## *Lab Profile for Washington State University*

The Radiogenic Isotope and Geochronology Laboratory (RIGL) at Washington State University is equipped with a ThermoFinnigan Neptune Plus MC-ICPMS for isotope ratio analysis. Our new Neptune Plus (installed in October 2018) is a doubly focusing, plasma source multicollector mass spectrometer (MC-ICPMS) that offers high elemental sensitivities. The Neptune has nine Faraday collectors and one high-sensitivity ion-counting electron multiplier. This collector configuration has wide-ranging utility in measuring high precision isotope ratios in a variety of isotopic systems including Lu-Hf, Sm-Nd, Pb and Sr. Other facilities in the RIGL include a ThermoFinnigan Element2 single collector, high resolution magnetic sector ICPMS and two sample introduction systems that can be interfaced with either the Element2 or Neptune Plus to perform a range of elemental and isotopic work that require either microsampling or low abundance analyses. These are the Cetak Aridus desolvating nebulizer with PFA introduction system from Elemental Scientific and an Analyte Excite 193 nm ArF excimer laser ablation system from Teledyne. The excimer laser, the Element2 and the Neptune Plus are all co-located enabling our implementation of the laser ablation split stream (LASS) technique. This allows for simultaneous measurement of laser generated aerosols "split" to two separate mass spectrometers: the HR-ICPMS ThermoFinnigan Element2 for U-Pb isotope analysis of zircons, baddeleyites, or monazites; and the MC-ICPMS Neptune Plus for Hf (zircon, baddeleyite) or Nd (monazite, titanite) isotope analysis (Fisher et al., 2014).

To support these instruments, we have an ULPA-filtered ~900 $ft^3$ class 1000 clean laboratory that is used to perform chemical separations of Lu-Hf, Sm-Nd, Rb-Sr, U-Th-Pb, and HFSE using column chromatography. This lab is fully equipped with low-blank distilled water, quartz and Savillex stills for generating low-blank HCl, $HNO_3$, and HF acids, and ion-exchange columns for Lu-Hf, Rb-Sr, Sm-Nd, and U-Th-Pb radiogenic isotope systems as well as the heavy stable isotopes Ca, Fe, Cu, and Zn. We also have thoroughly calibrated mixed Lu-Hf, Sm-Nd, and Rb-Sr isotopic tracers, which we use routinely for geochronological applications with these systems.

The Radiogenic Isotope and Geochronology Laboratory is well set up for hosting visiting researchers, and we regularly welcome visitors from around the world to visit our lab and use our facilities for their research under our guidance. One of the most frequent applications that bring visitors to our lab is garnet Lu-Hf and Sm-Nd geochronology. Garnet geochronology involves an isochron technique, which determines an age from the analysis of several co-genetic garnet fractions and the associated whole rock (or low Lu-Hf, Sm-Nd phase) from that sample. We recommend 4 garnet fractions and 2 whole-rock fractions per sample/isochron. Our chemical procedures allow for elemental separation of Lu, Hf, Sm, and Nd from the same dissolution, which makes it possible to determine both Lu-Hf and Sm-Nd garnet ages from the same sample material. Visitors are asked to bring their samples ready for dissolution. For the garnet, this involves "picking" 4 pure (or nominally pure) garnet fractions, each of 200-250 mg. For the whole rock dissolutions, we also recommend 200-250 mg for each whole-rock fraction. It is essential that these whole-rock powders ***not*** be ground in a tungsten-carbide shatterbox. A typical visit will last 3 to 4 weeks and in that time a visitor can expect to determine ages on 3 rock samples (closer to 3 weeks if just determining ages with one system; about 4 weeks if determining ages with both systems). Additional samples will require additional time, obviously.

The cost per analysis is $350/fraction if ages are determined using only one system (i.e., Lu-Hf or Sm-Nd) and $450/fraction for both systems. This means that a 6-point isochron would cost $2100/sample-age for one system and $2700/sample-age for the both Lu-Hf and Sm-Nd systems.

There are no other laboratory costs associated with the garnet geochronology. We are able to house many of our visitors very economically (currently $24/day) in nearby university-owned and operated apartments that are often available for stays of short to moderate duration.

We train all of our visitors for their use of our laboratory. No prior experience is necessary, although prior coursework in radiogenic isotope geochemistry and geochronology is greatly preferred so the visitor can understand the fundamentals behind the work being performed. Currently, clean lab manager Chao Zhang is training users in clean laboratory techniques, from sample dissolution through to chemical separations. All aspects of training with the analyses on the mass spectrometers, subsequent data reduction, as well as age calculations, are done by Chao Zhang and aided by post-doc Da Wang and senior technical specialist Charles Knaack. RIGL director Jeff Vervoort oversees all of this work, especially the final data analysis and age calculations/interpretations. We require that all data reduction and age calculations be completed prior to the visitor leaving our lab. We are also involved with the data interpretation including in any publications resulting from this work. Typically visitors can fit into our laboratory schedule within a few months of requesting time.

If interested, visitors should contact laboratory director Jeff Vervoort, by email (preferred) or phone (vervoort@wsu.edu; 509-592-3903). Our lab website is currently a work in progress but potential visitors can use the following link (https://labs.wsu.edu/rigl/events/) to view the calendar and to request time.