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Presentation of the Mineralogical Society of America Award for 1992 to Jonathan F. Stebbins

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President Holdaway, members and fellows of the Mineralogical Society of America, and guests: In 1967 Jonathan Farwell Stebbins was a 13-year-old lad living with his family in Seattle. That was the year I attended my first MSA luncheon, at the New Orleans GSA meeting. I was a second-year graduate student in mineralogy. At that meeting the 17th MSA Award was presented to Ted Ringwood for his pioneering experimental studies of pressure-induced phase transformations. One could argue that Ted's well-deserved recognition by MSA ushered in the era of modern mineral physics. The high point of that meeting for me was the speech by Linus Pauling accepting the Roebling Medal. I succeeded in introducing myself to Dr. Pauling and shook his hand. I recall how excited I felt about the specialty I had chosen to pursue in my graduate studies. Upon reflection, I realize how much mineralogy and petrology have changed in the intervening 25 years. Jonathan Stebbins is at the forefront of this change, and it is very appropriate that the Mineralogical Society of America is honoring Jonathan today as the 42nd recipient of the MSA Award.

I suspect that Jonathan was a precocious youngster on the basis of his academic accomplishments as an undergraduate at Harvard. He also met Jessica Donovan, his wife to be, while taking a class in optical mineralogy at Harvard. After graduating summa cum laude from Harvard in 1977 with an A.B. degree in geological sciences, he had the good sense to go to U.C. Berkeley, where he was discovered by a little-known mineralogist-petrologist named Ian Carmichael. His Ph.D. project at Berkeley involved calorimetric measurement of enthalpies and heat capacities of silicate liquids and was fraught with experimental complexities. Ian's genius for recognizing intellectual talent and matching it with an appropriately challenging project is well illustrated by Jonathan and his Ph.D. project. Not only did Jonathan prove to be a gifted experimentalist, but he also produced an outstanding Ph.D. thesis. The most important paper from Jonathan's thesis was published in 1984 with coauthors Carmichael and Leuren Moret in *Contributions to Mineralogy and Petrology*. This paper approximately doubled the existing data base of heat capacities and entropies for silicate liquids and glasses of a wide range of compositions. More importantly, it presented a simple and unifying model for evaluating the thermodynamic properties of silicate liquids and glasses as a function of composition. It also showed the close relationship between the structure and composition of melts and their bulk thermodynamic properties.

Following completion of his Ph.D. work, Jonathan very wisely accepted a postdoctoral position at Lawrence Berkeley Labs jointly with Ian Carmichael and Alex Pines of the Berkeley Chemistry Department. During his two-year postdoc, Jonathan essentially abandoned calorimetry and began his encounter with magnetic fields and atomic nuclei. He learned nuclear magnetic resonance spectroscopy from Pines, one of the world leaders in this field, and continued his collaboration with Ian and with fellow postdoc Jim Murdoch, working on solid-state NMR studies of silicate glasses, melts, and minerals. About ten papers resulted from this very fruitful collaboration. All were groundbreaking and firmly established Jonathan Stebbins as an authority on the mineralogical applications of solid-state NMR spectroscopy.

I asked Ian Carmichael for a few recollections about Jonathan during his tenure as a graduate student and postdoc at Berkeley. Ian contributed the following. "He arrived in 1978 from France, and although he manfully went to Mexico to unravel the history of Volcán Tequila, a recently extinct volcano, a combination of his allergic reaction to the dust and pollen and the rather noisy and spartan living conditions of Hotel Tequila, 3 m from the busiest highway in Mexico, combined to turn his attention away from the glories of thorn bushes, dirt roads, and the aftermath of Mexican cuisine. I was refurbishing an old drop calorimeter of K. K. Kelley, and from that moment on Jon became immersed in experiments, always involving some form of thermodynamic property of silicates. So four years later he was awarded his Ph.D., and the prospect of gainful employment was immediate. I had funds to support him as a postdoc at Berkeley, but I was competing with Oregon State, Michigan, VPI, the Smithsonian, Penn State, and later even Stanford to keep him. The only inducement was an imperfect intention to design and fabricate a drop calorimeter that could go to 2200 °C. That stalled, and so, with Jim Murdoch, another postdoc at Lawrence Berkeley Laboratory, Jon and I decided to try NMR on silicate liquids at high temperatures, while the design of the calorimeter was completed. Once their design of a high-temperature NMR probe was tested and worked, requiring a stupendous sum for 10 g of $^{29}SiO_2$, his future was set. He migrated across the bay and generated a research program that we are all here to celebrate."

I vaguely recall that Jonathan applied for graduate study in geology at Stanford in 1977 and was denied admission. We also rejected Ed Stolper when he applied for a junior faculty position in Geology at about the same time. Unfortunately, we didn't get a second chance with Ed, but we did get another shot at Jonathan, and we almost blew that one as well. In the early 1980s the Geology Department at Stanford started a faculty search in the broad area of experimental mineralogy-petrology-geochemistry. After several abortive attempts over a two-year period to find the right person, I was approached by Ian Carmichael in a smoke-filled hallway of the 1983 San Francisco AGU Meeting. Ian was aware of our search and cornered me to recommend Jonathan Stebbins strongly for the position. The late Allan Cox was Dean of the School of Earth Sciences at the time. He was not particularly enthusiastic about hiring a third person in a row from his alma mater. We had hired Gail Mahood, a Carmichael student, and Dennis Bird, a Helgeson student, in 1979 and 1982, respectively. However, Jonathan's interview visit to Stanford was so positive and his record was so strong that the search committee and department faculty strongly endorsed Jonathan as our top choice. Although Allan was not initially enthusiastic about hiring a person who specialized in what he considered molecular geology, he was quickly won over by Jonathan's keen intellect and scholarly approach to science.

During his seven years at Stanford, Jonathan has established a world-class research program in experimental mineralogy and geochemistry that has fundamentally changed the way we think about silicate liquids. Not only has he pursued NMR studies of minerals, melts, and glasses with a vengeance, but he also has directed experimental studies of the volumetric properties of silicate melts and element partitioning between hydrous melts and their vapor phase. He even found the time to get involved in research on high-temperature superconductors with several colleagues in applied physics at Stanford. I have had the distinct pleasure of serving with Jonathan as coadvisor of two very bright graduate students and can attest to Jonathan's inspirational advising style. His mentoring skills extend from the laboratory to the classroom, where he teaches an undergraduate course in geochemistry and coteaches with me a graduate course in mineral physics and chemistry. I have learned a great deal from Jonathan, as have his students, and I consider myself very lucky to have a colleague like Jonathan, who is dedicated to the highest levels of scholarship. He also is willing to pitch in where needed in undergraduate advising, teaching, serving on department committees, and taking visiting speakers to the local sushi restaurant. One of the attributes that has led to Jonathan's success is his curiosity about almost everything. George Parks, one of our colleagues at Stanford, has said on numerous occasions, "you can see much in a person's eyes." Jonathan's eyes are filled with curiosity about the natural world.

Jonathan Stebbins is perhaps best known in the international mineral physics community for his pioneering high-temperature NMR studies of silicate liquids. Over the past four years, he and Research Associate Ian Farnan have used NMR methods to demonstrate clearly that the structures of silicate liquids and glasses undergo dynamic changes as a function of temperature that mimic structural changes as a function of melt composition. Prior to this work, changes in silicate glass and liquid structure as a function of temperature were not well understood. Based on results reported in a 1989 paper published in the *Journal of Non-Crystalline Solids,* Jonathan concluded that there must be a high-energy, low-abundance defect state in glasses and melts that accounts to a large degree for properties like configurational heat capacity and viscous flow. This is a very fundamental idea that led Jonathan to NMR studies of glasses quenched from high pressures, where this defect state might be more favored. In a 1989 paper in the *American Mineralogist,* Jonathan and coauthor Paul McMillan present the first hard evidence for an increase in the coordination of Si in such glasses. Prior to this work, there had been much speculation about possible pressure-induced coordination changes of cations like Si in magmatic liquids, but the data were indirect or inferential. This work has important implications for the density and chemical properties of magmas at high pressures. It also is the first experimental evidence supporting numerous theoretical predictions that the presence of fivefold-coordinated Si in silicate liquids plays an important role in viscous flow.

Because of their close research collaboration for the past four years, I asked Research Associate Ian Farnan to give me his thoughts about Jonathan. Ian stated, "Jonathan works hard at choosing the experiment that will answer an important question. When I began working with him, I thought he (we) were very lucky to get so many significant results. After a while, the penny dropped, and I realized it was Jonathan's insight and clear thinking that were providing the luck." Ian concluded, "What I most admire about Jonathan is his ability to see both the big picture and attend to the smallest experimental details. This is a very powerful combination and is also a microcosm of mineral physics, where knowledge of very detailed physical processes have a big impact on our understanding of large Earth-scale processes."

It should be clear from my subjective summary of some of Jonathan's work that he is a very special young scientist, who is a most deserving recipient of the MSA Award. All of his work to date is world class. In a relatively short period of time, Jonathan has established himself as the leading expert in high-temperature NMR studies of silicate melt structure and dynamics and the mechanisms of atomic diffusion and viscous flow in melts. This information bears directly on the crystallization and migration of magmas in the Earth's crust. I can think of very few Earth scientists who have made such fundamental contributions to our understanding of petrologic processes so early in their careers. I am confident that

Jonathan will continue to work on important problems in the rapidly evolving fields of mineralogy and petrology and to make significant contributions in the Earth Sciences.

Mr. President, it is indeed a personal pleasure and an honor to present to you my colleague and friend Jonathan Stebbins for the 1992 MSA Award.