Boise State University Isotope Geology Laboratory
AGeS^3 Lab Partner
U-Pb LA-ICPMS and ID-TIMS Geochronology
Prof. Mark Schmitz, Director

Lab Description

The Boise State University Isotope Geology Laboratory (http://earth.boisestate.edu/isotope) is a multi-platform facility for the U-Pb age analysis of accessory minerals via both isotope dilution thermal ionization mass spectrometry (ID-TIMS) and laser-ablation inductively coupled plasma mass spectrometry (LA-ICPMS). The Isotope Geology Laboratory (IGL) includes a 1500 sq. ft. HEPA-filtered, positive pressure, class 100 clean laboratory suite with six class 10 laminar flow workstations for low-blank dissolution and ion chromatographic separation, and climate-controlled mass spectrometry rooms housing IsotopX Isoprobe-T and Phoenix X62 thermal ionization mass spectrometers and a ThermoElectron iCAP-RQ quadrupole ICPMS and Teledyne Analyte Excite+ (193 nm excimer) laser probe platform. These facilities are backed by a fully integrated rock preparation, mineral separation, and petrographic laboratory, and a Hitachi TM4000PlusII table-top scanning electron microscope outfitted with motorized stage, a four-quadrant back-scattered electron detector, low vacuum secondary electron (SE) - cathodoluminescence (CL) UVD detector, and Oxford Instruments XploreCompact 30 energy dispersive X-ray spectroscopy (EDS) detector with Aztec analysis software for high-resolution imaging of both uncoated and carbon-coated thin sections and mineral grain mounts.

Analytical protocols are established for the U-Pb age analysis of zircon, titanite, rutile, monazite, xenotime, apatite, andradite-grossular series garnet, and calcite. Our combined facilities offer unique opportunities for tandem *in situ* and *high precision* U-Pb geochronology using a combination of LA-ICPMS and ID-TIMS on the same crystals. Our quadrupole-based LAICPMS analysis provides a full trace element suite in addition to U-Pb ages on the same spot analysis, thus we can couple *in situ* petrogenetic information to high precision ages from the same extracted and dissolved crystal fragments. Further applications include detrital zircon provenance and accurate maximum depositional age via LA-ICPMS followed by chemical abrasion ID-TIMS on the youngest crystals.

For additional information prospective users may go to: http://earth.boisestate.edu/isotope/.

Expected Time Frame

We can successfully host students seeking to analyze from 1 to 5 samples from initial mineral separation and grain mount preparation and imaging, through mass spectrometry and data reduction in time spans from as little as one week (LA-ICPMS) to three weeks (ID-TIMS). The key to this accelerated time frame (while retaining the full analytical experience) is parallel processing of samples across the more time-consuming steps in the analytical protocols. Our professional science staff members facilitate sample pre-processing as well as guarantee efficient progression of tasks during the student visit. Prospective student investigators should ship rock samples (usually 0.5 to 1 kg of raw rock, although smaller quantities are possible) to the IGL at least four weeks prior to their visit, to receive feedback on the quality and appropriateness of samples and allow IGL staff to begin the pre-processing of a subset. With pre-processing, arriving students can enter into the sample processing workflow at multiple nodes for different samples. We do encourage full mineral separation, grain mount preparation and imaging in our facility, however students may also come with prepared grain mounts, for example from prior analyses in other laboratories.

The aforementioned 4 week pre-visit sample delivery places a minimum advance planning time on prospective visits; interested students should preferably enquire about scheduling a visit 2-3 months in advance.

For sample preparation students will work with staff to:

- Prepare rock samples via appropriate chemical and physical disaggregation methods.
- Separate heavy mineral separation via density and magnetic methods.
- Identify appropriate minerals using a binocular microscope.
- Thermally anneal selected zircon crystal populations.
- Mount, grind, and polish zircon crystal populations as cast epoxy grain mounts.
- Image crystals via CL and or BSE on a scanning electron microscope.

For LA-ICPMS analysis students will work with staff to:

- Select spot locations and set up an automated LA-ICPMS run table to analyze samples.
- Check sample status during analysis.
- Reduce data to calculate elemental abundances and U-Pb isotope ratios, and interpret ages.

For ID-TIMS analysis students will work with staff to:

- Select and extract appropriate grains for chemical abrasion and isotope dilution.
- Participate in clean laboratory chemical abrasion, dissolution, and ion chromatographic separations.
- Load samples and participate in thermal ionization mass spectrometric measurements.
- Reduce data to calculate U-Pb isotope ratios, and interpret ages.

Analytical Costs

The current Isotope Geology Laboratory cost-recovery fees are $275 per mineral separation, $5.50 per spot for LA-ICPMS, and $275 per crystal for ID-TIMS. Sample and spot costs are inclusive of the analysis of appropriate standard materials during the course of an experiment.

Preparation for Visit

Prospective student investigators should ship samples (usually 0.5 to 1 kg of raw rock, although smaller quantities are possible) to the IGL at least four weeks prior to their visit, to receive feedback on the quality and appropriateness of samples and allow IGL staff to begin the pre-processing of a subset. With pre-processing, arriving students can enter into the sample processing workflow at multiple nodes for different samples.

Students should also study the training slideshows, videos, and literature posted on the Education and Outreach page of the IGL website: http://earth.boisestate.edu/isotope/education-and-outreach/ prior to their visit, and if possible install and establish familiarity with the IsoplotR software for isotope ratio and age calculation and visualization. It is also important for students to compile all relevant metadata for their samples for inclusion in geoinformatics databases to which their data will be uploaded following publication or a negotiated embargo period.

Relevant Laboratory Staff

The Isotope Geology Laboratory is directed by Professor Mark Schmitz, and managed by a team of scientists including Ms. Krystl Malhas (mineral separations), Dr. James Crowley and Dr. Michael Mohr (ID-TIMS), and Dr. Darin Schwartz (LA-ICPMS). Dr. Schmitz and Crowley will be primarily in charge of facilitating student visits, and will direct their training, sample preparation, analysis, data reduction, and data interpretation in cooperation with Malhas, Mohr, and Schwartz.

Data Processing and Interpretation

While in the lab students will be learn how to process and reduce all of the data they have collected. This includes calculation of radiogenic and sample isotope ratios, interpretation of U-Pb dates, and the propagation of uncertainties. Schmitz and Crowley are available for post-visit consults with the students through email and/or videoconferencing until they are satisified that they understand the results.

Expected Lab Availability

In most situations, students may schedule time in the BSU Isotope Geology Laboratory with 1-2 months lead time.

Contacts

If you are interested in obtaining U-Pb data, or would like to discuss potential collaborations, please contact Prof. Mark Schmitz: markschmitz@boisestate.edu.