

# **Advances in the Use of Synchrotron-Based Techniques to Elucidate Biogeochemical Processes in Natural Systems**

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The use of state-of-the-art, in-situ synchrotron-based spectroscopic techniques has greatly advanced our understanding of biogeochemical reactivity and speciation of contaminants in natural, heterogeneous systems such as soils, sediments, particulates, and aquatic systems. These techniques enable one to make measurements at small spatial and rapid temporal scales and simulate natural environmental conditions. Undoubtedly, the molecular characterization of microenvironments and interfacial reactions will become increasingly significant in understanding the interactions between chemistry, physics, and biology in natural environments. There are a number of areas dealing with soil and environmental biogeochemistry where the application of molecular environmental science, which employs a multi-scale and multi-tool approach, is resulting in major frontiers. These include: speciation of contaminants; real-time reactivity of rapid sorption and redox processes on mineral surfaces; carbon-mineral complexation; mechanisms of trace metal interactions with humic substances; climate change impacts on contaminant cycling; and particulate transport. Examples of some of these research frontiers will be presented.

## ***Biography***

Donald L. Sparks is the S. Hallock du Pont Chair in Soil and Environmental Chemistry, Francis Alison Professor and Director of the Delaware Environmental Institute at the University of Delaware. He is internationally recognized for his landmark research on the kinetics and mechanisms of metal/oxyanion/nutrient reactions at biogeochemical interfaces. His pioneering studies on kinetic processes in soils and minerals include the development of widely used and novel kinetic methods, elucidation of rate-limiting steps and mechanisms over a range of spatial and temporal scales, and coupling of real-time kinetic studies with in-situ molecular scale investigations. His discoveries on the speciation, formation rates and stability mechanisms of metal hydroxide surface precipitates, and their role in the retention and bioavailability of toxic metals in the terrestrial environment, have received worldwide attention. This research has led to more effective soil remediation strategies and predictive models.

He is the author or coauthor of 290 publications. These include: 11 edited books, 53 book chapters, and 226 refereed papers. He is the author of two widely adopted textbooks, *Kinetics of Soil Chemical Processes* and *Environmental Soil Chemistry* (two editions) published by Academic Press. Dr. Sparks is an ISI Highly Cited Researcher; his research has been cited more than 8400 times and his h-index is 54 (Web of Science). He has given over 200 invited presentations at scientific conferences throughout the world, and been a lecturer at 100 universities and institutes in North America, Europe, Asia, and Australia.

He has received numerous honors and awards including Fellow of the Soil Science Society of America, the American Society of Agronomy, the American Association for the Advancement of Science, the Geochemical Society, and the European Association of Geochemists, the Liebig Medal from IUSS, Honorary Member of IUSS, Einstein Professor from the Chinese Academy of Sciences, the Soil Science Research Award and M.L. and Chrystie M. Jackson Award from the Soil Science Society of America, the Environmental Quality Research Award from the American Society of Agronomy, the University of Delaware's Francis Alison Award, the highest award presented to a faculty member and University of Delaware Outstanding Doctoral Student Advising and Mentoring Award, and Honorary Professor of the Institute for Urban Environment, Chinese Academy of Sciences and Huazhong Agricultural University. He has advised 90 graduate students and postdoctoral researchers and been the recipient of more than \$50 million in research funding. He served as President of both the Soil Science Society of America and the International Union of Soil Sciences.