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Texturally contrasting but isotopically similar: deciphering the journey of a grenvillian mafic sill using garnet and zircon petrochronology

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Syn to late-orogenic intrusions are an important feature of the Grenville Province, but their tectonic significance, at the interplay between magmatism and metamorphism, remains largely elusive. For instance, the Mid-Pressure belt of the Central Grenville, metamorphosed under granulite-facies conditions during the Ottawan orogenic phase (1080 to 1020Ma) is locally intruded by decimetric garnet and quartz- bearing mafic sills that document a complex magmato-metamorphic journey. Using detailed petrography, garnet Lu-Hf and Sm-Nd dating, and zircon U-Pb dating, this study aims to decode the relation between metamorphism and magmatism by investigating the contrasting record of two samples from the peripheric and inner parts of one of these sills. The inner part is composed of heterogeneously distributed garnet-plagioclase-quartz-amphibole-ilmenite-orthopyroxene while the peripheric part has a homogeneous groundmass dominated by plagioclase+amphibole, and garnet rimed by plagioclase+orthopyroxene symplectite.

Two garnet growth stages separated by one resorption episode are deduced from trace element zoning, which is confirmed by Lu-Hf ages spanning 20Myrs from ca. 1030 to 1010 Ma in both samples, with four garnet-whole-rock isochron ages approximating early garnet growth at 1030.1±3.4 Ma while 3 other pairs approximate second garnet growth at ca. 1010 Ma. The Sm-Nd system is equilibrated at the outcrop-scale and yields an isochron age of 1001.1±4.2Ma (MSWD=1.2, n=13), interpreted as cooling after garnet 2 crystallization. The preservation of orthopyroxene+plagioclase symplectite at the expanse of garnet highlights exhumation of the terrane, but is only recorded in the quartz-absent assemblage. In both samples, zircon shows multiple growth zones with ages spreading from ca. 1040 to 970 Ma, and spectacular textures recording multiple fluid-rock interactions.

Collectively, these data are consistent with either 1) early garnet growth at ca. 1030Ma during emplacement of the sill at depth, followed by a second growth at ca.1010Ma and then exhumation, or 2) incomplete melting of a 1030Ma garnet-bearing source, with the melt then emplaced at 1010Ma at lower pressure. This study highlights the robustness of Sm-Nd chronometer despite late fluid pulses; examines the subtle record by Lu-Hf in garnet of multiple stages in a complex evolving system; and documents the influence of quartz in triggering metamorphic reactions in mafic compositions.