EarthScope Student Geochronology Research and Training Program Laboratory Overview

New Mexico Geochronology Research Laboratory (NMGRL)
New Mexico Tech
3/2/2015

Lab Description

The NMGRL $^{40}Ar/^{39}Ar$ geochronology laboratory is a state-of-the-art facility designed to conduct the full range of research available to the method. We will be soon housed in a newly constructed 24 million dollar building with specially designed lab space and a beautiful work environment for data analysis and interpretation. We specialize in ultra-high precision and accuracy geochronology of volcanic rocks and thermochronology to examine exhumation of crustal rocks. Our fully automated lab includes two ARGUSVI multicollector mass spectrometers and one MAP-215-50 mass spectrometer tied to specialized argon extraction systems. Samples are heated via either one of two CO_2 laser systems, an 810 nm diode laser or an accurate temperature controlled double vacuum resistance furnace. A 193 nm Excimer laser is available for in situ analysis. We have complete mineral separation facilities with standard binocular microscopes as well as a binocular microscope fitted for viewing with transmitted and polarized light connected to a calibrated digital camera. Our assortment of equipment allows for microanalysis on single grains as young as Holocene through large bulk grain analysis of any age range. Although we can measure most any K-bearing minerals and/or rocks we suggest all proposal PI's contact us directly for specialized information relevant to their research. For additional information, go to: https://geoinfo.nmt.edu/labs/argon/home.html

Expected Time Frame

Because there is an extended timeframe between sample preparation and analysis (1-6 months) due to the need to irradiate samples, students will need to plan for a two-step process. Proximal students can travel to NM Tech to prepare mineral separations that involves sample crushing, sizing, magnetic separation and heavy liquid separation. There is a huge range in time required to prepare samples depending mainly upon age and mineralogy. For instance coarse micas greater than a few Ma require simple plucking of individual crystals from the rock, whereas low concentration, fine sanidine from ash samples can take many hours each. Handpicking final high purity mineral separates can also be very time consuming. Students have often come for a training period (typically 1-5 days) and then returned to their home institution to do more tedious and time-consuming handpicking. Students with current experience and proper separation laboratories at their home institutions can, with remote guidance from us, prepare the samples offsite. Students may or may not load their samples into irradiation trays depending upon scheduling. Following irradiation, students will return to NM Tech and participate in loading samples in analysis trays and placing them under vacuum. Years of experience in hosting visitors shows us that beginning the argon measurements on a sample set prior to a visitor coming to the lab provides an efficient opportunity to work on data reduction and sample analysis concurrently. That is, during automated analysis for argon isotopes of a subset of the samples that the visitor participates directly in, they can be conducting data reduction on already analyzed samples.
The basic steps that the student will learn and perform during and after their visit are as follows:

- Using crushing and grinding equipment
- Experience with magnetic and heavy liquid separation techniques.
- Identify appropriate minerals using a binocular microscope.
- Load samples into irradiation trays.
- Load samples into the ultra-high vacuum system for Ar analysis.
- 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 that requires many interpretive steps.
- Model data where appropriate for thermal history determination.
- Assign a geological age to apparent ages where appropriate.

Analytical Costs

Analysis fees vary depending upon a variety of factors that revolve around instrument time. Typically moderate resolution age spectrum and single crystal laser fusion analyses cost $600/sample. High-resolution

age spectrum analysis for K-feldspar or muscovite MDD work is charged at $750/sample. This rate is also used for detrital mineral dating where typically 100 grains are analyzed for determining maximum deposition age and/or provenance. These prices include irradiation fees and all consumables and supplies, use of equipment, and training. Because rates vary for a variety of reasons, students must contact us prior to submitting a budget.

Preparation for Visit
In general there is no special preparation needed for the visit. However, we would suggest that students send their rock samples to us for evaluation prior to beginning the separation process so that we can better just the required time of stay.

Relevant Laboratory Staff
The NMGRL is co-directed by Drs. Matthew Heizler and William McIntosh and the lab is managed by Lisa Peters, our senior lab technician. Students will also very likely interact with our current post-docs, Drs. Matthew Zimmerer and Jake Ross. Proposals will be coordinated with either Heizler and/or McIntosh. Following a successful grant award, students will initially interact with Lisa Peters to coordinate visits and to prepare samples for dating. Heizler, McIntosh and Peters will all work scientifically with visiting students and participate in data reduction training and data interpretation. Manuscript preparation will coordinate with the most appropriate individual(s).

Data Processing and Interpretation
Students will be expected to participate in all components of data processing and interpretation. There are extensive steps to go from isotope measurement to final processed data and this process will be carefully taught to the students. We will ensure that students have a full understanding of their results and that they will depart with publication quality figures and tables. We will help them write a full methods section as well to demonstrate knowledge of the process. As mentioned, final preparation for thesis, dissertation and/or manuscripts will fall on one or more of the NMGRL senior staff.

Expected Lab Availability
We can generally accommodate visitors within their required time schedule. Depending upon irradiation schedules, processed samples are available for isotope measurements with in a 2-6 month window. Samples should be analyzed within 6 months following irradiation.

Classroom opportunities
We offer 3 argon geochronology courses. GEOC-516 is a lecture/seminar course that covers the basic theory and application of $^{40}Ar/^{39}Ar$ geo and thermochronology. GEOC-517 is our advanced topics in argon geochronology course that is generally seminar style based on current and/or topical literature. Both courses are offered Fall 2015 and are expected to be provided via distance education using "Go to Office". GEOC-567 is our Practical Aspects course and is hands-on utilization of mass spectrometers and extraction systems as well as detailed investigations of data reduction and data presentation methods. This course, offered Spring 2016, requires personal attendance at NM Tech. Course descriptions can be found at http://www.nmt.edu/images/stories/registrar/2014-2015_PROGRAM_and_COURSE_Catalog_FINAL.pdf. Students from other New Mexico universities can directly enroll in NM Tech courses without tuition penalties at their home institution. Students outside of New Mexico will be required to enroll as special students. For more details on enrolling in the argon geochronology courses contact Matt Heizler.

Contacts
If you are interested in utilizing our facility for $^{40}Ar/^{39}Ar$ geo- or thermochronology or have any questions about possible proposals please contact either or all of:
Matt Heizler: matt@nmt.edu
Bill McIntosh: mcintosh@nmt.edu
Lisa Peters: lisa@nmt.edu