



AGeS Program Laboratory Profile
University of Colorado Boulder (U-Th)/He Laboratory
(CU TRaIL – Thermochronology Research and Instrumentation Lab)
Updated January 2025

Lab website: <http://cutrail.org>

(U-Th)/He and U-Pb Chronology

Contacts

If you are interested in acquiring (U-Th)/He or U-Pb data in our lab, or would like to discuss potential collaborations, please contact either:

Lab PI: Dr. Rebecca (Becky) Flowers, rebecca.flowers@colorado.edu

Lab Manager: Dr. James (Jim) Metcalf, james.metcalf@colorado.edu

Research associate Dr. Liam Courtney-Davies currently manages the U-Pb analyses by LA-ICP-MS in TRaIL. liam.courtney-davies@colorado.edu

Lab Description

The CU TRaIL (Thermochronology Research and Instrumentation Lab) includes all of the facilities required to prepare and analyze minerals for whole-crystal (U-Th)/He thermochronology and for U-Pb geochronology by LA-ICP-MS. Equipment includes three binocular microscopes with transmitted light and polarizing filters, three calibrated digital cameras for sample characterization and preparation, an ASI Alphachron He extraction and analysis line, an Agilent 7900 quadrupole ICP-MS, an ESI NWR193 excimer laser, and a clean lab for the wet chemistry required to prepare samples for ICP-MS analysis.

The lab can measure (U-Th)/He on a variety of minerals. However, visitors should discuss analysis of non-standard minerals (anything besides apatite, zircon, or titanite) with us before writing a proposal.

U-Pb analyses by LA-ICP-MS are regularly performed on zircon. Visitors interested in analyzing other materials (e.g. titanite, hematite, or other minerals) should consult with TRaIL staff.

TRaIL Statement of Lab Diversity, Equity, and Inclusion

We strive to make the CU TRaIL an inclusive, safe, and supportive space for everyone working in or visiting the lab. We are committed to supporting students from underrepresented backgrounds, including through AGeS research projects. We emphasize that creating and maintaining welcoming spaces that are anti-hostile is critical for both diversifying the earth sciences and ensuring that all lab members and visitors have the opportunity to participate in and contribute to our scientific and educational goals. We believe that equity, diversity, and inclusivity are both right and vital for the long-term success and relevance of the earth sciences.

Therefore, as a lab, research group, and active teaching facility, we pledge to

1. Promote and maintain an environment free from dehumanizing behavior including, but not limited to, discrimination and harassment based on race, sex, sexual orientation, physical ability, gender expression, body size, religion, age, or ethnicity.
2. Listen to the concerns of our group members and visitors, be open to the continual improvement of our lab policies and procedures, and be proactive in improving inclusivity in the lab.
3. Acknowledge that being inclusive is an active process, and continually strive to educate ourselves about diversity, equity, and inclusion in both the earth sciences and in society more broadly.
4. Use lab resources to provide research and training opportunities for students from underrepresented groups in the earth sciences.
5. Support our lab members when they work on projects promoting diversity, equity, inclusion, and science outreach.
6. Never tolerate abusive or harassing behavior, both of which we consider to be scientific misconduct and in direct opposition to the mission of the lab.

Expected Time Frame

For (U-Th)/He analyses, students should expect to spend a minimum of one week visiting our lab for preparation and analysis of a minimum of 5 samples. For analysis of 10-15 samples, a two week visit should be scheduled. Each sample can take anywhere from 2-8 hours to prepare depending on its size and quality, and the speed and experience of the user. The first step of analysis (He measurement) can accommodate 25 single-grains, which typically consists of 22 unknowns and 3 standards. Because He analysis is automated, once a batch of samples is ready, the visiting student can run them in parallel with additional sample preparation. Due to restrictions on clean lab use and the time frames of mineral dissolution, students will not participate in the dissolution of their samples, or in analyzing them for parent nuclide concentrations. Those steps will be handled by lab staff, and are covered in the per sample fee. However, students will have the opportunity to observe how the measurements are performed with the ICP-MS.

The basic (U-Th)/He steps that the student will learn and perform during and after the visit are as follows:

- Identify appropriate minerals using a binocular microscope.
- Measure and characterize single grain samples.
- Load single grains into metal packets.
- Load samples into the ultra-high vacuum He analysis line.
- Prepare the line for analysis by running standards and background measurements.

- Set up an automated run table to analyze samples.
- Check sample status during analysis.
- Reduce data and calculate total He abundances.
- Unload samples from the machine to prepare them for U, Th, and Sm analysis.
- Observe U,Th and Sm analysis by ICP-MS
- Use He, U, Th, and Sm data to calculate (U-Th)/He dates for their grains.
- Interpret and/or model data.

For LA-ICP-MS analyses, the expected visit time will vary depending upon how many individual spot analyses are desired. A typical user can analyze 200-300 individual spots per day. Igneous samples with relatively simple zircon populations typically require 30-50 individual spot analyses, whereas more complex igneous and metamorphic histories might need >50 and detrital samples will need >100 individual spot analyses. These estimates assume samples are already prepared as polished epoxy mounts or as polished thin sections. Users can prepare sample mounts at CU TRaIL and if interested should contact lab personnel to discuss time frames.

The basic LA-ICP-MS steps that the student will learn and perform during and after the visit are as follows:

- Identify appropriate measurement spots on samples.
- Set up laser ablation software to appropriate analytical conditions.
- Identify appropriate primary and secondary standards.
- Check sample status during analysis.
- Participate in basic data reduction using the Iolite software package.

Analytical Costs

(U-Th)/He Analyses

Our typical lab rates are a \$355 training fee, and an additional \$74 for each apatite analysis and \$131 for each zircon or titanite analysis. We typically recommend 5 individual apatite analyses per basement sample = \$370/sample, and 3 individual zircon or titanite analyses per basement sample = \$393/sample, although samples with complex protracted thermal histories may require >3 zircon or titanite analyses. Students interested in working on detrital samples should consider analyzing at least 8-10 individual grains per sample for apatite, zircon, or titanite. Our prices include all consumables and supplies, use of equipment, training, and preliminary data reduction.

Students interested in analyzing minerals other than apatite, zircon, or titanite should contact us to discuss costs.

LA-ICP-MS U-Pb Analyses

Our typical lab rates include a \$100 training fee for users who need to make mounts at CU, and additional ICP-MS analysis rates of \$1500/day or \$7.50 per analytical spot, whichever is less. The minimum charge for lab use is equivalent to one half day (\$750), and includes all primary and secondary standard analyses. This rate is also considered to be assisted, meaning that CU TRaIL staff will work with the user to set up and monitor analyses, troubleshoot the equipment, and perform basic data analysis.

****It may be possible to negotiate analytical costs for AGeS projects depending on the individual project requirements, resources, and timeframes. Please don't hesitate to contact us for more information if you are interested in using (U-Th)/He or U-Pb dating in a project.****

Preparation for Visit

For (U-Th)/He analyses, students should arrive at CU Boulder with pure mineral separates. Mineral separates are typically generated by crushing, pulverizing, and hydrodynamic, heavy liquid, and magnetic separation steps so that what remains is a dense, non-magnetic fraction, preferably a vial of apatite and/or zircon. Students who do not have access to mineral separation facilities should contact GeoSep Services (<http://www.geoseps.com/>), a commercial outfit that the CU Boulder lab regularly works with. Mineral separation can take substantial time, and students should make sure to check with GeoSep prior to scheduling a lab visit. Because sample quality can vary, students are encouraged to send the separates to the TRaIL facility for evaluation prior to their visit to make sure the samples contain the appropriate minerals for analysis.

Users interested in LA-ICP-MS zircon U-Pb analyses should also mount and polish their samples in epoxy. This can also be performed at CU but will require 1-3 days before samples are ready for analysis and will incur a \$100 training fee.

For additional information about traveling and staying in Boulder, visit:

<https://cutrail.org/visitor-info/>

Relevant Laboratory Staff

The CU TRaIL is directed by Professor Becky Flowers and managed by Dr. James Metcalf. Flowers, along with Metcalf, will be engaged with project planning, strategy, and interpretation. Metcalf will primarily coordinate on-site student visits associated with (U-Th)/He analysis, including training, sample preparation, analysis, and data reduction. Courtney-Davies will primarily coordinate on-site student visits associated with U-Pb analysis, including analysis and data reduction.

Data Processing and Interpretation

While in the lab, students will learn how to process and reduce all of the data they have collected. For (U-Th)/He analyses, this includes calculation of alpha-ejection factors, raw (U-Th)/He dates, corrected (U-Th)/He dates, and the propagation of uncertainties. In addition, students will be shown the basics of how to use a thermal history modeling program to better understand the significance of their results. Flowers and Metcalf will continue to be available to consult with the students through email and/or videoconferencing until they are satisfied that they understand the results. For LA-ICP-MS analyses, data processing includes data reduction using the Iolite software package, with personnel continuing to be available for consultation after the visit.

Expected Lab Availability

In most situations, students may schedule time in the CU TRaIL with 1-2 months lead time.