John Mark Brigham - Project Profile

2023 AGeS-Grad awardee
Project Title: Can Sm-Nd garnet geochronology on rodingites hosted in serpentinite constrain the timing of serpentinization in the northern Appalachian Mountains?
Lab: Boston College Center for Isotope Geochemistry
Lab Mentors: Professor Ethan Baxter, Dr. Steph Walker

What scientific question(s) does your research address and what motivates this work?
My research seeks to better understand the timescales of rodingitization and serpentinization. Serpentinization and rodingitization are metasomatic processes that are hypothesized to be geochemically and temporally connected. Although the tectonic significance of serpentinites is well recognized, determining the age of serpentinites is challenging because serpentinization does not produce many minerals suitable for radiometric dating. At Belvidere Mountain in the northern Appalachian Mountains, variably serpentinized ultramafic rocks contain rodingite zones rich in grossular garnet. One sample of rodingite collected from Belvidere Mountain contained three texturally and chemically distinct garnets (masses of garnetite >1cm, small garnets that define the foliation, and vein garnetite). The purpose of this study was to date each garnet type in the rodingite and determine if any of the garnets could be linked to serpentinization of the Belvidere Mountain ultramafic rocks.

What chronometric tool did you employ and why?
This project used Sm-Nd ID-TIMS garnet geochronology to date each of the garnet textural types. Although rodingites have diverse mineral assemblages, some minerals found in rodingites also exist in rodingite protoliths (e.g., zircon, rutile). Grossular garnet does not form in rodingite protoliths (e.g., basalt/gabbro), and therefore the crystallization age of grossular garnet likely records rodingitization and potentially, serpentinization. Furthermore, we chose to use Sm-Nd geochronology because the method has been successful in dating grossular garnet in meta-rodingite before (e.g., Haws et al., 2021).

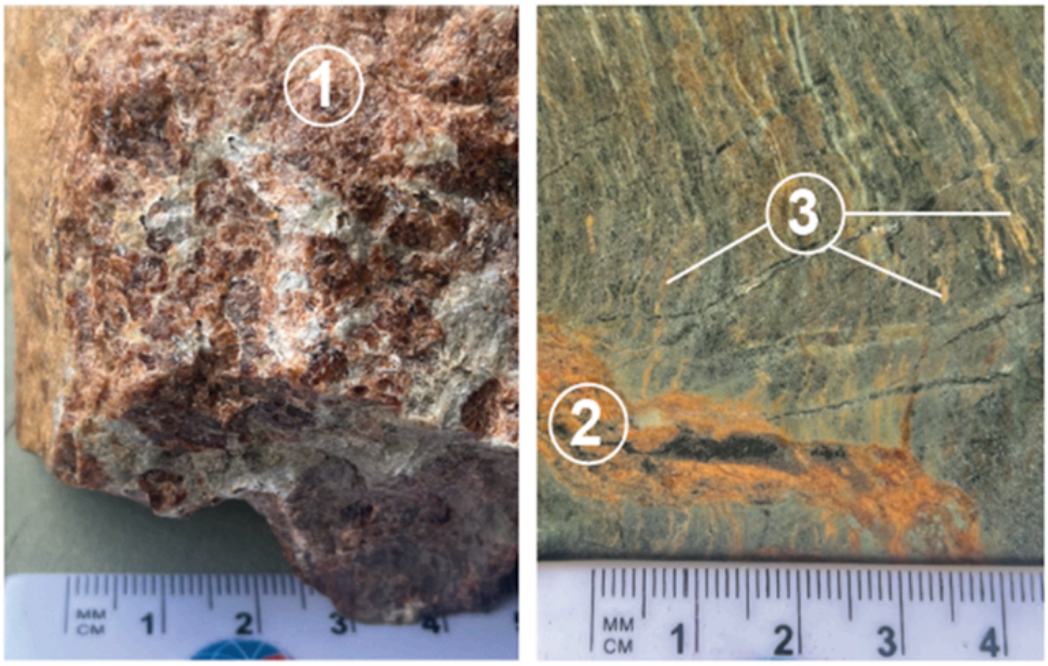

Figure 1: Photographs showing the studied rodingite sample with numbers indicating 1) massive garnets, 2) vein garnets, and 3) foliated garnets. Matrix minerals include diopside. chlorite, and epidote.

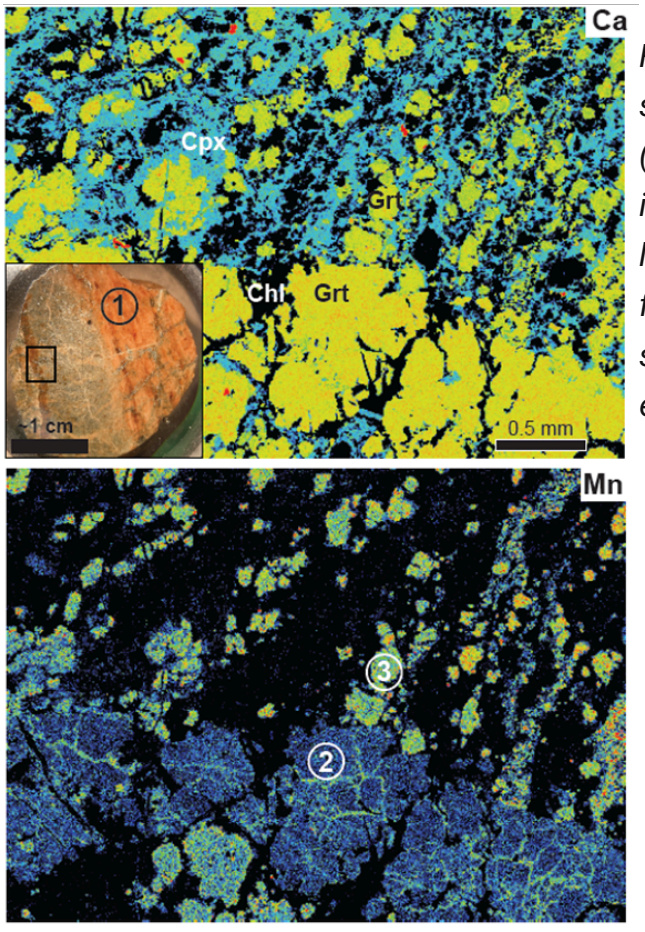

Figure 2: Electron microprobe maps showing the concentration of Ca and Mn (warmer colors=higher concentrations). The images show that vein garnets (2) have a lower concentration of Mn compared to foliated garnets (3). Inset photograph shows the corresponding rock mounted in epoxy for microprobe analysis.

What were some of the key takeaways of your research?

- We interpreted the age of the oldest garnet (massive garnets) to represent rodingitization at blueschist facies conditions during the Ordovician Taconic Orogeny, possibly coeval with serpentinization.
- One of the younger garnet generations contained inclusions of Nd-rich allanite. Although each garnet went through a rigorous partial dissolution procedure designed to remove inclusions, the allanite was not successfully removed. This affected the precision and accuracy of the foliated garnet age.
- The vein garnets formed ~70 million years after the massive garnets, likely during low-temperature brittle deformation associated with tectonic events after the Taconic Orogeny.

What new experiences, opportunities, and collaborations did you gain as an AGeS-Grad awardee?

Everyone at the Center for Isotope Geochemistry at Boston College made me feel welcome. I was invited to lab group meetings and developed close friendships with the graduate students who helped me in the lab. My lab visit lasted about 6 months, and I gained valuable experience preparing samples, working in an ultra-clean lab, and conducting TIMS analyses. I hope to continue using Sm-Nd geochronology for my future projects.

What is one piece of advice you have for future AGeS-Grad award applicants or awardees?

Reach out to your potential host lab early and do as much preliminary work as possible to characterize your samples. Also reach out to previous awardees, as I'm sure we all would love to share more details!