Isotope lab facility description rev. 10/18/18

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Summary

Mission: To use of geochemistry and isotope geochemistry to explore the processes, effects and chronology of natural volcanologic, sedimentologic and oceanographic phenomena, as well as the environmental effects of human activities

Instrumentation/Facilities: Multi-collector thermal and plasma ionization mass spectrometers, radioactive counting equipment, clean room complex, support labs.

Facility at-a-glance: Radiogenic/radioactive/stable isotope analysis in natural-matrix samples, including volcanic rocks, corals, sediments, soils, bone and natural waters, with both natural and anthropogenically perturbed compositions. It has been in continuous operation since 1987 and is currently the primary research facility for UH faculty members Ken Rubin and Jasper Konter, as well as affiliated faculty and their research groups at UH, plus national and international visitors. The lab is a Research Corporation of the University of Hawaii (RCUH) recharge facility, with operational costs covered from analytical fees levied on facility users and instrumentation acquisitions funded by extramural grants plus-minus university cost-share. The facility includes multiple components, as described below:

Class 100 Clean Room Laboratory

Wet chemistry and sample preparation are conducted in a recently built, four-room interlinked clean laboratory complex occupied in 2006. The lab provides all the necessary equipment and reagents for ultra-low-blank separation and concentration of Sr, Nd, Pb, Th, U, Ra, Pa, Ba, Rb, Sm, Hf, Li and Po from most rock, mineral, sediment, biological and aqueous matrixes for isotopic composition and isotopic dilution analysis (chemical fume hoods, laminar flow benches, high speed centrifuges, quartz stills, high precision balances, ion exchange columns, microscopes, etc.). A full suite of enriched isotope spikes are available and utilized for routine, high precision concentration determinations by isotope dilution analysis. The facility is licensed under the university's NRC broad-scope license for work with radioactive materials and tracers. Our methods, which use in-house produced ultra-pure reagents, result in some of the lowest procedural blanks in the business (e.g., <3 pg for Th and U, <1 fg for Ra, <30 pg for Pb, <300 pg for Ba, <12 pg for Nd, <35 pg for Sr, and <3 pg for Sm).

Radiometric counting

The Isotope Lab operates a two 12 detector Canberra high resolution, low baseline alpha-counting system with 450 mm^2 active area PIPs detectors, primarily used for ^{210}Po-^{210}Pb dating of very young (<2 yr old)) volcanic rocks and ^{210}Pb analysis of young (<100 yr old) volcanic rocks for ^{210}Pb-^{226}Ra geochronology. The first was acquired in 1997 and updated with new software and hardware in 2010. The facility hosts a second 12-detector system purchased in 2010 that is dedicated to NOAA-fisheries ^{210}Pb-^{226}Ra otolith geochronology projects.

Thermal Ionization Mass Spectrometry

The Isotope Lab operates 2 thermal ionization mass spectrometers, with different capabilities and semi-dedicated applications. The 18 year old VG Sector54 is used primarily for actinide decay chain analyses and other applications involving very small-ion-beams. The 25 year old VG Sector is used for large ion beam radiogenic isotope analysis and small-sample Nd (5 ng or less) isotopic analysis.

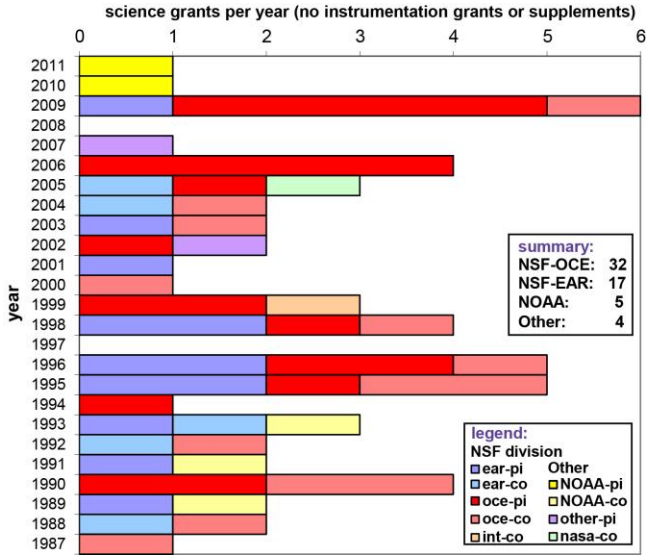
The Sector 54 is a 7 Faraday instrument with a Micromass WARP energy filter for high abundance sensitivity on the Axial collectors (10-15 ppb at 1 AMU for U mass) and a low noise ion-counting Daly detector (linear to within counting statistics from 10 to $2x10^6$ cps).. It is optimized for U-series isotopic analysis, for which it is routinely used. We routinely analyze Th and U isotopes in volcanic rocks and minerals to probably the highest attainable precision and accuracy of TIMS methods (2σ precision and accuracy 1%, 0.2% and 0.2%, 0.1% for $^{232}Th/^{230}Th$ and $^{234}U/^{238}U$, respectively; e.g., [*Rubin*, 2001, *Rubin et al.*, 2005]). Long term reproducibility and external precision for Th and U isotope ratio analyses are better than 1% for the UCSC-A standard, $^{232}Th/^{230}Th$ = 170600 (n=120) and 0.4% for NIST U010, $^{234}U/^{238}U$ = 546500 (n=40) [*Rubin*, 2001, *Rubin et al.*, 2005]. Reproducibility and external precision on ($^{230}Th/^{238}U$) exceeds 1%, and on Th and U abundances and Th/U ratios exceeds 0.3% [*Rubin et al.*, 2005]. External precision and accuracy for ^{226}Ra analysis by isotope dilution analysis for ($^{226}Ra/^{230}Th$) and for ($^{210}Pb/^{226}Ra$) applications is nominally 1% [*Rubin et al.*, 2005], although we routinely achieve 0.3 to 0.5% external precision on 20 fg sample sizes [*Russo et al., in prep*]. Methodology is under development for ^{231}Pa-^{235}U isotopic analysis. The instrument was acquired in 1994.

The VG Sector is a 5 Faraday instrument used for routine Pb, Sr, Nd (including small sample analysis @ <5ng) and double-spike Pb isotope analyses. It was acquired in 1987. Faraday detectors were replaced in 2000.Five-year reproducibility for NBS981 Pb using a ^{204}Pb-^{207}Pb double-spike technique and multi-dynamic measurement is ~60 ppm for $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$ [e.g., *Ingle et al.*, 2010]. Neodymium is measured by TIMS as the oxide, permitting routine measurement of small samples; the measured long-term $^{143}Nd/^{144}Nd$ value of the La Jolla Nd standard on the Sector is 0.511843 ± 0.000008. The NBS 987 Sr standard gives a long-term $^{87}Sr/^{86}Sr$ value of 0.7102438 ± 0.000014. Relative uncertainties on concentration measurements are 0.2% for Sm and Nd, 0.4% for Sr, ~1% for Rb, and 0.5% for Pb. It was acquired in 1987. Faraday detectors were replaced and the ion signal amplication systems was upgraded in 2000.

Multi-collector ICP-MS

A NU-HR 6kv MC-ICP-MS with 3 ion counters and a high abundance sensitivity filter was acquired in 2008, with a Nu DSN desolvating nebulizer and ASX100 autosampler. The facility and associated wet lab is integrated with the Isotope lab but currently operated a separate fee-based sister facility (see www.soest.hawaii.edu/krubin/mcicpms-lab.html). It is routinely used for standard bracketed Pb, Th, U, and Li isotope composition(IC) analysis (with Tl and U doping of Pb and Th solutions), Re ID, Os IC analysis (by sparging) and large sample Nd IC analyses. Precision and reproducibility for Pb is roughly 50% higher than the TIMS double spike numbers, Th-U IC and Re ID precision and accuracy exceed all 0.1% (2σ).

Staffing and Users:
The lab supports student, posdoc and faculty researchers at UH, as well as 1 to 4 national/international student-posdoc visitors each year. The day-to-day operations of the facility are managed by a Specialist Faculty member (currently in transition) as well as a part time instrument/wetlab technician (currently Denys Vandeerhaar). The specialist position is a 50% hard money faculty slot and the technician is soft money.



Funding profile:
The facility operating budget is roughly $50K/yr, excluding major purchases. Isotope lab primary researchers utilize a range of funding sources, primarily at NSF, but also from NOAA, NASA and DOD (see chart at left).

Projects:
Isotope Lab researchers work on a broad range of research topics in Earth, Ocean and Environmental Sciences. Rubin's and his group focus on active or recent volcanic and magmatic processes at subaerial and submarine volcanoes, Pleistocene and Holocene sea level history, mantle geochemistry, and environmental geochemistry.

- Volcanic Time scales with U-series disequlibrium
- Rapid response 210Po-210Pb dating of submarine volcanism
- Modern & LGM Deglacial sea level history from coral reef dating
- Sr-Nd-Pb-Hf isotopic composition of volcanic rocks
- Re-Os in marine and igneous materials
- Li isotopes in marine detrital minerals
- Sr isotopes in carbonates, fossils, waters
- Fe isotopes in igneous materials
- Timing and petrogenesis of historical bimodal (rhyolite-basalt) Icelandic volcanism
- Novel eruption chronology methods from recrystallized coral lithic clasts
- Submarine volcanoes and volcanism in Hawai'i and the Galápagos
- Oceanography via Nd isotopes in sea water
- Depleted Uranium contamination in Hawaiian Soils
- Global variations in mid-ocean ridge petrogenesis
- Earliest peopling of South Korea
- 210Pb-226Pa dating of opakapaka and other Hawaiian fishes