Technological advances have enabled researchers from various disciplines to collect more detailed data on biogeochemical transformations and cycles. One of these advances is the use of synchrotron radiation methods (SRM). Synchrotron radiation technology involves speeding up electrons to produce an extremely high-energy beam of light that is guided through a set of lenses and instruments to a sample. This bright X-ray beam can reveal compounds, structures, and images that are not otherwise observable. One of the advantages to using synchrotron radiation is that it works across a broader range of wavelengths and can be fine-tuned to aim a specific wavelength at a sample. As the technology improves and more facilities that can perform these analyses are built, researchers can take advantage of these techniques to collect data in ways that have previously not been possible.

An upcoming issue of the *Journal of Environmental Quality* (JEQ) will include a special section titled, “Synchrotron Radiation-Based Methods for Environmental Biogeochemistry.” Three guest editors who all use SRM technologies in their research assisted in producing this special section: Dr. Ganga Hettiarachchi, a professor at Kansas State University; Dr. Erica Donner, Associate Professor at the University of South Australia; and Dr. Emmanuel Doelsch, Research Scientist, CIRAD, France.

Dr. Hettiarachchi and her research team have been using SRM to study soil biogeochemical processes involved in the transformation, fate, and transport of nutrients and contaminants in soil and to study soil chemical processes that influence both agricultural and environmental sustainability. *CSA News* magazine discussed SRM technology and this special section with Hettiarachchi.

**CSA News:** What were the goals of this special section?

**Hettiarachchi:** Our goal statement was the following: The continued improvement of synchrotron light sources around the world has led to profound transformation and scientific breakthroughs in the field of environmental biogeochemistry. This special collection of papers provide examples of recent studies that use some of the most popular techniques and the new types of studies in complex environmental samples made possible by recent advancement of synchrotron radiation.
• Synchrotron radiation technology can be used to study biogeochemical processes.

• A special section in JEQ presents new methods and uses of synchrotron radiation technology.

• Improved methods and additional synchrotron facilities may expand use of these methods in biological and geological sciences.

CSA News: What are some of the advantages to using SRM for biogeochemistry research?

Hettiarachchi: These methods make it possible to study biogeochemical processes under real-world (environmentally relevant) concentrations and reactions in situ as they are happening. For example, when studying mercury in plants, we are often limited in the field by low concentrations and lack the capability to measure accurately. Sometimes experimenters would add mercury to achieve levels that could be measured but then the concentrations would be unrealistic. With SRM, we can actually let plants grow in their natural environment and let them accumulate whatever small concentrations of mercury, or other compounds, they will accumulate under natural conditions. With this technology, we can detect and study the biogeochemistry of those elements or compounds at those low concentrations.

Another example would be studying nanoparticles. With nanoparticles, or any other particles in soil or other natural samples, reactions start at the surface. When we analyze a bulk sample, we may be missing the reactions we are interested in because it is occurring in a very small portion of the sample. So for those types of studies, we need to have a focused beam with higher resolution for a better detection capability to really study those portions where these reactions are occurring.

CSA News: Are there drawbacks to using SRM?

Hettiarachchi: Accessibility to facilities that can do synchrotron analyses are limited, and the number of samples that researchers can study is limited as well. Also, when doing these analyses, we are looking at a very small portion of a sample, and the environmental samples are highly heterogeneous and highly complex, so we have unique challenges when analyzing and interpreting our data. Researchers have to wonder if they are really understanding the whole system from these small samples. One way to overcome this issue of scale is to also do different bulk analyses and combine those with micron-to-sub-micro-level data obtained using these technologies.

CSA News: Are there any papers that stand out in this section?

Hettiarachchi: I have to say that all papers are contributing to this special section in a unique way. But, I would like to give a special mention to four papers.

The first paper of note addresses the two main obstacles that limit our ability to study diluted elements in a complex matrix such as soils. The first is that signals delivered by major elements in soils can overwhelm the detectors, masking signals from diluted elements. The second is that signals from the major elements may be close in energy to the diluted elements of interest and detectors do not discriminate between the two sources. Currently, at most beamlines, we use filters to cut off signals when studying diluted elements, and this is also cutting off the signals coming from our compounds of interest, making things difficult and complicated. The paper, “High-Energy Resolution Fluorescence Detected X-ray Absorption Spectroscopy: A New Powerful Structural Tool in Environmental Biogeochemistry Sciences,” (see http://bit.ly/2yIBbi0) focuses on describing new upgrades on some synchrotron beamlines, enabling us to perform high-energy resolution fluorescence detected X-ray absorption spectroscopy. This is a very useful technique continued on page 16
In Memoriam

Terry J. Logan

ASA, SSSA, and AAAS Fellow Terry J. Logan, a beloved husband, father, and grandfather, passed away unexpectedly in Sarasota, FL on 20 Aug. 2017. He will be greatly missed by family and friends and remembered for his intellectual curiosity, endless stories, and the encouragement and thoughtful leadership he showed to those around him.

Dr. Logan was a retired professor of soil science from The Ohio State University. A native of Guyana, he obtained his undergraduate degree in soil science from Cal Poly, San Luis Obispo, and his masters and Ph.D. in soil chemistry from Ohio State. After retirement, Logan became President and CEO of N-Viro International, Inc., a waste management company. He also operated consulting businesses with his wife to encourage the beneficial use of solid waste and energy efficiency. He judged science fair competitions at Beaufort County schools in South Carolina for many years. He was Editor-in-Chief of Critical Reviews in Environmental Science and Technology and was the author of several published works of fiction, including Bitter Spring, The Dark Stone, and Little Sand Key.

He is survived by his wife Billie Lindsay; three children, David Logan, Noelle Logan, and Jennifer Snyder; two step-children Jane Harrison and Scott Harrison; and his grandchildren Jack Herbeck, Mia Herbeck, and Caroline Snyder as well as his twin brother Robin Logan and sister Suzanne Grey.

Lyle E. Nelson

Lyle E. Nelson, 96, a 68-year member of ASA and CSSA from Starkville, MS, died 27 July 2017. He was born in Greenbush Township, Ward County, ND on 6 Jan. 1921. He entered North Dakota State University during 1939 and graduated 1948, his education interrupted by service in the U.S. Army in WWII. In 1948, he began graduate school at Cornell University and obtained an M.S. degree in 1950 and a Ph.D. in 1952.

He joined the faculty of Mississippi State University as an assistant professor of agronomy in 1952 and retired a professor emeritus in 1986, having served the University for 32 years as a researcher and a teacher of elementary soils, soil fertility, and forest soils. He received many awards and recognitions for his numerous contributions in research, teaching, and service and was a member of many faculty and student organizations. He was also a member of many professional societies and was a Fellow of AAAS.

He is survived by his brother, Lester J. Nelson, Scottsdale, AZ; three sisters, Hazle Barke, Fargo, ND; Elsie Weber, Jamestown, ND; and Ann (Donald) Wilson, Giltner, NE; and numerous nieces and nephews and several great-nieces and great-nephews. He was preceded in death by his sister Helen (Robert) Cole of Davis, CA and his parents.


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to overcome above-mentioned weaknesses to properly study diluted elements in complex matrices.

The second paper is, “Advances in Scanning Transmission X-Ray Microscopy for Elucidating Soil Biogeochemical Processes at the Submicron Scale” (see http://bit.ly/2xZlXr8). I picked this one as it is addressing slowly advancing soft X-ray techniques, allowing us to study lighter, but extremely important, elements in bio-geo-environmental samples such as carbon and nitrogen. More beamline with this focus would be extremely useful for so many researchers from various disciplines.

It is extremely important to understand the behavior of various potentially toxic trace elements in soils and their toxicity to plants and the mechanisms that some plants use to tolerate toxicities. The paper, “Synchrotron-based X-Ray Approaches for Examining Toxic Trace Metal(loid)s in Soil–Plant Systems” (http://bit.ly/2yG1Idi), focuses on using synchrotron-based approaches for the examination of various trace elements in soil–plant systems and will be of interest to many disciplines, particularly soil scientists and plant biologists.

Lastly, the Geo-Soil-Enviro CARS sector X-ray microprobe beamlines at the Advanced Photon Source (APS), housed at Argonne National Laboratory, have attracted a large number of researchers in environmental biogeochemistry around the world because of its capabilities. In the paper titled, “Spatially-Resolved Elemental Analysis, Spectroscopy and Diffraction at the GSECARS Sector at the Advanced Photon Source” (http://bit.ly/2kprFhq), the authors are describing recent upgrades to their microprobe beamline as well as upgrades of APS.

CSA News: What do you see in the future for SRM?

Hettiarachchi: We see increasing applications for SRM from biological sciences to geological sciences. With new advancements in synchrotron science, some of these facilities are now capable of delivering extremely bright light. Once these are met with similar advancements in related instrumentation, sample environments (reduce beam damage), and software (for extracting information), I see tremendous potential for new scientific discoveries in environmental biogeochemistry.

Dig Deeper

Many of the papers from this special section are currently available on the "Just Published" section of the JEQ website: https://dl.sciencesocieties.org/publications/jeq/justpublished.