

## Lab Description

The LDEO Argon Geochronology for the Earth Sciences  $^{40}\text{Ar}/^{39}\text{Ar}$  lab comprises two mass spectrometers capable of a range of argon isotope measurements. The lab is located within the larger LDEO Noble Gas Lab, and the resources of the entire lab are available to support the work of student visitors. The lab is located within the Gary C. Comer Geochemistry Building at the Lamont-Doherty Earth Observatory in Palisades, New York, 15 miles north of Manhattan. Two noble gas mass spectrometers are fed by fully-automated extraction systems with the ability to heat samples using  $\text{CO}_2$  and diode lasers, diffusion cells, and resistance furnaces. The mass spectrometers are a VG 5400 single collector instrument, ideal for high-throughput and provenance measurements, and an Isotopx NGX multicollector with ATONA amplifiers, ideal for high-precision measurements and extremely young samples. The lab is supported by a sample processing facility consisting of a SEFRAG, a pneumatic crusher, disc mills and jaw crushers, a Frantz magnetic separator, and LST and MEI heavy liquids. The expertise of the laboratory staff ranges from dating very young volcanic rocks to timescale measurements to provenance surveys of Phanerozoic to Archaean detrital minerals in sediments. Interested students are invited to consult the lab website and contact the staff for more information.

## Contact Information

<https://ages.ldeo.columbia.edu>

- **Professor Sidney HEMMING** (she/her; [sidney@ldeo.columbia.edu](mailto:sidney@ldeo.columbia.edu)) – sediment provenance, climate records, young volcanic rocks, timescale geochronology, thermochronology
- **Dr. Stephen COX** (he/him; [cox@ldeo.columbia.edu](mailto:cox@ldeo.columbia.edu)) – young volcanic rocks, thermochronology, diffusion kinetics, mass spectrometry, methods development

## Diversity, Equity, and Inclusion

The LDEO AGES lab is committed to fostering diversity and inclusion in the geosciences across race, ethnicity, class, citizenship, gender, gender expression, age, religion, neurotype, ability, and identity. We particularly encourage students from underrepresented backgrounds to contact the lab and apply to work with us through the AGeS program. We are committed to educating ourselves and learning to foster a more inclusive environment, and we look forward to working with visitors to strengthen our community.

## Expected Time Frame

The time frame depends on the degree of sample preparation required. Samples for  $^{40}\text{Ar}/^{39}\text{Ar}$  analysis require offsite irradiation, which introduces either a gap or an initial delay after sample submission in the student visits. Depending on the reactor schedule, the age of the samples, and the goals of the project, the irradiation procedure typically takes between three and six weeks to complete. Three visit tiers are possible depending on the goals of the research project.

- **Tier one.** For students with access to sample preparation facilities and appropriate expertise at their home institutions, samples will be mailed to LDEO after preparation of mineral separates. Lab staff will package the minerals for irradiation. The student will then visit LDEO for the analyses; the amount of time required will depend on the project, but will range from three days to two weeks in most cases.
- **Tier two.** Students with limited access to preparation facilities may plan to visit twice, first to prepare samples for irradiation, then again after irradiation. The initial visit will take between two and five days, depending on the nature and number of the samples and the student's access to microscopy for final preparation at their home institutions. The second visit will range from three days to two weeks as in tier one.
- **Tier three.** Alternatively, students with limited access to preparation facilities may submit rock samples to be prepared by lab staff before a single visit. In this case, the budget will include sample preparation services, but only a second visit after irradiation will be necessary for the student. Again, the visit will range from three days to two weeks.

## Budget

Students should budget for either lodging in New York City or lodging and transportation near Palisades. Those staying in the city can use the shuttle from the main Columbia campus in Morningside Heights to reach Lamont every day, and should account for this when arranging lodging. Few lodging options—and no major hotels—are available within walking distance of LDEO. We encourage interested students to contact the lab ahead of time for advice about planning lodging and transportation. In some cases lab staff may be available to help with local transportation needs. New York is served by three major airports—LGA, JFK, and EWR. The latter is most convenient to LDEO, but all three are convenient for access to New York City.

In addition to travel, students should budget for analyses after consultation with the lab staff. Costs depend on the nature of the project, but typical analytical costs are as follows:

- Sample preparation (standard, by lab staff, if required, per rock sample): \$100
- Sample preparation (elaborate, by lab staff, if required, per rock sample): \$200
- Single-step fusion analysis (charged per crystal, for provenance or special work): \$40
- Single-step fusion analysis complete date (charged per sample, normal population): \$400
- Step-heating analysis (normal precision, per sample): \$800
- Step-heating analysis (high precision, rush, Late Pleistocene or Holocene, or diffusion kinetics): \$1200-1800

## Student Preparation

Preparation depends on the visit tier chosen (see section **Expected Time Frame**). Students working in tier one should mail prepared mineral separates to the laboratory several weeks or more before visiting (please contact the lab staff during planning for an exact set of requirements and timeline). Students in tier two need arrive only with hand sample-sized rocks for the first leg of the visit; the exact nature of the samples will determine the requirements. Finally, students in tier three should mail adequate quantities of rock for mineral processing to the lab. Generally,

this should be done as early as possible, and at least three months before the visit (contact lab staff if a tighter timeline is required).

The exact requirements will vary according to the rock and the goals of the project, but in the vast majority of cases, fist-sized samples (several hundred grams) are more than adequate. Lab staff will advise about sampling procedures for exceptionally small samples or samples with challenging preparation requirements.

No particular training is required for visitors, but students with exposure to the basics of geology, mineral separation, chemistry, and mass spectrometry will be able to engage more quickly with the lab procedures. The lab staff is happy to consult with students seeking advice about course selection or training at their home institutions ahead of the visit.

### **Laboratory Staff**

Student visitors will be supervised by Prof. Sidney Hemming, the leader of the group, and by Dr. Stephen Cox, an associate research scientist in the group. Other members of the group that students may interact with include Tanzhuo Liu, a senior staff associate who facilitates many daily operations in the lab, and by research staff in the mineral separation facility. Students may also interact with the undergraduate and graduate students in the lab as appropriate for the projects in question, and will be given the opportunity to interact with the wide range of scientists in the noble gas group and in other groups at LDEO during the visits.

### **Data Reduction and Advising**

Data reduction for  $^{40}\text{Ar}/^{39}\text{Ar}$  is handled using bespoke software maintained by the community and by members of the lab staff at LDEO. The student visitors will participate in each step of data collection, data reduction, and interpretation under the supervision of the lab staff. They will retain full rights to the raw data and will be expected to disseminate data openly according to the standards of the field. Lab staff will work closely with students before, during, and after visits to ensure that they fully understand the procedures and the considerations that go into data reduction, and lab staff will assist with preparation, submission, and revision of manuscripts, reports, and theses produced as a result of the visits.

### **Expected timeframe of availability**

New projects can typically be accommodated within a two- to three-month window; students should expect to be able to either begin sample preparation at LDEO or to submit samples for irradiation within two months. Projects requiring special preparation or extensive step heating (for diffusion experiments, for example) may require more advance notice. Projects that require a rapid turnaround, for example when a field season, embargo window, or other external consideration imposes a rush schedule, may be accommodated depending on the lab schedule; contact lab staff for additional information.