the key to binding, says Laura Sigg of Eawag (Switzerland). That information could help in determining how much mercury is available to microbes for methylation of the toxic metal.

But the sleepless week in Brookhaven was not enough to confirm what the team was seeing. Skyllberg eventually traveled to Grenoble, France, to take advantage of a more powerful synchrotron, which allowed him to get more spectroscopic data. "I think we were very lucky," he says. "The beam line has to be optimized; it varies from one day to another." Meanwhile, several years passed and other work encroached, Skyllberg says.

That time also gave Skyllberg the experience he needed to interpret the data, Bloom says. The additional measurements from Grenoble allowed Skyllberg "to explain some peaks we couldn't explain" with only the Brookhaven data, he continues. "It made everything fall together, and we got some really good data."

"I think it's very difficult to work with natural organic matter in general" because of its heterogeneity, Sigg says. Applying EXAFS is "really quite new" and "technically difficult", she adds. In addition to the expense and resources necessary for EXAFS, Sigg says, the "interpretation is also quite tricky. It requires quite a lot of insight to properly interpret these spectra. It seems this group has the expertise to do that."

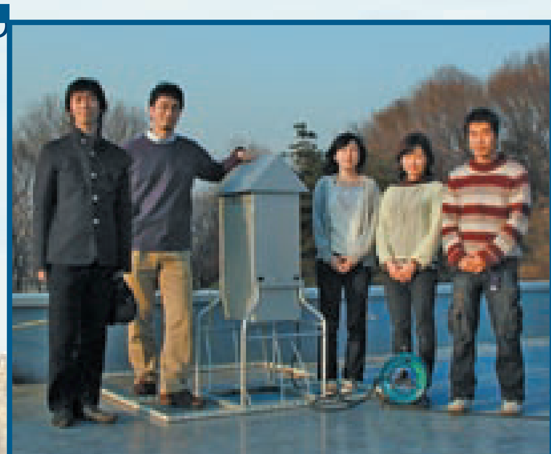
Skyllberg says that this is the first time any researchers have been able to examine mercury complexation at environmentally relevant concentrations. Previous work at relatively high concentrations was published in *ES&T* by his group (*Environ. Sci. Technol.* 1999, *33*, 257–261) and another (*Environ. Sci. Technol.* 2001, *35*, 2741–2745).

Skyllberg says that his group continues its research linking mercury geochemistry to ecological effects. But he will always remember that first week of measurements: "For some reason, you work hard, you are excited—everything is running around in your head," he says. That state of mind contributed to his fruitful, sleepless nights that week, many years ago.

—NAOMI LUBICK

First runner-up: PAHs in Tokyo aerosols

"Compound Class Specific ^{14}C Analysis of Polycyclic Aromatic Hydrocarbons Associated with PM$_{10}$ and PM$_{1.1}$ Aerosols from Residential Areas of Suburban Tokyo" by Hidetoshi Kumata, Eisuke Sakuma, Tatsuya Uchida, Kitao Fujiwara, and Mikio Tsuzuki, Tokyo University of Pharmacy and Life Science; Masao Uchida, Japan Agency for Marine-Earth Science and Technology (JAMSTEC); and Minoru Yoneda and Yasuyuki Shibata, National Institute for Environmental Studies (Japan), *2006*, *40* (11), 3474–3480.



TETSUOAKASHI

Hidetoshi Kumata (second from left) and his students sample aerosols from a residential area in suburban Tokyo.

Combustion-derived PAHs are important aerosol pollutants that have been linked to cancer in humans, but it is unclear exactly where these PAHs originate in cities, where their concentrations can be high. Are they mainly formed during fossil-fuel burning, or does biomass burning contribute as well? To answer those questions, Hidetoshi Kumata and colleagues turned to a technique for analyzing ^{14}C that was originally developed for the analysis of marine sediments by Masao Uchida of JAMSTEC.

Kumata and Uchida first had to adapt Uchida's method to analyze atmospheric particles. ^{14}C has a half-life of more than 5000 years, which makes it an ideal tracer for distinguishing between combustion products from fossil fuels (^{14}C-free) and those from modern biomass (contemporary ^{14}C).

"In 2002, no paper on ^{14}C analysis of atmospheric PAHs existed, so we thought we could be the very first to approach this question," Kumata recalls. However, the work proved much more tedious and difficult than the researchers had expected. After 3 years, they finally got some results. The team collected aerosol samples at a site in suburban Tokyo with no direct source from industrial input. The goal was to learn more about how PAH sources vary depending on the season and particle size: fine particles of <1.1 μm in diameter are of particular concern because they can penetrate deeply into human lungs.

The first difficulty the team faced was getting enough sample for the ^{14}C analysis: 20–40 μg of carbon per analysis. "We could not take any samples during the rainy seasons between May and July and in the autumn, so it finally took us 2 years to accumulate enough carbon," recalls Kumata. Another technical problem proved to be the graphitization of the carbon and subsequent radiocarbon analysis of the small samples in the accelerator mass spectrometer facility at the National Institute for Environmental Studies in Tsukuba, Uchida says.

When Kumata and Uchida finally saw their results on the seasonal and particle-size variation in PAH sources, in the summer of 2005, at first they did not believe them. "The ^{14}C signal was too strong, so we first thought we could not explain our results," Kumata says. However, comparison with other data made the researchers confident that their data were correct. They concluded that biomass burning contributes much more to PAHs in Tokyo aerosols than previously assumed and is responsible for a large part of the PAH elevation seen during the winter months.

"While biomass-based fuels are very useful for reducing CO_2 emissions, we need to realize that biomass burning may be bad for the environment for other reasons," Kumata says. "If we want to develop the use of biomass-based fuels, we also need to develop the technology to use them very efficiently, so that emissions are reduced," he adds.

Uchida stresses that field-based source discrimination studies such as theirs are essential for the future regulation of atmospheric PAH pollution. "The Tokyo government is eager to reduce emissions, and we need to detect whether new regulations are actually effective," Kumata says.

The future goal of the researchers is to get more data on the effects of biomass burning of a larger geographical scale. "Because other countries in East Asia are more dependent on biomass-based fuels than Japan and continue to develop fast, I expect that biomass burning will increase its importance as a source of energy and pollution in East Asia countries," Kumata predicts.

—ANKE SCHAEFER

Second runner-up: Antibiotic resistance genes

"Antibiotic Resistance Genes as Emerging Contaminants: Studies in Northern Colorado" by Amy Pruden, Ruoting Pei, Heather Storteboom, and Kenneth Carlson, Colorado State University, 2006, 40 (23), 7445–7450.

COLORADO STATE UNIVERSITY COLLEGE OF ENGINEERING

Amy Pruden (right) and Ruoting Pei collect samples from Cache la Poudre River.

In 2002, when environmental microbiologist Amy Pruden joined the faculty at Colorado State University, researchers were already worried about the upward trend of concentrations of antibiotics in the environment. Yet, no one really understood the environmental impact of these drugs. "The big question that a lot of people are raising is: what are the actual impacts and should we care?" says Pruden. To find the answer, Pruden teamed up with her colleague Kenneth Carlson, who had documented unnaturally high levels of antibiotics in nearby rivers and sediments. Together they embarked on the project that led to their winning ES&T paper.

Antibiotic resistance is a growing problem for human health, Pruden points out, and both the Centers for Disease Control and Prevention and the World Health Organization are concerned. Although the problem is largely attributed to the overprescription of antibiotics, a handful of studies have linked overuse of antibiotics in agricultural settings to resistance in human infections. Pruden knew that investigating the environmental impacts of antibiotics meant going to the source: antibiotic resistance genes (ARGs) in microbes themselves.

Excessive agricultural and urban use had been shown to cause the antibiotics tetracycline (tet) and sulfonamide (sul) to accumulate in the sediments of the Cache la Poudre River. So, Pruden and Carlson decided to look at the levels of several tet- and sul-resistance genes in river sediments as well as in nearby dairy lagoon water, irrigation ditch water, a wastewater recycling plant, and two drinking-water treatment plants. (Dairy lagoons are large ponds for storing waste from dairy farms; wastewater from the lagoons is eventually used for irrigation.)

Using a quantitative DNA amplification technique, the team measured ARG levels and found significantly higher amounts of the genes in all sites impacted by agriculture and urban activity than at a pristine site that received less effluent from urban or agricultural activities. In addition, they found a consistent pattern in the ARG levels—the highest levels were found in dairy lagoons, followed by irrigation ditch water and river sediments impacted by agriculture and urban activity. This suggested a potential route by which the antibiotics and ARGs spread in the environment: from dairy farms to irrigation ditches to rivers. Samples from the wastewater and drinking-water plants also contained high amounts of two kinds of ARGs, tet(W) and tet(O).