Inferring timescales of garnet crystallization from Lu-Hf dating of a size-sorted porphyroblast population

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We present a sample preparation method that enables timescales of garnet crystallization to be quantified in metamorphic terranes by sorting porphyroblasts according to size prior to dissolution. The studied sample is a psmmatic schist from the staurolite-zone of an inverted metammorphic sequence in the Cape Breton Highlands of Nova Scotia. Garnet porphyroblasts were liberated from the quartzofeldspathic matrix via electric pulse disaagreation (EPD). Intact garnets ranging from 4.8 to 0.5 mm in diameter were picked from the EPD-prepared separates and sorted according to size into 8 distinct size classes using a handheld digital caliper. Whereas size classes 1-4 each consisted of a single >3 mm garnet, size classes 5-8 each contained multiple (n = 5-60) <3 mm similar-sized garnets to ensure enough material for isotopic analysis. During all stages of dissolution and column chemistry the individual size classes were preparred and treated seperately.

A systematic relationship between grain size and Lu-Hf age was observed in the analzyed population. Size classes 1-5 (>2.5 mm) yielded Lu-Hf ages which overlap an independent 4-point 'bulk' age of 394.1 ± 1.2 Ma, whereas size classes 6-8 (<2 mm) yielded consistently younger Lu-Hf ages of 390.6 ± 2.0, 388.1 ± 2.0 and 391.9 ± 2.0 Ma respectively. These data indicate that nucleation occurred over a protracted interval, with smaller grains having nucleated later during prograde metamorphism than larger ones. Coupling Lu-Hf ages for the largest and smallest size classes, a timescale of ~6 Ma is established for garnet crystallization in the studied sample, and when integrated with results from garnet growth simulations indicate prograde heating rates of ~10°C Ma^{-1}. These ages and the inferred timescale are identical to that previously established for the staurolite-zone of the study area, demonstrating the validity of the method. This method is potentially advantegious over strategies which couple Lu-Hf and Sm-Nd isotope systematics, as sample preparation is minimial and potential issues relating to co-dissolution of unequilibrated Nd-rich mineral inclusions are avoided.