"Small" Science Puts UNH In Select League

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DURHAM, N.H. -- What costs nearly half-a-million dollars and can detect elements of the periodic table down to levels of a few hundred parts-per-quadrillion or the equivalent of one particle in 9,999,999,999,999?

The answer is an Inductively Coupled Plasma Mass Spectrometer, and the University of New Hampshire recently installed one at the Institute for the Study of Earth, Oceans, and Space (EOS). The instrument is the first of its type installed anywhere in the world.

Made by the Wales-based company Nu Instruments, the mass spectrometer is able to analyze small specimens and samples with complex compositions that researchers in Earth, marine, and atmospheric sciences encounter. The instrument uses plasma – a hot ionized gas – generated from argon gas to vaporize materials into their elemental form and thereby detect ultra-trace levels of substances.

The state-of-the-art mass spectrometer was purchased through the university's air quality and climate program known as AIRMAP and will be used by a variety of departments for interdisciplinary work.

"We plan on it providing a framework for many research programs across campus," notes research professor Robert Talbot, director of AIRMAP and the Climate Change Research Center at EOS. Talbot adds, "Obviously this type of instrument is very expensive and we want to leverage its use on as many different applications as possible."

For example, chemical oceanographer Karen Von Damm, a professor in the EOS Complex Systems Research Center and the Department of Earth Sciences, will analyze water samples she gathered recently from a newly discovered hydrothermal vent or "black smoker" on a volcanic ridge along the Pacific Ocean floor off Mexico. And assistant professor Julie Bryce of the Department of Earth Sciences and her students will, among other things, use the mass spectrometer in their work analyzing trace elements in rocks.

Notes Bryce, who has taken the lead role in getting the new instrument up and running since its arrival, "Rainwater samples collected at AIRMAP's Thompson Farm observatory in Durham will be one of the main things analyzed. We'll spritz them into the plasma and everything will ionize."

Inside the mass spectrometer, the ions – an atom or group of atoms that change their electrical state – get separated/deflected based on their mass as they flow by a giant magnet and are deposited on a collector where they can be identified.

So what, exactly, does the ability to detect something that can be up to .0000000000001 of its former self get you?

“There’s a whole suite of exotic elements the mass spectrometer can detect, and, combined with the other types of measurements we make, this will give us a much more powerful tool for looking at sources of aerosols and the components of rainwater that we collect,” explains Talbot.

For example, better pinpointing the sources of aerosols – the minute, ubiquitous particles in the air – will provide atmospheric scientists at UNH with key information about their transport around the globe. Aerosols are fundamental components of air quality and potential climate change; they play a very complex role in the climate system by having the ability to both increase or decrease the greenhouse effect depending upon their size and location.

Adds Talbot, “What we’re trying to do all the time in our research of the atmosphere is attribute the observed quantity of some particular gas or aerosol to a complex suite of sources.”

One of AIRMAP’s emerging research areas is the atmospheric transport of mercury. This highly toxic metal that, among other sources, is a byproduct of coal combustion can only be detected in the parts-per-quadrillion range. Having the extraordinarily sensitive instrument will allow such research to proceed, and may help foster further scientific investigation in this and related areas.

The AIRMAP program, which is funded through a grant from the National Oceanic and Atmospheric Administration (NOAA), is unraveling fundamental chemistry-climate connections in the rural atmosphere of New England directly downwind of major urban and industrialized emissions. The program’s six permanent, ground-based atmospheric observatories are some of the most sophisticated in the world and sample the air day and night for over 180 chemicals critical to the region’s air quality.

In addition to research done by faculty and staff in the AIRMAP program and departments around campus, Bryce notes that having such sophisticated instrumentation is a real boon for graduate student research opportunities and training.

“We’re particularly fortunate in having a number of well-qualified and skilled graduate students who, as part of their research efforts, will work out a lot of the subtle techniques required to use this instrument,” Bryce says.