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## Evidence for hybridization in the Tynong Province granitoids, Lachlan Orogen, Eastern Australia

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### Abstract

Granitoids of the Tynong Province, Lachlan Orogen, Australia show evidence for mingling and mixing between mantle- and crustal-derived magmas, such as microgranitoid enclaves (MMEs), larger dioritic bodies, like many other plutons of this Orogen. This paper explores the extent of hybridization of these rocks by means of petrography, major and trace element geochemistry, whole rock Rb-Sr and Sm-Nd isotope data, as well as Hf isotopes in zircons, focusing on samples of the Toorongu and Tynong plutons. At outcrop scale, there are widespread rounded, pillow-shaped mafic-intermediate enclaves, commonly with concave-convex irregular boundaries and xenocrysts of quartz and K-feldspars derived from the surrounding felsic rock. These enclaves show textural features characteristic of hybridization; especially: rapakivi and antirapakivi textures, quartz and feldspar ocelli, and acicular apatite. Harker diagrams of major and trace elements typically define clear to diffuse linear trends, most compatible with for magma mixing, probably combined with other processes such as fractional crystallization.

Zircons yielded a weighted average crystallization age of  $375 \pm 2$  Ma ( LA-ICP-MS;  $2\sigma$ ) and  $\epsilon_{\text{Hf}}(t)$  varying between -1.1 and +7.8 for the Toorongu pluton, and  $368 \pm 7$  Ma and  $353 \pm 6$  Ma ( LA-ICP-MS;  $2\sigma$ ) and  $\epsilon_{\text{Hf}}(t)$  varying between +4.3 and +8.8, and -0.8 to +9.3 for two samples of the Tynong pluton. Hafnium isotopes indicate a relatively small crustal contribution in the origin of zircons in these rocks, and the higher average  $\epsilon_{\text{Hf}}(t)$  values for zircons of the Tynong pluton (+6.9 and +4.3) compared to that of the Toorongu pluton (+3.9), suggests that the Tynong pluton has a less significant crustal input. In general, rocks of the Tynong Province have  $\epsilon_{\text{Nd}}$  and  $\text{Sr}(i)$ , varying from close to chondrite values to crust-like, radiogenic values. However, taken as a whole they do not define any clear trend between  $\epsilon_{\text{Nd}}$  or  $^{87}\text{Sr}/^{86}\text{Sr}$  values and silica content, with more felsic rocks of some of individual plutons having less evolved  $^{87}\text{Sr}/^{86}\text{Sr}$  isotopic signatures than more mafic rocks, contrary to expectations from simple mixing of magmas from mantle and crustal sources. These results suggest that the magmas may have undergone more than one phase of hybridization: juvenile mantle-derived magmas mixed with crustal

magmas to varying extents, and subsequent interactions between the hybrids led to local inversion of expected isotopic trends with silica.

*Keywords: multiple hybridisation, magma mixing, Hf isotopes, zircon, Tynong Province, Lachlan Orogen*

