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Geochemical tools for lithium-rich pegmatites and their application to Archean and Proterozoic examples in Australia

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Australia hosts globally significant hard rock lithium resources in the form of lithium-caesium-tantalum (LCT) pegmatites that contain spodumene as the primary ore mineral. The largest and most lithium-endowed pegmatites occur within the Archean Pilbara and Yilgarn cratons, including the giant Greenbushes pegmatite in the latter, although significant examples also occur in the Paleoproterozoic orogens that surround the cratons. Much recent work has focused on understanding the age and broader structural controls on pegmatite emplacement in these terranes, as well as on genetic models for their formation and zonation. However, many of the economically viable LCT pegmatites were discovered from surface outcrops, and there is much interest in developing criteria to enable the targeting of these pegmatites and their associated alteration systems under younger cover. We here report a microchemical study of minerals in lithium-mineralised pegmatites, such as apatite, tourmaline, cassiterite, tantalite and muscovite, that could be regarded as indicator minerals for spodumene-bearing pegmatites and have the potential to be dispersed as resistate phases in regolith profiles and stream sediments. This includes trace element data, as well as age and isotope tracer information, from a number of Archean and Proterozoic LCT pegmatites in western and central Australia. We discuss how these data, in tandem with whole rock geochemical compositions, can be used to reconstruct the source and magmatic evolution of the pegmatite body, including lithium enrichment pathways, and to assess fertility for lithium mineralisation.