EarthScope Student Geochronology Research and Training Program Laboratory Plan

University of Massachusetts Cosmogenic Nuclide Laboratory
22 November 2019

Lab Description
The University of Massachusetts Cosmogenic Nuclide Laboratory consists of clean wet chemistry space for preparation of bedrock, soil, and sediment for *in situ*-produced ^{10}Be and ^{26}Al and meteoric ^{10}Be measurements by accelerator mass spectrometry (AMS). The lab consists of three connected spaces fed by a positive pressure ULPA air supply; a vestibule that separates the clean rooms from the building corridor, a 400 ft^2 laboratory for quartz preparation and meteoric ^{10}Be chemistry, and a 400 ft^2 laboratory for chemical separation of *in situ*-produced ^{10}Be and ^{26}Al. The quartz preparation and meteoric ^{10}Be lab contains two polypropylene fume hoods, one for mineral separation and general chemistry, and a fully exhausting, perchloric acid-rated laminar flow hood dedicated to meteoric ^{10}Be fusion chemistry. The space contains three ultrasonic baths for quartz etching using HF, a vacuum pump and separatory funnels for density separation with non-toxic heavy liquid, two dedicated ovens for drying *in situ* and meteoric samples, an anti-static device, and two analytical balances connected to a computer running a sample management database on a departmental file server, and eight Pt crucibles and associated labware for fusion chemistry. The *in situ* chemistry laboratory contains two polypropylene fume hoods, one fully exhausting laminar flow hood for chemical separation of Be and Al, and a hood for cleaning Teflon labware. The lab also contains a glovebox for AMS cathode packing, a centrifuge, a drying oven, and an ultrapure water generator. A high-capacity Outotec magnetic roll separator for mineral separation is housed outside of the clean lab. Facilities for rock crushing, disk milling, dry and wet sieving are also available for sample preparation are available within the department, as is an ICP-OES for elemental analysis. The department houses an XRF lab and arrangements can be made for students interested in coupling ^{10}Be and elemental mass balance to investigate chemical weathering to use the lab. The lab is currently focused on using *in situ*-produced ^{10}Be to address a range of questions via quantification of soil production and catchment-scale denudation rates and using exposure and depth profile dating to quantify bedrock incision rates and the timing of glacial outburst floods.

Expected time frame
Students should expect to spend three weeks working on their first batch of samples for *in situ* ^{10}Be and ^{26}Al work and two weeks for meteoric ^{10}Be work. Subsequent batches will take slightly less time. The minimum number of samples per batch for *in situ*-produced nuclides is eight, plus one blank and the maximum is eleven, plus one blank. Students working with *in situ*-produced nuclides who are at institutions within driving distance of Amherst can break this into two shorter trips, one dedicated to sample preparation and a trip dedicated to chemistry. The batch size for meteoric ^{10}Be is seven samples and one blank.

Students working with *in situ*-produced nuclides will learn: 1) quartz purification by HF etching, heavy liquid, and surfactant mineral separation; 2) sample weighing and ^{9}Be carrier addition; 3) HF sample dissolution; 4) ion chromatography; 5) hydroxide precipitation; and 6) cathode packing.

Students working with meteoric ^{10}Be will learn: 1) fusion chemistry using KHF_2, 2) ^{9}Be carrier addition; 3) Be extraction and separation from fusion residue; 4) K removal 5) hydroxide precipitation; and 6) cathode packing.

Analytical costs

The costs below assume AMS measurements at PRIME Lab; students should contact Dr. Isaac Larsen if they are interested in having their samples measured at Lawrence Livermore National Lab. The per sample price for *in situ*-produced ^{10}Be is $872.50, which includes expendables, supplies, equipment use, and the AMS measurement cost. The per sample price for ^{26}Al measurements is $272.50, and is for the AMS measurement only, and assumes ^{10}Be is also being separated from the same sample. The per sample cost for meteoric ^{10}Be is $470, which includes the expendables, supplies, equipment use, and the AMS measurement cost.

Preparation for visit

Interested students should contact the lab 3-4 months in advance and discuss the nature of the project prior to the collection of the samples. The use of sample preparation facilities for crushing, sieving and mineral separation at their home institution will save days of consuming lab time, but these facilities are available at UMass if they do not exist at the student's institution. Students must have a vested interest in the samples, such that they are part of their thesis or dissertation research. In the event there are more than four students interested in submitting proposals to our lab, there will be an internal process to select projects that best align with the lab capabilities and specialties.

Relevant laboratory staff

The lab is directed by Dr. Isaac Larsen (ilarsen@umass.edu).

Data processing and interpretation

Students will be trained in AMS data reduction and propagation of uncertainties in nuclide concentrations. Students will be trained to use on-line calculators for generating reproducible exposure age and denudation rate values. Training for determining watershed-scale nuclide production rates is also available.

Expected lab availability

Students should schedule their visit at least two months prior to their anticipated arrival date.

Contacts

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