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Presentation of the Mineralogical Society of America Award for 1996 to Donald B. Dingwell

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President Brown, members of the Society, and guests:

When Don asked me to introduce him at this presentation, my response was "Why me?" His reply was "It's traditional to choose a scientific colleague who's also a friend." Don is actually in the company of many scientific friends today—as well as his wife Anke—and while I feel very honored to be introducing him, I am not really the friend who should be fullfilling this role today. The person who should be here is the late Chris Scarfe, who was Don's advisor in graduate school. In a letter to Hat Yoder, dated November 28th, 1983, written in support of Don as a post-doctoral fellow at the Geophysical Laboratory, Chris wrote "If you accept him as a fellow, I guarantee he will be a credit to the Institution and eventually a leader in his chosen field." Chris would have been enormously proud of Don today, and I know that Don would be equally proud to have had Chris pat him on the shoulder and say "Don, you've done well lad."

Don was born in Corner Brook, Newfoundland, and in 1980 received a B.Sc. (Honors) degree from the Memorial University of Newfoundland in St. John's. I will note two highlights of his undergraduate years. First, he worked as a part-time announcer at the Canadian Broadcasting Corporation in Corner Brook, obviously honing the oratorical skills that he now berates us with at national and international meetings. And second, he spent quite some time in the field with Professor Dave Strong, studying granitic rocks—an experience that probably underlies his subsequent experimental focus on siliceous magmatic systems.

For his Ph.D., Don moved west in Canada to the University of Alberta in Edmonton, in 1980, where he worked with Chris Scarfe on the solubility, diffusion, and viscosity of fluorine in silicate melts. Then in 1984 he won a postdoctoral position at the Geophysical Laboratory, where he spent two years. Don, just so you know why you got accepted at the Lab, Hat Yoder's handwritten summary of a telephone conversation with you dated January 18th, 1984, highlights the fact that you were "not married." We figured that in Hat's mind, this meant that you would be freer to work harder, but he says that it also meant that he did not have to pay you as much money. Either way, you were a bargain!

At the Geophysical Laboratory, Don left two memorable marks. First, there was the joy he gave Bjorn Mysen every time an iron-bearing melt in his viscometer overflowed and ruined the alumina tube in Bjorn's Deltec furnace. And second, we were all impressed with his industry. I was recently reminded of his work habits when as the newest "keeper of the precious metals" at the Lab, my first inventory showed that, during his two year stay, Don signed out for 1232.67 grams of platinum—or almost 2½ pounds—at present prices worth $15,372.60! Unfortunately my inventory also showed that Don did not account for 770.95 grams—or about 1½ pounds, worth $9,614.50, when he left the Lab. So, after this presentation, Don, Charlie Prewitt has a bill that you might want to avoid receiving. After leaving the Geophysical Lab, Don spent one year as an Assistant Professor at the Erindale College of the University of Toronto; then in 1987, at the invitation of Fritz Seifert who was then Director of the Bayeriches Geo-Institut, Bayreuth, Germany, he moved to Bayreuth where he currently resides.

Before I get into Don's research achievements, I might note he has been winning awards almost continuously since high school. Most recently he received the V.M. Goldschmidt Prize of the German Mineralogical Society and the Gerhard-Hess Research Prize of the German Science Foundation. He has also been conscientious about his responsibilities to the earth science community having served on the editorial boards for *The Journal of Geophysical Research*, the *European Journal of Mineralogy*, *Chemical Geology*, *Geochimica et Cosmochimica Acta*, and *Phase Diagrams for Ceramists*. He has edited two special volumes on melts and magmas for international scientific journals; he has participated in and co-edited a short course for the Mineralogical Society of America; he has been involved in the organization of 13 international meetings; and he is currently serving as Director of the Geochemical Society.

The research accomplishments for which Don is receiving the 1996 MSA award span a period beginning with his Ph.D. work and extending through June, 1993, about three and a half years ago. During that time Don authored or co-authored some 60 papers, mostly on the properties and structure of silicate melts and their relevance to igneous processes. About 20 of these papers are concerned with the viscosity and chemical diffusion in melts as a function of melt temperature, oxygen fugacity, and composition. Don measured the one atmosphere viscosities of alumino-, gallio-, ferro-, boro-, and titano-silicate melts, and I doubt that any experimentalist has put more of the periodic table into a viscometer. One colleague referred to him as the "Goldschmidt of viscometry." Through his work, he showed that the compositional dependence of silicate melt viscosities can be largely explained in terms of cation electronegativities regardless of whether the network former is Al, Ga, Fe, B, or Ti and regardless of whether the network stabilizer is Cs, Rb, Li, K, Na, Ba, Sr, Ca, or Mg. Don, I often think how fortunate that you have been because you have never had to think about crystals—they just never appear in your experiments! He has also evaluated the effect of fluorine on melt viscosity and its diffusivity. These studies are nicely summarized in a 1988 special volume published by *The Canadian Institute*

of Mining and Metallurgy.

Many petrogenetic processes occur in the range of the glass-transition temperatures of silicate melts, and I think that it is fair to say that Don was the first person in the earth sciences to see clearly that the melt structural relaxation associated with this transition was important to magmatic processes. He published outstanding papers on this subject, co-authored with Sharon Webb, in *Physics and Chemistry of Minerals* in 1989 and in the *European Journal of Mineralogy* in 1990. Their work shows that the shear relaxation times in the neighborhood of the glass transition can be calculated from the Maxwell relationship for a viscoelastic material. Relaxation times can be simply, but accurately approximated using the ratio of the shear viscosity, a property that could be readily measured in the laboratory, to the shear modulus at infinite frequency, a quantity that is essentially constant; and they can be represented by time–temperature curves that depend only on composition, and that nicely distinguish the purely viscous "liquid" regime from the purely elastic "glassy" regime. Armed with this simplification, Don and Sharon showed that an array of physical and spectroscopic data on silicate melts fell into place. They showed that the viscous flow in melts could be explained atomistically in terms of relatively long lifetimes of nonbridging oxygen ions and the relatively fast diffusion rates of trace cations; they explained the temperature dependence of the speciation of water in silicate melts, they explained the onset for non-Newtonian rheology in silicate melts and its likely occurrence in ashflow eruptions and in general provided a framework for determining true equilibrium properties of melts by matching the timescale of the experimental probe, the timescale of the property being measured, and the timescale of experiment itself.

About ten of the other papers that Don published before June 1993 dealt with density and thermal expansivity of silicate melts. Through classical density measurements, he determined partial molar volumes of the oxides of Fe, Ti, Ga, B, and F, and he demonstrated that some of them have important composition dependencies. He and his colleagues also developed new methods by which thermal expansitivities could be determined from low-temperature molar expansitivities at temperatures just above the glass transition. These results, in combination with high-temperature densities measured at super-liquidus temperatures, yield thermal expansitivities over the entire supercooled stable liquid range. Don's methods now enable the determination of volume data on melts that have inacccesible liquidus temperatures or contain volatile elements such as P, F, and B.

The physics of degassing and foaming of siliceous magmas is important to understanding explosive and effusive eruptions. In a series of about six papers, Don and co-workers began an experimental evaluation of this relationship. Working with natural rhyolite compositions, they measured how percentages of bubbles and crystals affect compressional viscosity and thermal conductivity and they documented the effect of different strains and strain rates on the shear and volume viscosities of rhyolitic foams. Their results proxy field observations of a partially crystallized melt containing dissolved volatiles.

Finally, six publications concerned water solubilities in melts in the Qz-Ab-Or system. The aims of these studies were to gradually build a comprehensive framework of water solubilities as function of melt composition, temperature, and pressure that can be used to understand the physical and chemical properties of granitic magmas.

All experimentalists have occasionally had experiments go awry, but some have special skill in turning problematical results into successes. Don is rather exceptional in this regard, so I will finish this review with an example, dating from his time in Edmonton, that demonstrates his knack. As the story goes, he was trying to make F-bearing melts on Pt loops at 1 atm but he soon discovered that the F quickly evaporated from the sample in the gas stream flowing through the furnace tube. So he then astutely turned the problem around and measured the diffusion profile of the F as it was leaving the glass-bead interface, thereby launching himself into the marvels of chemical diffusion in melts.

This brief review is a testament to Don's involvement in a very broad range of important problems concerning silicate melts. We have a saying in Australia "you have to drink the froth to get to the beer." Thus if the 60 papers Don published before June 1993 are the froth, and the 68 he has produced since then are the first sips of beer, then I think it is fair to assume we still have a lot of drinking to do, because Don is obviously on track to making many more significant contributions.

It is therefore my pleasure and honor, Mr. President, to present Don Dingwell for the 1996 MSA award.