EarthScope Student Geochronology Research and Training Program Laboratory Overview

Purdue Rare Isotope Measurement Laboratory (PRIME Lab)

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Lab Description

The Purdue Rare Isotope Measurement Laboratory (PRIME Lab) – http://science.purdue.edu/primelab/ – is a dedicated research and user facility for accelerator mass spectrometry (AMS), an ultra-sensitive analytical technique for measuring long-lived radionuclides. PRIME Lab provides measurements of these radionuclides for researchers at Purdue University, at other universities, at national laboratories, and at agencies in the U.S. and throughout the world. PRIME Lab comprises a ca. 31,000 ft^2 facility which, in addition to the AMS system, houses 14 offices and 16 laboratories, including laboratories needed for physical preparation of samples and the chemical separation and purification of long-lived radionuclides. There is also ca. 1,000 ft^2 of additional laboratory space for chemical preparation of samples in a separate building.

As an NSF facility, PRIME Lab is a focal point for the measurement and application of AMS radionuclides in Earth sciences in the U.S. We routinely analyze ^{10}Be, ^{26}Al, ^{36}Cl, and ^{129}I in rock, soil, water, and air, and ^{14}C in organic materials, for a large community of users. PRIME Lab also offers sample preparation services that enable investigators without these facilities access to AMS methods. In addition, PRIME Lab regularly hosts graduate students from various institutions both inside and outside the United States in our laboratories, providing the next generation of researchers opportunities to learn sample preparation and analytical techniques needed for cosmogenic nuclide research. As part of this effort, these students have either worked in our chemical preparation laboratories, learning the techniques needed to extract radionuclides from geologic materials, or had an extended visit during which time they toured our laboratories, visited PRIME Lab staff, and participated in data acquisition for their samples. In many of these projects these students are collaborating with researchers at PRIME Lab on geologic applications.

Expected Time Frame

Scheduling of student visits will depend on the number and types of samples to be analyzed, and will be coordinated with the appropriate laboratory contacts listed below. Students with samples already loaded into AMS targets (holders provided by PRIME Lab in advance) could plan on a visit of a week or less, while those requiring full processing from bulk rock should plan on longer stays. Typical throughput for full ^{10}Be and ^{26}Al processing from bulk rock to AMS target (granites, sandstones, or other rocks with high quartz content) is ca. 8 samples in two weeks. Rocks with lower quartz content may take longer. These durations are generally representative for other nuclides as well, but would be estimated on a case-by-case basis.

We also encourage the students to observe samples being run on the AMS to gain a deeper appreciation for the techniques, whether or not they are the student's samples. The run dates for each nuclide are typically scheduled 2-3 months in advance, with regular updates online. We are currently scheduling ^{10}Be and ^{26}Al for quasi-monthly runs, with less frequent but still regular runs for nuclides with lower user demand.

Analytical Costs

Costs for sample processing and analysis depend on sample type, level of processing needed, and

the nuclide to be measured. For *in situ* ^{10}Be and ^{26}Al analyses, AMS costs are quoted below at our NSF-sponsored rates, since EarthScope is funded by NSF:

Crushing and grinding: $130
Quartz separation and purification: $380
Chemical preparation: $420 (BeO and Al_2O_3), $350 (BeO only)
AMS measurement: $235 per nuclide (i.e., $470 for both ^{10}Be and ^{26}Al)

Rates for processing and AMS analysis for other nuclides/sample types are listed on the PRIME Lab website (http://science.purdue.edu/primelab/user-information/pricelist.php).

Preparation for Visit

A key requirement for students using our lab facilities is that they must have completed at least a full year of a university laboratory-based chemistry course (2 semesters or equivalent). We also require that the student have a vested interest in the samples (i.e., they are for their thesis/dissertation or a portion of thereof, or another project in which they are involved). On arrival they must complete basic laboratory safety training specific to our facility, since they will be handling hazardous reagents such as HF and other toxic chemicals. Lead times for a visit should be coordinated with one of the laboratory contacts listed below – at least 2-3 months ahead of the visit would be an appropriate minimum. Visiting students will be provided office space and wireless internet access while visiting PRIME Lab. We can work with the student to coordinate low-cost guest housing on or near campus.

Relevant Laboratory Contacts

Lab Principals
Dr. Marc Caffee (mcaffee@purdue.edu)
Dr. Darryl Granger (dgranger@purdue.edu)
Dr. Nathaniel Lifton (nlifton@purdue.edu)

Sample Processing Training and Supervision
Dr. Greg Chmiel (gjc@purdue.edu)
Tom Clifton (tclifton@purdue.edu)

Data Processing and Interpretation

During an AMS sample run, students will be shown how PRIME Lab converts the raw AMS data into isotope ratios. This data reduction involves comparison of sample measurements to concurrent measurements of international standards and in-house secondary standards, as well as measurements of procedural blank samples to quantify measurement backgrounds. Students will then be trained in how to convert the final reported sample ratios into nuclide concentrations for each sample. If needed, we can also assist with interpreting these concentrations using state-of-the-art techniques.

Expected Lab Availability

We limit visitation to one student at a time in our labs to enable proper supervision and training by PRIME Lab personnel. As such, visits should be coordinated with one of the PRIME Lab Principals listed above. Typical visit durations may range from a few days to a few weeks, depending on the numbers and types of samples to be analyzed.