Awards for Geochronology Student Research (AGeS) — Laboratory Overview

New Mexico Geochronology Research Laboratory (NMGRL)
New Mexico Tech
1/8/2021

Lab Description

The NMGRL is a state-of-the-art $^{40}Ar/^{39}Ar$ geochronology laboratory designed to conduct the full range of research available to the method. We are 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 and thermal histories of magmatic systems. Our fully automated lab includes an ARGUS VI multicollector mass spectrometer and a Helix MC plus multicollector mass spectrometer connected to specialized argon extraction systems. Samples are heated with either a CO_2 laser system, an 810 nm diode laser, or an accurate temperature controlled double vacuum resistance furnace. 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. This process involves sample crushing, sizing, magnetic separation and heavy liquid separation. There is a large range in time required to prepare samples depending mainly upon age and mineralogy. For example, 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, placing samples under vacuum, writing experiments for automated data collection, and going through the entire reduction process. 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 reduce data on samples already analyzed.
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 sanidine dating where typically 200 to 300 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 judge the required time of stay.

Relevant Laboratory Staff

Dr. Matthew Heizler directs the NMGRL with technical, management and software support provided by Dr. Jake Ross. Drs. William McIntosh (retired co-director of the NMGRL) and Matthew Zimmerer (field geologist) are other active contributing researchers of the NMGRL. All personnel are available do direct AGeS projects and due to our varied specializations projects can be aligned with the most appropriate mentor. Research interests of the lab personnel can be found at geoinfo.nmt.edu. AGeS students will also very likely interact with our current graduate students and post-docs. Following a successful grant award, students will initially interact with their primary lab contact to coordinate visits and to prepare samples for dating. However, Heizler, Ross, McIntosh, and Zimmerer 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 Collection, Processing, and Interpretation

Students will be expected to participate in all components of data collection, processing, and interpretation using Pychron software. There are extensive steps to go from isotope measurement to final processed data. 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 to 6-month window. Samples should be analyzed within 6 months following irradiation.

Classroom opportunities

We offer three 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-516 is typically offered every fall semester and can accommodate off-campus students via distance learning. GEOC-567 is our Practical Aspects course, designed to complement GEOC-516. This class involves hands-on utilization of mass spectrometers and extraction systems as well as detailed investigations of data reduction and data presentation methods. This course, offered in most spring semesters, requires personal attendance at NM Tech. GEOC-517 is our advanced topics in argon geochronology course that includes seminar-style discussions of topical literature and/or laboratory experiments. GEOC-517 is taught during both fall and spring semesters as desired and can also accommodate off-campus students. 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 graduate students and pay NM instate tuition. For more details on enrolling in the argon geochronology courses contact Matt Heizler.

Contacts

If you are interested in using our facility for $^{40}Ar/^{39}Ar$ geo- or thermochronology or have any questions about possible proposals please contact either or all of:

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