Whole-rock geochemistry, Sm-Nd isotopes, and U-Pb geochronology of mafic granulites from the Canyon domain, central Grenville province, Canada

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The late Paleoproterozoic to Mesoproterozoic (~1.7–1.2 Ga) evolution of the active southeastern margin of Laurentia terminated with the Grenvillian continental collision and the development of a large, hot, long-duration orogen (LHO) at ~1.09–0.98 Ga, part of which is preserved in the orogenic hinterland as imbricated stacks of high-grade gneisses, that contain a large repository of the geological evolution of both the pre-Grenvillian active margin and the subsequent Grenvillian continental collision.

The geological evolution of M*P* granulite-facies mafic gneisses from the Canyon domain (Manicouagan area, central Grenville Province) is investigated through whole-rock major and trace element chemistry, Sm-Nd isotopes, and CA-TIMS geochronological analyses, which suggest that their protoliths were derived from depleted to slightly enriched asthenospheric mantle, and evolved through variable degrees of fractional crystallization and contamination by crust, or were modified at source, and that they range from pre-Grenvillian to Grenvillian in age. The pre-Grenvillian gneisses from the southern Canyon domain comprise two suites, one consisting of a suite of mafic sills that intruded into a ca. 1500 Ma supracrustal metasedimentary sequence (Complexe de la Plus Value) at 1438 +73/-64 Ma in an extensional arc/back-arc setting, and the other previously dated coeval to slightly younger suite of mafic rocks that was emplaced at 1410 ± 16 Ma in a compressional arc/back-arc setting. The Grenvillian mafic gneisses from the central and northern part of the domain were emplaced as dykes and sills at 1006 ± 4 Ma (in the Vein Complex) and 997 ± 2.6 Ma (in the Layered Bimodal Sequence) in a late-orogenic extensional setting.

Considered together with other information, the data for the pre-Grenvillian mafic rocks support a model of a long-lived continental-margin arc and back-arc on southeast Laurentia during the Mesoproterozoic (ca. 1.5– 1.4 Ga), whereas the record of late-orogenic (~1.0 Ga) mafic magmatism followed by granulite-facies metamorphism is compatible with deep-seated processes (e.g., slab break-off, delamination or crustal foundering, convective thinning etc.) leading to thinning of over-thickened crust in a collapsed LHO, associated with decompression melting of rising asthenosphere and conductive heating of the thinned crust.

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