

Memorial of Charles L. Christ 1916–1980

ROBERT M. GARRELS

*Department of Marine Science, University of South Florida
St. Petersburg, Florida 33701*

AND JOAN R. CLARK¹

479 Ferne Avenue, Palo Alto, California 94306

Charles Louis Christ died June 29, 1980 at Palo Alto, California, after a long illness with heart disease. He was born March 12, 1916 in Baltimore, Maryland, of German–American parents. He grew up in Baltimore and attended Baltimore City College (high school).

From 1933 to 1940 he studied at The Johns Hopkins University, Baltimore. At an early age he demonstrated unusual scientific ability and so was able to bypass the usual Bachelor's and Master's degree programs, receiving the Ph.D. degree in 1940. His thesis was "X-ray crystallographic studies upon Etioporphyrin-1," no doubt influenced by his now famous thesis advisor, David Harker. Charles taught at JHU from September, 1936 to May, 1940 and, in addition, was a research assistant during school years and summers to W. M. Thornton, Jr. in analytical chemistry, S. S. Jenkins in organic chemistry, and D. H. Andrews in chemical physics.

On June 6, 1938 he married Gertrude C. Callahan who survives him. Her work during the early years of their marriage helped support his university studies. Her encouragement and devotion to his profession and interests continued throughout his career.

After receiving his degree, Charles first worked as a research chemist at the General Electric Company, Pittsfield, Massachusetts. Here he was responsible for setting up an X-ray diffraction laboratory and conducted research on transformer steels and lightning arrester materials, using X-ray emission spectrographic and microchemical techniques. In September, 1941 he returned to academic life as an instructor at Wesleyan University, Middletown, Connecticut. In addition to his teaching, he again set up an X-ray diffraction laboratory.

From October, 1942 to July, 1945 he was back at JHU, this time as an instructor and Associate Direc-



Charles L. Christ *circa* 1959

tor of their C. Y. War Research Laboratory. This Laboratory, under contract with the U. S. Army Signal Corps and the U.S. Navy Bureau of Ships, was responsible for the development of the superconducting bolometer for the detection of infrared radiation. Charles was in charge of all ground and airborne tests of equipment. Towards the end of the war, he became a consultant with Rheem Research

¹Retired, U. S. Geological Survey.

Products, Baltimore (July, 1945–March, 1946) for research on the production of surface protective coatings on metals.

From March, 1946 to October, 1949 he was Group Leader for X-ray crystallography at the American Cyanamid Company, Stamford, Connecticut. His collaboration with E. F. Champayne, R. B. Barnes, and Dan McLachlan resulted in issuance of two patents for X-ray instrumentation, as well as several publications on instrumentation and crystallography.

Charles began his career with the U. S. Geological Survey in October, 1949 as head of their diffraction research. Once again he became responsible for expanding and developing an X-ray diffraction laboratory. Over the next decade he assembled one of the country's leading crystallographic groups for mineralogical research. His own knowledge of both crystallography and chemistry enabled him to recognize mineralogical problems that could be solved by using crystal-structure analyses.

While his many publications singly and with members of the group (particularly H. T. Evans, Jr., J. R. Clark, D. E. Appleman, and M. Ross) dealt with minerals containing uranium, vanadium, and various rare elements, he was especially interested in hydrated borate minerals because of the crystal-chemical challenge they presented. In 1960 he published a set of rules governing the formation of complex borate polyanions that became known as "Christ's rules". One of his last published papers amplified and further developed these rules. He was also particularly interested in the origin and associations of borate minerals. The relations of the sodium borate hydrates at the Kramer deposit were elucidated in a classic 1959 paper with R. M. Garrels. Charles extended these ideas to the system, $\text{Na}_2\text{O}-\text{CaO}-\text{MgO}-\text{B}_2\text{O}_3-\text{H}_2\text{O}$, in a 1967 paper with A. H. Truesdell and R. C. Erd. As a result of Charles' keen interest in new methods, the crystal structures of the calcium borate minerals, colemanite and meyerhofferite, were the first determined (1954, 1956) by successfully using the then controversial method of phase determination proposed by J. Karle and H. Hauptman.

Charles encouraged and inspired many students during his tenure as Professorial Lecturer, George Washington University, Washington, D.C. (1956–1965). In 1959 he received the honor of a Rockefeller Public Service Award and spent the academic year (1959–1960) at Harvard University as a Research Fellow in Geologic Science. Upon his return to the Survey, he took on the additional administrative and scientific responsibilities of Chief, Branch of Experi-

mental Geochemistry and Mineralogy, for the Geologic Division. When these duties ended, he turned his attention to application of physical chemistry to geology, continuing his successful collaboration with Garrels.

The two scientists first began to work together in 1952 on problems related to the origin of uranium deposits. Charles immediately showed a natural talent for the application of chemistry and crystallography to geochemical problems. He published on the oxidation relations of uranium deposits, environments of borate mineral deposition, and cation exchange properties of clays. Soon he was recognized as an outstanding geochemist as well as crystallographer and physical chemist.

In 1965 he moved from Washington, D.C. to the U. S. Geological Survey offices in Menlo Park, California. That same year the geochemistry text, "Solutions, Minerals, and Equilibria" by Garrels and Christ, was published. This text has since been translated into French and Russian and is still widely used in those languages and in English.

His abilities were appreciated by his colleagues at the Survey. He joined J. J. Hemley, P. B. Hostetler, and others in studies of high-temperature systems, collaborated with A. S. Radtke in the investigation of the Carlin gold mine, and ranged widely into other research problems. Meanwhile he continued work with J. R. Clark, J. A. Konnert, and R. C. Erd on his first love, the borate minerals. In 1977 Charles' important contributions to mineralogy were again recognized when a new thallium mineral from the Carlin gold deposit, Nevada, was named christite in his honor.² The constant demand for his help, and his generous giving of it, is documented by the 33 different scientists with whom he published.

Charles was a Fellow of the Mineralogical Society of America and of the Geological Society of America. He served MSA as an Associate Editor for *The American Mineralogist* 1955–1959 and as Councilor 1968–1970. In 1972 he lectured as Visiting Professor at the University of Hawaii. He was elected to the Council of the Geochemical Society in 1978 but his illness prevented him from serving. He was a charter member of the American Crystallographic Association and served on the National Research Council's U. S. A. National Committee on Crystallography 1955–1959. He was a member of the honorary societies, Sigma Xi and Phi Lambda Upsilon.

²Radtke, A. S., F. W. Dickson, J. F. Slack and K. L. Brown (1977). *Am. Mineral.* 62, 421–425.

When he retired from the Geological Survey in 1979, Michael Fleischer wrote him as follows: "Thirty years ago, your combination of extraordinary breadth of understanding of physico-chemical equilibria with crystallographic insight opened a broad path in geology—so broad that the numerous young men who follow it have forgotten who broke it open. We who watched you do it won't forget."

In addition to these and other major scientific contributions to chemistry, crystallography, mineralogy, and geology, Charles will be remembered for the excellence of his technical writing, his absolute scientific integrity, and the careful attention he gave to the support and promotion of his associates. He demanded high standards of everyone, but most of all of himself. Charles hated laziness, pretense, and im-

precision of all kinds. He was never too busy to spend unlimited hours helping colleagues with their chemical and crystallographic problems. Balancing his remarkable scientific breadth were his deep interests in art, music, and sports and a special penchant and knack for the stock market. Charles had a mordant wit that delighted his friends but was usually unsuspected by new acquaintances. His presence and support in the scientific community will be greatly missed; we mourn him as a beloved friend.³

³To receive a bibliography, order Document AM-81-162 from the Business Office, Mineralogical Society of America, 2000 Florida Avenue, NW, Washington, DC 20009. Please remit \$1.00 in advance for the microfiche.