**SHUSTER LABS AT BERKELEY GEOCHRONOLOGY CENTER AND UC-BERKELEY**

***Lab Descriptions***

PI Shuster directs laboratory facilities at BGC and UCB for sample preparation, characterization, (U-Th)/He and $^{4}He/^{3}He$ thermochronometry, and cosmogenic nuclide analyses. Facilities include:

***BGC Noble Gas Laboratory.*** The BGC Noble Gas Laboratory houses:

• *The Noble Gas Thermochronometry Lab* (NGTL). This facility is designed for $^{4}He/^{3}He$ thermochronometry, $^{40}Ar/^{39}Ar$ thermochronometry, characterization of noble gas diffusion kinetics by controlled thermal extraction, and cosmogenic $^{21}Ne$ and $^{3}He$ measurements. The lab also operates as a conventional (U-Th)/He lab. The NGTL consists of (i) a calibrated binocular microscope and camera system for preparing and measuring the geometry of samples; (ii) an ultra-high-vacuum NG extraction system including three diode laser systems with beam delivery optics and both pyrometer and thermocouple feedback control, providing better than +/- 10 $^{o}C$ precision and accuracy between 175-1500 $^{o}C$; (iii) a gas purification system, including a Janis cryogenic system, and calibrated standard and gas spiking system; (iv) a Pfeiffer gas-source quadrupole mass spectrometer for measuring NG abundances using isotope dilution; (v) an adjustable collector slit MAP-215-50 sector-field NG mass spectrometer for high-precision isotope ratio measurements; and (vi) a laser ablation ICPMS lab (described below) for measuring U and Th. The initial construction of the NGTL was supported in part by NSF MRI grant EAR-0618219 to PI Shuster and receives continuing support from the Ann and Gordon Getty Foundation.

The NGTL lab includes a second adjustable collector slit MAP-215-50 NG mass spectrometer with an automated noble gas extraction and cryopurification system that couples to the NGTL laser heating systems described above, and that is optimized for cosmogenic $^{3}He$ and $^{21}Ne$ measurements, and was initially funded by NSF I&F program grant EAR-1054079 to PI Shuster.

***BGC U-daughter Laboratory.*** The BGC U-daughter laboratory includes a temperature-controlled instrument room with filtered air supply that houses a LA-ICPMS facility; an adjacent HEPA-filtered clean chemistry lab; and dedicated sample preparation facilities.

• Laser Ablation ICPMS lab. This facility is used to measure U and Th concentrations in apatite and/or zircon, both by isotope dilution and laser ablation, for (U-Th)/He determinations and $^{4}He/^{3}He$ thermochronometry. The facility is also used to measure U and Th in quartz, necessary for interpretation of cosmogenic $^{21}Ne$ measurements, by isotope dilution. It consists of a Thermo Fisher Scientific Neptune *Plus* multi-collector ICPMS, with nine Faraday detectors with computer-switched $10^{11}$ and $10^{12}$ ohm input resistors, discrete dynode electron multiplier with ion counting and high abundance sensitivity ion energy filter, large capacity dry interface pump, and high performance sample and skimmer cones. This lab was initially funded by the NSF MRI grant EAR-0930054 to PIs W. Sharp and D. Shuster and receives continuing support from the Ann and Gordon Getty Foundation.

***Wet chemistry laboratories at UCB and BGC.*** Dedicated wet chemistry laboratory space is available to PI Shuster both at BGC and at the nearby UC-Berkeley Department of Earth and Planetary Sciences. These labs include both standard fume hoods (suitable for mineral separation, sample preparation by acid etching, and routine, i.e. non-blank-limited, Be extraction from quartz) and one filtered-air laminar downflow hood (suitable for low-blank Be extraction chemistry).

***Sample preparation labs at UCB and BGC.*** Geochronology sample preparation labs contain general rock crushing, sawing, and grinding equipment, sieving apparatus, ultrasonic baths, 2 Frantz magnetic separators, centrifuges, heavy liquid separation facilities, drying ovens, 3 binocular microscopes (one with photomicrography module), 3 petrographic microscopes (2 with reflected light capability and digital photomicrography modules), and a photo stand for sample documentation.

***Expected Time Frame***

Visiting students should schedule at least 1 week for preparing samples for (U-Th)/He analysis. For samples involving $^{4}He/^{3}He$, students should contact Shuster to discuss the timeframe associated

with proton and neutron irradiations, respectively, which typically occur only a few times a year. Thus, such projects will require several months of lead time prior to analyses at Berkeley. Students will be trained/assisted in crystal selection and characterizations with optical microscopy; noble gas analyses; wet chemistry dissolution and isotope dilution analysis using ICPMS, data reduction and calculations, and assistance with interpretation in geological context. Visiting students should schedule their visit 4-6 months in advance of their preferred arrival date.

***Analytical Costs***

Students should budget $350 for training and an additional $65 for each apatite and $130 for each zircon (U-Th)/He analysis; $1500 per sample for $^{4}He/^{3}He$ thermochronometry analysis (which includes a prorated cost of proton irradiation); $200 for each sample for cosmogenic $^{3}He$ or $^{21}Ne$ analyses.

***Relevant Laboratory Staff***

The Berkeley Noble Gas Thermochronometry Lab is directed by David Shuster, who will consult with the student with analyses and data reductions and interpretations. Geochronology technician Brian Jones will assist with laboratory training and procedures.

***Contacts***

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