EarthScope Student Geochronology Research and Training Program Laboratory Overview

Berkeley Geochronology Center U-series Laboratory

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Lab Description

The Berkeley Geochronology Center (BGC) U-Daughter laboratory conducts U-series (^{238}U-^{234}U-^{230}Th) dating of pedogenic (soil) carbonates, speleothems, tufa, vein fillings, corals and other materials in order to address research questions in neotectonics, earthquake science, landscape evolution, paleoclimate, archaeology, and paleoanthropology. U-Th isotopic analyses are carried out using an inductively coupled plasma mass spectrometer (ICP-MS) in both solution and laser ablation modes. Major instrumentation in our lab includes: (1) a Thermo-Fisher NEPTUNE *Plus* multi-collector ICP-MS with ion counter and ion energy filter; (2) a Cetac Aridus II sample introduction system for solution analyses, including desolvation nebulizer and autosampler system; and (3) a Photon Machines programmable laser ablation system including a 193 nm excimer laser and a two-volume, ANU-type sample cell. Supporting facilities at BGC include a temperature-controlled instrument room with filtered air supply, an adjacent HEPA-filtered low-background chemistry lab, and dedicated sample preparation facilities.

Expected Time Frame

Visiting students should schedule approximately 2 weeks at the BGC lab in order to date 10 samples via solution ICP-MS including time for sample preparation, chemical separation of U-Th from matrix elements, mass spectrometry, and data reduction/interpretation. Visiting students will require chemical safety training (depending on prior experience) and will be trained in all necessary techniques during the course of the analyses by Dr. Warren Sharp and Geochronology Technicians Christine Polito and Nick Fylstra. For laser ablation ICP-MS analyses, students should schedule approximately 1 week at the lab in order to select, prepare, and date multiple regions on 6 samples.

The basic steps that the student will learn and perform before, during, and after the visit are as follows:

- Identifying suitable materials for U-series dating in the context of their research
- Observing and documenting sample characteristics relevant to the U-series method
- Preparing and analyzing samples
    1. For solution ICP-MS – physically isolating dating samples, purifying U and Th via ion exchange chemistry, and operating the ICP-MS
    2. For laser ablation ICP-MS – mounting and polishing samples, photo-documenting them, selecting laser ablation parameters (spot size, etc.), and operating the laser-ICP-MS system
- Data reduction and age calculations
- Integrating U-series dates with other geologic observations and geochemical data

Analytical Costs

Students should budget $5000 for training and analytical costs for 10 solution ICP-MS dates and $3000 for 6 laser ablation ICP-MS analyses (assuming 2 hours of instrument + technician time per sample; e.g., analysis of ~6-10 regions/sample). Prices include all consumables and supplies associated with analyses, instrument time, and staff time. U-Daughter Laboratory staff will train and assist the student with sample selection and preparation, clean lab protocols for ion exchange techniques, operation of the laser/ICP-MS system, and data reduction/interpretation.

Preparation for Visit

Visiting students should arrive at BGC with appropriate samples for analysis based on prior consultation. Students are encouraged to contact the BGC U-Daughter laboratory to discuss samples well in advance of the actual arrival date. Visiting students are required to make housing and travel arrangements individually.

Relevant Laboratory Staff

The relevant staff includes Dr. Warren D. Sharp who directs the U-series dating lab. Sharp will consult with students regarding selection of suitable materials for analysis, the appropriate preparation and analytical strategies, data interpretation, and integration of U-series dates with overall geologic interpretations. Geochronology Technician Christina Polito oversees the U-Daughter chemistry lab and Geochronology Technician Nick Fylstra oversees operation of the ICP-MS and laser.

Data Processing and Interpretation

Students will be trained in data reduction and age interpretation by BGC U-Daughter Laboratory staff. This includes interpreting and reducing ICP-MS data and calculating U-series ages. Dr. Sharp will be available to consult with students during each visit and thereafter through email to aid in the interpretation of results obtained in the U-Daughter Laboratory and their integration with other geological observations and geochemical data.

Expected Lab Availability

Visiting students should schedule there visit 2-3 months in advance of their preferred arrival date.

Contacts

Students interested in conducting U-series analyses in the U-Daughter Laboratory should contact Dr. Warren Sharp (wsharp@bgc.org).