SYNTHESIZING PETROGRAPHIC ANALYSIS AND MODERN THERMODYNAMIC MODELING TO DETERMINE P–T CONDITIONS OF METAMORPHISM IN THE NASHOBA TERRANE, EAST-CENTRAL MA

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Background

- The Nashoba terrane in east-central Massachusetts contains high-grade metamorphosed volcanic, volcanic-clastic, and pelitic rocks.
- The Nashoba terrane records a complex polymetamorphic history, including amphibolite facies arc-related regional metamorphism as a result of late Silurian subduction of Avalonia under the trailing edge of Ganderia and up to granulite facies metamorphism with local anatexis due to the collision of Avalonia with Laurentia through the late Devonian (Fig. 1).
- Here, we synthesize the results of petrographic analysis, phase equilibria modeling, and garnet trace element maps to interpret P–T paths for samples along a N-S transect in the Shrewsbury Quadrangle.
- Phase equilibria modeling was completed using program GIBBS with the SPaC18 thermodynamic dataset within the MnNCKFMASHTi chemical system (Spear and Wolfe, 2022). Bulk composition data for samples 21-AC-02-A, 21-AC-04-A, and 21-AC-06-A were collected via fused glass XRF at the Hamilton College Analytical Lab.

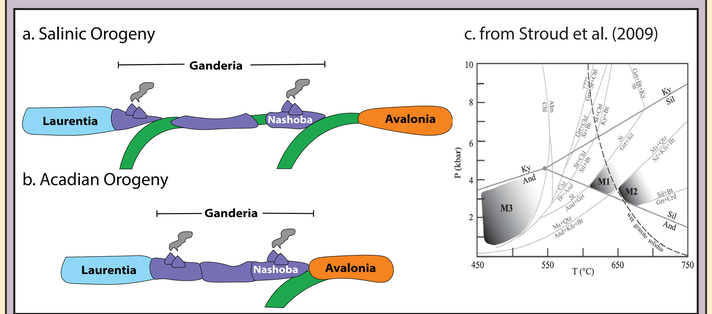

Figure 1: Tectonic model of the Salinic (a) and Acadian (b) orogenies in Southern New England. Adapted from Hepburn et al. (2021) and Reynolds (2012). Metamorphic events during the Salinic orogeny is indicated by the M1 field and events during the Acadian orogeny by the M2 field in the petrogenetic grid (c) from Stroud et al. (2009).

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Map and Photomicrographs

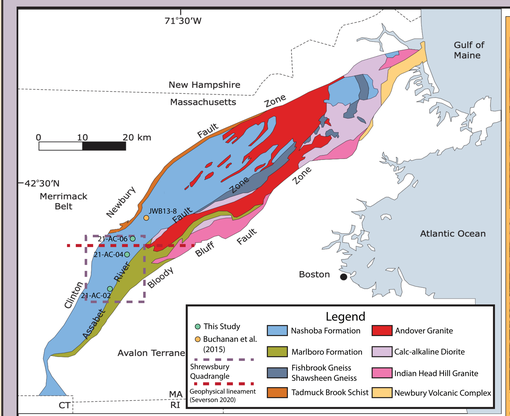

Figure 2: Map of the Nashoba terrane with sample locations. Modified from Buchanan et al. (2015).

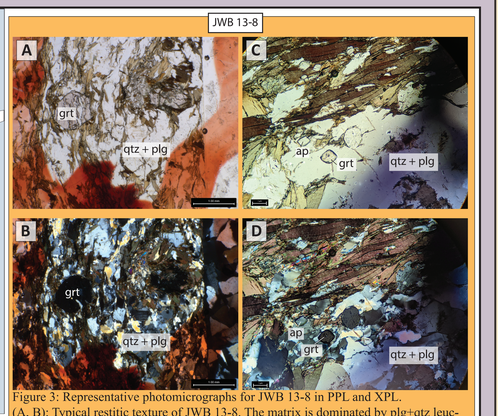

Figure 3: Representative photomicrographs for JWB 13-8 in PPL and XPL. (A, B): Typical restitic texture of JWB 13-8. The matrix is dominated by plg+qtz leucosomes, and garnet is locally replaced by bt+plg+sil. (C, D): Peritectic garnet in qtz+plg leucosome.

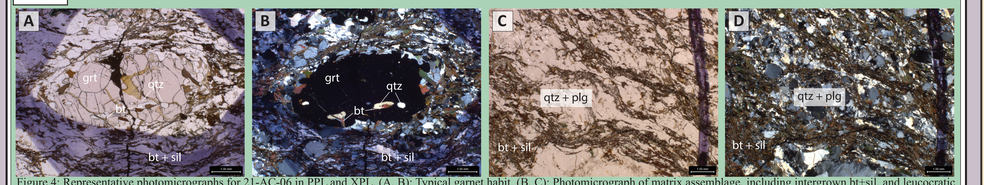

Figure 4: Representative photomicrographs for 21-AC-06 in PPL and XPL. (A, B): Typical garnet habit. (B, C): Photomicrograph of matrix assemblage, including intergrown bt+sil, and leucocratic qtz+plg.

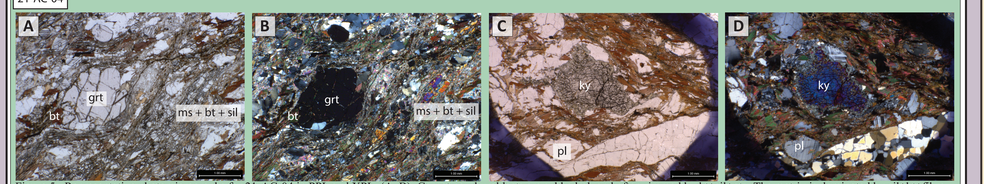

Figure 5: Representative photomicrographs for 21-AC-04 in PPL and XPL. (A, B): Garnet porphyroblasts are subhedral, and often rimmed by bt+sil+qtz. The matrix is dominated by sil+bt+fibrolite. (C, D): Typical kyanite habit. Kyanite is typically rimmed by sil.

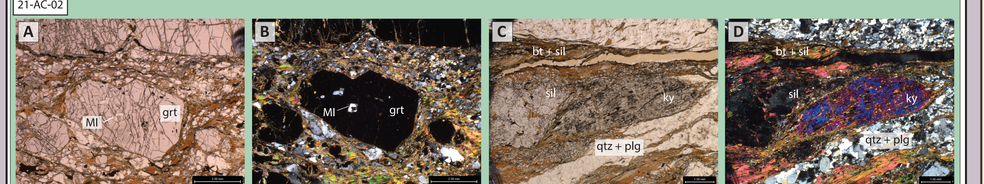

Figure 6: Representative photomicrographs for 21-AC-02 in PPL and XPL. (A, B): Typical garnet habit. Note fine grained plg+sil+bt rims, and melt inclusions. (C, D): Photomicrograph of ky and sil after and pseudomorphs. Kyanite porphyroblasts appear texturally early. Note the folded leucosome in the lower third of the image. MI = melt inclusion.

Mineral Assemblage Diagrams

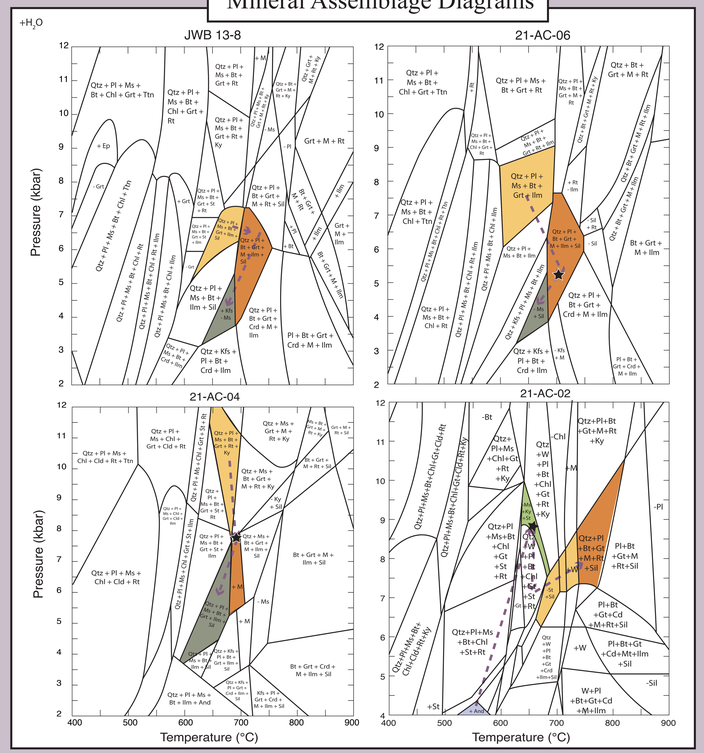

Figure 7: Mineral assemblage diagrams (pseudosections) of the 4 samples. Yellow fields represent peak subsolidus conditions, orange fields represent P–T conditions of anatexis, and gray fields represent P–T conditions of retrograde metamorphic reactions. 21-AC-02 records a more complex polymetamorphic than the other samples, with the purple field denoting the earliest andalusite grade metamorphism, followed by kyanite grade metamorphism (green field). Stars indicate intersection points of garnet rim isopleths for 21-AC-04 and 21-AC-06 and garnet core isopleths for 21-AC-02. All fields of the MADs include H_2O.

Results and Future Work

- The results of petrographic analysis and thermodynamic modeling indicate that anatexis in the Nashoba terrane is more prevalent than previously thought. Rocks that have been mapped as non-anatectic could be restites (e.g., Buchanan et al. 2015, Stroud et al. 2009).
- MAD results are consistent with clockwise P–T paths for Nashoba polymetamorphism. Peak P–T conditions are hotter and deeper than previously estimated, with an analogous M1 event (yellow fields in MADs) occurring up to 100 ˚C hotter and 2-7 kbar deeper and an analogous M2 event (orange fields in MADs) occurring 25-175 ˚C hotter and 1-5.5 kbar deeper (Stroud et al. 2009).
- Samples located south of the geophysical lineament presented in Severson (2020) (Fig. 2) record evidence for kyanite grade P–T conditions not recorded elsewhere in the Nashoba terrane.
- Additional work includes monazite and zircon dating to determine ages of identified metamorphic events and melt reintegration modeling.