EarthScope Student Geochronology Research and Training Program Laboratory Overview
Texas Tech University Mineral Isotope Laser Laboratory (MILL)
28 January 2019

Lab Description

The Mineral Isotope Laser Laboratory (MILL) is located at Texas Tech University in Lubbock, Texas. The lab offers LA-ICP-MS U-Th-Pb geochronology of accessory minerals such as zircon, rutile, and apatite, and in-situ LA-MC-ICP-MS Lu-Hf isotope analyses of zircon. The lab specializes in the use of small ablation spots, 7-15 microns, for U-Th-Pb analyses of small grains or small domains in larger grains. Grains may be analyzed in epoxy mounts or directly in polished thin sections. Cathodoluminescence (CL) or high-contrast backscattered electron (BSE) images should be collected prior to arrival in the LA-ICP-MS laboratory.

Instrumentation consists of a Nu Plasma II MC-ICP-MS, a Nu AttoM magnetic sector, single-collector ICP-MS, and an ESI NWR193 laser ablation system with a 193 nm ArF excimer laser and a TwoVol2 two-volume ablation chamber. The AttoM is used for U-Th-Pb geochronology and the Plasma II is used for isotope tracer analyses (e.g. in-situ Lu-Hf isotope analyses). Data can be acquired manually or in fully automated mode.

Expected Time Fame

The typical analytical day is from 9 AM – 7 PM. Students can expect to analyze 2 – 5 samples per day and should plan for at least a full day of data reduction and interpretation per visit. The actual time required to analyze a sample is heavily dependent on several factors including the total number of spot analyses per sample (typically ~120 spots for detrital sample; 35-50 spots for igneous or metamorphic samples), the quality of images generated prior to arrival, and the familiarity and experience of the user with laser ablation analysis and data reduction. The time spent reducing data is dependent on the number of samples analyzed and experience of the user.

Analytical procedures that a student will be involved in during their visit include:
- Instrument and experiment setup
- Laser spot placement and standardization protocols
  - Using SEM images to place laser spots
  - Laser system software operation
- Mass spectrometer operation
  - Mass spectrometer software operation for acquiring data
  - Exporting data
- Data Processing
  - Interval selection and basic data reduction procedure using Iolite

- o Uncertainty propagation for LA-ICP-MS data
- Data Reporting and Interpretation
    - o Creating data tables for thesis and publications
    - o Method description for thesis and publications
    - o Data interpretation with Isoplot, or similar program.

Analytical Costs

Students should budget US$1000 / day for U-Th-Pb analyses and US$1000 / day for Lu-Hf analyses. Analysis time can vary considerably depending on several factors noted above, and this should be considered in planning. These prices include all consumables, supplies and training related to use of the MILL facility.

Users planning on both U-Th-Pb and Lu-Hf analyses should plan on a minimum of 2 days of analytical time. U-Th-Pb LA-ICP-MS analyses for all grains will be run first and all data reduced. Hf isotopic analysis on targeted grains (based on U-Th-Pb results) will follow.

Preparation for Visit

Lab visitors must complete mineral separation, sample mounting/polishing, and SEM BSE or CL imaging prior to visit. Please contact the MILL staff prior to visit for sample processing and image guidance. Visitors to the lab may bring polished, uncovered standard-size thin sections (27 x 46 mm) or 25 mm diameter polished epoxy mounts. Please remove any carbon or gold coating from samples prior to arrival. Locations of all grains and samples should be noted on an electronic 'overview' image of each epoxy mount or thin section prior to the first analytical day in the lab. A second BSE/CL image that is zoomed in to show the internal structures of individual grain(s) should also be provided. Exact spot locations will be recorded on high-magnification images.

Data Processing, and Interpretation

Students will learn how to process and reduce all the data they have collected while in the lab. This includes calculation of isotope ratios and U-Pb dates, propagation of uncertainties, and interpretation of U-Pb dates. Professor Sylvester will continue to be available to consult with students through email and/or video chat until they are satisfied they understand results. Students will also be produce analytical method and data tables for future thesis and publications following the recommendations for data reporting by the LA-ICP-MS U-Th-Pb Network.

Expected Laboratory Availability

We are usually able to accommodate visitors within 4 – 6 weeks. Please contact Professor Paul Sylvester **(paul.sylvester@ttu.edu)** to check availability.

Relevant Laboratory Staff

The MILL is directed by Professor Paul Sylvester (paul.sylvester@ttu.edu). Professor Sylvester will be primarily in charge of visiting students, and will direct their training, analyses, data reduction, and data interpretation. Several graduate student research assistants provide practical day-to-day guidance. Dr. Kate Souders, a member of the Adjunct Faculty at Texas Tech (kate.souders@ttu.edu) is also available for assistance, consultation and advice.