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Memorial of Orville Frank Tuttle
June 25, 1916–December 13, 1983

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Frank Tuttle, "Tut," passed on of complications induced by Parkinsonism on December 13, 1983. His contributions to the study of granites and feldspars, with major innovations in the development of experimental apparatus, led the way to whole new fields of endeavor. Among his awards were the first Mineralogical Society of America Award (1952), the Roebling Medal of the Mineralogical Society of America (1975), and the Arthur L. Day Medal (1967) of the Geological Society of America. In addition to these societies, Frank was a member of the Geochemical Society, a fellow of the American Geophysical Union, and a member of the Geological Society of Washington and the Mineralogical Society of London; and he was elected to foreign membership in the Geological Society of London. He was elected to membership in the National Academy of Sciences in 1968 and was a long-term member of the Cosmos Club in Washington, D.C. His beloved wife, Dawn, preceded him in death the previous December. Their daughters, Ann Starr and Jean Schiffman, reside in Albuquerque, New Mexico, and Toronto, Canada, respectively.

Tut was born in Olean, New York, on June 25, 1916. The family moved to Smethport, Pennsylvania, and he graduated from Smethport High School in 1933. Following graduation he worked in the Bradford oil fields at a variety of jobs, including tractor driver, pumper, driller, and tool dresser, then enrolled on a part-time basis at the Bradford Center of the Pennsylvania State College. In the fall of 1936 Frank enrolled at the main campus in State College. He received his B.S. in geology in June 1939 and his M.S. a year later. While at Penn State, he was a teaching assistant in petrology and geology and an assistant in the summer field-geology course. His work with Professor P. D. Krynine on heavy-mineral assemblages in sedimentary rocks resulted in his first publication.

Tut began his Ph.D. research at the Massachusetts Institute of Technology in the fall of 1940 and had completed essentially all of the required course by the summer of 1942. He and Dawn Hardes were married on November 21, 1941. From June of 1942 through January of 1947 he was involved in a series of National Defense activities, first at MIT, then the Geophysical Laboratory, and finally the Naval Research Laboratory. These studies involved crystal synthesis and characterization and led to several publications. Frank began studies on hydrous granitic systems and developed close contacts with L. H. Adams and J. F. Schairer of the Geophysical Laboratory of the Carnegie Institution of Washington and N. L. Bowen of the University of Chicago during this period. Frank completed his Ph.D. dissertation on fluid inclusions in quartz and their use in structural petrology during this period, receiving his Ph.D. from the Massachusetts Institute of Technology in 1948.

Following the war, Leason Adams, director of the Geophysical Laboratory, recognized that a high-priority area of research would be the experimental determination of equilibrium conditions "between crystals and liquids in the presence of volatile components, usually under pressure, and at first with water vapor and later with carbon dioxide and other gases" (p. 27, *Annual Report of the Director for 1945–1946*). Bowen rejoined the Geophysical Lab, after a decade at the University of Chicago, with Frank Tuttle on January 1, 1947, to begin their highly productive collaboration. During the first year of this effort, they began experimental studies on the systems MgO-SiO_2-H_2O and K_2O-Al_2O_3-SiO_2-H_2O and on extensions of Goranson's classic studies on the melting of natural granitic compositions. This research program involved use of the "Tuttle press," the first of two major experimental innovations by Tut that would be keys to worldwide experimental studies of the stability of rock-forming minerals. A review of the *Annual Report of the Director of the Geophysical Laboratory* (Yearbook 46, p. 27–29) for 1947 conveys the sense of excitement, wonder, and achievement regarding these studies.

Even a brief summary of the research conducted by Frank and his many co-workers at the Geophysical Laboratory during his tenure as a petrologist until June 30, 1953, would far exceed the space available here. Experimental studies on the high–low quartz inversion, feldspars, feldspathoids, and melting relations in natural and synthetic granitic compositions were of fundamental importance in their own right and laid a foundation for many subsequent research contributions. The experimental investigation of phase relations in the system MgO-SiO_2-H_2O provided a basis for rejecting the concept of a serpentinite liquid, a preview of *P-T* "petrogenetic grids," and a base for the extension by Yoder to the alumina-bearing system so fundamental to metamorphic petrology and the concept of metamorphic facies. The very careful analysis of the variable temperature of the α–β quartz inversion, its relationship to mode of occurrence, and the proposed explanation led to Frank's becoming the first recipient of the Mineralogical Society of America Award for young scientists in 1952. During his stay at the Geophysical Laboratory, Frank also developed the "Tuttle

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bomb," or externally heated, cold-seal, pressure vessel. This simple (after the fact) device became the key to unlocking many mysteries of mineral stability in academic, government, and industry labs worldwide because of its reliability, economy, and ease of use.

In general, Frank's experimental studies were directed toward resolution of petrologic problems defined in the field. He was an accomplished petrographic mineralogist, who delighted in discussing the intricacies of feldspar and quartz-feldspar intergrowths. At Professor Tilley's invitation, he spent three months at Cambridge examining thin sections from the Harker Collection and a month collecting feldspar-bearing rocks from classic localities in 1951. While abroad, he also visited the French Pyrenees, the Isle of Skye, Finland, and Norway for the purpose of collecting granitic specimens, particularly those near the contacts with the country rock. These field and petrographic studies were closely tied to his evolving ideas on the development of textural features in rocks of similar chemical compositions. These ideas were expressed with remarkable clarity in his 1952 paper on the "Origin of the Contrasting Mineralogy of the Extrusive and Plutonic Salic Rocks." Although publication of the classic study *Origin of Granite in the Light of Experimental Studies in the System* $NaAlSi_3O_8$-$KAlSi_3O_8$-SiO_2-H_2O was delayed until 1958, it represented a summary of the work done by Frank and N. L. Bowen at the Geophysical Laboratory. The experimental data and analysis of phase relations in this system have provided a base from which uncounted additional studies have been undertaken.

He joined the faculty at the Pennsylvania State University on July 1, 1953, as professor of geochemistry and head of the Department of Earth Sciences. He, with E. F. Osborn, R. Roy, M. L. Keith, and many others, was instrumental in building the organization to one of the world's leading institutions in geological education and research. Although the administrative, teaching, and fundraising activities did result in a reduction of personal research time, Tut was successful in maintaining a very active research program. This involved collaborative studies with fellow faculty members (J. V. Smith, P. J. Wyllie, C. P. Thornton, D. Roy, R. Roy, and R. H. Jahns), as well as postdoctoral and predoctoral researchers. The studies covered a broad range: from decarbonation reactions and carbonatite magmas, through studies of petrogeny's residua system with and without additional components, including some of the first studies on the role of mixed volatiles, to chemical petrology, and including at least three field theses. It seems quite clear that a large number of us are truly indebted to Frank for a start, or a boost, in our careers.

In 1959 Frank was appointed dean, College of Mineral Industries (now the College of Earth and Mineral Sciences) at the Pennsylvania State University, replacing his close friend and colleague, E. F. Osborn, who had been named vice president for research. In February 1960, he received a preliminary diagnosis of Parkinson's disease, confirmed in April. In May, Frank requested that he be permitted to resign as dean, while remaining as a research professor of geochemistry. The request was granted, effective October 31, 1960. He cancelled plans to provide invited lectures in Russia, Helsinki, and Copenhagen during that summer and spent the time completely away from academic duties, combining a vacation with collecting granite specimens in New England. On return to Penn State in the fall, many of the more unpleasant symptoms had essentially disappeared, only to recur on a periodic basis for the remainder of his life. He received several of the liquid-nitrogen probe treatments, and, somewhat later was one of the early recipients of the L-dopa treatment.

On a somewhat more personal note, it was in the fall of 1960 when I first met Frank on starting graduate work in geochemistry at Penn State. The following five years as a graduate student and postdoc with Tut were among the busiest and most exciting of my professional life. On his acceptance of the MSA Award for 1965, Pete Wyllie noted that above all else, Frank Tuttle was a man of ideas. In general, he kept those of us that had the good fortune of working with him excited about three, four, or more projects at the same time. Yet, a portion of the thrill of working with him was that he sought out your ideas, not just passed his own down to you. This approach carried through to jointly authored publications and involved extensive discussion and rethinking. His ideas have had profound impact on mineralogy and petrology both for their originality and insight as well as in the development of experimental apparatus for testing ideas and hypotheses.

In the summer of 1965, Frank left Penn State to join the faculty at Stanford University, as professor of Geochemistry. Dick Jahns, a colleague at Penn State, who had become dean of the School of Earth Sciences at Stanford in 1964, was instrumental in attracting Tut to Stanford. During the next two years he, with a cadre of graduate students and postdoctoral fellows from Penn State, established a major experimental geochemistry laboratory at Stanford. He also started several individuals in experimentally oriented thesis research; continued his collaboration with Dick Jahns on field, chemical, and experimental studies of pegmatite genesis; and taught several courses and seminars. In 1967 Frank requested medical leave from Stanford, feeling that he could no longer contribute, at his high level of standards, to the academic and research program because of the continuing effects of Parkinsonism. He tendered his formal resignation in 1971. He and Dawn had moved to Tucson in 1968 and built a new home in the foothills of the Tucson Mountains. Dawn joined the faculty at the University of Arizona and Tut spent much of his time working the stock market. Frank's health continued to decline and in early 1977 he received a tentative diagnosis of Alzheimer's disease. Subsequently, he and Dawn moved into a residential nursing home in Tucson, where they remained until death.

On reading the preceding, with the emphasis on Frank's research contributions, I fear that I have left you with a

false impression, a certain one-dimensionality. My apologies, for nothing could be further from the case. Tut was an excellent and stimulating, though demanding, teacher in phase equilibria, mineralogy, and petrology. His seminars on the origin of granite were widely attended. He lectured at many academic institutions both here and abroad. Although his contributions in experimental petrology are highly prominent, he could swing a 12-pound sledge, used in collecting granite specimens, with the best of them. Tut served as a consultant for RCA Research Labs, Dupont, Linde, and others at various times during his career, and was one of the founders of Tem-Pres Research. I have no direct knowledge relative to his role as an academic administrator, but strongly suspect that his high standards, willingness to make difficult decisions, and compassion were instrumental in his success. He was an avid golfer, thoroughly enjoyed squash and handball, and (so rumor has it!) played a mean game of poker. In this memorial, I have attempted to outline some of his many personal and professional contributions. I would urge the reader to examine the presentation awards by N. L. Bowen, "The Mineralogical Society of America Award" (*Am. Min.,* 1952, p. 250–253), by E. F. Osborn, "Presentation of the 1967 Arthur L. Day Medal to Orville Frank Tuttle" (*Proc. Geol. Soc. Amer. for 1967,* p. 93–95), and by E. F. Osborn, "Presentation of the Roebling Medal of the Mineralogical Society of America for 1975 to O. Frank Tuttle" (*Am. Min.,* 1976, p. 513–514) to garner a better understanding of the debt we owe Tut.

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[1] To obtain a copy of the complete bibliography of O. F. Tuttle, order Document AM-87-358 from the Business Office, Mineralogical Society of America, 1625 I Street, N.W., Suite 414, Washington, D.C. 20006, U.S.A. Please remit $5.00 in advance for the microfiche.