Duration of low-*P*/*T* type metamorphism and zircon/garnet REE partitioning in migmatites from the Ryoke metamorphic belt, Japan

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Zircon in pelitic migmatites (ca. 800ºC, 0.5GPa) from the Aoyama area, Ryoke metamorphic belt, Japan has dark-CL annulus containing glass inclusions between inherited cores and metamorphic rims. SHRIMP U-Pb zircon dating showed that rims show age variation from 95.5 Ma to 88.7 Ma, suggesting the duration of hypersolidus condition for ca. 6-7 Myr. Zircon rim with older ages (ca. 95-94 Ma) tend to show steeply positive HREE patterns whereas the younger rims (ca. 91-89 Ma) tend to show gently positive HREE patterns. REE and Y in coexisting garnet are high in the core and low in the rim, suggesting prograde growth of garnet. High-Y annulus is present in the garnet, although zircon rims do not. Garnet cores show steeply positive HREE patterns whereas the rims show less steep patterns. Zircon with dark-CL annulus and μm-sized inclusions are included in garnet as well, and their rims show steeply positive HREE patterns.

Systematic change of REE patterns in garnet and zircon rims suggests simultaneous growth. However, D_{REE}(Grt/Zrn) does not show flat pattern nor approach unity for HREE, different from the UHT examples [1]. Possible controlling factors of D_{REE}(Grt/Zrn) include (i) difference in *P-T* conditions, (ii) difference in grossular content in garnet [1], (iii) self-diffusion of trace element compositional profiles of garnet under UHT [2], and (iv) different timing of zircon and garnet growth [2]. Among these, (ii) is not likely because garnet in this study has low grossular content (<0.03), and (iii)-(iv) are also not likely from observations above. Rather, presence of high-Y annulus in garnet implies disequilibrium between garnet and zircon rim.

Although the controlling factor of D_{REE}(Grt/Zrn) is still not clear, our example suggests that it can be misleading to judge timing of 'normal' granulite facies metamorphism solely from the D_{REE}(Grt/Zrn) pattern or HREE pattern of zircon on the assumption that M-HREE pattern of garnet and zircon become flat and D_{REE}(Grt/Zrn) approaches unity during 'normal' granulite facies metamorphism.

[1] Taylor et al., (2014). [2] Buick et al., (2006).