

At a Meeting of the Faculty of Arts and Sciences on November 18, 2003, the following Minute was placed upon the records.

### **CLIFFORD FRONDEL**

Born: January 8, 1907

Died: November 12, 2002

Clifford Frondel, Curator of the Mineralogical Museum and Professor of Mineralogy from 1946 until his retirement in 1977, died on November 12, 2002, after a long illness.

Professor Frondel, known simply as “Cliff” to his friends and colleagues, was noted for an unusual diversity of research interests. He was one of the first scientists to study the rocks brought from the Moon by the Apollo astronauts. He was an expert on urinary calculi, on the mineralogy and hazards of asbestos, and on the piezoelectric properties and technological uses of quartz and tourmaline. Working with the Linde Air Products Co., he developed the process for the synthesis of star rubies and star sapphires. As a curator he worked with local museums on pigments, patinas, and other materials relevant to the provenance and authenticity of art objects.

Cliff was born on January 8, 1907 in the Washington Heights district of Manhattan. At an early age he moved to Queens where he attended public schools in Bayside and Flushing. A teacher in Flushing High School aroused his interest in mineralogy and introduced him to the collections at the American Museum of Natural History in New York, and to many fascinating mineral localities in northern New Jersey, Westchester, and southwestern Connecticut. After high school he obtained a degree in Geological Engineering at the Colorado School of Mines (1929), an A.M. at Columbia (1936), and a Ph.D. at MIT (1939) under the guidance of Martin Buerger.

Fronde’s first contributions to mineral science were based in part on work done at the American Museum and appeared while he was a graduate student at Columbia. They dealt with the orientations of overgrowths and incrustations of one mineral upon another, and the relative orientations of host and inclusions when one mineral surrounds another. These orientations proved to be severely constrained, both crystallographically and structurally. Cliff’s contributions to the successful syntheses of star rubies and sapphires were a direct consequence. A general concern with coherent and quasi-coherent interfaces led to further contributions on exsolution textures and polytypism.

After MIT, Cliff came to Harvard as a Research Associate, studying rare minerals. In collaboration with urologist Dr. E. L. Prien, he also wrote two important papers on urinary calculi. In association with Harry Berman, he began research on the development and use of quartz oscillator plates. He left Harvard in 1942 to become a senior physicist in the War Department, to continue the research on quartz. He was in Britain in 1942-43, and later became Director of Research at Reeves Sound Laboratories (1943-45). Returning to Harvard as professor and curator in 1946, Cliff did extensive research (until 1951), sponsored by the Atomic Energy Commission and the U.S. Geological Survey, on the nature and occurrence of uranium and thorium minerals, and on the mineralogy of scandium.

Cliff was author or co-author (with Charles Palache and Harry Berman) of three volumes of the seventh edition of *Dana’s System of Mineralogy*, an encyclopedic reference covering the several thousand known mineral species. He published nearly 200 papers, many of them related to this major work. In the process he discovered and named 48 new mineral species, but discredited more than 50 that had been “named” by over-enthusiastic predecessors. The net result made things slightly easier for the users of Dana’s System! Two new minerals, Cliffordite and Frondelite, were named by others in his honor. He also wrote two book-length monographs, one dealing with the mineralogy of uranium

and thorium, the other with the remarkable mineral occurrences of the Franklin-Sterling Hill district in northern New Jersey. Cliff was blessed in his prime with a remarkable, near-photographic memory, that served his curatorial duties well. Lazy colleagues sometimes took advantage of this ability. It was often easier simply to “ask Cliff” than to go to the library.

To Cliff and to his friends the most exciting and stimulating period in his career was the decade during which he was closely associated with the Apollo Lunar Program. In 1964 Cliff was asked by the National Academy of Sciences to chair a committee to formulate procedures for the sampling and examination of lunar materials that might be brought back to earth. As a consequence, Cliff had the privilege of opening the first box of lunar rocks following the return of the Apollo 11 team in 1967. The opening had to be done with great care to avoid contamination either way. A glove-burst after Apollo 12 required the entire examination crew to be quarantined for two weeks. Poker provided a pastime during isolation, and it is said that Cliff relieved the rest of the crew of a considerable amount of cash. Colleagues at Harvard, aware of Cliff’s prowess at poker, could have warned them! Cliff attended four Apollo launches and two splashdowns. A significant fraction of the subsequent mineralogical and petrologic research was done at Harvard in the then Department of Geological Sciences. Cliff was Department Chairman from 1965 to 1969 and wrote an account of its early history.

Cliff’s many honors include the Becke Medal (1956) of the Austrian Mineralogical Society, the Roebling Medal (1964) of the Mineralogical Society of America, the Distinguished Achievement Medal (1964) of the Colorado School of Mines, and the Boricky Medal (1969) of the Charles University, Prague. He was elected in 1963 to the Accademia Nazionale dei Lincei, the Italian scientific academy.

Cliff’s first marriage, to Eleanor Travis in 1941, ended in divorce in 1947. In 1949 Cliff married Judith Weiss, herself a mineralogist of distinction, and an expert on extra-terrestrial materials. Cliff and Judy were also devotees of books, opera, fine food, and Siamese cats. Cliff is survived by his wife, Judy, of Winchester, Massachusetts, by a sister, Martita Van Ness, of Atlanta, Georgia, by a daughter, Dana L., of Lexington, Kentucky, from his first marriage, and by a daughter, Barbara, of Haifa, Israel, from his second marriage.

Respectfully submitted,

Carl A. Francis

Cornelius S. Hurlbut

James B. Thompson, Jr.

Heinrich D. Holland, Chairman