

EarthScope Student Geochronology Research and Training Program Lab Overview

The University of North Carolina at Chapel Hill
Thermal Ionization Mass Spectrometry (TIMS) Laboratory (geochem.unc.edu)
Prof. Drew Coleman and Dr. Ryan Mills: 3/10/16

Laboratory Description

The UNC Department of Geological Sciences houses a state-of-the-art isotope dilution-thermal ionization mass spectrometry (ID-TIMS) lab. The lab operates two TIMS instruments: 1) a recently installed PhoeniX-X62 with 9 adjustable Faraday cups, two complete amplifier housing bins (one with a full set of 10^{11} Ω resistors, and a second with a full set of 10^{12} Ω resistors), a Daly ion counting system and a 20-bead turret, and 2) an automated VG Sector 54 mass spectrometer with eight adjustable Faraday cups, a Daly ion-counting photomultiplier system, and a 20-bead turret. A complete electronics upgrade of the Sector 54 occurred during the summer of 2001. Additionally, a new axial Faraday detector was installed in December 2003. Both machines are maintained, in part, through yearly service visits that are included in a service contract with the vendor (currently IsotopX). Both instruments are supported by an IsotopX DG60 for filament preparation.

The Sector 54 and sample preparation facilities are housed in a class-1000 clean lab. The lab contains supporting electronics and computing for the mass spectrometer. Additionally, seven class 100 vented-hood workstations are available for sample preparation and column chemistry (for isolation of elements for analysis). The clean lab houses facilities for geochemical work with acids, including whole-rock dissolution and etching/staining. The entire 3-room lab facility is pressurized and contains two Savillex acid stills and a Direct-Q water purification system. Cleaning protocols for the lab and equipment are rigorously maintained to minimize blank contamination.

At UNC, much work has been done using U-Pb geochronology to enhance understanding of the rates of geologic processes. The U-Pb lab is a separate lab facility specifically for working with zircon, titanite, monazite and apatite for U-Pb dating. The U-Pb lab is a class 100 clean lab with facilities geared towards the separation and preparation of single mineral grains in an ultra-clean environment.

There are three ancillary lab rooms for various parts of sample preparation. The rock-crushing lab which contains standard rock-crushing equipment including a shatterbox, disk mill, and jaw crushers, as well as other preparation equipment such as a diamond rock saw. The rock preparation room which contains equipment for density separation of minerals using dense liquids, magnetic separation equipment and furnaces for the heating of Parr dissolution vessels. The pick lab contains two optical microscopes for mineral picking.

The geochronology lab is also supported by the department Scanning Electron Microscopy (SEM) lab. This lab features a TESCAN Vega TS5136 SEM. The SEM is fitted with a Link IIXL energy dispersive spectrophotometer with an Si-drift detector and 4pi image analysis system. The new SEM and image analysis system allows rapid collection of high-resolution backscattered electron and X-ray map images, and can be used for semiquantitative chemical analysis. In 2012 we added a Centaurus (extended UV range) cathodoluminescence detector to the system.

The SEM is currently used to identify and image mineral grains for geochronology. Images obtained on the SEM can be used in conjunction with our New Wave Research/Merchantek Products MicroMill system. This system includes a video microscope mated with a high-speed drill and a computer-controlled motorized stage. With careful monitoring, we have been able to

drill samples with spot diameters and line widths as small as 30 μm . The powdered sample is then removed and analyzed using conventional ID-TIMS techniques.

Procedural Time Estimates

The options for geochronology in our labs are U-Pb dating of zircon, titanite, monazite, and apatite, Sm-Nd and/or Rb-Sr isochrons of mineral separates from whole rocks, and Sr chemostratigraphy. These different methods take very variable amounts of time to complete with Sr stratigraphy taking approximately 1 week for up to 40 samples, Sm-Nd and Rb-Sr isochrons taking approximately 2-4 weeks/isochron, and U-Pb taking 2-6 weeks/sample. Additional time should be allocated for additional sample preparation such as micromilling or ashing to remove organic material.

Preparation Prior to Visit

Prior to arrival in Chapel Hill one could start the preparation of the materials by breaking down materials and separating mineral grains if your local university has the proper facilities. This will reduce the time frames for Sm-Nd, Rb-Sr, and U-Pb by approximately 4-6 days. Description of current lab practices are provided on our [website](#) and students are encouraged to visit the site prior to arrival.

Analytical Costs

Costs are set by the UNC-CH Geochemical Recharge Center. Presently for external users, U-Pb dates are \$1360/sample (assuming 8 fractions/sample). Additional fractions may be purchased for \$170/fraction. We do not recommend analysis of fewer than 8 fractions. Samples for Sr-chemostratigraphy can be analyzed for \$27 each. Analysis for Rb-Sr isotope geochronology is \$54 for each Rb-Sr pair. Costs for Sm-Nd geochronology are \$84 for each parent-daughter pair. For all analyses there is an additional \$10 charge if silicate dissolution is necessary. Users should contact the lab to inquire about whether there may be additional costs for mineral separation, micro-sampling, leaching, ashing, *etc.*

Laboratory Staff and Contacts

The lab is under the direction of Dr. Drew Coleman (dcoleman@unc.edu) and managed by Dr. Ryan Mills (rdmills@unc.edu). Both Coleman and Mills will assist in mass spectrometry, data management, and interpretation. Mills manages the day-to-day chemical procedures. Coleman's graduate students will also assist with chemical procedures.

Lab Availability

We would prefer two or three months of lead-time prior to the visit, but in special circumstances one month of lead-time will suffice.