

## EarthScope Student Geochronology Program, Lab Educational Plan

### USGS LA-ICPMS Isotope Research Lab, Denver, CO

Chris Holm-Denoma, Ph.D            Research Scientist

Kate Souders, Ph.D                Research Scientist

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#### ***Lab Description:***

The USGS Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) Isotope Research Lab is a modern facility with many capabilities including U-Th-Pb geochronology of accessory minerals including zircon, apatite, titanite, and monazite as well as ore-related minerals including cassiterite (primary tin ore mineral) and hydrothermal (skarn) garnet, and Pb-Pb isotope studies of minerals such as feldspar, sanidine, magnetite, and pyrite.

Our lab includes a Photon Machines 193 nm excimer laser equipped with a HeEx ablation cell, and a Nu Instruments AttoM high-resolution, sector field, single-collector ICPMS. The facility is staffed by three USGS research scientists (Neymark, Holm-Denoma, and Pietruszka). Additionally the Central Mineral and Environmental Resources Science Center houses a mineral separation facility that routinely separates mineral phases of interests from rock and sediment samples using modern techniques. Students may choose to participate in rock preparation and mineral separation if time allows. Electron beam microscopy instruments are also available to support sample characterization prior to U-Th-Pb LA-ICPMS analysis.

#### ***Expected Time Frame:***

Student should expect to spend a minimum of 1 week (5 days) visiting our lab for both data collection and data reduction. Lab scientists are available after the visit to finalize data interpretations for publication. We also suggest that the student participate in mineral separation, preparation (if necessary) and electron beam imaging if time allows (2-3 days). Students can expect to analyze 3-6 igneous or metamorphic samples/day (30-50 analyses of unknowns/sample) or 2 detrital samples/day (~120 analyses of unknown/sample). Complex in situ samples may take longer if fully manual operation is necessary (2-3 samples/day).

*The timeline for a typical study is as follows:*

-Mineral separates are sent to USGS-GGGSC Mineral Separation Lab at least 2 weeks prior to instrument time for mounting, imaging, and final preparation.

-Researcher(s) arrives and are introduced to lab personnel; participate in safety training, methods, and lab instrumentation. If researcher requires imaging, they are requested to arrive 1-2 days earlier than designated instrument time. Background information on the theory and application of geochronology is discussed during instrument training.

-When researcher is ready, analysis begins. First the instrument is “tuned” using standard reference materials. Samples are then analyzed in fully automated mode (spots are programmed into laser and acquired by mass spectrometer as a time resolved analysis- “TRA”) where 1-2 detrital zircon samples (~120-250 unknowns/day) or 3-6 igneous/metamorphic (30-60 unknowns/sample) are analyzed. For in situ samples (i.e. thin section or thick section mounts) manual mode is often required. This may slow the pace to 1-2 samples per day for complex samples.

-All data are reduced and finalized tables and plots are generated while the researcher is at the laboratory. Researchers are encouraged to interface with USGS scientist(s) after lab visit in order to finalize interpretations for publication.

### ***Expected Costs:***

Instrument costs \$1000/day (12-18 hours) Sample preparation, mineral separation, mounting and SEM imaging costs \$465/sample; this cost may be reduced if student researcher participates in sample preparation activities. Student should budget approximately \$1000/week for living expenses while visiting the lab.

### ***Preparation for Visit:***

This is highly variable depending on student researcher’s prior experience. Student may show up on day of instrument time if samples are imaged and ready for analysis. If student arrives with unprocessed sample in hand, he/she should arrive at least a week prior to scheduled analytical time to process samples and prepare and image sample mounts. Student researcher must contact lab contact at least 2 months prior to proposed instrument time to plan sample preparation and schedule visit.

### ***Relevant Laboratory Staff:***

The USGS LA-ICPMS Isotope Research Lab in Denver is staffed by four Research Scientists: Chris Holm-Denoma, Kate Souders, Leonid Neymark, and Aaron Pietrszka. Chris Holm-Denoma will be primarily responsible for the visiting student researcher, and will direct training, sample preparation, analysis, data reduction, and data interpretation.

### ***Data Processing and Interpretation:***

While in the lab the visiting student researcher will learn how to process and reduce all of the data they collect. This includes processing of raw data into isotope ratios and calculation of ages (Iolite Data Reduction Software), as well as interpretation of the data (using Isoplot, for example). Chris Holm-Denoma will be available after the lab visit through email/videoconferencing until the student researcher is satisfied that they understand the results and have produced publication quality data and data interpretations.

***Expected Lab Availability:***

In most instances, student researchers can schedule time in the USGS LA-ICPMS Isotope Lab 2-3 months in advance.

***Contact:***

If you are interested in acquiring U-Th-Pb geochronology data at the USGS LA-ICPMS Isotope Lab (Denver, CO), contact Chris Holm-Denoma; [cholm-denoma@usgs.gov](mailto:cholm-denoma@usgs.gov)