musgrave Complex (Fig. 1). Despite the obvious economic interest in the mafic rocks of the area, and in particular the copper–nickel-mineralized layered mafic–ultramafic rocks of the c. 1070 Ma Giles intrusions, felsic rocks volumetrically dominate the west Musgrave Complex. It is these rocks, therefore, that will probably provide the most information on the crustal evolution of the area, including processes that led to the formation and final sites of emplacement of the Giles intrusions.

The west Musgrave Complex (Fig. 1) comprises various combinations of crustal components separated into domains with different structural and metamorphic histories. The volumetrically dominant component, feldspar-porphyritic biotite(–hornblende–pyroxene) leucogranite, formed during at least five separate events at c. 1320, c. 1210, c. 1175, c. 1150, and c. 1070 Ma. All of these pre-date the c. 550 Ma Petermann Orogeny, the metamorphic and structural overprint of which has commonly destroyed most reasonable means of confidently identifying individual granite (or gneiss) age groups in the field.

The five granite groups also have superficially similar geochemical features that include high concentrations of K_2O (2–7 wt%), total Fe (1.5 – 11 wt% Fe_2O_3), high field strength elements (HFSE, e.g. Nb, Zr, Y) and rare earth elements (e.g. La, Ce, Yb). However, subtle but persistent geochemical differences allow individual age groups, and suites within specific age groups, to be uniquely identified and mapped.

The results highlight the specific geographical ranges of each granite group and also some different modes of occurrence. The c. 1320 Ma granites have not been identified in the deep-crustal (high-pressure granulite-facies) segment north of the east-trending Mann Fault (Fig. 1), but they appear to form a major (possibly dominant) component of the lower pressure granulite-facies crust exposed to the south. Granites intruded between c. 1210 and c. 1175 Ma dominate outcrop north of the Mann Fault, but form only a minor component, mainly as dykes and small bodies, to the south. The c. 1150 Ma granites, however, have so far only been identified south of the Mann Fault. Minor dykes of c. 1075 Ma granite have intruded north of the Mann Fault, but the great majority of these granites, including large (10 km-diameter) plutons, lie to the south.

Geochemical data suggest that the c. 1320 Ma granites are likely to be I-type granites, most of the c. 1210, c. 1175, and c. 1150 Ma intrusions are probably A-type granites, whereas the c. 1070 Ma granites have strongly developed A-type features. Thus, there is a secular trend, from c. 1320 to c. 1070 Ma, to generally increasing K_2O and HFSE concentrations. The Nd-isotopic signatures of the five granite groups are indistinguishable, suggesting derivation from a common (?)crustal source region, possibly with some recycling of older granites into younger magma batches. Notably, however, the deep

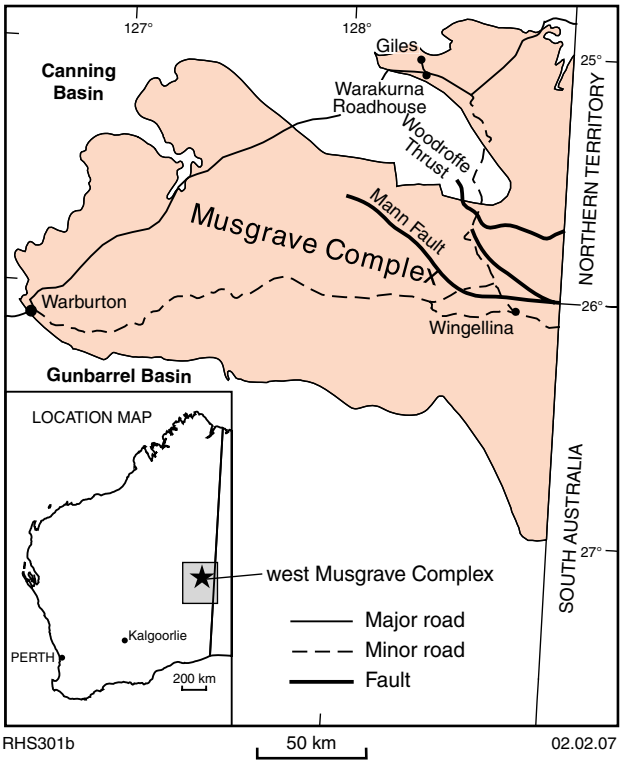

Figure 1. Location of the west Musgrave Complex in Western Australia

crustal c. 1210 to c. 1175 Ma granites north of the Mann Fault cannot have formed through recycling of the higher crustal c. 1320 Ma granites exposed to the south (although this is a possible origin for the c. 1210 to c. 1175 Ma granite dykes and veins in the south).

Sedimentary and volcanosedimentary rocks of the Birksgate Metamorphics are the oldest (>1390 Ma) known rocks in the region and form inclusions, up to tens of kilometres in size, in all granites. Nd-isotopic data indicate that, compared to rocks of the Birksgate Metamorphics north of the Mann Fault, rocks of the Birksgate Metamorphics to the south have a much larger source component that was ultimately derived from Archean crust that is older than 2800 Ma. Nevertheless, the supracrustal rocks of the Birksgate Metamorphics either side of the Mann Fault cannot have formed a major source component of any of the younger granites because the supracrustal rocks have notably less radiogenic Nd-isotopic signatures (and high Nd concentrations).

Granitic magmatism at c. 1070 Ma (and the temporally associated mafic–ultramafic Giles intrusions) was also accompanied by locally extensive felsic volcanism (Tollu Group – Bentley Supergroup). However, although the granites analyses thus far are from a source isotopically identical to that of the older granites (ε_{Nd} ~ -3 at 1070 Ma), the c. 1070 Ma felsic volcanic rocks have a source as isotopically juvenile (ε_{Nd} ~ +0.7 at 1070 Ma) as the least crustally contaminated rocks of the contemporaneous Giles intrusions. The felsic volcanic rocks are associated with locally emergent cryptodomes of granophyric-textured gabbro, and possibly belong to the same, predominantly mantle sourced, magma series.