EarthScope Student Geochronology Research And Training Program
Laboratory Overview

North Carolina State University Terrestrial Cosmogenic Nuclide Laboratories
December 31, 2019

Laboratory Description

The North Carolina State University (NC State) Terrestrial Cosmogenic Nuclide (TCN) Laboratories were established in 2019 having been moved from the University of Cincinnati (UC) where they had been established for the past 15 years. The UC laboratories have processed several thousand samples over the past decade and the labs at NC State will continue this work. Research has focused on Quaternary paleoenvironmental change and landscape evolution along active plate margins. This has included dating alluvial fans, strath terraces, river terraces, moraines and landslides, and determining erosion rates using sediments.

The NC State TCN Laboratories have the facilities to prepare sediment and rock samples for ^{10}Be, ^{26}Al and ^{36}Cl cosmogenic surface exposure dating and erosion studies. This includes: a rock crushing laboratory; a heavy liquid separation facility; a chemistry laboratory for ^{10}Be and ^{26}Al that has ultrasonic baths, hot rollers for leaching sediment and rock, columns for cation and anion exchange, and HF hoods for acid work; a perchloric laboratory; and a station for target loading. There is a separate laboratory for ^{36}Cl work, which has a chemical hood, ovens, centrifuges and balances. In addition, there is a separate laboratory for ICP-OES to determine major and minor elements. A post-doctoral researcher laboratory manager oversees the safety and training activities of the laboratories.

Expected Time Frame and Procedure

Visitors should discuss the nature of the samples they would like to process before writing grants. Usually, we estimate that it takes about two-three weeks to prepare a batch of about ten samples. But this might be longer dependent upon the type of samples being processed. Generally, for each addition sample over ten then add one extra day should be added to the laboratory visit. Visitors are encouraged to fully discuss the nature of their samples with the laboratory director to help calculate a realistic timeframe for their work.

Visitors will first undertake safety training online and in the laboratory. This is followed by a day-long course on the theory, methods and application of terrestrial cosmogenic nuclides. The general procedure for ^{10}Be/^{26}Al work includes crushing and sieving samples to a 250-500 µm particle size and treatment with aqua regia. The sample will then be placed in a 24-hour 5% hydrofluoric solution. The remaining sample will be rinsed and agitated with a high velocity 10% Lauryl Amine and CO_2 spray. Samples will then be subjected to further quartz purification using a Frantz Magnetic Separator and lithium sodiumpolytungstate. The chemical preparation of quartz follows the method developed by Kohl and Nishiizumi (1992, *Geochimica et Cosmochimica Acta*). The resulting $Be(OH)_2$ and Al_2O_3 gels of each sample will be dried and combusted at 700^{o}C

before being loaded into targets for accelerator mass spectrometry (AMS) at PRIME lab at Purdue University to determine $^{10}Be/^{9}Be$ and $^{26}Al/^{27}Al$ ratios.

Generally, samples for ^{36}Cl will be processed for whole-rock analysis as outlined by Stone et al. (1996, *Geochimica et Cosmochimica Acta*). Most samples will be crushed and sieved to collect 250–500 micron particle size fraction. Crushed samples will be leached thoroughly, first in 18mΩ water and then in 10% HNO_3 for more than 12 h at room temperature. Major elements, including U and Th, before and after leaching, will be determined by X-ray fluorescence, and B and Gd by prompt-gamma-emission spectrometry. The samples will be dissolved over 2 days in a 15M HF and 2M HNO_3 mixture at 60–70^{o}C. A chloride spike (non-terrestrial $^{37}Cl/^{35}Cl$) will be added to each dissolved sample. Chloride will be recovered from the sample solutions as AgCl. The $^{36}Cl/^{37}Cl$ and $^{35}Cl/^{37}Cl$ will be measured using accelerator mass spectrometry (AMS) at the PRIME Laboratory of Purdue University.

Analytical Costs
Students should budget $500 for the training fee. Each sample will cost $400 for processing, which includes all consumables and supplies and use of equipment, plus $272.50 per sample for each AMS measurements. If visitors only require ^{10}Be analysis then each sample will cost $672.50, but if they require both ^{10}Be and ^{26}Al then the cost will be $945 per sample. If visitors are undertaking ^{36}Cl work then they should budget an addition $300 for bulk chemical analysis (each ^{36}Cl sample will cost $972.50). There are no costs for chemical blanks. We would generally expect visitors to processes a minimum of ten samples to make the training and visit worthwhile.

Preparation for the Visit
No sample preparation is required before visiting the TCN Laboratories. But visitors will be required to fully discuss their projects and nature of their samples before they write a grant proposal. Visitors will be encouraged to take the online safety courses before arriving.

Date Processing and Interpretation
Visitors will be trained in how to process and reduce their data to calculate ages and/or erosion rates.

Expected Laboratory Availability
The TCN Laboratories are available most of the year round, but we would appreciate a lead-time of about three months.

Laboratory Staff
Professor Lewis Owen (lewis.owen@ncsu.edu) is the director of the TCN Laboratories and has over 15 years of experience managing geochronology laboratories. Dr. Paula Figueriedo (paula_figueiredo@ncsu.edu) is the laboratory manager and safety officer. She joined the UC laboratories in 2011 and moved to NC State in 2019.

Contacts

Please contact Lewis Owen (lewis.owen@ncsu.edu) if you are interested in collaborative work and preparing samples for ^{10}Be, ^{26}Al and/or ^{36}Cl.