

EarthScope Student Geochronology and Thermochronology Research and Training Program Laboratory Overview

MIT U-Th Geochronology Laboratory (McGee Lab)

Lab Description

The McGee laboratory specializes in high precision U-Th geochronology through the ID-MC-ICP-MS method. The lab facilities are designed to efficiently process carbonate samples from drilling to chemical preparation to analysis. We have experience using U-Th geochronology to date a wide range of carbonates, including speleothems, lake tufas, carbonate-rich lake sediments, and marine biogenic carbonates. We maintain a sample preparation room containing a rock saw, polishing equipment, a high-precision sample mill and hand-held drill for preparing and drilling samples. Chemical purification of samples is performed in a clean laboratory containing HEPA-filtered air supply, ULPA-filtered laminar flow hoods, laminar flow work stations, a weighing room, graphite hot plates, a Millipore water purification system and an ultraclean acid distillation system. ^{236}U - ^{233}U - ^{229}Th isotopic tracer solution is added to each sample. The lab's tracer solutions have been calibrated against internal gravimetric standards and tested against the University of Minnesota tracer and the U. Minnesota aliquot of the HU-1 uraninite standard. In 2016 the lab will participate in an intercalibration project for U-Th geochronology organized by three UK groups and the University of Minnesota. Samples are analyzed on a Nu Plasma II-ES MC-ICP-MS maintained by McGee's group. This instrument is used almost exclusively for U-Th analyses and achieves 1.2-1.5% ionization, transmission and detection efficiency for U and Th. An Aridus II desolvating nebulizer is used to reduce oxides and provide maximum sensitivity.

Expected Time Frame

Depending on the number of samples and how much of the procedure the student wishes to actively participate in, we suggest a visit duration of 1.5 to 4 weeks to complete a "small" project. If sample drilling is done before the student arrives, a visit of ~1.5-2 weeks is sufficient to prepare 2 rounds of ~8 samples in the clean lab and analyze at least one set of samples on the MC-ICP-MS. If the student wants to do the drilling at MIT, be present for all the mass spectrometry and/or analyze more than 16-18 samples, more time and/or multiple visits will be necessary. We can also arrange preliminary U and Th concentration analyses by quadrupole ICP-MS if desired.

The following list shows approximately how much time each step in the procedure requires:

Drilling (1 day)

- Collect sample powders using milling machine

Chemical preparation (3 days per set of ~8 samples)

- Spike with mixed U-Th tracer
- Dissolve powders
- Remove calcium with iron oxy-hydroxide co-precipitation
- Prepare for column chemistry
- Column chemistry

MC-ICP-MS analysis (1-2 days per set of ~8 samples)

- Measure U and Th isotopes

Data reduction (1-2 hours per set)

- Determine U-Th ages with in-house Matlab script□

Analytical Costs

□Analytical costs are difficult to assess when training students. Our approach is to work with investigators to recover sufficient funds to cover costs while not discouraging the visitors from doing too few analyses to save money. The number of samples analyzed is highly dependent on the problem being addressed. Our basic charge is \$2000/sample set including ~8 analyses. The student will work with our staff to design the best approach, and our goal will always be to solve the problem, regardless of number of analyses. □

Preparation for Visit □

There are two ways a student can prepare samples for a visit to MIT: □

1. Determine U and Th concentrations at the home institution, or send a small set of 1-mg sample powders to determine U and Th concentrations if not known.
2. Drill powders ahead of time. Typical sample sizes range from 5-200 mg depending on U concentrations, approximate age, sample type and study goals. We will assist in deciding optimal sample sizes for each project.

Additional Lab Capabilities

In addition to high precision U-Th geochronology, the McGee lab is also equipped to measure Sr isotopes by MC-ICP-MS. We can also measure trace element compositions (e.g., Mg/Ca, Sr/Ca) of carbonates by quadrupole ICP-MS in an adjacent department. We are also in the process of setting up U-Pb carbonate geochronology in collaboration with Dr. Jahan Ramezani of the Bowring lab at MIT. Please contact us if you have a special request for analysis!

Laboratory Staff

The lab is run by Dr. David McGee and his group of graduate students, post docs and researchers. The lab manager, Irit Tal, and research scientist Dr. Ben Hardt will be responsible for working with and training student visitors.

Data Processing and Interpretation

We have developed in-house Matlab scripts that simplify data reduction and U-Th age calculations for most samples. We will work with students to interpret age data and to ensure that students understand the corrections applied to the data (e.g., mass bias, ion counter yield, tailing, etc.). We also have experience with U-Th isochrons for determining $^{230}\text{Th}/^{232}\text{Th}$ ratios for initial Th corrections and can guide students in isochron analysis if necessary. Data interpretation will continue after the student leaves MIT, and students are encouraged to stay in touch with Dr. McGee as the project moves forward. We are happy to provide assistance and guidance.

Expected Lab Availability

In most situations, students will be able to schedule a visit to the McGee Lab 6 weeks to 2 months in advance.

Contact Information

If you are interested in pursuing a research project at MIT and would like to discuss potential collaborations, please contact David McGee: davidmcg@mit.edu