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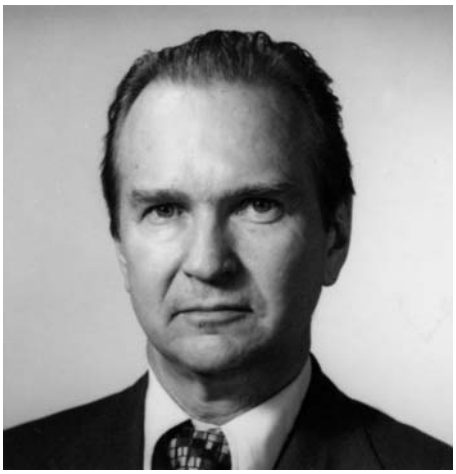
Memorial

Kurt Fredriksson (1926–2001)



Kurt Fredriksson pioneered the application of the electron microprobe to extraterrestrial materials: he made the first such probe analyses in 1957 of cosmic spherules from deep sea sediments. He worked with the pioneer developer of the instrument, R. Castaing in Paris. Kurt was the first probe analyst to develop a set of probe standards that were close to the compositions of the phases being analyzed. This meant that the huge mass absorption corrections that arose in early probe analyses were reduced to a minimum. He, along with J. V. P. Long and a few others were the first to make probe analyses quantitative.

Kurt published over one hundred research papers, most of them in English but some in German, French, and Swedish. Today the electron microprobe has become a standard device, automated and computer driven. Probe analyses in the 1950s were tedious, with unstable electronics, murky optics, and data reduction by hand or, later, punch cards fed to a main frame computer, the reduced results coming back in a few days. During these times there was considerable doubt cast on probe analyses by chemists using wet chemical methods. Kurt initiated a study in which a probe analysis was done of the bulk composition of a rock that was also analyzed in a chemical laboratory. The results were identical (within error) and demonstrated that the probe is a valid quantitative method.

Kurt was born in Sweden in 1926. His first degree was in chemical engineering from the Institute of Technology in Stockholm. His doctoral degree was in mineralogy and geology from the University of Stockholm. He became interested in cosmic spherules in sediments when he worked at the Institute of Oceanography in Gothenburg in the mid 1950s. His first seven published papers dealt with spherules. Because of his early work with the microprobe and his knowledge of meteorites, as well as his ability to run a laboratory facility, he was invited in 1960 by Gustaf Arrhenius to the University of California, San Diego, which had recently acquired a probe. Kurt became deeply involved with probe work on meteorites and his paper with Klaus Keil in 1964 on the compositions of coexisting olivines and rhombic pyroxenes in chondrites became one of the most quoted papers in meteoritics for several decades. Many chondrites, they found, were grossly unequilibrated, something that was not suspected by most (optical) meteorite petrologists at the time. This led ultimately to a chondrite classification scheme proposed by Van Schmus and Wood, the scheme that (with many embellishments) is current today.

In 1964 Kurt moved to the Smithsonian Department of Mineral Sciences. The Smithsonian wanted to increase their research capability, especially that based on their extensive meteorite holdings. Kurt set up a new electron microprobe laboratory. The move set the tone for the rest of his professional career. From then on he published a host of papers on meteorite (and lunar) mineralogy and petrology, most of them based upon probe analyses. In addition, he worked on shock experiments in chondrites with colleagues at the Stanford Research Institute and the University of California, Berkeley, and made extensive studies of the Lonar impact site in India and the Rochechouart impact site in France. His shock experiments demonstrated that high velocity shock waves were a source of heating that caused physical redistribution of some phases as well as metamorphism in chondrite parent bodies. Later in his career he made contributions to archaeology by his studies of the chemistry and petrology of vitrified rocks used in the construction of Celtic Iron Age forts in Germany, France, and Scotland. At the Smithsonian he undertook a systematic examination of every stone meteorite in the collection, and had thin sections made of any and all that showed noteworthy features.

At some point, Kurt heard that Ray Beauchamp of Batelle NW had developed a method to make ultrathin sections for metallurgical purposes. With Kurt's encouragement Ray succeeded in developing the technique to make ultrathin sections of stone meteorites. Kurt introduced the method to many labs around the world. Ultrathin sections revealed new details about matrix phases and textures in stone meteorites.

Kurt received the Jacquet-Lucas Award from the International Metallographic Society and the Excellence in Metallography Award (jointly with Ray Beauchamp) from the American Society for Metals. He served as visiting scientist at NASA's Johnson Space Center and the Max Planck Institute for Chemistry in Mainz, and was an Honorary Fellow at the Australian National University, and Corresponding Member of the Naturhistorisches Museum in Vienna. The mineral fredrikssonite, from Långban, Sweden, was named in his honor.

Throughout his career he was bedeviled by his discoveries in chondrites. From his work with ultrathin sections he found that ultrafine matrix (which John O'Keefe dubbed, "holy smoke") was out of equilibrium with chondrule minerals even in what were considered equilibrated chondrites. Also, in his analyses of bulk chondrite compositions by a pellet method he devised, he discovered that there were positive correlations between refractory oxides in chondrites that are considered unequilibrated, while chondrites of high equilibration show no correlations between these same refractory oxides. These observations confirmed his long held contention that the classification scheme that related chondrite groups by a gradually increasing degree of metamorphic equilibration is not correct. He also found it puzzling that although chondrites consist of variable proportions of chondrules (with a range of compositions) and ultrafine matrix (also with a range of compositions), all chondrites have approximately the same bulk composition in spite of the obviously variable proportions of chondrules to matrix. This came to be called "Fredriksson's paradox".

During the past 37 years his wife, Becky, was his ever present research colleague and confidante, exchanging ideas and sharing the work load. In addition to Becky, Kurt is survived by his daughter Christine Burman from his first marriage to Ingrid Nilsson, two grandchildren, and two sisters, all of Sweden.

For those of us who were close to Kurt, we will miss his feisty temper and his continual insistence on adherence to the details revealed in chondrites, as opposed to broad brush approaches that ignore any details that contradict the "big picture" view of many researchers. We will also miss his delightful Swedish accent, which never abandoned him throughout his 41 years of immersion in English.

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SELECTED PUBLICATIONS OF KURT FREDRIKSSON

(in chronological order)

CASTAING R. AND FREDRIKSSON K. (1958) Analyses of cosmic spherules with an x-ray microanalyzer. *Geochim. Cosmochim. Acta* **14**, 1114–117.

FREDRIKSSON K. (1963) Chondrules and the meteorite parent bodies. *Trans. N.Y. Acad. Sci.* **25**, 756–769.

FREDRIKSSON K., DECARLI P. S. AND AARAMAE A. (1963) Shock-induced veins in chondrites. In *Space Research 3* (ed. W. Priester), pp. 974–983. North Holland Publ. Co., Amsterdam, The Netherlands.

KEIL K. AND FREDRIKSSON K. (1964) The Fe, Mg, and Ca distribution in coexisting olivines and rhombic pyroxenes of chondrites. *J. Geophys. Res.* **69**, 1403–1411.

BOSTROM K. AND FREDRIKSSON K. (1966) Surface conditions of the Orgueil meteorite parent body as indicated by mineral associations. *Smithson. Misc. Coll.* **151**, 1–39.

FREDRIKSSON K. (1968) The Sharps chondrite—New evidence on the origin of chondrules and chondrites. In *Meteorite Research* (ed. P. Millman), pp. 155–165. Reidel Publ. Co., Dordrecht, The Netherlands.

MASON B., FREDRIKSSON K., HENDERSON E. P., JAROSEWICH E., MELSON W. G., TOWE K. M. AND WHITE J. S., JR. (1970) Mineralogy and petrography of lunar samples. *Science* **167**, 656–659.

FREDRIKSSON K., DUBE A., MILTON D. AND BALASUNDARAM M. S. (1973) Lonar Lake, India: An impact crater in basalt. *Science* **180**, 862–864.

FREDRIKSSON K., DUBE A., JAROSEWICH E., NELEN J. A. AND NOONAN A. F. (1975) The Pulsora anomaly: A case against metamorphic equilibration in chondrites. *Smithsonian Contrib. Earth Sci.* **14**, 41–54.

RAMBALDI E. R., FREDRIKSSON B. J. AND FREDRIKSSON K. (1981) Primitive ultrafine matrix in ordinary chondrites. *Earth Planet. Sci. Lett.* **56**, 107–126.

FREDRIKSSON K. AND KERRIDGE J. F. (1988) Carbonates and sulfates in CI chondrites: Formation by aqueous activity on the parent body. *Meteoritics* **23**, 35–44.

FREDRIKSSON K., BRENNER P. R., FREDRIKSSON B. J. AND OLSEN E. (1997) A nondestructive analytical method for stone meteorites—and a controversial discrepancy. *Meteorit. Planet. Sci.* **32**, 55–60.