Timing and duration of deformation and amphibolite-facies metamorphism from U-Pb dating of texturally constrained monazite

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Many isotopic techniques are now routinely used to determine the timing of thermotectonic events, but measuring the duration of metamorphism and related deformation is more challenging. The Mount Barren Group in the Albany-Fraser Orogen of Western Australia was deformed and metamorphosed during crustal shortening related to continental collision between the West Australian and Mawson Cratons. In situ U-Pb SHRIMP analysis of monazite grains that can be texturally related to deformational fabrics and post-tectonic peak amphibolite-facies metamorphism show that tectonism occurred over a 20-25 Myr period from ~1210-1185 Ma.

Monazite inclusions within a biotite porphyroblast in a metapelitic schist are aligned with muscovite and titanhematite that define an early (S_1) foliation, and have ages of 1204±8 and 1206±9 Ma (1σ errors). Monazite aligned with muscovite and titanhematite defining the dominant (S_2) foliation in the matrix of the same rock has ages of 1191±8 and 1195±13 Ma (1σ). These ages are interpreted to reflect the timing of two phases of isoclinal folding that are recorded throughout the Mount Barren Group.

X-ray element mapping of monazite from a range of metapelitic rocks from several localities within the Mount Barren Group shows that many grains are zoned, with up to four distinct compositional domains in some grains. Individual ages for the three inner zones cannot be resolved by SHRIMP analysis and a combined age of 1209±10 Ma (2σ) has been derived from 14 analyses of grains from three samples. The outermost monazite compositional zone is texturally later than titanhematite that defines the S_2 foliation, and an age of 1186±6 Ma (2σ) has been calculated from 16 analyses of grains from two samples. This is interpreted to be the age of peak thermal metamorphism during which porphyroblasts of biotite, staurolite and kyanite grew over the earlier foliations. In situ dating of texturally constrained monazite indicates that deformation and metamorphism of the Mount Barren Group lasted for a period of at least 20-25 Myr, similar to estimates of the duration of orogenic cycles in analogous tectonic settings.