Boston College Center for Isotope Geochemistry - AGeS2 program lab profile

The Center for Isotope Geochemistry at Boston College has hosted many national and international external visitors for a variety of different projects, although the most common is Sm-Nd dating of garnets. **Sm-Nd dating of garnets** by Thermal Ionization Mass Spectrometery (TIMS) is a valuable tool for providing insights into the timing, duration, and rate of different tectonic and metamorphic processes (e.g. Baxter et al. 2017). Lu-Hf is another powerful method to directly date garnets, but this requires a MC-ICPMS and is not something we offer at Boston College. For information and an overview of garnet geochronology and petrochronology, please see Baxter & Scherer (2013) or Baxter et al. (2017).

Overview of lab facilities

Constructed in 2016, the Center for Isotope Geochemistry at Boston College is a world-class facility for the high-precision analysis of a wide array of materials. Located within the Department of Earth and Environmental Sciences, the Center consists of a 750 sq ft class 1000 trace metal clean room with class 100 work spaces, and an IsotopX Phoenix Thermal Ionization Mass Spectrometer (TIMS). The lab specializes in small-sample Sm, Nd, and Sr isotope analysis on a variety of Earth materials.

Two trace-metal clean rooms are at the heart of the center. The metal-free HEPA filtered labs were designed for the processing of small amounts of sample (sub ng) with minimal environmental contamination. The space features 14 class 100 ULPA filtered laminar flow benches and hoods, Savillex Teflon distillation devices, Analab metal-free hotplates, and three analytical balances. The labs are designed to hold a steady temperature and positive pressure monitored by a Setra Multisense monitor at the interface of each lab door.

The IsotopX Phoenix TIMS is equipped with nine movable Faraday detectors and an ion-counting Daly detector. The sensitivity of the TIMS permits acquisition of high-precision (10ppm) isotope data for the smallest samples down to the sub-nanogram level for high mass elements (e.g. $^{143}Nd/^{144}Nd$, $^{87}Sr/^{86}Sr$). Filaments are prepared and degassed in-house. Samples are loaded under ULPA-filtered laminar flow using an in-house designed filament loading bench.

We also have a mineral preparation lab for processing solid samples and isolation of specific mineral phases. The lab features a Spex ball mill for producing powders from rock fragments, petrographic and binocular picking microscopes, an exhausting fume-hood used for heavy liquid density separation, a new Frantz isodynamic separator for magnetic separation, and a New Wave MicroMill device for high-precision micro-sampling of zoned minerals.

Time estimates for visits

Garnet geochronology is a time-consuming task that requires significant training and guidance so the time-frame of any visit would be heavily dependent on the experience level of the visitor, the scope of the project, and the required contribution from the staff of the center. A hallmark of the

lab philosophy is the investment of our time in training and collaborating with visitors who get to learn and perform the work hands on. Typically, for a visitor who has no prior experience in isotope geochemistry, one isochron could be determined in 2-5 weeks if most of the sample preparation is undertaken prior to arrival at BC. However, visits of several months are more common when multiple samples, or zoned garnet microsampling, are being proposed. Reach out to Ethan Baxter and/or Steph Walker for a better estimate of the time needed for your project.

Costs and expenses

Given the complexity and variables involved in garnet geochronology, the center can operate on a fee-for-service model for external users and rates can be developed with prospective users dependent upon considerations such as sample type, sample number, sample preparation, required assistance, user training, and other factors. Users should also account for samples run during training and preliminary analysis. This covers all training, sample preparation, clean lab chemistry, and mass spectrometry conducted in the center. Project costs should be reviewed and discussed in advance with Prof. Baxter and Dr. Walker.

Pre-visit sample prep

Any preparatory work and mineral separation you can do before arriving at Boston College will maximize the number of samples you can process in the lab. It is very useful (though not required) to have some chemical information (i.e. maps, profiles, or spots) on the garnets/minerals we are targeting, preferably trace- and major-elements (by LA-ICPMS and/or EPMA).

If possible, mineral separation should be started or completed before arriving at Boston College, unless planning to use the MicromMill or if those facilities are not available at your institution. This will speed up the procedure by up to a week for each sample. Please consult with our lab before you begin any sample preparation at your home institution.

We also recommend that lab visitors consult the following papers that describe many of our methods for isotopic analysis, garnet preparation, and geochronologic interpretations. The Starr et al. (2020) paper is a good example of our most recent efforts, procedures, and results.

- Baxter, E.F., Caddick, M.J., Dragovic, B. (2017). Garnet: A Rock Forming Mineral Petrochronometer. *Reviews in Mineralogy & Geochemistry*, 83, p. 469-533.
- Baxter E.F., and Scherer E.E. (2013). Garnet: Timekeeper of Tectonometamorphic Evolution. *Elements,* 9, 433-438
- Pollington, A.D. and Baxter, E.F. (2011). High precision microsampling and preparation of zoned garnet porphyroblasts for Sm-Nd geochronology. *Chemical Geology,* 281, p. 270-282.
- Harvey J. and Baxter E.F., (2009). An improved method for TIMS high precision neodymium isotope analysis of very small aliquots (1 – 10 ng). *Chemical Geology,* 258*,* p. 251-257.
- Starr, P.G., Broadwell, K.S., Dragovic, B., Scambelluri, M., Haws, A.A., Caddick, M.J., Smye, A.S., Baxter, E.F. (2020). The subduction and exhumation history of the Voltri Ophiolite, Italy: Evaluating exhumation mechanisms for high-pressure metamorphic massifs. *Lithos*, 376, 105767.

Laboratory staff who will train and oversee students

Training will be primarily undertaken by Dr Steph Walker and/or an experienced postdoc/upper-level graduate student who will be assigned as a lab mentor and collaborator.
Data interpretations and project design will be assisted by both Prof Baxter and Dr Walker.

Lab staff and contacts

Prof. Ethan Baxter, Chair of the Center for Isotope Geochemistry Faculty Advisory Committee – ethan.baxter@bc.edu and Dr. Stephanie Walker, Director, Center for Isotope Geochemistry – walkerfj@bc.edu

Visit lead-times

Preferably >2-3 months, but highly dependent on lab availability.

DEI statement

The Center for Isotope Geochemistry at Boston College prioritizes undertaking innovative world-class research in a safe, welcoming, accessible, and equitable environment. We greatly value mentorship and therefore each lab visitor is given a mentor from the senior members of the lab, and will be welcome to all lab meetings and discussions before, during, and after their stay. We are also actively engaged with organizations for widening participation in STEM such as AGU, SACNAS, and the Unlearning Racism in Geoscience (URGE) program.