MEASURING LEAD IN TAP WATER WITH HANDHELD XRF

Academic Spotlight with Professor Marya Lieberman, University of Notre Dame

Dr. Marya Lieberman, an analytical chemist at University of Notre Dame, was driving to work early in 2017 when she heard a story that changed the course of her work. NPR aired a Reuters investigative story revealing that thousands of areas in the U.S. had worse lead poisoning than Flint, Michigan, including less than two miles away in South Bend.

Dr. Marya Lieberman, College of Science
Photo by Barbara Johnston/University of Notre Dame

Lieberman recalls the details: "They found publicly accessible data about lead levels in the blood of children in counties all over the country. The article had links and maps to see how each county ranked, but I didn't have to go to the link because South Bend was called out as one of the cities with high rates of children who have elevated blood-lead levels."

The report stated that in census tract 6 of South Bend, a mile and a half from Notre Dame's campus, "31 percent of small children tested from 2005 to 2015 had high levels – more than six times Flint's rate last year."

Lieberman put aside her normal research on detecting fake pharmaceuticals and immediately went to work researching what she could do about the lead-level problem. Lieberman wasn't the only faculty member who heard the story and was moved to action.

"We found there was a little group of about five faculty who were working on different aspects of the environmental lead hazard in South Bend," she says. The Notre Dame Lead Innovations Team discovered that one of the main ways that the state of Indiana detects environmental lead is when a child gets lead poisoning. The health department will then do a home hazard assessment.

"If I suggested in a research proposal that we use children to detect lead, the IRB (Institutional Review Board) would never agree to it. But this is essentially how a lot of states detect environmental lead. We felt we could do better," Lieberman says.

Measuring lead in tap water with handheld XRF

The Notre Dame team needed to gather common contamination culprits. For samples of paint, dust and soil, Lieberman and her colleagues created citizen science collection kits. But measuring lead in tap water was a whole other issue. There is currently no way to do a home water test. A person has to collect a water sample and then ship it to a lab where analysts run an inductively coupled plasma (ICP) experiment with an expensive instrument sensitive enough to measure lead.

Lieberman demonstrates the attributes of SciAps handheld XRF.

But through research and multiple trials, Lieberman and her graduate student Meghanne Tighe created a method to test lead in water using a two-liter bottle and a special carbon filter that collects the lead as the water passes through. The remaining difficulty was in finding a better way to test those samples for lead. Lieberman had been using the handheld SciAps XRF for other research projects and tried it on the samples.

"We discovered our carbon filter test with the SciAps XRF is nearly as sensitive as the ICP. Our limit of detection for the carbon filter and a two-liter water sample was about six parts per billion in the water, and our ICP goes down to three parts per billion. For a handheld instrument, that's pretty good," she says.

Now, they can do on-the-spot testing of the water filters. SciAps technology became a game changer.

Seeking the source

Nowhere in the country is there a map that pinpoints the location of lead issues in the water system, but somewhere between the source and a kitchen sink, lead gets in the water.

"In most cities, if the plumbing is old enough, there are old feeder lines that are made of lead, and those pipes are well coated with a passivation layer to keep the lead from dissolving in the water. But if something damages the passivation layer, lead can start leaching into the water, affecting thousands of people in the system," Lieberman says.

However, there can also be more localized problems. In older houses, lead could be leaching into the water while it sits in pipes overnight. The first water that comes out of the faucet might have a lead level above the Environmental Protection Agency limit at 23 parts per billion. But if the person runs the water for three minutes, that water will be flushed out. At that point, the lead content might only be two or three parts per billion. Using the carbon filter kit and the XRF in the home can determine whether the problem is in the house or part of the

(continues on reverse)

MEASURING LEAD IN TAP WATER WITH HANDHELD XRF *(continued from reverse)*

bigger system, which leads to Lieberman's ultimate goal.

"If we can get more people to participate in these tests, we could draw a map and figure out what parts of the water system are high in lead and what parts are not a problem and monitor the health of the water system on a regular basis. We just have to figure out how to get people to actually do this test and how to analyze thousands of samples in a rapid way so that we can get the results quickly," she says.

School by school

One way might be through primary and secondary school science labs. Many students already test for water hardness and pH levels, so adding lead to the test is a simple addition. Lieberman has already started making this goal a reality by recently working with a private high school in New York where she was able to collect about 100 water samples.

"We actually found two samples that were over the EPA limit and two more samples that were pretty close to it using the carbon filter tests. We're really interested in seeing how that matches up with the New York Water Authority's findings," says Lieberman. (New York residents can get their water tested for free a certain number of times per year, but the students who found lead in their water have not received their state test results yet.)

Lieberman was able to bring the SciAps XRF into the high school classroom so that the students could watch the XRF operate and see the results immediately. Lieberman did all the testing because XRF users need to be trained in how to use the instrument and wear a ring badge, which monitors exposure to radiation. "The XRF is not a dangerous instrument, but it still produces X-ray radiation localized right at the nozzle of the instrument," she says.

At Notre Dame, the undergraduates who go through the radiation safety class and get a ring badge are allowed to use the instrument themselves and have used it for other research projects, like discovering that there are still consumer hair dyes that contain high levels of lead.

For Lieberman, seeing the results of scientific instrumentation and making a difference in her community is what's been exciting. "Detecting lead is an important project. I'm glad SciAps is out there making an XRF that gets the job done."

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SciAps, Inc.
7 Constitution Way
Woburn, MA 01801
sciaps.com
339.927.9455