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Acceptance of the Roebling Medal of the Mineralogical Society of America for 2003

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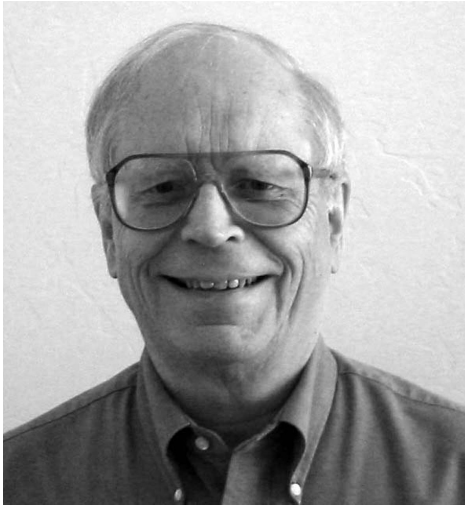
Mr. President, Members of the Society, and Guests:

Alex, thank you so much for the wonderful introduction. I also want to thank Nancy Ross, Ross Angel, Rus Hemley, Sorena Sorensen, and Hanna Nekvasil for all they have done to make this occasion so exciting for Gretchen and me, and especially for the reception we all attended on Sunday night.

It is customary for Roebling Medalists to tell something about their background and how they happened to become involved in the science of mineralogy, crystallography, and/or petrology. Thus, I will follow this custom and try to highlight in this short time some of the influences that guided me into my career that has been based primarily on mineralogy and crystallography.

I grew up on a farm near Mt. Sterling, Kentucky, a small town of about 5000 people, but one having a wide range of interests and one I look back upon with great fondness. My father and mother were very supportive of my interests, and from an early age I was more comfortable with mechanical rather than agricultural pursuits. In high school, my primary mentor was Tiny Jones, the football and basketball coach as well as the teacher of chemistry and physics. Tiny terrified many of the students with his tempestuous personality, but for some reason I got along well with him and thrived in his chemistry and physics courses. Although I was a mediocre football player, Tiny didn't seem to hold that against me. In the early part of my senior year in high school, I became interested in metallurgical engineering because a former graduate came back to the school and told about his experiences in this field at the University of Kentucky. However, my life was changed completely when, later during my senior year, I read an article in Time magazine about an incident in Cambridge, Massachusetts, where the town fathers closed a theater in Central Square that had been showing the movie "Ecstasy" in which the actress Hedy Lamar was featured in a bathtub scene. In response, MIT students marched on Central Square protesting the closing of the theater and then went back to their dormitories, dyed sheets red to make Soviet-style flags, which they hung out of their dormitory windows, and accompanied this with the Internationale played on their hi-fi amplifiers. I decided this was where I would like to go for a university education and applied for admission. To my surprise I was admitted and entered MIT in the fall of 1951.

All MIT freshmen took essentially the same courses, so I didn't decide on a major until later in my freshman year. Although I was still interested in metallurgy, I was influenced by two of my older fraternity brothers, Freeman Gilbert and Stewart Smith,



who were majoring in geophysics. After thinking about the alternatives, I decided to enter what was then called the Department of Geology and Geophysics. My first experience with mineralogy was in a course taught by Bill Dennen. This was a very modern course for its time with much emphasis on chemistry and physical properties of minerals. Subsequently, I thought I would specialize in mineral exploration and focused my efforts on related courses, a summer job in west Texas on a seismic crew, and a Bachelor's thesis on geochemical exploration. After graduation, I spent six months working for the Groundwater Branch of the U.S. Geological Survey, six months in the army, and three months working for the U.S. Geological Survey in Washington, D.C., the latter on a project that emphasized powder x-ray diffraction. After that I returned to MIT for graduate school and still thought I would pursue some aspect of mineral exploration. However, I had taken a course from Martin Buerger in my senior year, which he called Theoretical Crystallography. I thought this was the best of all my undergraduate courses and covered what was very close to today's field of mineral physics. In graduate school, I needed financial support and Martin Buerger had a Research Assistantship available. We had an interview and both of us seemed to like the answers the other gave to our questions, so I was hired and was assigned to a diffraction data collection project supervised by a postdoc, Theo Hahn. Theo was a wonderful tutor and I learned a lot from him—Theo later returned to Germany and became a Professor in Aachen and is well-known as a primary editor of

International Tables for Crystallography and as a former President of the International Union of Crystallography. After about a year working in Buerger's lab, I decided to switch to a program emphasizing crystallography and mineralogy.

During my graduate years I shared an office with Tibor Zoltai, Bernie Wuensch, Charlie Burnham, Don Peacor, Hilda Cid-Dresdner, and Wayne Dollase. This was an incredibly interactive and supportive group of students, all of whom later became professors in major institutions in the U.S. and Chile. My decision after graduation, however, was to join industry and I became an employee of the DuPont Company in Wilmington, Delaware. At that time, DuPont was very interested in inorganic, solid-state materials that had the potential to become commercial products. With Chuck Fritchie an inorganic chemist from CalTech (and later another chemist, Lloyd Guggenberger), we received extensive company support to set up a state of the art x-ray laboratory and were given carte blanche to work on any or all of a wide range of materials synthesized by others in the Central Research Department. My primary collaborators were Bob Shannon, Art Sleight, and Howard Young, and we had a great time exploring many new materials, particularly those that could be synthesized at high pressure in our tetrahedral apparatus that was capable of pressures as high as about 7 GPa and 1200 °C. Although I was happy at DuPont, I missed mineralogy and when a job offer came from SUNY Stony Brook that would allow me to return to a geological research environment, I accepted the offer as an Associate Professor of Crystallography. This decision was greatly influenced by the simultaneous recruiting of Don Lindsley, Jim Papike, and Ted Bence by the faculty at Stony Brook.

I spent 17 years at Stony Brook engaged in a wide variety of research and teaching activities. In the beginning, Jim Papike and I, together with a number of talented graduate students and postdocs, pursued a research program centered on the mineralogy and crystallography of rock-forming minerals. We produced a number of groundbreaking papers and conducted the most comprehensive study of crystal structures at high temperatures that has been performed anywhere in the world. In 1975–1976, I took sabbatical leave at the University of Cambridge and Monash University. In the former, I worked with Desmond McConnell, postdoc Bob Hazen, and graduate students Andrew Putnis, Michael Carpenter, and David Price. We all became good friends and it is especially exciting that Michael and Bob are going to be the next two Presidents of MSA. At Monash, I worked primarily with Bruce Hobbs and Alex McLaren and learned a lot about microstructures of minerals. One interesting result of my leave in Australia was that I met John Parise on a field trip in Queensland that was initiated by John and his colleagues from James Cook University. John said that he was interested in a postdoc position in the U.S., so after I returned to Stony Brook, I was able to obtain funding for a postdoc position, which John accepted. John spent several years in the U.S., returned to Australia for a series of jobs, and joined the Stony Brook faculty when I became Director of the Geophysical Laboratory.

Shortly after I returned from sabbatical leave, the Department of Earth and Space Science hired Bob Liebermann, who had been a staff member at the Research School of Earth Sciences at Australian National University. Together with Don Weidner, we began to talk about developing a program focused on high-pressure research. At that time, research in high pressure in the U.S. was trending away from the tetrahedral or opposed-anvil type of equipment, but emphasized diamond-anvil experiments that could achieve higher pressures at a much lower cost. In January 1981 we attended what was the most important and exciting scientific meeting in my career, the U.S.–Japan Seminar in High Pressure Research that was held in Hakone, Japan. At that meeting and in laboratory visits afterward, we found that Japanese scientists had greatly extended the large-volume pressure and temperature capabilities through the employment of multi-anvil apparatus that was capable of reproducing conditions comparable to those in the upper lower mantle. We were very excited by this, returned home and submitted a proposal to NSF, which was funded. In the meantime, I went on sabbatical leave again, splitting the year among the University of Copenhagen, Arizona State University, and the University of Tsukuba. After that leave, Don, Bob, and I returned to Japan for a tour of laboratories and decided to purchase a multi-anvil press and guideblock based on the split-sphere design of Professor Kawai, an operating version of which was installed in Misasa, which later became the Center for Study of Earth's Interior. Although Ted Ringwood had installed a similar guideblock in a press at ANU, this was the first complete system of its kind to be installed outside of Japan. Since then many multi-anvil systems of a variety of designs have been installed in laboratories around the world. Another benefit of this initiative was greatly increased collaboration among U.S. and Japanese scientists, and I treasure all the friendships and scientific collaborations we made during this period.

In the late 1970s, it became apparent that application of synchrotron x-radiation to analysis of high-presssure experiments would be of great value. A consortium of geoscientists, chemists, and physicists from different SUNY campuses obtained funding to build the SUNY Beam Line at the National Synchrotron Light Source. I became involved in this effort and have continued my interest in synchrotron-aided experiments to the present time.

In early 1986, I served on a Visiting Committee to both the Geophysical Laboratory and Department of Terrestrial Magnetism, with the major topic being either the proposed move to one of several university campuses, to upgrade existing facilities, or to co-locate on the DTM campus in Washington. A couple of months later I received a phone call from Jim Ebert, President of the Carnegie Institution. He said, "You are on the short list and are you interested?" I replied, "What short list?" He said, "To be considered to be Director of the Geophysical Laboratory!" I was astounded, but said that I would be happy to visit the Lab to discuss this possibility. One thing led to another and I was offered the job and accepted after talking it over with Gretchen.

I spent thirteen years at the Lab as Director and five more as a Senior Staff Member after I turned 65, the age at which Carnegie tells Directors they have to stop directing. Being at the Lab was a wonderful experience and one that would be hard to beat in any institution. During my early years we spent much of our time in carrying out the wishes of the Carnegie Trustees, who decided that we should construct a new building and renovate existing buildings on the Broad Branch Road campus and that the Geophysical Lab should move there as soon as possible. Although there was some grumbling in both departments along the way, I think the co-location has been a great success and

that both departments have benefited greatly through increased collaboration and use of common facilities. One major event for the Geophysical Lab during my tenure was the establishment of the Center for High Pressure Research, in which the Lab and departments at SUNY Stony Brook and Princeton were designated as an NSF Science and Technology Center and funded for an 11 year period beginning in 1991. The primary result of CHiPR was the publication of over 1000 papers on high-pressure science and technology and the concomitant influence on related research in institutions around the world. Although the CHiPR grant and organization terminated in 2002, CHiPR has been succeeded by a new consortium, COMPRES, which includes many additional institutions.

There are so many people that I worked and associated with at SUNY Stony Brook and the Geophysical Laboratory that I cannot list them all here. However, I do want to especially recognize those who were most closely connected to the crystallographic research effort, including Louise Levien, Hubert King, Gordon Brown, Shigeho Sueno, Toshi Sasaki, Don Swanson, V. Rajamani, Howard Belsky, Ken Baldwin, Peter Lyman, Maryellen Cameron, Ken Schwartz, Tibor Gasparik, Barry Wechsler, Xing Liu, Jaidong Ko, Takamitsu Yamanaka, Bob Hazen, Larry Finger, Ross Angel, Nancy Ross, David Palmer, Jinmin Zhang, Hexiong Yang, Przemek Dera, Steve Gramsch, Yang Ding, Stefanie Japel, Yanzhang Ma, Nabil Boctor, Jinmin Zhang, Bob Downs, Yasuhiro Kudoh, Yingwei Fei, Rus Hemley, and Dave Mao. Another crystallographer should be mentioned, one with whom I have had a long and productive collaboration and friendship, Jerry Gibbs.

This past summer, I retired and we moved to Tucson, Arizona, where I am an Adjunct Professor in the University of Arizona Department of Geosciences. I continue to pursue an active research program with Bob Downs and his students, and hope to remain in frequent contact with many of you in the years to come.

Now, I want to thank my best friend and partner, Gretchen, for all the support she provided over the 45 years we have been married. Every day it is a pleasure to wake up, read The New York Times, and be together to pursue the rest of the day's activities. So, thanks to you, Gretchen, for everything--I couldn't have gone anywhere without you.

Finally, thank you Alex for nominating me, and thanks to all of my colleagues, students, and friends for all the good times we have had together. And thank you, Mr. President and MSA, for the great honor you have bestowed upon me.