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Cryptic Early "Barrovian" Metamorphism in the Trailing Edge of Ganderia: Evidence from Aluminosilicate Reaction Textures, Garnet Trace Element Zoning, and Phase Equilibria Modeling

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The Nashoba Terrane of central Massachusetts contains anatectic amphibolite-grade rocks juxtaposed between two low-grade tectonic blocks.These amphibolite-grade rocks record a complex polymetamorphic history as a result of the collision of peri-Gondwanan blocks onto Laurentia. This includes arc-related Buchan-style metamorphism from the subduction of Avalon under Ganderia (~435-400 Ma), followed by up to granulite facies metamorphism from the collision of Avalon (~400-360 Ma). While the structural and geochronological evolution of this terrane has been extensively studied, these data have not been clearly connected to the terrane's metamorphic history. Accurately constraining this history is key to unraveling the tectonic evolution of Laurentia. Here, we synthesize the results of petrographic analysis, garnet trace element LA-ICPMS mapping, and thermodynamic modeling to present evidence for an early "Barrovian" metamorphic event in the Nashoba Terrane.

Our samples are from a unit of interbedded sillimanite-biotite-plagioclase restites and kyanite-sillimanite-garnet-biotite-plagioclase anatectic schists. Kyanite occurs as ~5.5 mm long texturally early grains that are overprinted by the matrix fabric. Sillimanite occurs as ~1-3 mm diameter porphyroblasts and prismatic grains intergrown with biotite. Porphyroblastic sillimanite displays "patchy" zoning likely inherited from earlier andalusite. There are two generations of garnet: 1) subsolidus ~6mm diameter grains, and 2) <1mm diameter peritectic grains. Subsolidus garnet retains growth zoning and hosts melt inclusions. Trace element maps of garnet record patchy and embayed zoning, interpreted to represent two periods of garnet growth bracketing a period of resorption.

These data suggest a P–T history of: 1) Early kyanite-grade Barrovian metamorphism at ~650 °C and 8.5 kbar, 2) garnet resorption as a result of ~5 kbar of exhumation to andalusite-in conditions, 3) high-grade metamorphism at ~700-750 °C and 6-10 kbar facilitating sillimanite replacement of andalusite, anatexis, the nucleation of peritectic garnet, and crystallization of overgrowths on subsolidus garnet. Results will be supplemented with chemical U-Pb dating of monazite inclusions in kyanite. Alternative P–T paths and regional tectonic implications will also be explored. Ultimately, these data suggest the metamorphic history of the Nashoba is not as well constrained as previously assumed, and more careful study is necessary to understand the role these rocks play in the assembly of Laurentia.