Awards for Geochronology Student Research2 (AGeS2) Program Laboratory Overview

UC Davis Interdisciplinary Center for Inductively-Coupled Plasma Mass Spectrometry (UCD/ICPMS)

Lab Description

The UC Davis/Interdisciplinary Center for Plasma Mass Spectrometry (UCD/ICPMS) is dedicated to precise and accurate determinations of inorganic trace element and isotope abundances in geological, biological, agricultural, nuclear, environmental and engineering materials aimed at understanding the composition, rates and pathways of chemical transport and evolution in natural and laboratory systems. UC Davis/Interdisciplinary Center for Plasma Mass Spectrometry (UCD/ICPMS) is a facility for trace element and isotope analyses with inductively coupled plasma-mass spectrometry (ICP-MS). UCD/ICPMS is comprised of two laboratories.

• The Quadrupole ICP-MS/Laser Ablation instrumentation is located in the Plant and Environmental Science Building

The UCD ICPMS center has two ICP quadrupole mass spectrometers (Agilent Techologies 7500a and 7500ce). The 7500ce instrument has an additional octopole component called a reaction/collision cell between the ion lens system and quadrupole (the reaction/collision cell is not shown in the above figure). When hydrogen gas is used to react with argon oxides and argon dimers to reduce their interference with elements such as Fe and Se. When helium gas is used, it decelerates compounds such as chlorine oxide and argon chloride through collision, reducing their interference with V and As. The reaction/collision cell ICP-MS is a useful tool for reducing interferences that cannot be minimized using standard methods.

• The Multiple Collection (MC) ICP-MS/Laser Ablation instrumentation is located in the Earth and Physical Sciences Building

We utilize a Nu Plasma HR (Nu032) multiple-collection high-resolution double-focusing mass spectrometer ICP system (pictured above) capable of determining isotope ratios with external precision on the order of 10-20 ppm. This instrumentation better constrains isotopic proportions in natural samples than by quadrupole ICPMS or single-collector HR-ICPMS systems. MC-ICPMS (multiple collection inductively coupled plasma mass spectrometry) precision is similar to that achieved by TIMS (thermal ionization mass spectrometry) but has a tremendous speed advantage over TIMS for analyses can be performed within 20 minutes per sample (depending on the analytes) as compared to hours per sample typically required for TIMS. In addition, due to the ionization efficiency of the high temperature ICP ion source, MC-ICPMS can be used to study both traditional and nontraditional isotope systems for a wide range of applications.

For U-series dating, the lab uses a ^{229}Th-^{233}U tracer, calibrated with a combination of gravimetric standards and rock standards known to be in secular equilibrium (e.g., TML-2, BCR-2, AGV-2), and uses widely available U and Th standards (e.g., CRM112a for U, IRMM-035 and IRMM-036 for Th) for instrument calibration and for internal normalization. Use of a desolvating nebulizer to run 'dry plasma' increases sensitivity and decreases uranium oxide speciation.

Expected Time Frame

Depending on the number of samples and the novelty of the proposed technique, we recommend ~1 week to complete a small project. This assumes that all sample preparation, including anion exchange chemistry, has been performed prior to arrival.

Time at UCD/ICPMS will be spent optimizing and stabilizing signal intensities for elements of interest, modifying methods as needed for specific applications, quantifying instrument measurement parameters like peak tail shape/size, instrumental isotopic fractionation, and instrumental baselines, and performing measurement sessions of reference materials and unknowns.

Data reduction will be performed after each analytical session using a lab-specific data reduction spreadsheet. Students will be guided through the data reduction process in the same way that they are guided through the analytical process, with the end goal of achieving understanding and independent interpretation.

Analytical Costs

Analytical costs follow existing rate schedules for the UCD/ICPMS facility (http://icpms.ucdavis.edu/rates-policies), and in most cases will include two days of 'Center Performed' rate for intensive one-on-one training with the student, and the balance of the analytical time billed at the 'Level I' rate. Academic rates for the AGeS2 program will follow the UC and Non-UC campus rates below.

Quadrupole-ICPMS (solution/laser ablation)	UC campuses	Non-UC campuses
Center Performed	$85	$114
Level I	$60	$80

MC-ICPMS (solution/laser ablation)	UC campuses	Non-UC campuses
Center Performed	$159	$213
Level I	$82	$109

Preparation for Visit

Before visiting the UCD/ICPMS facility, all sample preparation for ICMPS analysis must be finished, including dissolution and anion exchange chemistry. Samples are best transported as dry salts of the U and Th splits from chemistry. Conversion to working acid concentrations (~0.2 M hydrochloric or nitric acid, with the addition of 0.005M hydrofluoric acid for Th samples) will take place at the UCD/ICPMS facility. The UCD Geology clean laboratory is not part of the recharge facility, but if you need access to a

clean lab in order to perform ion exchange chemistry as part of your project, please contact Prof. Kari Cooper well in advance to discuss possible collaborations.

Additional lab capabilities

UCD/ICPMS has experience in measuring a wide variety of trace elements, including traditional and non-traditional isotope systems. For more information, please refer to the UC\ICPMS website: http://icpms.ucdavis.edu/

Laboratory Staff

Geochronology analyses for the AGeS2 program will be overseen by Dr. Justin Glessner, the Techincal Director and MC-ICPMS Laboratory Manager. Additional support for U/Th measurement setup, quality control, and data reduction, will be provided by Prof. Kari Cooper from the UC Davis Department of Geology.

Data Processing and Interpretation

Students will use a set of in-house data reduction and uncertainty propagation spreadsheets, which include mass spectrometric corrections (mass bias, ion counter yield, peak tailing, etc) as well as tracer, blank, and background subtraction. We anticipate that data interpretation will proceed after the student leaves UCD, and are happy to provide assistance and guidance through geological interpretation of the dataset.

Expected Lab Availability

The UCD/ICPMS facility is frequently booked several weeks or months out, so students are encouraged to schedule a visit well in advance. An up-to-date calendar for each instrument can be found at http://icpms.ucdavis.edu/calendar

Contact Information

If you interested in pursuing an AGeS2 geochronology research project at UCD/ICPMS, please contact Kari Cooper (kmcooper@ucdavis.edu) or Justin Glessner (jjglessner@ucdavis.edu).