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How it's made: An in-situ study of zircon-forming reactions in subsolidus metamorphic systems

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Trace element concentrations in metamorphic zircon are frequently used to determine the timing of zircon formation relative to other metamorphic minerals such as garnet or plagioclase. Notable examples are REE patterns [1] and the temperatures of growth using Ti concentrations [2]. Linking concentrations of trace elements in zircon to associated mineral assemblages—and pressure–temperature conditions—requires the assumption that these elements are sufficiently mobile to reach equilibrium in closed metamorphic systems. Furthermore, the reactions that grow new zircon are commonly unknown, yet such information is critical for accurately modelling pressure-temperature-time paths using zircon composition in subsolidus systems. In this study, we present *in* analyses of zircon, ilmenite, and magnetite textures and compositions measured with LA-ICP-MS and EPMA in several samples of zircon-rich granulite-facies metamonzonite. Metamorphic zircon rims with flat and patchy zoning are commonly found overgrowing oscillatory zoned igneous zircon and are adjacent to magnetite and ilmenite. We suggest that new zircon growth is a local process that occurs due to the breakdown of and magnetite. Considering the ubiquity of ilmenite and magnetite in metamorphic rocks, we suggest that subsolidus reactions with these minerals may be an important and underappreciated mechanism of zircon growth in metamorphic rocks. Metamorphic zircon in the metamonazite samples has consistent trends in concentration of REEs across a thin section, but HFSEs such as Hf and Nb are highly variable; this suggests limited equilibration of these elements between zircon and major minerals. Even at high temperatures, equilibration of Hf and Nb appears problematic in metamorphic systems and their concentrations in zircon probably reflect local equilibrium and should not be used to infer the equilibrium mineral assemblage in metamorphic rocks from zircon separates. This work illustrates the utility of in-situ geochronological analyses in metamorphic systems and

[1] Rubatto (2001), *Chemical Geology* 184, 123-138

[2] Ferry and Watson (2007), *Contrib Mineral Petrol* 154, 429-437