

## Acceptance of the Roebling Medal of the Mineralogical Society of America for 1991

E-AN ZEN

Department of Geology, University of Maryland, College Park, Maryland 20742, U.S.A.

Thank you, Mac. I am especially pleased to receive the medal from Mac's hands because he has shown us both the importance of putting good science to public service and the meaning of the courage of one's convictions.

I know that on this occasion one is supposed to talk about the roses one has smelled and not about the thorns one has run into, so I'll at least begin by being civilized. I want to acknowledge my former colleagues in the old Experimental Geochemistry and Mineralogy Branch of the U.S. Geological Survey. It was a group that demanded and expected much from one another and provided the support to allow each of us to do his best. I was fortunate to be one of this group. I wish I could thank each person individually, but I must make this a generic thank you, with one exception. A decade ago Jane Hammarstrom and I began an exploration of the land of ig-

neous rocks, and we are still at it. Thanks, Jane, for your company and for sharing.

Many of us spend part of our professional lives trying to spread mineralogical and geological knowledge among our future citizens and future scientists and among our general public, as is properly attested to by our recognition today of Mark Barton and Cathy Skinner. Two recent adventures drove home some of the challenges that face us in this endeavor. For a few days last spring I was the geologist in residence for kindergarten through third-grade pupils at an elementary school in northern Virginia. One day I was in charge of the table where we had laid out a smorgasbord of minerals and rocks. Suddenly I found myself dealing with about a hundred enthusiastic seven and eight year olds, with sparkling eyes, eager to lay their hands on the minerals, to touch the rocks, to



E-an Zen (left) with Citationist Susan Kieffer and President Malcolm Ross.

use, probably for the first time in their lives, a hand lens to examine the pieces more closely. Some of them wanted to know why a mineral I called quartz could have so many different colors and shapes; many wanted to try their hand at splitting a book of muscovite. They weren't destructive; they just wanted to experiment and to check me out. These children naturally preferred to learn things hands on without realizing the pedagogical theories. They live in the real world, not an abstract, model world that some of us adult scientists inhabit.

Would such an experience make a difference in the children's appreciation of the natural world? Our stake in their education is large not only because they need to grow up as informed citizens and as teachers in their turn, but also because among them there just might be one who will metamorphose into another Linus Pauling or Norman Bowen in some field of inquiry. This brings me to my other adventure. That was the AAAS forum organized by Leon Lederman on issues of funding academic science research. Lederman, you'll recall, claimed that science research is so underfunded by the federal government that many bright graduate students, demoralized, will no longer stay in academe. One young professor he introduced to champion the cause said that competition for grants is so tight that in order to ensure the future of his project, and here I use a direct quote from *Science*, "I cannot give my students the same freedom I was given; the most exciting and risky projects have been put in limbo." In other words, get safe results, don't jeopardize my funding. And this message was from someone who's a role model and a harbinger of the shape of science to come.

These two incidents may seem disparate, yet they epitomize our challenge as scientist-teacher-citizens, and we need to attend to both. We must teach the young children

and teach those who will teach them so as not to dim the sparkle in their eyes. Equally pressing, we must preserve our graduate students from the bondage of production-oriented research, designed by people who have their own career agenda to pursue. We must distinguish educating students from using them. We must think about the implications of concentrating in one person control of the research agenda and the purse strings and the authority to judge the fitness of a student to become a colleague. That's a lot of power over another individual; how do we ensure that it will be exercised wisely? As geology becomes more of a big science, the issue will be more urgent, so let us prepare against it. I think that at least in their earlier, formative years, the graduate students should have means of support that allow them to explore the intellectual field and find their best habitat. This support could be through a system of federal grants entirely independent of projects. The students might, as one possibility, repay this support by pledging time for precollege science education, like the old ROTC system, thus closing the cycle of the educational challenge. Above all, we must ensure these graduate students the opportunity to experience the excitement and the awkwardness of charting one's own path of inquiry and following it through, for they need the experience of learning by the invalidation, what Karl Popper called falsification, of their working hypotheses. They need such experience because invalidations improve our understanding by defining what reality isn't, whereas tests that confirm our ideas, part of the safe results that I mentioned a moment ago, tell us little that's new.

I deeply appreciate this award, for me a special privilege because MSA's been my society since my junior year in college. I accept it with humble thanks.