Awards for Geochronology Student Research (AGeS) Program Laboratory Overview

Isotoparium, Caltech
$^{234}U/^{238}U$ equilibrium dating in marine carbonates

Lab description

The Isotoparium is a trace-metal, clean laboratory specialized in high-precision U isotope analyses, including $^{234}U/^{238}U$ ratios. In recent marine carbonates, the $^{234}U/^{238}U$ ratio can be used to calculate model ages, under the assumption that said carbonate formed with a modern $^{234}U/^{238}U$ and behaved as closed system since formation.

Sample preparation before clean laboratory work can be done using rock saw, polishing equipment, a high-precision sample mill and hand-held drill for preparing and drilling samples. Uranium chemical purification is performed in the Isotoparium clean room: a ~700 sq feet Class 100 trace-metal laboratory space equipped with seven fully-exhausted vertical laminar flow workstations for low-level contamination trace element chemistry. Sample analyses is performed on the Isotoparium *Neptune Plus* (ThermoFisher) MC-IPCMS in combination with an *Aridus3* desolvating nebulizer (to minimize oxide generation and increase sensitivity). Measurements are performed against and CRM-112a natural U standard, and using a ^{233}U-^{236}U double spike (IRMM3636).

Expected Time Frame

The time frame for a visit depends on the number of samples, the amount of sample preparation needed before samples digestion, and if any analytical development is needed for the project.

For a "small" and simple (no development required) project, we suggest a visit duration of 2 to 3 weeks. The shorter end of the window would be sufficient to prepare and analyze a batch of ~24 samples, already in powder form, while the higher end of the window would allow for time to perform sample extraction on simple samples as well as powdering prior to sample digestion. We strongly recommend reaching out to the lab to assess the time frame needed for any project.

Analytical Costs

Analytical costs depend on the complexity of the samples (*e.g.*, heterogenous samples are more time consuming to prepare), the desired analytical precision, and the amount of training the student needs.

Typical final costs thus range from ~ $50-300 per sample (pricing per sample also decreases if more analyses are to be performed). Our goal is to make sure high-quality, reliable data is being obtained, regardless of number of analyses. The student will work with our staff to design the best approach.

Preparation for Visit

The best way to prepare for the visit is to coordinate with our team. Typical recommended steps would include either:

(i) To determine the U concentration at the home institution, or send a small powder aliquot (1-10 mg) for concentration measurements at the Isotoparium.

(ii) To prepare sample powders before the visit. Typical sample masses range from 5-200 mg depending on U concentrations, approximate age, sample type and study goals.

Additional Lab Capabilities
The Isotoparium is equipped with a quadrupole mass spectrometer (iCAP RQ) for major and trace element concentration measurements, as well as a femtosecond laser ablation system, which can be coupled to the Q-ICPMS or MC-ICPMS instrument. We also measure a range of other isotope systems (*e.g.*, Mg, Ca, Fe, Cu, Zn, Zr), which may provide additional context for data interpretation. Discuss with our staff if such analyses are of interest.

Laboratory Staff
The lab is run by Dr. François Tissot and his group of graduate students, postdocs and researchers. Senior members of the current Isotoparium team will be responsible for working with and training student visitors.

Data Processing and Interpretation
Details of the data treatment have been reported in multiple publications throughout the last decade (*e.g.*, Tissot & Dauphas 2015; Tissot et al., 2018; Kipp et al., 2022, to cite only a few, most relevant, publications). We will work with the students to ensure they understand the broad (and finer) details of the data reduction: including mass bias correction with the double-spike, ion counter yield, or tailing correction. Data interpretation will continue after the student leaves the Isotoparium, and students are encouraged to stay in touch with Dr. Tissot and his team as the project moves forward and the interpretation keeps on being refined.

Expected Lab Availability
In most situations, students will be able to schedule a visit to the Isotoparium 6 weeks to 2 months in advance.

Contact Information
If you are interested in pursuing an AGeS research project at the Isotoparium and would like to discuss potential collaborations, please contact François Tissot: tissot@caltech.edu.