

Garnet Sm-Nd Geochronological Insights into the Metamorphism of the Nashoba Terrane, Massachusetts, USA

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The Nashoba Terrane is a fault-bounded, metamorphosed remnant arc accreted to Laurentia in southeast New England. Three metamorphic events have been proposed for the Nashoba Terrane: an amphibolite grade event (M1) associated with early arc-metamorphism due to the subduction of the Acadian seaway, a migmatization event (M2) due to tectonic wedging during the Devonian collision of Avalonia, and a later retrograde greenschist facies event (M3). Published monazite geochronology in the Nashoba Terrane puts these metamorphic events at 435-400 Ma (M1), ca. 390 Ma (M2), and ca. 378-371 Ma (M3)¹. Further constraints conclude that the Nashoba Terrane experienced conditions above 500°C from ca. 320-430 Ma², although no direct chronology of metamorphic index minerals – like garnet – have been reported to test this proposed metamorphic timing.

Here, we present the first Sm-Nd geochronological results derived from garnet-bearing samples within the Nashoba Terrane, complemented by thermodynamic modeling to contextualize timing and conditions of metamorphism. A garnet growth age of ca. 377 Ma and cooling age of ca. 369 Ma within the Nashoba Formation indicate a ~8 Ma long event spanning from near-peak kyanite-grade anatexis to cooling through Sm-Nd closure. Modeled peak conditions of garnet growth (at ca. 377 Ma) are ~700°C and 8.5 kbar³ and the closure age of ca. 369 Ma corresponds to a temperature of ~600°C for these small garnets. These results suggest that peak metamorphic conditions persisted through the late Acadian/early Neocadian orogenies, which is a substantial revision of previously proposed tectonic models.¹

Additionally, a garnet growth age of ca. 394 Ma in a small non-foliated pegmatitic body intruding the foliated Tadmuck Brook Schist records the youngest possible age for metamorphism in the Tadmuck Brook Schist, chronicling a distinctly earlier thermal history as compared to the Nashoba Formation. Element profiles in these garnets record oscillatory zonation likely reflecting igneous growth. These findings underscore the distinct and varied thermal and tectonic histories experienced by formations currently included within the Nashoba Terrane. The unraveling of this complex metamorphic record can help to refine large-scale tectonic models.

^[1]Stroud et al. (2009) *Lithosphere* ^[2]Walsh et al. (2021) *Geosphere* ^[3]Yao et al. (2023) *Lithosphere*