American Mineralogist, Volume 80, pages 1082–1084, 1995

Memorial of Roger G. Burns 1937–1994

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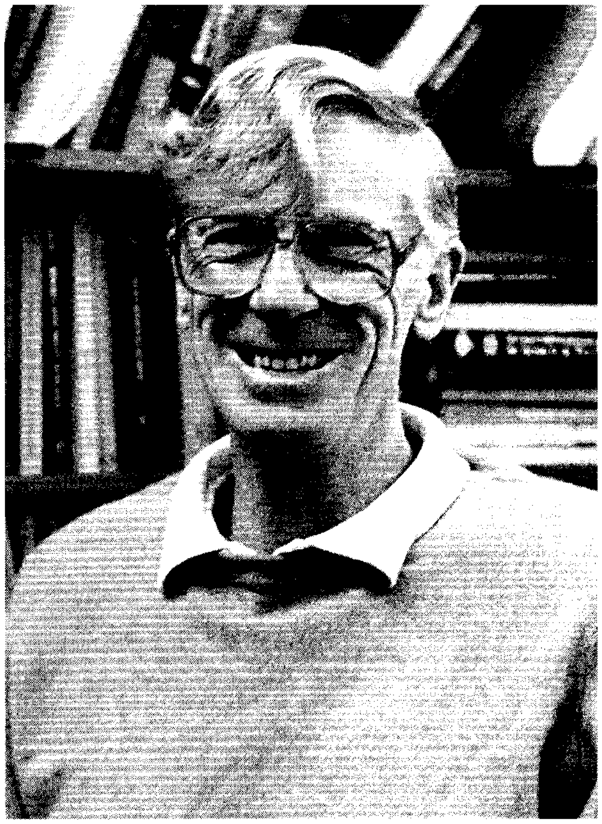

Roger G. Burns, professor of mineralogy and geochemistry in the Earth, Atmospheric, and Planetary Sciences Department at the Massachusetts Institute of Technology (MIT), died of cancer in Cambridge, Massachusetts, on January 7, 1994. He was well known and highly respected because of his major role in developing the field of mineral spectroscopy and as the author of a very influential, now classic, book, *Mineralogical Applications of Crystal Field Theory.* Roger was born in Wellington, New Zealand, in 1937 and received a B.Sc. degree (1959, chemistry and geology) and a M.Sc. degree (1961, first-class honors in chemistry) from Victoria University of Wellington and a Ph.D. degree from the University of California, Berkeley (1965, geochemistry). As he continued his graduate studies in the United States, Roger recognized that there was much to be learned in applying the instrumental and theoretical capabilities of chemistry to geology. His 1965 Ph.D. thesis, "Electronic Spectra of Silicate Minerals: Application of Crystal-Field Theory to Aspects of Geochemistry," supervised by a fellow New Zealander, W. S. Fyfe, was a breakthrough in using chemical principles to understand the bonding environment of transition metals in silicate minerals. In particular, Roger was a pioneer in using absorption spectra to study minerals. In this technique, the selective absorption of light with different wavelengths reveals the location and atomic coordination of transition metals in minerals.

Following the completion of his Ph.D. thesis, Roger spent four exciting years in England and New Zealand, first as a senior research visitor at Cambridge University, then as a senior lecturer in geochemistry at Victoria University of Wellington, and finally as a lecturer in geochemistry at Oxford University. From 1966 to 1970, Roger and his colleagues developed a new research approach for understanding the structure of minerals by applying a variety of spectroscopic techniques, including Mössbauer spectroscopy, to rock-forming minerals. Important advances were made, not only in the specialized field of crystal chemistry, but also in understanding the causes of color in minerals and gems, an aspect of his research that has significance beyond the realm of science. Roger clearly had made a transition from chemist to mineralogist. He rapidly gained international recognition with publications resulting from this early research, particularly the 1970 publication of his book, *Mineralogical Applications of Crystal Field Theory.* This book, addressed to students and a wide range of Earth and planetary scientists, showed clearly how laboratory study of minerals interpreted in the context of the crystal field theory leads to an understanding of mineral structure that could not be obtained by other research techniques. The first edition was soon translated into Japanese, Chinese, and Russian, and a revised second edition was published in 1993.

Roger joined the faculty at MIT in 1970 as an associate professor of geochemistry, and within two years he was promoted to professor of mineralogy and geochemistry. At MIT his expertise in mineralogy and geochemistry and his rapport with students led to innovative research. In addition to his energetic pursuit of the application of spectroscopic techniques to mineralogical problems, Roger broke new ground in several areas of Earth and planetary science. In the 1970s, Roger and his wife, Virginia, were instrumental in characterizing and understanding the ubiquitous formation of Mn-rich minerals on the sea floor.

His efforts were in part motivated by a desire to pursue research that would have positive societal impact. In recent years, Roger continued his interest in directly relevant research by evaluating the reactivity of zeolites in proposed repositories for high-level nuclear waste. Throughout his career he was an active consultant in diverse contexts, ranging from the Battery Products Division of Union Carbide, to a manufacturer of synthetic gems, to the Nevada nuclear waste isolation program.

Also in the 1970s, Roger collaborated with experimental mineralogists to obtain spectroscopic data while minerals were subjected to very high pressures in a diamond cell. Because the diamond crystals are transparent, measurements can be made while the mineral is at high pressure and temperature. With this device, Burns and his students were among the first to observe atomic coordination changes in silicate minerals at high pressure. Roger was also interested in the oxidation states of planetary interiors and how they might be recorded by transition metals in magmas generated within planetary interiors. He applied spectroscopic techniques to determine the redox state of the lunar interior, as recorded in small glass spheres erupted in volcanic fire fountains on the Moon's surface.

Roger was instrumental in melding together the previously diverse fields of planetary science and mineralogy because he quickly recognized that spectral profiles of sunlight reflected from planetary surfaces, combined with the spectra of minerals measured in the laboratory, could be used to identify the minerals on planetary surfaces and the presence of specific transitional metal ions. Together with MIT planetary scientists, Roger developed the techniques for using remotely sensed reflectance spectra to identify transition metal-bearing minerals on the surfaces of distant planets. The recently published second edition of his book has an entire chapter devoted to the topic of determining the compositions and mineral content of planetary surfaces by remote sensing. Beginning in the early 1980s, he made major contributions to understanding the composition and mineralogy of the martian surface. These efforts culminated in 1993 with his contributions to and editorial handling of a special section of *Geochimica et Cosmochimica Acta* devoted to papers presented at a 1992 workshop titled Chemical Weathering on Mars. Roger's last words on this fascinating subject are in an abstract for the 1994 Lunar and Planetary Science Conference. Although much of his career focused on understanding the major rock-forming minerals, he also delighted in understanding the exotics; e.g., that 1994 abstract focuses on schwertmannite, and a 1991 *American Mineralogist* paper is about babingtonite, the state mineral of Massachusetts. In recent years, Roger and associated students were also using Mössbauer spectroscopy to characterize Fe^{3+}-bearing minerals in meteorites, with the objectives of understanding how meteorites are affected by the terrestrial environment and of providing evidence for preterrestrial oxidative processes.

Roger also was an enthusiastic teacher who was popular with undergraduate and graduate students. Each semester at MIT, he devoted considerable effort to teaching; his courses, Chemistry and Physics of Minerals and Rocks and Geochemistry of the Transition Elements, were taken by many generations of MIT students. Undoubtedly, many MIT graduates will remember Roger bringing several minerals and rocks to their general exam and asking them to identify objects ranging from an iron meteorite to quartz.

During his career, he supervised 23 Ph.D. and ten M.S. theses, published more than 140 research papers, served as an editor for several journals and books, and received additional degrees and many honors, awards, and fellowships, including a M.A. degree in geology and a D.Sc. degree in mineralogy from Oxford and a prestigious Guggenheim fellowship in 1991. The presentation of the 1975 Mineralogist Society of America award to Roger Burns showed that his leadership and impact in mineralogy were recognized early in his career. He was a Life Fellow of the Mineralogical Society of America, a Member of the Mineralogical Society of Great Britain, the American Geophysical Union, the Geochemical Society, and the New Zealand Geochemical Group.

Roger had many nonscientific interests, including opera and the rocky coast of Maine, which reminded him of New Zealand. Many of us will also remember him as a dedicated distance runner: running was more than a means of commuting to MIT from his Cambridge home. He was also a frequent finisher of the Boston Marathon. Finally, and most importantly, Roger Burns was a caring and genuinely kind human being who will be missed by his wife, Virginia, who was a frequent research collaborator, his sons, Kirk and Jonathan, his faculty and research colleagues, and his many students from MIT, Harvard University, and Wellesley College.

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[1] For the complete bibliography of Roger G. Burns, request Document AM-95-580 from the Business Office, 1015 Eighteenth Street NW, Suite 601, Washington, DC 20036. Please remit $5.00 in advance for the microfiche.

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