

Citation for presentation of the 2004 Alfred E. Treibs Medal to Roger Summons

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Roger Summons came to organic geochemistry with training in organic chemistry, a background in plant biochemistry, and an intellectual personality that is both strong and engaging. The combination has yielded important new information about microbial processes, earth history, and petroleum geochemistry. It is also creating a succession of inspired students, postdoctoral associates, and collaborators.

Roger was among the first full-time students when the University of New South Wales, Australia, established a new campus at Wollongong. He became interested in organic chemistry and stayed on to complete a Ph.D. in that subject, specializing in the study of complex, nitrogen-containing compounds produced by plants. The task was to determine the molecular structures of these materials. Elemental analyses yielded chemical formulas. Spectroscopic techniques provided information about chemical bonds. Overall structures were estimated and then assembled using unambiguous synthetic reactions. If the product matched the natural material, the structure was accepted as correct. The chemists who solved such problems efficiently and elegantly were recognized as laboratory *artists*. In fact, the coupling of enormous experimental skill with incisively chosen scientific objectives has been a hallmark of Roger's career.

A postdoctoral appointment at Stanford University acquainted Roger with the most modern approaches to the study of natural molecules. He worked with Alan Duffield and Joshua Lederberg in the Department of Genetics just as revolutionary ideas about artificial intelligence and computer-assisted interpretation of spectral data were being combined with rapidly developing, new instrumentation. Even in these early studies, he was remarkably productive. After completing his doctoral and postdoctoral work in less than five years, he was author or coauthor of 21 papers.

From 1973 until 1983, Roger was at Australian National University, first in the Research School of Chemistry and then in the Research School of Biological Sciences, where he studied plant hormones and physiology and the photosynthetic metabolism of carbon, nitrogen, and oxygen in aquatic unicellular organisms. Two visitors fired his interests in biogeochemistry and earth history. With Andrew Benson – one of the elucidators of the pathway of carbon in photosynthesis – Roger worked on element cycling on the Great Barrier Reef. At the Australian Institute of Marine Sciences (Townsville, Queensland), he crossed paths with another visitor, the American paleobiologist Preston Cloud. The latter's influence was so strong that Roger soon applied to join the staff of the Baas-Becking Geobiological Laboratory, then located at the Bureau of Mineral Resources, in Canberra.

Roger's first paper from the Baas-Becking Laboratory commanded attention. Summons and Powell (1986) announced in *Nature* that obligately anaerobic, green photosynthetic bacteria had flourished in Paleozoic seas. The conclusion and the evidence were both revolutionary. Structurally, a series of aromatic, polyisoprenoid hydrocarbons found in Silurian and Devonian oils resembled isorenieratene, a carotenoid pigment produced only by the Chlorobiaceae. Like algae, these organisms derive energy from sunlight and build biomass from dissolved inorganic carbon. Unlike algae, they require sulfide as an electron donor and are poisoned by O₂. Their pathway of carbon fixation, the very rare, reversed tricarboxylic-acid cycle, happens to be distinguished by very low isotopic discrimination. Brilliantly, Roger produced the first compound-specific isotopic analyses of diagnostic microbial products, demonstrating that the ancient molecules were uniquely enriched in ¹³C, linking them decisively to the Chlorobiaceae, and pioneering an investigative technique that has led to many subsequent breakthroughs in biogeochemical research.

In the modern world, the Black Sea is the only large, marine basin where sulfide reaches the photic zone. The new interpretation required that, in earlier times, such remarkable stratification was attained in open-ocean environments. The extraordinary claim was accepted as Summons and Powell (1987)

provided extraordinary evidence in a second, more detailed report in *Geochimica*. That account was recognized by the Organic Geochemistry Division of the Geochemical Society as the Best Paper of 1987. Evidence for episodes of widespread, near-surface anaerobic conditions has been accumulating ever since. The aryl-isoprenoid molecular proxy stands as one of the most reliable environmental indicators. It represents nicely both the talents of its originators and the value of organic-geochemical lines of evidence.

A third paper from Roger's initial work at the Baas-Becking Laboratory – again placed in *Nature* – established another major theme of his subsequent work in organic geochemistry. Jackson *et al.* (1986) reported the presence of abundant petroleum hydrocarbons and associated source rocks in the Mesoproterozoic (1.7 × 10⁹ years old) McArthur Basin. A follow-up paper in *Geochimica* (Summons *et al.*, 1988) presented clear evidence for the presence of hopanes and steranes, included thorough comparisons to all other reports of Precambrian lipid biomarkers, and – laying the foundation for what is now a flourishing line of research at many institutions – systematically discussed the paleobiological implications of these findings.

And then the Baas-Becking Laboratory was closed, a victim of financial pressures in the Australian research environment. Roger stayed on at the Bureau of Mineral Resources and turned his attention to petroleum geochemistry, exploiting molecular biomarkers as a means of recognizing relationships between oils and between oils and source rocks. In 1998, he was the honored lecturer of the Petroleum Explorationists Society of Australia. By 2004, petroleum-geochemical studies accounted for 50 of the entries in his extensive list of publications.

Collaborations with paleobiologists and biogeochemists continued. He was a leading member of the second phase of the Precambrian Paleobiology Research Group – Proterozoic, led at UCLA by Bill Schopf (1987-1988). With Linda Jahnke of the Ames Research Center (National Aeronautics and Space Administration, USA), he first examined microbial sources of the hopanoid carbon skeletons that appear in petroleum (Summons and Jahnke, 1990), then extended the work in a continuing series of studies of microbial products (*e. g.*, Jahnke *et al.*, 2001). Precambrian problems, often attacked together with visiting students and postdocs, have been a principal focus. As a result of this work, Roger is now recognized as an authority on Precambrian Paleobiology and the key member of teams that have provided the earliest secure evidence for oxygenic photosynthesis (Summons *et al.*, 1999) and for the evolution of eukaryotic cells (Brocks *et al.*, 1999). His contributions are shaping the early chapters of texts dealing not only with earth history but with biological evolution.

To facilitate the work, Roger often welcomed visitors not only into his laboratory but, together with his wife, Elizabeth, and daughters Justine, Alice, and Rebecca, into his home. Eager, young collaborators would find themselves spending their days in Roger's laboratory, sharing meals with this family, and sleeping in the basement apartment.

In all, it provided an example not only of scientific excellence but also of social and intellectual generosity. Not a bad formula for a professor. In 2001, Roger accepted appointment as Professor of Geobiology in the Department of Earth, Atmospheric, and Planetary Sciences at the Massachusetts Institute of Technology, Cambridge, Massachusetts. There, he welcomes an ever-widening array of students and research associates, thus ensuring that – to the good fortune of geochemists everywhere – we can look forward to many further examples of the Summons style.

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