Secondary ion mass spectrometry for Christmas

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A large wooden crate was delivered to the Compton Hall loading dock Dec. 4, direct from Paris. The crate contained a fabulous new instrument that Washington University in St. Louis scientists say will transform their ability to study everything from the long-term evolution of the Earth's surface to high-performance ceramics.

The instrument, called the Cameca SIMS ims7f-geo, is a state-of-the-art secondary ion mass spectrometer (SIMS), one of only three in the world.

Uncrated in the basement of Rudolph Hall, the Cameca SIMS is being assembled under the watchful eye of Cameca engineers and Clive Jones, PhD, a SIMS research scientist.

It is Jones' job to ensure that the instrument, which will serve as a cross-disciplinary and cross-institutional resource, can pivot quickly from one problem to the next.

Great things are expected of the Cameca instrument in a variety of disciplines, including geology, biology, space science, engineering and materials science, but especially in biogeochemistry, a relatively new discipline that explores exchanges of chemical elements between the sea, air, rock and living creatures.

The Cameca instrument will be used to study, for example: the release of carcinogenic arsenic into groundwater; the release of neurotoxic lead from pipes in cities with old infrastructure; the viscous flow of mantle

rocks that drives earthquakes and continental drift; and the emergence of life and an oxygen-containing atmosphere on our planet.

But this is just the beginning of a long queue of projects waiting for time on the new Cameca SIMS. "We have quite a bit of pent-up demand," Jones said.

The $3 million instrument, funded by a National Science Foundation grant awarded to a team of geo- and cosmochemists led by David Fike, PhD, assistant professor of earth and planetary sciences in Arts & Sciences, will become part of the shared instrumentation within the newly established Institute of Materials Science and Engineering. The institute was jointly established by Arts & Sciences and the School of Engineering & Applied Science.

Although the Cameca ims-7f-geo is a state-of-the-art scientific instrument, its underlying analytical principle is straightforward. A beam of charged atoms (called primary ions) knocks atoms out of the sample under study.

Some of these atoms become ionized in the process, and these secondary ions can be extracted and focused, via an ion optical system, through a mass spectrometer. The resulting "mass spec" data then are used to identify the type and original location of the secondary ions, Jones said.

The instrument can be configured to count atoms of different elements, to create two-dimensional images of the elements in the top few nanometers of a surface, or to create profiles that show how the composition changes as the sample is slowly sputtered away.

In addition, the instrument has a custom-made detection system optimized to provide very precise data for the analysis of isotopes, variants of elements with different masses.

Isotopic ratios are useful in many disciplines, including cosmochemistry and biogeochemistry, two of WUSTL's enduring research strengths.

Fike, for example, uses sulfur isotope ratios to understand Earth's 4-billion-year history. Because microbes strongly differentiate between sulfur isotopes, they leave their imprint in sedimentary rocks. And the microbe's metabolic activity in turn can be tied to the oxygenation of the oceans and of the atmosphere.

But the data are complicated and their interpretation often controversial. "With its high precision and high spatial resolution, this instrument will revolutionize our ability to link environmental conditions and microbial metabolic activity," Fike said.

"I am extremely pleased to welcome the Cameca SIMS to the Institute of Materials Science and Engineering," said Ken Kelton, PhD, director of the institute and the Arthur Holly Compton Professor of Arts & Sciences. "In addition to helping Washington University stay at the forefont of cosmochemistry and biogeochemistry, this sophisticated instrument will help establish us as a regional center for modern materials science."

Provided by Washington University School of Medicine in St. Louis