

**EarthScope Student Geochronology Research and Training Program Laboratory Overview**  
**University of Arizona (U-Th)/He Laboratory**  
3/3/15

**Lab Description**

The UA (U-Th)/He dating lab includes a microscopy lab, He line/mass spec lab, wet chemistry lab with two fume hoods, and sector ICP-MS lab. Lab maintenance, sample processing, and user training are shared by Peter Reiners, technician/lab manager Dr. Uttam Chowdhury, and research staff Erin Abel.

Microscopy. The He-dating microscopy lab includes three high-power (160-240x) stereozoom microscopes (two Leica MZ16s and one Olympus SZX-16) with transmitted and reflected light sources, cross-polarization, bright- and dark-field capabilities, and digital cameras and computers for crystal documentation and measurement. A fourth, lower power stereomicroscope is used for manipulation of foil envelopes into laser cells. The lab also has a large collection of glassware and tools for picking and various metal foil and tube sample holders.

He analysis. The mass spec (He line) lab houses two custom built He extraction/purification/measurement lines, each with Janis cryogenic purification systems (including He-refrigerated cold stage, T-controller, water-cooled compressor, and two extra compressors for emergency use), Pfeiffer QMS quadrupole mass spectrometers, turbo, ion, and mechanical pumps, pneumatically-actuated all-metal valves controlled by LabVIEW automation, associated getters, two resistance furnaces for gas extraction, and lightbulb-mini-furnace for diffusion experiments. Sample heating for routine dating is performed by either 20-W Nd:YAG or 25-W CO<sub>2</sub> or 40-W diode lasers with beam delivery and custom-made sample cells, sapphire and ZnS windows, and high-vacuum ports. The lab also includes air compressors for automatic valve operation and gas processing/measurement following user-controlled laser heating.

Wet chemistry. The wet chemistry lab occupies a lab adjacent the He analysis lab, and contains two fume hoods, a large variety of teflon labware, twelve large capacity and 12 x 10-sample capacity Parr bombs, a high precision oven, hotplates, ultrasonic bath, six high precision pipettes, <sup>229</sup>Th, <sup>230</sup>Th, <sup>235</sup>U, <sup>233</sup>U, <sup>147</sup>Sm, <sup>90</sup>Zr, and <sup>42</sup>Ca spikes, normal of the same elements, and a variety of ultra-high-purity and environmental grade acids. Isotope dilution measurements are made on U, Th, Sm, and either Zr or Ca for zircon or apatite/titanite, the latter in order to determine high precision U-Th concentration data (e.g., for eU-age correlations) on irregularly shaped grains and check mineral identities.

Element2 HR-ICP-MS. A Thermo Element2 sector ICP-MS is routinely used for U-Th-Sm-Ca-Zr isotope dilution for He dating, with a self-aspirating low-flow teflon nebulizer, an all-PFA Teflon sample introduction system, and Cetac autosampler.

**Typical lab procedures for visiting students and researchers**

Visiting students or researchers can prepare and analyze apatite, zircon, titanite, and other minerals for He dating, starting with a mineral separate (mineral separation should be done using another facility). Other minerals can also be dated, but please contact us to discuss these first. Students will generally pick and prepare grains using the microscopes and imaging, load the samples in the He lines, lase/heat and extract gas from the sample and let the instrument process and measure the He. Several standards of known age (typically Durango apatite or Fish Canyon Tuff zircon) (approximately one per 5-8 unknowns) are also run during the measurements at no cost to the user. On-line gas standards and blanks are also routinely analyzed during every run for calibration. The lab staff will then handle subsequent spiking, dissolution, and ICP-MS measurements, though visitors may observe if they want to.

Single-grain aliquot analyses are typically made in most cases. Procedures can be adapted to user needs, but we generally recommend analysis of at least three single-grain aliquots for non-detrital zircon samples and five for non-detrital apatite samples. Detrital or partially reset samples may require larger numbers of aliquots to adequately characterize He age ranges and possible age-eU correlations.

Students should expect to need about one week to prepare and analyze 5 samples for apatite or zircon He dating (assuming a sample comprises 5 single-grain aliquots for apatite or 3 for zircon). Students will be trained to identify, pick, characterize and photograph grains, pack them into Nb tubes for He analyses, laser the samples and let the He lines take over and purify and measure the  $^4\text{He}$ . They will also run several age standards and on-line gas standards and blanks. They will have the opportunity to reduce the data to calculate ages and concentrations, apply alpha ejection corrections, understand the error propagation procedures, and will be given preliminary guidance for interpretation and modeling of the data significance.

Visitors should budget \$350 for training, and an additional \$325 for each apatite sample (5 individual grain analyses) and \$375 for each zircon sample (3 individual grain analyses).

The UA He dating lab (ARHDL) is directed by Peter Reiners and managed by Dr. Uttam Chowdhury, with assistance from research staff member Erin Abel. All three will help coordinate visits, and will direct visitor training, sample preparation, analysis, data reduction, and preliminary interpretation. Typically, visitors can schedule time with 2-3 months lead time.

Visitors should be aware that not all rock samples provide apatite (or, more rarely, zircon) in sufficient quantity or quality for useful (U-Th)/He dating. We are happy to provide preliminary assessment of mineral separates and sample quality to increase the likelihood of (but not guarantee) successful dating results. We encourage prospective users to contact us to discuss the suitability of these techniques, rock types, objectives, etc.

**Contacts:**

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