The Auburn Noble Isotope Mass Analysis Laboratory

Laboratory Facilities Available

The ANIMAL facility provides researchers with access to noble gas mass spectrometry facilities of high quality and a wide range of capability. The lab specializes in $^{40}Ar/^{39}Ar$ age measurements for very small sample quantities (typically single crystals), with automated procedures that enable efficient collection of large data sets. Areas of research emphasis in ANIMAL include studies of crustal evolution and tectonics, volcanism and extensional development of large igneous provinces (LIPs), temperature-time evolution of metamorphic and igneous terrains, evolution of sedimentary basins and characterization of sedimentary provenance. The single-crystal research of the lab encourages mineralogical, process-oriented studies to investigate factors (such as diffusion properties, crystallization history, etc.) that may result in age variations within a population of crystals from single samples. ANIMAL facilities are within ~750 ft^2 of dedicated lab space in the Department of Geosciences of Auburn University, with provision for temperature control and uninterruptable electrical service. Routine analytical procedures in the ANIMAL facility are fully automated. The laboratory equipment of the ANIMAL facility include the following Noble gas mass spectrometers:

- The GLM-110 mass spectrometer (built in house) with an exceptionally low volume (~0.4 liter) and a high-sensitivity electron-multiplier suitable for the analysis of extremely small sample quantities;
- Two MAP mass spectrometers (a MAP-215 and a MAP-215-50) are being reconditioned and upgraded for use in the ANIMAL facility beginning in 2015.

Four ultrahigh vacuum extraction systems (on 'carts') can be moved independently among the lab mass spectrometers and configured to match the sample requirements for differing geochronologic studies, with gas extraction by one of the following devices:

- 60 W CO_2 laser system (10.6 μm) suitable for incremental heating and fusion of single crystals (e.g., sanidine phenocrysts from a rhyolite) and small amounts of whole-rock material (e.g., phenocryst-free portions of basalt groundmass, etc.);
- 40 W diode laser system (908 nm) suitable for fusion of some mineral phases (e.g., micas) and also temperature-controlled incremental heating of foil-encapsulated minerals (e.g., feldspars from plutonic rocks) and whole-rock material;
- A 'prototype' crushing apparatus for the analysis of vacuum-encapsulated clays;
- Double-vacuum resistance furnace (Modifications Ltd.) for use in temperature-controlled incremental heating when large sample quantities are required.

Facilities of ANIMAL and the Auburn University Department of Geosciences include equipment for sample crushing, sieving, microscopes for 'picking' individual crystals and petrographic characterization, magnetic and density separation of minerals, and archival storage space for representative sample material as part of ongoing commitments for data management.

Time Frame

Research work in ANIMAL is generally based on collaborations leading to publication of results, and typically involves the participation of laboratory personnel with students and research scientists. Approximately three to six months of 'turn-around time' is generally

required from receipt of prepared samples to the time of analysis and final data reduction (primarily to allow for the sample's irradiation). Please contact laboratory personnel for questions regarding preparation and needs for characterization of specific sample types. The potassium and calcium content should be evaluated in all phases, particularly those that may have less than ~ 1-2% K_2O and/or relatively high calcium (e.g., plagioclase, amphibole, and certain glasses). The sample petrography should be characterized. Samples will be evaluated for their suitability in $^{40}Ar/^{39}Ar$ dating by laboratory personnel soon after their receipt.

Costs

We request that all lab users pay a standard fee of $500 per sample in order to help defray some of the direct costs incurred in the age determinations, including their irradiation. This fee applies to external and internal users, and is generally requested upon completion of analytical work. A typical 'sample analysis' comprises many single-crystal laser fusion analyses, or many steps of laser incremental heating. In some cases, robust age determinations require a combination of incremental heating and single-crystal fusion techniques. The lab personnel will determine the optimum strategy for analyzing samples and the number of analyses for a given sample, and discuss all potential costs with collaborators prior to undertaking the study. Additional considerations and charges for analyses may apply in certain cases, discussed prior to accepting analytical work, as noted below:

- Studies that require more than 50 analyses per sample will be billed at a flat rate of $10/analysis. Thus, for example, a provenance study requiring 100 analyses of detrital minerals of a given sandstone will cost $1000/sample.
- Additional fees may apply if significant sample preparation (mineral separation from a rock sample, etc.) is required in ANIMAL. Such preparation will generally extend the turn-around time required for analysis.
- Additional fees to expedite irradiation and analysis may be considered for cases that specifically require a turn-around time of three months or less.
- Arrangements can be made for a modest additional cost ($50/sample) to measure the composition of a phase of interest prior to irradiation and $^{40}Ar/^{39}Ar$ analysis (particularly the potassium and calcium concentrations), to characterize the structure and composition of a mineral aliquot with powder XRD analysis, or to have thin sections prepared, if such information is not otherwise available.

Preparation for a Visit

Students are particularly encouraged to visit and work in ANIMAL to assist in the analysis and data reduction for their samples. Students should be familiar with the basis and practical applications of the $^{40}Ar/^{39}Ar$ method, with emphasis to theory, the underlying physical principles, and practical applications that relate to their particular study.

Laboratory Staff

The ANIMAL facility is directed and managed by Dr. Wills ('Bill') Hames. Experienced students and research staff of the Department of Geosciences also provide training and assistance for users of the ANIMAL facility.

Data Reduction and Interpretation

The automated laboratory operations and instrument control of the ANIMAL facility are implemented through Labview programs created in collaboration with engineers, computer programmers and IT specialists at Auburn University and in the $^{40}Ar/^{39}Ar$ research community worldwide. The essential files containing a complete tabulation of all analytical and procedural data (the essential 'raw data') are provided to lab users and archived in servers at Auburn University. Users are provided with a spreadsheet-based program for $^{40}Ar/^{39}Ar$ data reduction (written at Auburn University) that includes add-ins for mathematical analysis and plotting functions that are specific to geochronologic studies. The essential data files are also amenable to data reduction through other geochronologic data management programs that are available in the research community. The laboratory director will review and give advice regarding the preparation of final tables of reduced data and figures (as for publication).

Scheduling

Prospective workers should contact Dr. Hames prior to sample preparation to discuss the project. The standard turn around time for completion of analyses in the lab is six months from the receipt of prepared samples as discussed above. Factors that may influence, and potentially lengthen, the time for analysis include additional needs for sample preparation, the schedule of irradiations in available nuclear reactors, etc. In all cases, it is best for the lab users to advise the lab director of any constraints regarding the time available to obtain results.

Contact

Please contact Dr. Bill Hames (tel. 334.844.4881; hameswe@auburn.edu) to discuss potential collaboration for $^{40}Ar/^{39}Ar$ geochronologic study in the ANIMAL facility. You may find additional information about the ANIMAL facility on the lab web page (http://www.auburn.edu/ANIMAL). The complete contact and mailing address for Dr. Hames and the ANIMAL facility is:

Dr. Bill Hames
Professor of Geology
Department of Geosciences
201 Petrie Hall
Auburn University
Auburn, Alabama 36849
Main Office: 334 844-4282
Fax: 334 844-4486