



GeoSep Services

Quality Mineral Separations and Analytical Services

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AGeS: Awards for Geochronology Student Research

GeoSep Services Student Experience Program: Training in Mineral Separation and Fission Track Thermochronology

Overview

GeoSep Services, LLC (GSS) offers training opportunities designed for graduate and undergraduate students who require mineral separations and/or thermochronology for their research. Students learn by active participation and detailed procedural training, provided by GSS staff at no extra charge.

Program highlights:

- Hands-on experience with heavy mineral separation techniques, at discounted rates.
- Immediate turnaround without an additional charge for a rush job.
- Opportunity to learn about apatite fission track (AFT+UPb) and/or zircon fission track (ZFT+UPb) double dating analytical techniques.
- Potential for generating AFT+UPb and/or ZFT+UPb analytical data during the same visit.
- Chance to explore the beautiful Palouse region of Idaho and Washington, USA.

This program is based at the GSS production facility in Moscow, Idaho, and has been in operation since February 2015. Typical visit lengths: 1) 5-7 days for mineral separation training only—to process and separate up to 20 samples (targeting apatite, zircon, and titanite); 2) an additional ~5-7 days would be needed for a combination program including AFT+UPb and/or ZFT+UPb data generation from up to 5 samples. Note: the maximum number of analyses to be carried out is flexible; contact GSS with any questions.

Lab Description (Facilities and Operation)

Mineral Separations: GSS is a specialized small business with a purpose-built, fully equipped facility for carrying out mineral separations on whole rock, cuttings, or stream-sediment samples to produce the desired concentrated mineral fractions. Equipment includes a Bico Chipmunk jaw crusher, Frantz magnetic separators, microscopes, centrifuges, and glassware, etc. for heavy liquid separations: lithium metatungstate (LMT, specific gravity: 2.95) and diiodomethane (DIM or MI, specific gravity: 3.3).

AFT+UPb and ZFT+UPb Analyses: GSS owns, or has operational agreements for access to, all equipment necessary to carry out FT+UPb analyses. These include our own Californium-252 (Cf-252) neutron source for production of enhanced confined track numbers, and two microscope-counting systems for the initial fission track data acquisition (counting spontaneous tracks and measuring confined track lengths):

- Zeiss Axioscope microscope, automated stage, and digitizing tablet.
- Leica DM6M motorized inspection microscope with screen control and camera.

GSS uses the Laser Ablation–Inductively Coupled Plasma Mass Spectrometer (LA-ICP-MS) method of FT analysis data generation (EDM not available). This approach allows for a quick turnaround from grain mounting to data generation (scale = days instead of weeks), as well as direct isotopic measurements of each grain dated using mass spectrometry instead of isotopic proxies. For our LA-ICP-MS measurements, we access the facilities at Washington State University (Agilent 7700x quadrupole inductively coupled plasma-mass spectrometer equipped with a New Wave Nd-YAG 213nm laser ablation system).

Due to the complex nature of fission track analysis and the time required to develop an individual calibration factor (Zeta), GSS does not offer for students to generate their own fission track data. However, GSS personnel will work with the student to explain the data acquisition processes (track counts, lengths, interpretation, etc.).

All analytical procedures follow accepted geochronology quality assurance protocols, incorporating a set range of age standards as controls, with multiple data points for each standard (replicate analysis) throughout each acquisition session.

Facility Scheduling and Expected Time Frame

Students should contact GSS Principal Manager Paul O'Sullivan or Facility Manager Jim McMillan 3-10 weeks prior to intended visit. We may be able to accommodate shorter deadlines depending on our workload.

The specific plan for each visit is tailored to the student's needs and always involves active participation. A student who plans to do mineral separations only with GSS can generally process 10-15 samples (max 20 samples) during 5-7 days of intensive training and processing. To maximize the available time for the student's visit, we recommend that rock samples be sent to our facility in advance so GSS personnel can complete initial sample crushing prior to the student's arrival.

A student who plans to do a combination min sep and analytical program should plan to stay up to two weeks in order to experience all stages of data generation following mineral separation—from making FT mounts to counting spontaneous tracks, apatite Cf-252 irradiation and measuring confined tracks, LA-ICP-MS analysis, data processing, and interpretation.

Student experience options:

1. Mineral Separation.

- Student works with GSS staff to process up to 15-20 samples in 5-7 days.
- Student learns standard methods to separate mineral grains from a sample, with a focus on concentrating apatite, zircon, and titanite grains for eventual helium, fission-track, or UPb chronology.
- Student actively participates in most phases of mineral separation, including sieving, washing, magnetic separations, and heavy liquid separations (LMT, and possibly DIM). For safety reasons, GSS limits student participation in rock crushing and sometimes DIM separation.
- Student departs with completed mineral separates for eventual analysis.

2. Min Sep plus Apatite and/or Zircon Fission Track Analysis. Combination program for students interested in separating their samples then observing aspects of AFT+UPb or ZFT+UPb analytical data generation for up to 5 samples over 2 weeks.

- Initially, the student works with GSS staff to process samples and obtain mineral separates.
- Student observes and participates in grain mount and etching process.
- Paul O'Sullivan instructs student and demonstrates the procedures for selecting appropriate grains, counting valid fission tracks, accurately measuring lengths and etch pit diameters (Dpar) in apatite, etc.
- Student actively participates in the LA-ICP-MS analytical data collection, under supervision.
- Student participates in data processing/reduction using custom-designed software incorporating peer-reviewed analytical methods and equations.
- Student actively participates in thermal modeling and interpretation of their results.
- Ideally, student departs with their mineral separates, analytical results, and preliminary interpretations.

3. Analytical Only: Fission Track Analysis. For student interested in analytical data generation for up to 5 samples.

- Student provides "clean" mineral concentrates at least a week before arrival. These should be processed appropriately and ready to mount, but if not, they can be cleaned up properly prior to student's arrival.
- Program elements are the same as for option 2, without the mineral separation component.

Scheduling the length of a stay is highly dependent on several factors. These include: 1) Pre-arranged access to the nearby LA-ICP-MS facility. 2) If apatite Cf-252 irradiation is needed due to low numbers of confined tracks, this will add 3-4 days of downtime while mounts are irradiated. 3) Etching of zircons for ZFT can require anything from a few hours (for older grains) to a couple of days (younger grains) depending on the age of zircons grains to be dated.

The program is designed such that the student will be an active participant in all steps for all visiting options. During mineral separation, the student will be responsible for all stages of the separation except for the initial rock crushing. For the analytical options, the student will participate in/observe all steps of the analysis from initial grain selection and data generation through isotope data generation and final modeling and interpretation. Paul O'Sullivan can also help guide the student with further data interpretation and thermal history (time-temperature) modeling after the student has returned to their research institution.

Preparation for Visit

Paul can advise student on sampling and analytical strategy in relation to research project goals. We can also recommend or provide relevant publications and other information for the student to read prior to their visit, particularly if the student intends to work with GSS for analyses.

- If the student plans to do mineral separations at GSS, they should send their rock samples (in fist-sized pieces) to GSS at least 2 weeks in advance, so GSS staff can crush the samples and have a few ready for heavy liquid separation.
- If the student plans to do analytical work only at GSS, they must provide pure (“clean”) mineral concentrates processed appropriately and not requiring any further cleanup before mounting.
- If the student intends to bring prepared grain mounts, check with GSS staff about the acceptable options, and arrange any grain imaging in advance.

Mineral Separation and Analytical Costs

The student or their supervisor is responsible to arrange and pay for all travel and accommodation for the student’s visit.

Mineral separations (apatite, zircon, and titanite):

- In-person student experience/training mineral separation program is offered at a reduced price of \$225 per sample (compared to the standard rate for student projects of \$275/sample).
- If a student does not have time for the in-person training program, GSS can do the mineral separations for the standard student rate of \$275 per sample.

Thermochronology (AFT+UPb or ZFT+UPb):

- This student analytical experience/training program is offered at a price of \$900 per AFT+UPb or ZFT+UPb analysis.
- For additional samples beyond the student experience program, GSS can provide analytical services at reduced student rates (15+% lower than normal collaborative/academic rates).

Contact Paul O’Sullivan for estimated costs based on the specific research plan. We request proper acknowledgement of the services provided by GSS in resulting presentations and publications.

Key Facility Staff

Paul O’Sullivan, Ph.D., GSS Principal Manager, has 30+ years of experience in the field of geochronology, thermochronology, and basin analysis (emphasis on petroleum studies), with specific expertise in apatite and zircon fission track analyses and U-Pb zircon mineral dating. Paul oversees LA-ICP-MS data collection and personally completes all aspects of the analytical activities, including all final data processing and thermal history/basin analysis interpretations. Paul used the fission track external detector method (EDM) for 2 decades then transitioned to conducting using LA-ICP-MS in 2005. He assisted with development and refining of this technique and is a coauthor of one of the reference publications (Donelick, O’Sullivan, and Ketcham, 2005). The LA-ICP-MS method of fission track analysis also provides the ability to produce a U-Pb age for each analyzed grain (known as “double dating”).

GSS Facility Manager **Jim McMillan** oversees all technical personnel and procedures, keeping a close watch on all aspects of the facility and general organization practices. Jim and other staff members will work closely with the student to explain each step of the process. GSS personnel follow detailed standard operating procedures (SOPs) for each specific set of tasks—from the cleaning of used glassware through the entire mineral separation process, to preparing grain mounts and conducting data collection on the LA-ICP-MS.

Contacts

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Since early 2015, GSS has completed 500+ projects for more than 150 clients worldwide across dozens of entities, with multiple projects for repeat clients. Our clients rely on us to always provide high-quality, accurate, and consistent services.

GSS welcomes students of all backgrounds. GSS is a government contractor and equal opportunity employer. GSS does not discriminate in hiring or employment decisions on any basis protected by federal, state, or local law.