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Presentation of the Roebling Medal of the Mineralogical Society of America for 1996 to Donald H. Lindsley

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Mr. President, members of the society, and guests:

It is a pleasure for me to introduce someone who, as the cliché says, needs no introduction. Don Lindsley has been a major figure in the petrologic community for more than 30 years and an active participant in the governance of the Mineralogical Society of America for twenty-five years. Because I do not have to introduce Don to you, I can use this opportunity to celebrate his many contributions to the sciences of mineralogy and petrology.

I ask you to visualize a thin section of a tholeiitic basalt. This rock contains laths of plagioclase, isolated crystals of olivine, augite, and pigeonite, and scattered grains of ilmenite and titanomagnetite. From this assemblage we can tell the oxygen fugacity, silica activity, and temperature at which this rock erupted and, if the minerals were well-behaved during cooling, even the pressure of the magma chamber. We can do this today primarily because of the experimental and theoretical work that Don has conducted during his career. During the past thirty years he has made fundamental experiments on phase relations in the Fe-Ti oxides, pyroxenes, and olivines. Furthermore, from those experiments he and his students have extracted thermodynamic parameters for those minerals and have used these parameters to calibrate thermometers, oxybarometers, and barometers that can be applied to the wide variety of rocks that contain pyroxenes, ternary feldspars, and Fe-Ti oxides.

Don burst on the scene in 1964 with the publication of the famous paper he co-authored with A.F. Buddington. This paper described the phase relations between titanomagnetite and ilmenite, explained many of the microtextures of Fe-Ti oxides that hitherto had been cryptic, and presented the Fe-Ti oxide thermometer. True, it was a graphical version of the thermometer that was crude by modern standards. However, this was the first quantitative thermometer in petrology, and at the same time it provided the first tool that petrologists could use to monitor oxygen fugacity in rocks. This thermometer immediately gained tremendous popularity and, although mathematical versions were developed in the 1970s, the Buddington and Lindsley graphical thermometer was applied to the study of volcanic rocks well into the 1980s. In 1983 Don presented a graphical thermometer for pyroxenes, which, like the oxide thermometer, proved to be widely popular.

Don has not been content to operate as a "cook-and-look" experimental petrologist, instead throughout the 1980s he and his students played a leading role in deriving solution models for important rock-forming minerals. This resulted in solution models for Fe-Ti oxides, olivine, pyroxenes, and ternary feldspars that were published in the late 1980s. These solution models provided us with important and versatile mathematical versions of the Fe-Ti oxide, pryoxene, and feldspar thermometers. Finally, to culminate this transition that began with the graphical thermometry of 30 years ago, Don has been instrumental in developing QUILF, the first multi-equilibria approach to thermometry, barometry, and oxybarometery. A primitive form of QUILF was first presented in 1988, with the sophisticated version being published by Dave Andersen and him in 1993.

In addition to his stellar work in experimental petrology, Don has also been active in field studies. For the past 15 years he has been a major participant in mapping of the Laramie Anorthosite Complex. Using the same meticulous approach that characterizes his experimental work he has made detailed maps of the complex. The work on the LAC has produced numerous papers that have helped to solve many of the mysteries associated with the origin of anorthosites. More importantly, in the LAC he recognized that magnetite was absent from rocks containing quartz and fayalite. He realized that this was a manifestation of the reaction quartz + ulvöspinel = fayalite + ilmenite and named this reaction QUILF. It was a small step from identifying the reaction in the rocks of the LAC to recognizing that this is the equilibrium that governs the interaction between silicates and Fe-Ti oxides in a vast variety of crustal rocks.

As I noted above, Don has been an active participant in MSA for more than 25 years. He was an organizer for the first oxide short course in 1971, a participant in the pyroxene short course in 1980, and an organizer of the 1991 oxide short course. He was a member of MSA Council from 1972 to 1973, a member of the editorial board of American Mineralogist from 1984 to 1987, the vice president of the society in 1981 and the president in 1982.

Don earned his AB in Geology with high honors from Princeton in 1956 and his Ph.D. in Geology at Johns Hopkins in 1961. For his Ph.D. dissertation he mapped the Spray Quadrangle in the John Day country of Oregon. A major aspect of his Ph.D. was to study the mineralogical control of rock magnetism. This led him to a post-doc at the Geophysical Lab where he endeavored to unravel the relationship between oxide mineralogy and rock magnetism. Although it was clear that much of paleomagnetism involved non-equilibrium processes, Don figured that it was best to understand the equilibrium relations first. It was these experiments that led directly to his formulation of the oxide thermometer.

His experiments on Fe-Ti oxides set the course that Don followed for the rest of his career—experimental investigation of the ferromagnesian minerals in basalts—first oxides, then pyroxenes and olivine. He conducted many of these experiments at the Geophysical Lab between 1960 and 1970, where he was first a postdoctoral fellow and then a member of the scientific staff. In 1971 he took a position as professor at the State University of New York at Stony Brook, where he established one of the most important experimental petrology labs in the world. In 1976–1977 he took sabbatical at the University of British Columbia, where, with Hugh Greenwood, he honed his tools for deriving solution parameters from experimental data. From this experience, he achieved the background necessary to develop the solution models for Fe-Ti oxides, pyroxenes, olivines, and feldspars.

In March of 1979 Don visited the University of Wyoming as a distinguished speaker. I had just received a suite of thin sections from the Laramie Anorthosite Complex and, as we looked at them together, we became excited at the prospect of using the LAC as a natural lab to test the results of his experiments. His flight out of Laramie didn't leave until noon that Saturday so we decided to take a quick field trip to the LAC before the flight. As is normal in March, the roads were icy and snow was piled high along the sides of the road. I still remember Don, wearing his street shoes and dress pants, standing in knee-deep snow with temperatures well below freezing looking at an outcrop through a hand lens and nearly dancing in excitement. While we were driving back to Laramie we made plans to begin a study of the Laramie Anorthosite Complex. Thus began a collaboration that continues today. It took us a few years to get our first NSF grant on the Laramie Anorthosite funded. One problem we had was that some reviewers believed that Don was solely an experimental petrologist, and they didn't think that he should be funded to do field work!

To someone who was attentive, Don's problem-solving abilities and interest in high-temperature processes were evident at an early age. When he was ten he made a flame thrower (he never told me how). It worked very nicely, so he decided to make it bigger by using twice as much fuel. He didn't realize that chemical reactions may not scale in a simple linear matter. When he used his new flame thrower it produced an immense flame that burnt the hair off the top of his brother's head and scorched a hole through the foliage of a nearby tree.

At another time, in high school, Don was attending a pep-rally before a key football game. The organizers had planned a bonfire, but the weather was foul. It was raining and blowing and it was difficult to start the fire. They doused the wood with kerosene but could not light it. Then they tried gasoline, but even that didn't volatilize enough in the cold to be lit. It looked as if the bonfire would be a dud until Don came up with a way to solve the problem. He threw a handful of carbide into the kerosene-, gasoline-, and water-soaked wood. With the application of a slight spark the acetylene produced by the mixture of water and carbide burst into flame. The resulting conflagration closed the state highway through town for several hours.

Knowing Don's love of fire and flame, I feel that humanity in general, and petrologists in particular are very lucky that Don turned his talent to solving some of the major petrologic problems facing us this century. Just think of how awful it would have been if instead he had turned his creativity free in the field of weapons research! With this thought, Mr. President, I present you Donald H. Lindsley as the recipient of the Roebling Medal of the Mineralogical Society of America for 1996.