Stanford ICPMS Facility
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^{230}Th-U Geochronology by MC-ICPMS

The facility contains two inductively coupled plasma mass spectrometers (ICPMS and a Picotrace (class <1,000) metal-free clean laboratory for sample preparation. Additional sample preparation, characterization, and imaging facilities are also available. Methods are available for ^{230}Th-U geochronology of low-temperature deposits, including calcite and opal.

In the clean lab facility samples are selected under an optical microscope and combined with a calibrated mixed spike of ^{236}U and ^{229}Th (see Ibarra et al. 2014) and then dissolved prior to ion exchange chromatography. The isotopic compositions of purified U and Th samples are measured using a Nu Instruments Plasma HR multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) equipped with 12 Faradays and 4 discrete dynode secondary electron multipliers (ion counters). One of the ion counters (IC0) has an additional decelerating lens filter to improve abundance sensitivity. Measurements are made in dry plasma mode using an Aridus II desolvating nebulizer or a Nu Instrument DSN-100 desolvating nebulizer. All U and Th isotopic standards and solutions are measured in 2 % HNO_3 and 2 % HNO_3 + 0.1 % HF, respectively. Additional capabilities include measurement of trace elements by ICPMS and other radiogenic and stable isotope systems; contact lab staff before arrival to arrange for these services at an additional charge.

Expected time frame

In most situations, laboratory time may be scheduled 2-4 months in advance. We recommend that students arrive having conducted preliminary pre-screening work, including physical separation and visual inspection of samples and measurement of U and Th concentrations, if possible.

Approximately two to three weeks of full-time work is required for sample evaluation (pre-screening) and preparation of between 10 and 20 samples. If the user has prior training or certification in radiation safety the timing may be expedited. Analysis of 10 samples to determine both U and Th isotopic composition requires approximately 20 to 30 hours of instrument time, including analysis of multiple reference materials and duplicates. Students should allow an additional 1 to 2 days for data analysis.

Students will receive training in basic chemical safety and basic clean laboratory methods when they arrive. Students that acquire radiation safety training prior to arrival will be fully trained in sample digestion, isotope dilution and ion chromatography in the process of preparing their samples. Otherwise, students will assist the laboratory staff with the process. A general working understanding of sample preparation and purification methods, along with the principles of mass spectrometry is an expected outcome of working in the laboratory.

Data processing and interpretation

While in the lab, students will work with laboratory staff to evaluate data quality and process data. This will include calculation of elemental concentrations, isotopic ratios and ultimately sample ages. Students will work with lab staff (both on-site and after the student has returned to their home institution) to generate a description of methods and data processing appropriate to include in publications with the data.

Laboratory staff

The Stanford University ICPMS/TIMS facility is directed by Kate Maher and managed by Karrie Weaver. Senior graduate students also serve as research assistants in both the clean lab and the instrument facility. Visiting students will be trained to perform as much of their work as possible, from sample selection and dissolution to final isotopic analysis, except where handling of radioactive materials makes this prohibitive. Laboratory staff will perform separation chemistry for the purification and isolation of U and Th in cases where students do not have prior radiation safety training, or for students whose timeframe will not accommodate on-site radiation safety training (see below).

Cost of analyses

Please contact the director of the facility (Kate Maher) and the lab manager (Karrie Weaver) to discuss the specifics of the project and anticipated costs. The total analytical costs depend on the type of samples, the need for sample characterization and anticipated U concentrations and U/Th ratios. As a general estimate, we typically charge $200 per sample for U and $150 per sample for Th, or $350 for one sample/age. The price includes the cost of the double spike, ion exchange resin and reagents, as well as the reference materials and analytical standards used in the mass spectrometry, and assumes that the student will participate in the preparation of the materials, the ion chromatography and the data collection and analysis. If students require that the facility staff perform the ion chromatography on prepared samples, then there is an additional cost of $50/sample.

References

Ibarra D. E., Egger A. E, Weaver K. L, Harris C. R. Maher, K. (2014) Rise and fall of late Pleistocene pluvial lakes in response to reduced evaporation and precipitation: Evidence from Lake Surprise, California. *Geological Society of America Bulletin, 9;* DOI: 10.1130/B31014.1.