

Acceptance of the Mineralogical Society of America Award for 1990

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Mr. President, Charlie, and members of the MSA:

At the outset, I must say that I feel humbled to stand before such a distinguished group of scientists to accept this award; the list of previous recipients is indeed impressive. But I am also delighted because in my view this award is really meant to draw distinction to a branch of science that now flourishes at the triple junction of mineralogy, chemistry, and physics. I am further delighted to be here because it gives me the opportunity to express appreciation to a number of people who have helped me along the way.

I shall do this by way of a brief personal history. I entered college as a philosophy major. During freshman year I quickly realized, however, that as much as professors of philosophy might wish it otherwise, the whole of philosophy is and has always been contingent on breakthroughs in science. Some courses by a couple of inspiring physical chemistry teachers, Luther Bryce and Bryan Kohler, convinced me to try chemistry. The next thing I knew I had published a couple of papers and was going to graduate school at Harvard. There I had the great fortune to work with Veronica Vaida, Martin Karplus, and Roy Gordon, each of whom was an excellent teacher. My father suggested that more could be learned (or if not, at least more fun could be had) next door in the geology department. This assessment was correct, and I met up with Charlie Burnham and his students and with Raymond Jeanloz, who introduced me to studying the deep Earth with a device called the diamond-anvil cell. Sometime later I attended a departmental lecture by Dave Mao. Here I heard about silicate perovskite, the composition of the mantle, Sue Kieffer's models, and hydrogen, and I was hooked. I introduced myself after his talk and shortly found myself with a fellowship at the Geophysical Lab. I joined the staff three years later.

Any success I've had working at the Lab I owe to its extraordinary environment for letting research happen and to the first-rate scientists who work there. I am grateful to the Lab's directors: Hat Yoder, who took the initial risk in giving me a job, despite my naivete in geological matters, and Charlie Prewitt, who continues to maintain the Carnegie tradition of allowing complete freedom of research and who has been extremely supportive of my research projects. Larry Finger, Bob Hazen, Peter Bell, Ron Cohen, and numerous postdoctoral fellows have taught me a great deal. But I would like to give special thanks to my close collaborator, Dave Mao. The clarity with which Dave can see through to the essence of a problem, and then solve it, continues to astonish me. It is



indeed a great privilege to work with such an individual. And I would like to think that Dave should share this award, but he already has one (so I won't).

I would like to trace briefly the thread of our work over the last few years. Simply put, the aim of our research has been to attain a fundamental understanding of the behavior of materials at high pressure in order to improve our knowledge of the structure, dynamics, and evolution of the Earth and planets. We have found it useful (and in fact necessary) to start at the top of the periodic table with hydrogen, the most abundant element in the cosmos and probably the most plentiful metal. Just as quantum theory began with the hydrogen atom, our understanding of the behavior of materials at very high pressures must start with an examination of what happens to solid hydrogen at high density. This includes the predicted and long-sought high-pressure transition to a metallic form. I think we have made considerable head-

way in attacking this problem during the past two years. But much more needs to be done to characterize the metallic solid and to determine its role in the large planets, including unraveling the phase relations and physical properties of hydrogen-rich mixtures under high P - T conditions.

Moving down the periodic table to silicates and oxides, work carried out in a variety of labs, not just our own, has contributed to understanding the nature of silicate perovskites, probably the most abundant minerals in the Earth. Careful high P - T density measurements on silicate perovskites point toward a silica-enriched, predominantly perovskite lower mantle. New work on the stability of hydrogen in mantle and core phases may result in a revision of models of both the composition and the early evolution of the Earth. Theoretical studies of minerals have contributed to the emerging paradigms, but it is clear that in the application of fundamental theory to major geologic questions we have only scratched the surface of what can be done.

If these have been some of the Earth science applications, it is encouraging to witness the effect of some of our work in the greater physics and chemistry communities. Many recent developments in diamond-cell tech-

niques are now in use in a variety of physics and chemistry labs. These include microspectroscopic methods that we have helped pioneer. The results of our hydrogen experiments show that the standard approximations made in theoretical solid-state physics are insufficient to describe the behavior of hydrogen at high densities; our results appear to be driving the development of new theoretical methods for treating solids. Our observations of pressure-induced structural transformations in amorphous solids also seem to have opened new lines of research in the physics of noncrystalline materials. In short, it is the multidisciplinary aspect of this research that makes it an exciting area, with implications ranging from atomic to global, from fundamental to applied. And I would like to think that by giving me this award, you recognize that this approach has some merit. I am indeed grateful for your interest and support.

Finally, returning to the personal side, I would like to thank Dana, who puts up with my very long hours in the lab. I also thank my family, who have been very tolerant of a certain single-mindedness with which I go about this business and who have been very supportive over the years. I thank the MSA once again for this honor and only hope that I can fulfill its promises in my future work.