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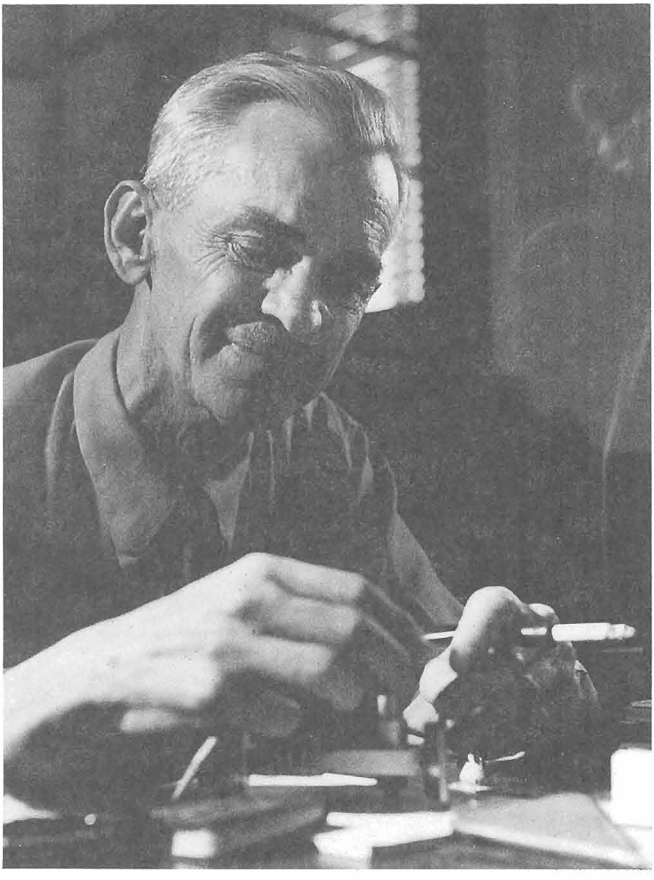
DON MERLIN LEE YOST

1893—1977

A Biographical Memoir by

JOHN S. WAUGH

Biographical Memoir



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DON MERLIN LEE YOST

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BY JOHN S. WAUGH

DON YOST, WHO SPENT his entire professional career at the California Institute of Technology, was one of the leading American chemists of the period between the two world wars. He brought to inorganic chemistry the rigor of the physical chemist's approach, following the Berkeley school and the A. A. Noyes tradition in which he had been educated. He remained in the vanguard of new developments in chemistry and physics, pioneering the exploration and applications of Raman spectroscopy, the third law of thermodynamics, chemical applications of radioactive isotopes, fast reaction kinetics, and microwave spectroscopy and magnetic resonance. He was the author of influential monographs on inorganic chemistry and on the rare earth elements.

Yost was born on a strawberry farm near the small town of Tedrow, Ohio. After a succession of moves within the middle west, the family settled permanently on a ranch near Boise, Idaho, in 1902. There Yost finished elementary and high school. In that frontier environment no formal courses in chemistry, physics, or any other science were available. However, Yost and his boyhood friends formed a radio club and designed and built working radio stations. The receivers had diode detectors made from galena crystals found in the surrounding mountains. Yost's vector to-

ward a career in science originated from these experiences and from an apparently unusual high school teacher of mathematics, a man named Sawyer. On graduation, it was evidently taken for granted that Yost would attend college, where he intended to pursue his interests in electricity. In private correspondence he relates, "An ex-cowboy told me that Harvard was too old fashioned, so I finally chose Berkeley." There he traveled in August 1914, by rail to Portland, Oregon, and thence by steamship to San Francisco.

In his first year at Berkeley Yost studied chemistry. The lectures were given by Joel Hildebrand, and the laboratories and recitations were conducted by Gerald E. K. Branch and Richard Chace Tolman. It is scarcely surprising that he switched his major to chemistry. He also took a minor in mathematics, a subject which was to remain an avocation throughout his life. During this period he met Susan Marguerite Sims, also a student at Berkeley. They were married on March 7, 1917, at her parents' house in Salt Lake City. Yost had dropped out of college, and when the United States entered the war he enlisted in the Navy. After the war ended he returned to Salt Lake City, where he spent a semester at the University of Utah. Their daughter Helen Marguerite was born on October 16, 1918. The family then went back to the ranch in Idaho, probably for lack of money for college.

It was not until the fall of 1921 that Yost was able to return to Berkeley. He had the opportunity to assist William C. Bray—today we would call it undergraduate research—in his monumental researches on the rare elements. On graduating in June 1923, Yost was offered a graduate fellowship at Utah by Walter Bonner, who had befriended him during his brief stay in 1918. After a year there Bonner evidently thought the young man needed broader horizons, and he helped Yost get a fellowship at Caltech. Yost

wrote of the stimulating environment he found in Pasadena in 1924: ". . . the faculty in mathematics and mathematical physics were outstanding, as well as the visiting professors. H. A. Lorentz, Albert Einstein, Schroedinger, Raman and others lectured. . . . For a country boy from rural Idaho to be involved actively in all this very modern and highbrow scientific endeavor struck me as almost unbelievable. I enjoyed and appreciated it more than I can express."

After two years of research Yost received a Ph.D. degree, magna cum laude, in chemistry and mathematics, and was given an appointment as instructor. His son Max Cayley Yost had been born on August 17, 1927. His thesis supervisor was probably A. A. Noyes. However, no acknowledgment or other indication appears in Yost's thesis, which consists only of reprints of his four papers published in 1926 (1926,2) under a cover page with the title "The Mechanisms and Rates of Certain Oxidation-Reduction Reactions in Aqueous Solution. The Existence of Trivalent Silver."

It was still important in those days for an ambitious young scientist to study in the scientific capitals of Europe. In 1928 Yost applied for and received a Rockefeller Foundation fellowship. He spent a half a year at the University of Uppsala working on X-rays with Manne Siegbahn, followed by a half year working in the University of Berlin with Peter Pringsheim on the newly discovered Raman effect. He was especially stimulated by Pringsheim, and also by Walter Nernst, the head of the physical institute in Berlin. Both of these influences are evident in Yost's bibliography for the following twenty years.

Between his return to Caltech and the outbreak of World War II, Yost built up a very active program of research and teaching. His interests were broad: we find publications on Raman spectroscopy and low-temperature heat capaci-

ties, growing from seeds planted in Berlin; on X-ray absorption edges (recall Uppsala); on chemical equilibria and cell potentials, following the traditions of A. A. Noyes and of the Berkeley school of physical chemistry; and on radioactivity and neutron physics, no doubt reflecting the interest in nuclear physics and chemistry stimulated at Caltech by R. A. Millikan, R. C. Tolman, C. C. Lauritsen, and J. R. Oppenheimer. We also find a growing interest in reaction kinetics and catalysis and even in nuclear medicine. All of these varied researches, leading to perhaps fifty publications, were carried out with simple homemade apparatus; the sophisticated commercial instrumentation of today did not exist. A conspicuous quality of Yost's papers was an insistence on rigorous and quantitative characterization of chemical substances and reactions, quite different from the descriptive flavor of much work in inorganic chemistry at the time.

The chemistry of rare or "difficult" elements was always a challenge to Yost. Fluorine chemistry was no exception. Indeed, Yost earned an international reputation for his work on the volatile inorganic halides. Apparently the notion arose in the early 1930s (probably from Linus Pauling) that xenon, a "noble gas" guaranteed by all the textbooks to be chemically inert, might form chemical compounds with fluorine, the most electronegative element. Yost (who would not have used the word electronegative) and Albert L. Kaye describe in a 1933 paper a failed attempt to prepare such compounds. Neil Bartlett, who won fame many years later for preparing xenon fluorides, considers it nearly certain that such compounds must have been created under the conditions used by Yost and Kaye. We can only speculate on the reasons for their negative result on an experiment which might have had a revolutionary effect.

Late in the 1930s, after World War II began in Europe, Yost took a commission as lieutenant commander in the

U.S. Naval Reserve. In 1940 he applied for a government contract—the first of several—to pursue research on chemical warfare at Caltech under the National Defense Research Committee (NDRC). After the United States entered the war, and the NDRC gave way to the Office of Scientific Research and Development, Yost became steadily more involved and responsible for a larger and larger program, supervising research teams at Caltech and Northwestern University and maintaining liaison with groups in the United Kingdom. These efforts were ultimately to win him a Presidential Certificate of Merit. Then, in July of 1943, he abruptly quit this work. The reasons are not completely clear; there had been squabbles with government accountants over reimbursement of minor travel expenses, and one of these may have provided the trigger. At about the same time Yost was struck by osteomyelitis of the jaw, which might have ended his life except for successful efforts to obtain for him the newly developed antibiotic penicillin. Even with treatment the disease persisted for months, causing great pain and robbing Yost of most of his physical vigor. His intellectual effort, however, continued unabated. This was the period in which he published, with Horace Russell, his book *Systematic Inorganic Chemistry* and wrote sections of a projected text, "Advanced Inorganic Chemistry," which was never completed. With Russell and Clifford S. Garner he wrote the influential book *The Rare-Earth Elements and Their Compounds,* which was published in 1947. The two books were regarded for years as authoritative critical treatises on their subjects. (It is interesting that this should have been so of the rare earth book, in view of the fact that Yost's bibliography contains not a single paper on any of the lanthanides up to that time.) Yost was elected to the National Academy of Sciences in 1944. In July 1945, Yost again became involved in war research, this time

under the Manhattan Project. The work was connected with high explosives and was conducted at Caltech and Los Alamos.

In the years after the war, Yost returned to basic research. He still maintained an interest in reaction kinetics, especially as studied by radioactive tracer methods, but he also saw the promise of the new spectroscopies at radio frequencies. His last students worked in the fields of microwave spectroscopy of gases, nuclear magnetic resonance, and electron spin resonance. He remained physically frail, and his vision and mobility suffered further as a result of two cataract operations. During convalescences he kept in touch with his students through long and far-ranging afternoon conversations at his home (a house on San Pasqual Street near the campus, no longer standing, which had earlier belonged to A. A. Noyes). When on the campus he spent his time reading or experimenting with war surplus electronics in his office. Visitors would be greeted by a slight, cheerful figure, always dressed in a neatly pressed blue tweed suit, blue shirt, and red and blue striped tie, shading his eyes with one hand and waving either a cigarette or a six shooter with the other.

Always a supremely independent person, Yost refused to adapt to the new style and scale of scientific research that followed the war. He would not accept government grants or contracts, likely because of unpleasant experiences with bureaucrats during the war. In a 1950 letter to Kenneth Pitzer, then Director of Research of the Atomic Energy Commission, he wrote, ". . . for a working scientist the cost of research contracts in self respect and equanimity is great, but the incentive is uninspiring." He sneered at the new fashion for "gang research." Toward the end of his career he had only a small grant from the Newmont Mining Company; sometimes he would secretly buy supplies for his

students out of his own pocket. He withdrew from active participation in departmental affairs at Caltech, and he had little good to say of the research in structural chemistry which was flourishing there under Pauling and his school.

In his last years, especially after his retirement in 1964, Yost's scholarly interests expressed themselves in an avocation for mathematics. He was perhaps the first student in fifty years to devote himself to the algebra of quaternions and the properties of discriminants, catalecticants, and evectants. While he published little (only a short encyclopedia article on quaternions), he gave rein to his thoughts on these and a variety of other subjects in an informal but intellectual correspondence with members of the Iron Nail Club. This was a society of his own invention, composed of former scientific colleagues and personal friends, each of whom was given a nom de plume (Yost was Cisco, his boyhood friend Ivan Nelson from Boise was Pancho, I was Currito, etc.). He also became famous for his perceptive and colorfully written book reviews, which often were vehicles for his views on science and society. In a 1950 review of *The Transuranium Elements* by Seaborg, Katz, and Manning, he wrote:

> . . . the reader may well pause to reflect that the books are of little use to anyone except those few having access to the materials described; there is no normal, healthy way to check the many measurements and statements made. This field of scientific endeavor is highly monopolized; and extreme monopolization, like compartmentalization, is one of the sordid forms of state controlled enterprise. It is not free, and is not in the spirit of that part of the Atomic Energy Act quoted by Mr. [David] Lilienthal in his foreword. Accordingly, the reader, after further charitable meditation, could justly class the whole content of the books along with W. C. Fields' fabulous, three legged ostrich. And if it were not for the sobering undercurrent of both pleasant and unlovely fact now enmeshed with the new elements, which would require the deep insight of another Saint Jerome to evaluate, he, the reader, might well dismiss the whole matter from his mind and, with Shakesepeare, say "Mucho Ruido y Pocas Nueces."

Abbreviated references to those book reviews that could be found appear at the end of the bibliography.

Yost's lecturing style in the undergraduate classroom was awkward and uninspiring, and in later years he tended to hand these lectures off to his postdoctoral associates. However, he had a strong effect on his research students. His own palpable independence encouraged them to pursue their own ideas, learn from their own mistakes, and take credit for their successes. When they needed help, he would provide it or point the way toward someone who could. At other times his conversation tended to avoid the research at hand and range over a variety of subjects, scientific, historical, political, and personal. At times he seemed to speak obliquely or in parables. His students were most influenced in the long run by his scientific taste, his wit, and his utter intolerance of pretense. He was called by one colleague "the foremost anti-stuffed-shirt in American Science."

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